西北农林科技大学

博 士 学 位 论 文

柬埔寨大米出口竞争力与影响因素实证研究

RESEARCH ON CAMBODIAN RICE EXPORT COMPETITIVENESS AND DETERMINANTS

学 科 专 业　农业经济管理

研 究 方 向　农业经济理论与政策

论 文 作 者　KEA SOKVIBOL (谢速文)

指 导 教 师　李桦　教授

联合指导教师

论文提交时间　2020 年 5 月

Dissertation Submitted to Northwest A&F University

in Partial Fulfillment of the Requirements

for Degree of

Doctor of Philosophy

RESEARCH ON CAMBODIAN RICE EXPORT COMPETITIVENESS AND DETERMINANTS

Major : **Economics and Management of Agriculture**

Research Field : **Agricultural Economic Theory and Policy**

Candidate : **KEA SOKVIBOL**

Supervisor : **Professor LI HUA**

Co-Supervisor :

Date of Submission : **May, 2020**

College of Economics and Management

Northwest A&F University

分类号 ： F014.1　　学校代码 ： 10712
U D C ： 300　　研究生学号： 2017071017
密级 ： _不保密_

西北农林科技大学博士学位论文

柬埔寨大米出口竞争力与影响因素实证研究

论文作者 KEA SOKVIBOL (谢速文)

指导教师 李桦　教授

指导小组 郑少锋、姚顺波、薛彩霞、宋剑锋

答辩委员会：（单位、姓名、职称）

1. 西北农林科技大学 郑少锋 教授　（主席）
2. 西北农林科技大学 姚顺波 教授
3. 西北农林科技大学 陆迁 教授
4. 西北农林科技大学 张晓慧 副教授
5. 西安交通大学 杨秀云 教授

答辩日期： 2020 年 5 月 18 日

本研究得到 中国国家社会科学基金的“地理标志引导农户绿色生产机制研究”（编号：18XJY007）和西北农林科技大学的资助。

研究生学位论文的独创性声明

本人声明：所呈交的学位论文是我个人在导师指导下独立进行的研究工作及取得的研究结果；论文中的研究数据及结果的获得完全符合学校《关于规范西北农林科技大学研究生学术道德的暂行规定》，如果违反此规定，一切后果与法律责任均由本人承担。

尽我所知，除了文中特别加以标注和致谢的地方外，论文中不包含其他人已经发表或撰写过的研究结果，也不包含其他人和自己本人已获得西北农林科技大学或其它教育机构的学位或证书而使用过的材料。与我一同工作的同事对本研究所做的任何贡献均已在论文的致谢中作了明确的说明并表示了谢意。

研究生签名：  时间： 2020 年 5 月 20 日

导师指导研究生学位论文的承诺

本人承诺：我的研究生 **KEA SOKVIBOL (谢速文)** 所呈交的学位论文是在我指导下独立开展研究工作及取得的研究结果，属于我现岗职务工作的结果，并严格按照学校《关于规范西北农林科技大学研究生学术道德的暂行规定》而获得的研究结果。如果违反学校《关于规范西北农林科技大学研究生学术道德的暂行规定》，我愿接受按学校有关规定的处罚处理并承担相应导师连带责任。

导师签名：李梓 时间： 2020 年 5 月 31 日

关于研究生学位论文使用授权的说明

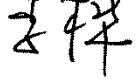
本学位论文的知识产权归属西北农林科技大学。本人同意西北农林科技大学保存或向国家有关部门或机构送交论文的纸质版和电子版，允许论文被查阅和借阅；同意西北农林科技大学将本学位论文的全部或部分内容授权汇编录入《中国博士/硕士学位论文全文数据库》和《中国学位论文全文数据库》进行出版，并享受相关权益。

本人保证，在毕业离开（或者工作调离）西北农林科技大学后，发表或者使用本学位论文及其相关的工作成果时，将以西北农林科技大学为第一署名单位，否则，愿意按《中华人民共和国著作权法》等有关规定接受处理并承担法律责任。

任何收存和保管本论文各种版本的其他单位和个人(包括研究生本人)未经本论文作者的导师同意，不得有对本论文进行复制、修改、发行、出租、改编等侵犯著作权的行为，否则，按违背《中华人民共和国著作权法》等有关规定处理并追究法律责任。

（保密的学位论文在保密期限内，不得以任何方式发表、借阅、复印、缩印或扫描复制手段保存、汇编论文）

研究生签名：  时间： 2020 年 5 月 20 日

导 师 签名：  时间：2020 年 5 月 31 日

摘要

作为人类重要的主食，大米是包括柬埔寨在内的大多数亚洲国家外汇的主要来源。大米在柬埔寨被广泛称为 “白色黄金” ，是该国的经济基础和最重要的农业出口产品。因此，本论文旨在研究柬埔寨大米出口的竞争力和出口影响因素，并通过以下五个方面（采用不同的计量经济学估算和统计分析方法），如下：

1) 对柬埔寨大米经济现状和趋势的实证分析：使用描述性统计方法（如表格、图表、地图等描述性统计）。
2) 贸易有关政策对柬埔寨大米出口的影响分析：在现有文献的基础上进行了讨论。
3) 柬埔寨大米在世界市场上的相对出口竞争力（REC）分析：建立了 REC 和相对对称出口竞争力（RSEC）的指标。估计了短期回归（SRR）模型，以确定柬埔寨大米行业 REC 的潜在决定因素。该分析使用的数据是从 1995 年到 2018 年（24 年）。
4) 柬埔寨大米出口的主要影响因素分析：建立了 Dynamic Panel Gravity 模型，并基于 GLS，PPML 和 Heckman 模型进行了分析，该分析有 880 样本（1995 年至 2016 年 22 年×40 个选定的进口伙伴）。
5) 绿色贸易壁垒（SPS）对柬埔寨大米出口的影响分析：利用基于 GLS，PPML 和 Heckman 方法分析的 SPS Gravity 模型，包含 874 样本（1996 年至 2018 年 23 年×38 个主要进口伙伴）。

本研究得出的主要结论、如下：欧盟 是柬埔寨大米的最大市场，而中国（包括中国大陆、香港、澳门、和台湾）逐渐成为第二大国际市场。第三大市场是 东盟市场，而“一带一路”沿线国家 将成为柬埔寨大米出口的另一个重要市场。目前柬埔寨大米出口的主要品种有 *Long Grain, Fragrant Sen Kraob and Neang Sauy, Jasmine Phka Rumduol or Phka Malis* 和 *Long Grain Parboiled*。研究表明，柬埔寨大米在国际市场上的出口竞争力随着时间的推移逐渐提高，尤其是在实施 “大米出口政策” （RP2010）之后。证据表明，RP2010 已把柬埔寨的 REC 从非常低的阶段推到了与其他世界最大大米出口国的可比阶段。SRR 模型揭示了内地政策（尤其是 RP2010 和 RS-III）的实施对该国家大米行业的重要影响。该模型还表明，欧洲 EBA 和中国 “一带一路” 对柬埔寨大米出口产生了积极的影响。此外，国内供需管理被

定义为维持柬埔寨大米出口竞争力的另一个主要来源。Dynamic Panel Gravity 模型表明，历史关系在柬埔寨大米出口中起着重要作用。但是，该国的大米出口对宏观经济因素（例如：金融危机等）更加敏感。研究结果还表明，汇率政策和农业用地政策也是促进大米出口的核心影响因素之一。本研究的 SPS Gravity 模型还表明，SPS（绿色贸易壁垒）对柬埔寨大米出口具有很高的负面影响。柬埔寨大米似乎是在高收入国际市场上（比如欧盟）比其他国家更受欢迎。此外，本研究结果也表明，如果柬埔寨能够积累经验并考虑在进入市场之前考虑满足 SPS（或者其他分类的绿色贸易壁垒）所要求的更高标准，那么柬埔寨应该有很大的机会来扩大市场份额。根据研究结果，本研究也提出了一些对柬埔寨大米发展的应用和建议。

关键词：柬埔寨稻米行业；出口竞争力；引力模型；赫克曼选择模型（Heckman）；泊松模型（PPML）；中国政府的‘一带一路’倡议（BRI）；欧盟国家的 除武器外全部免税条约（EBA）；“绿色”贸易壁垒（GBTs）

ABSTRACT

As an important staple food for humanity, rice is the main source of foreign exchange for most Asian countries, included Cambodia. Widely known as "*white gold*" in Cambodia, milled rice is the country's economic foundation and foremost agro-exportable commodity. Thus, this dissertation aims to investigate the *export competitiveness* and to identify the *determinants of Cambodian rice exports,* by focusing on five imperative aspects (through different econometric estimations and statistical analytical methods), as follows:

1) *Empirical analysis of current situation and trends of Cambodian rice economy:* the descriptive statistical methods (e.g. tables, graphs, maps and so on) were utilized.
2) *Investigation of numerous trade-related policies' impacts on Cambodian rice exports:* the discussion methods based on existing literatures were conducted.
3) *Analysis of the Relative export competitiveness (REC) of Cambodian rice sector in the world rice market:* the indexes of REC and *Relative symmetric export competitiveness* (RSEC) were developed. The short-run regression (SRR) model was estimated for identifying the potential determinants of the REC of Cambodian rice sector. The data sets used for this analysis were available from 1995 to 2018 (24-year).
4) *Estimation of major influencing factors of Cambodian rice exports:* the dynamic panel gravity model was constructed and analyzed based on GLS, PPML and Heckman model. Our data sets contained 880 observations (22-year 1995-2016 × 40 selected partners).
5) *Analysis of impacts of SPS measures:* the SPS gravity models analyzed based on GLS, PPML, and Heckman approaches were utilized, based on data sets contained a total observations of 874 (23-year 1996-2018 × 38 importing major partners).

The main findings derived from the research are as follows: EU is the biggest market for Cambodian rice, while China (included the mainland China, Hong Kong, Macao and Taiwan) is gradually become the second largest international market. The third market is ASEAN market, and the countries along the BRI would be another important market for Cambodian rice exports. Main varieties of rice exported from Cambodia are *Long Grain, Fragrant Sen Kraob* and *Neang Sauy, Jasmine Phka Rumduol or Phka Malis* and *Long Grain Parboiled.* Our findings revealed the gradually improvement of Cambodian rice's

export competitiveness in the international market over times, especially after the application of "*Rice export policy*" (RP2010). The evidences showed that the RP2010 had pushed the Cambodia's REC from the very lower stage to the comparable stage of other world's rice exporters. SRR model reveals the important effects of local policies' implementation (*RP2010* and *RS-III* in particular) on the national rice industry. The model also indicated that the European EBA and the Chinese BRI positive-significantly influencing the exports of Cambodian rice. Moreover, the domestic supply/demand management was defined as another major source for maintaining the *export competitiveness* of rice sector in Cambodia. The *Dynamic Panel Gravity Model* suggested that the historical ties play important role in Cambodian rice exports. However, these exports were further sensitive to the macroeconomic factors (like financial crisis and so on). The findings also indicated that the exchange rate policy and agricultural land expansion are one of the core influencing factors promoting rice exports. The *SPS Gravity Model* of the study also indicated that SPS measures have high negative impact on Cambodian rice exports. Cambodian rice is more-popular in the higher-income international markets such as the EU, than others. Additionally, our findings revealed that there should be great opportunities for Cambodia to expand the market shares if Cambodia could accumulate experiences and consider for fulfilling the higher standards required by SPS beforehand of market access. Some applications and recommendations for Cambodian rice development have been suggested based on the findings of the research.

Keywords: Cambodian rice economy; Export competitiveness; Gravity model; Heckman selection model; Poisson Pseudo-Maximum-Likelihood (PPML); 'Belt & Road' Initiative (BRI); 'Everything but Arms' (EBA); 'Green' Trade Barriers (GTBs)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. INTRODUCTION

1.1. Background of Research

Rice (*Scientific Name:* "*Oryza Sativa L.*") is the main exportable agro-product and widely regarded as "*white gold*" in the *Lower Mekong Basin*, especially in Cambodia (RGC 2010 , Cramb 2020). It is not only the world's most-compulsory food crops, but also a major diet-fragment feeding more than half of the humanities. Thus, the great assessments to economic important of rice had been drawn in the literature (Cosslett and Cosslett 2018 , Mishra, Bairagi, Velasco and Mohanty 2018 , Khac, Nha and Than 2019 , Kontgis, Schneider, Ozdogan, Kucharik, Tri, Duc and Schatz 2019 , Nguyen Van, Tran Van, Meas, Tado, Kyaw and Gummert 2019). The prior studies (Sanjuán-López and Dawson 2010 , Mahmood and Munir 2017) had also found a linkage between agricultural exports and economic growth. In other words, the agricultural exports could potentially boost the rapid development growths of numerous Asian developing countries, like Cambodia.

People in Cambodia valued rice as '*life*' as they believed that '*rice is their everything*'. At the national level, rice had been playing a significant role in the development of the national economy, and milled rice is the core-commodity of Cambodian agricultural exports. Cambodia, currently, exported (*milled*) rice to 92 countries around the globe within the period of 1995-2016 (UNCTAD 2019). Likewise, the exported quantity of rice from Cambodia had been increasing gradually in the recent decade, and almost double from about 380 to 531 thousand tons between 2013-2016. However, to the author's cognizance, there is no any study that has considered the analysis of the *competitiveness* and *determinants of Cambodian agricultural exports* or *rice exports*. Thus, to fill this gap, this research aims to investigate the *competitiveness* and *determinants of Cambodian rice exports*. The *potentials* and *challenges* of this sector would be comprehensively captured in the study. Specifically, five important aspects were purposively focused, including: (1) investigation of current *situation* and *trends* of Cambodian rice sectoral development, (2) impacts evaluation of the numerous *trade-related policies* on rice exports, (3) analysis of the *Relative export competitiveness* (REC) of the country's rice sector in the international market, (4) estimation of *factors influencing Cambodian rice exports*, and (5) the analysis of the impacts of *'Green' trade barriers* (GTBs) in form of "*food safety standards*" on this sector.

1.2. Research Questions and Objectives

1.2.1. Research Questions

The research was designed for considering the research questions:

1) How rice is important for Cambodian society? What is the current development stage and trend of Cambodian rice sector?
2) How the '*trade-related*' policies would affect the exports of Cambodian rice?
3) What is the position and REC of Cambodian rice sector in the international market? What are factors might have significant influences on the Cambodian rice's REC score?
4) What are the core determinant factors influencing (the entire of) Cambodian rice exports? What kinds of determinants that the RGC should pay more attentions for ensuring the sustainable development of its exports of "*white gold*"?
5) How the *'Green' trade barriers* (GTBs) or "*food safety standards*" might impact on rice exports of Cambodia?

1.2.2. Research Objectives

The current research focuses on the econometric estimation and statistical analysis of the *export competitiveness*, and the *determinants* for *Cambodian rice exports*. The in-depth objectives of this research are as follows:

1) To evaluate the *economic important of rice to Cambodian society*, and to explore the *current development stage and trends of rice sector* in Cambodia.
2) To discuss the *impacts of trade-related policies* on Cambodian rice exports (included, *Rectangular Strategy*, *Rice export policy*, the '*Everything but Arms*' EBA of the European Union and the '*Belt & Road*' initiative BRI of the People's Republic of China).
3) To calculate the *level* and to identify the *factors influencing REC of Cambodia's rice sector*, in comparison to the other world's largest rice exporters in the international market.
4) To discover the *determinants of Cambodian rice export* through the *dynamic panel gravity model*'s application.
5) To investigate the *impacts of GTBs* or "*food safety standards*" (proxies by SPS measures) *on Cambodian rice exports* with an application of *SPS gravity model*.

1.3. Research Methodology

The different econometric estimations and statistical analytical methods were applied for different objective of the studies, as follows:

1) If the *current situation and development trend of Cambodian rice sector* were analyzed, the descriptive statistical methods, such as tables, graphs, maps and so on were utilized.
2) If the *impacts of trade-related policies* were analyzed, the discussion methods based on existing literatures were conducted.
3) If the *export competitiveness* was analyzed, the indexes of REC and the relative symmetric export competitiveness (RSEC) were developed, based on the concepts of *comparative advantage*. The short-run regression (SRR) model was estimated for identifying the potential determinants of the REC of Cambodian rice sector. The data sets used for this analysis covered 24-year (1995-2018) and the comparison of the world's 20 top rice exporting countries, i.e. 480 observations.
4) If the *major determinants influencing rice exports of Cambodia* were analyzed, the *dynamic panel gravity model* was constructed. The analysis was based on implementation of serval approaches, such as the *generalized least squares* (GLS), the *Poisson Pseudo-Maximum-Likelihood* PPML developed by Santos Silva and Tenreyro (2006), and the Heckman (1979)'s *sample selection model* (hereafter, *Heckman* model). Dataset contained a total of 880 observations (i.e. 22-year panel 1995-2016 and 40 trading partners).
5) If the *impacts of SPS measures on Cambodian rice exports* were investigated, the gravity models analyzed based on GLS, PPML, and *Heckman* approaches were utilized, based on data sets contained a total observations of 874 (23-year from 1996-2018 × 38 importing major partners).

1.4. Motivation and Significance of Research

The motivation for the current study is to contribute to the literature on agricultural exports of Cambodia (particularly, rice exports) and it would significantly contribute to the *commodity-specific trade* and the *gravity* literature in various ways:

- It is the *first empirical* and *comprehensive research* on *Cambodian rice exports* (*competitiveness* and *determinants*) from numerous aspects as earlier mentioned,

which would contribute to *in-depth understanding* of rice sectoral advancement. The policy makers and rice industry-insider experts, therefore, would get some innovative insights from this empirical modelling, in the consideration of policy designs for ensuring the sector's *sustainable development*.

- In order to generate reliable and trustworthy results, *various kinds of modern econometrics and statistical approaches* had been applied in the research. For instance, REC, RSEC, SRR model, Dynamic panel gravity model, SPS (*Sanitary and Phyto-Sanitary*) gravity model, GLS, PPML, Heckman Model.
- The study would enlarge the literature on the determining *factor of the commodity-specific gravity model of trade in agro-products*, which is extensively applied by scholars. For instance, rice (Cosslett and Cosslett 2018 , Irshad, Xin and Arshad 2018 , Thuong 2018), soybean (Boerema, Peeters, Swolfs, Vandevenne, Jacobs, Staes and Meire 2016 , Wang 2016), tea (Hwang and Lim 2017), poultry (Zhou, Li and Lei 2018), egg (Tamini, Doyon and Simon 2016), sea-food (Natale, Borrello and Motova 2015), honey (Wei, Huang and Yang 2012a), wine (Dascal, Mattas and Tzouvelekas 2002 , Castillo, Villanueva and García-Cortijo 2016 , Dal Bianco, Boatto, Caracciolo and Santeramo 2016), beef (Ghazalian, Tamini, Larue and Gervais 2012 , Schierhorn, Meyfroidt, Kastner, Kuemmerle, Prishchepov and Müller 2016), sheep meat (Lee and Tcha 2005), arms (Martínez-Zarzoso and Johannsen 2017), and fishery products (Hammarlund and Andersson 2019).
- The study enriches the current literature on GTBs (*Green Trade Barriers*), trade in agro-products, and provides a basis for future studies, since it is the first study on the impact of SPS on Cambodian agro-exports in general, or rice exports in particular.
- The *dynamic panel gravity model* and *SPS gravity model* were firstly applied with GLS, PPML and Heckman approaches simultaneously in a single study, as these approaches were often separately applied in the trade literature, e.g. GLS (Amin, Zhang and Yang 2015 , Shujah Ur, Chen, Saud, Saleem and Bari 2019), PPML (Larch, Wanner, Yotov and Zylkin 2018 , Lee and Pyun 2018 , Hammarlund and Andersson 2019 , Li, Sun and Long 2019 , Rahman, Shahriar and Kea 2019), and Heckman selection model (Haq, Meilke and Cranfield 2013 , Semykina and Wooldridge 2013 , Xiong and Chen 2014).

- The current study covered *three unique datasets* for different objectives, i.e. (1) a total of 480 observations (20 world's largest rice exporters × 24-years 1995-2018) for competitiveness (REC) analysis, (2) a total of 880 observations (40 countries × 22-years 1995-2016) for export determinants analysis, (3) a total of 874 observations (38 countries × 23-years 1996-2018) for the analysis of SPS impacts on Cambodian rice exports.
- Moreover, the EU states are purposively taken into account, since they are not only the largest market for the Cambodian rice exports, but also indicated the most advanced creation of strict GTBs. It is a big market with 27 state members and GDP is about 13 trillion USD in 2011, accounts for 27% of the world's GDP (Lang 2012 , Khoi and Thuy 2014). The impact of EU's GTBs on trade had also been investigated by many studies (e.g. Otsuki, Wilson and Sewadeh 2001a , Wilson, Otsuki and Majumdsar 2003 , Lang 2012 , Wei, Huang and Yang 2012b , Khoi and Thuy 2014 , Kuppusamy and Gharleghi 2014 , Kareem 2016).

1.5. Research Contents and the Structure of Dissertation

The comprehensive analysis on *export competitiveness* and the *factors influencing on Cambodian rice exports* were conducted focusing on several aspects. Therefore, the principle components of this dissertation was classified into eight chapters, as shown in **Table 1.1**. The technical route of this research was presented in **Figure 1.1**. The figure illustrated the flow of research framework and how the research was carried out in the schematic, systematic, and organized-designs.

Table 1.1: The principle components of this dissertation

Chapter	Title and Contents
1	**Introduction**
	This chapter specifically include background of research, research questions and objectives, important and significant of research, contents and structure of research, and research's technical route.
2	**Literature reviews on export competitiveness and the gravity trade model**
	This chapter reviewed the related literature on both the concepts and analytical methods of the *export competitiveness*, and the *gravity model for international trade*.
3	**The world market of rice: Current situation and trends**
	This chapter provides an overviews of the world market of rice, and also the rice economy of Cambodia. An overall trends of the global rice economy, included rice production, consumption, and market (exports, imports, and price) of the global rice, Asian rice, and Cambodian rice sector, are discussed in this chapter.
4	**Trade-related policies and their impacts on Cambodian rice economy**
	This chapter provides the discussions on the impacts or potential effects of the numerous trade-related policies (such as the RGC's *Rectangular Strategy*, *Rice export policy*, the *EBA* and the *BRI*) on the performance of Cambodian rice exports.
5	**Relative export competitiveness of Cambodian rice industry**
	Three indexes of *relative export competitiveness* of Cambodian rice industry, i.e. REC, REC_WF, REC_WM, were derived from 1995-2018 to determine the Cambodia's position in the world market of rice. The study also provided the comparison among the world's 20 largest rice exporters. Additionally, the potential determining factors of Cambodian rice's REC are also investigated, focused on global and local supply/demand capacity, price factors, foreign and domestic policies, and PTAs.
6	**The major determinants of Cambodian rice exports**
	This chapter exposed the major determinants influencing Cambodian rice exports by *dynamic gravity model*'s application. *Generalized Least Square*

	(GLS), *Poisson Pseudo-Maximum-Likelihood* (PPML) and *Heckman sample selection* models were applied, with the 880-observations dataset (22-year panel 1995-2016 × 40 trading partners).
7	**'Green' trade barriers and Cambodian rice exports**
	This chapter explores how GTBs or "*food safety standards*" proxies by *Sanitary and Phyto-Sanitary* (SPS) measures affect rice exports of Cambodia, through an application of the gravity model with different estimation approaches to handle zero-trade flows (GLS, PPML, Heckman). Data sets contain 874 observations (38 major partners × 23-year 1996–2018).
8	**Research summary and Policy recommendations**
	The final chapter of this dissertation provides conclusions summary and several significant policy recommendations for policymakers and the RGC in the contribution of research and development of Cambodian rice sector and for promoting Cambodian rice to the world market.

Source: Own elaboration.

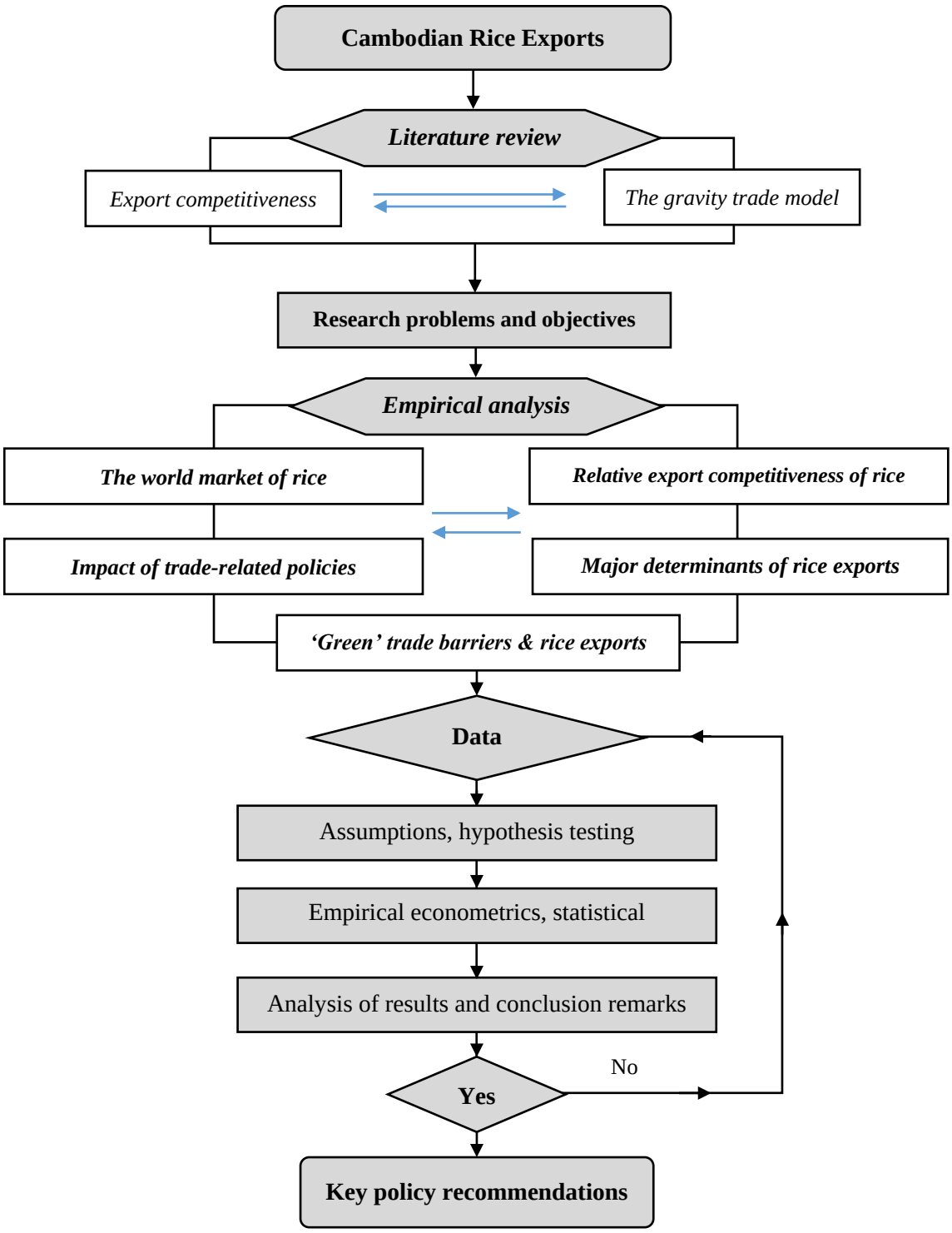


Figure 1.1: Technical route of the study

Source: Own Elaboration

CHAPTER 2. LITERATURE REVIEWS ON EXPORT COMPETITIVENESS AND THE GRAVITY TRADE MODEL

This chapter reviewed the literature on the *export competitiveness* and the '*gravity*' *trade model*. The theoretical framework and various analytical approaches of the *export competitiveness* are discussed in the first section, while the discussions on the '*gravity*' *model for international trade* are given in the second section. The last section of this chapter provides a short summary of the chapter.

2.1. Export Competitiveness

2.1.1. Overview

Competitiveness is the root for accomplishment the market share, both local and international. It can be captured and measured by several aspects at firm (*micro-economic*), sectoral (*meso-economic*) and state (*macro-economic*) level (Etuk and Ohen 2017 , Pascucci 2018). Nevertheless, although the term "*competitiveness*" being largely used, its meaning and definition is still remained uncertain. Numerous definitions had been defined:

- *The ability to face the competition and to be able to success in dealing with the competition* (Etuk and Ohen 2017).
- *The set of institutions, policies and determinant factors of a country's productivity*, defined by World Economic Forum WEF (Kanat 2019).
- *The degree a country can produce goods/services to meet the global competition and maintaining the domestic earnings* defined by OECD (Kanat 2019).

From trade and policy perspectives, *competitiveness* could be derived from David Ricardo's theory of the *comparative advantage* (Ricardo 1817). It incidentally encouraged numerous countries to trade in commodity/industry they are having the *competitiveness* or *comparative advantage*, although *absolute advantage* (Smith 1776) did not obtainable .

The *revealed comparative advantage* (RCA) was introduced by Balassa (1965) in his ground-breaking work "*Trade liberalization and revealed comparative advantage*", stated that *comparative advantage* could be *revealed* by real-world trade patterns (e.g. market

shares), reflecting the variation in countries' *endowment factors* (Balassa 1965 , Balassa 1977).

Adam Smith (1723–1790)

Theory of Absolute Advantage

David Ricardo (1772–1823)

Theory of Comparative Advantage

Figure 2.1: Adam Smith and David Ricardo

Source: www.google.com

RCA index imitates one country's *competitiveness* in a certain product/industry by assesses the relative performance of exports (Rossato, Susaeta, Adams, Hidalgo, de Araujo and de Queiroz 2018). Successively, empirical RAC application had been extensively applied for examining the international trade *competitiveness*, for instance, merchandise exports (Sinanan and Hosein 2012), agro-food (Fertö and Hubbard 2003 , Bojnec and Ferto 2018), agro-processed products (Oduro and Offei 2014), honey (Ignjatijevic, Milojevic and Andzic 2018), vegetables (Laosutsan, Shivakoti and Soni 2017), tropical fruits (Nik Rozana, Suntharalingam and Othman 2017), shrimp (Chang, McAleer and Nguyen 2019), and rice commodities (Goyal and Vajid 2017 , Irshad, Xin and Arshad 2018).

2.1.2. Revealed comparative advantage (RCA) index

2.1.2.1. Balassa's RCA index

The index of RCA[1] captures the *relative trade performances* by assessing exports of a commodity/industry relative to the export sets of other countries (Balassa and Noland 1989), expressed as follows:

[1] RCA, also called *'Balassa index'* (BRCAI) or *'Balassa's RCA index'* or *Revealed export advantage* index in the literature.

$$RCA_{ik} = (X_{ik}/X_{it})/(X_{wk}/X_{wt}) \quad (2.1)$$

where, i, w, k, t : denote the exporting country, the world, the investigated commodity or industry, and the time period, respectively.

RCA_{ik} : *revealed comparative advantage* of country i's k commodity.

X_{ik} : the *export* quantity of k in country i.

X_{it} : the *export* quantity of the country i's *total exports* during t.

X_{wk} : the *export* quantity of k in the world (w).

X_{wt} : the *export* quantity of the *whole commodities* in the world (w).

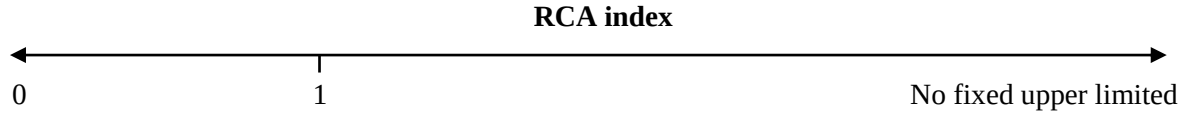


Figure 2.2: The range of the RCA index

Source: Own elaboration.

Table 2.1: The states of comparative advantage

Class	Value of RCA index	Descriptions
1	$0 \leq RCA < 1$	Commodity with *comparative disadvantage*
2	$RCA = 1$	Commodity with *neutral* comparative advantage
3	$1 < RCA \leq 2$	Commodity with *weak* comparative advantage
4	$2 < RCA \leq 4$	Commodity with *medium* comparative advantage
5	$RCA > 4$	Commodity with *strong* comparative advantage

Source: Based on Hinloopen and Van Marrewijk (2001).

Empirical advantages of RCA application are: (1) easy calculation; (2) assessing useful facts on a country's competitiveness in one commodity or industry. However, its utility in *comparative advantage* studies has proven to be limited (Bowen 1983 , Ballance, Forstner and Murray 1987). **First**, RCA captures a country's *competitiveness* only at one point in time (Hillman 1980 , Yeats 1985). Nevertheless, it had been extensively used for examining the *competitiveness patterns* across time, commodities, industries and even countries (Richardson and Zhang 1999). **Second**, various trade distortion issues (e.g. tariff, quota, etc.) were not considered in the competitiveness measurement (Fertö and Hubbard 2003).

However, some scholars (Vollrath 1991) suggested *competitiveness* would be relatively gain if the markets were more open (i.e. without government intervention). **Third**, the major shortcoming of the RCA index is its "*Asymmetric*" property (De Benedictis and Tamberi 2004). The index has a static zero lower-bound, but has no upper-bound (**Figure 2.2**). Thus, for giving additional interpretational elements to the distribution of the RCA, it was later sub-divided into several range, as shown in **Table 2.1**.

2.1.2.2. Symmetric RCA (RSCA) index

Dealing with the *Asymmetry* problem of Balassa's RCA index, Laursen (1998) suggested a modification to make the index *symmetric* as $(RCA-1)/(RCA+1)$, which gives a range of values from -1 to $+1$. This modification is labelled '*Revealed symmetric comparative advantage*' (RSCA[2]). Positive (*negative*) values of RSCA show a competitive advantage (*disadvantage*) in exporting commodity/industry k, as follow:

$$RSCA_{ik} = (RCA_{ik}-1)/(RCA_{ik}+1) \tag{2.2}$$

where, the i and k denotes the exporting country and the commodity/industry, respectively.

Béla Balassa (1928–1991)

Revealed comparative advantage (RCA)

Thomas L. Vollrath

Vollrath's RCA Specifications

Figure 2.3: Béla Balassa, and Thomas L. Vollrath

Source: www.google.com

[2] RSCA is also called "*Normalized RCA*" (NRCA)

2.1.2.3. Bilateral RCA (BRCA) index

Bilateral RCA (BRCA[3]) of each pair countries, ranged $-1 \leq BRCA \leq +1$, reflects the comparison position of a country's export/import of certain commodity or industry in the global market.

$$BRCA_{ijk} = (X_{ijk} - M_{ijk})/(X_{ijk} + M_{ijk}) \quad (2.3)$$

where, i, j, k : denote the exporter, importer, and the investigated commodity or industry, respectively.

X, M : symbolize the export and import, respectively.

$-1 \leq BRCA < 0$: revealed no *competitiveness* in k commodity/industry.

$0 < BRCA \leq +1$: revealed have *competitiveness* in k commodity/industry.

2.1.3. Vollrath's RCA specifications

Thomas L. Vollrath offered three alternative specifications of RCA for assessing the agricultural *international competitiveness* (see further, Vollrath 1987 , Vollrath 1989 , Vollrath 1991).

2.1.3.1. Relative trade advantage (RTA) index

The *first specification* (RTA_{ik}) is captured as the difference of '*relative export advantage*' (RXA) and '*relative import advantage*' (RMA).

$$RTA_{ik} = RXA_{ik} - RMA_{ik} = \frac{(X_{ik}/X_i)}{(X_{wk}/X_w)} - \frac{(M_{ik}/M_i)}{(M_{wk}/M_w)} \quad (2.4)$$

where, RTA_{ik}, RXA_{ik}, RMA_{ik} : Relative *trade*, *exports* & *imports* advantage

X_{ik}, X_{wk} : country i and the world's *export* of product/industry k

X_i, X_w : country i and the world's total exports

M_{ik}, M_{wk} : country i and the world's *import* of product/industry k

M_i, M_w : country i and the world's total imports

2.1.3.2. Logarithm of the relative export advantage

The *second specification* is the $\ln(RXA_{ik})$.

[3] BRCA, also called *comparable net export* (NTB) index, or the *"competition index"*.

$$\ln(RXA_{ik}) = \ln\left[\frac{(X_{ik}/X_i)}{(X_{wk}/X_w)}\right] \tag{2.5}$$

where, X_{ik}, X_{wk} : country i and the world's *export* of product/industry k

X_i, X_w : country i and the world's total exports

2.1.3.3. Revealed competiveness (RC) index

The *third specification* of Vollrath (1991) is *revealed competiveness* (RC), is the difference between the *logarithm* of *relative export advantage* and *relative import advantage*.

$$RC_{ik} = \ln(RXA_{ik}) - \ln(RMA_{ik}) = \ln\left[\frac{(X_{ik}/X_i)}{(X_{wk}/X_w)}\right] - \ln\left[\frac{(M_{ik}/M_i)}{(M_{wk}/M_w)}\right] \tag{2.6}$$

where, X_{ik}, X_{wk} : country i and the world's *export* of product/industry k

X_i, X_w : country i and the world's *total exports*

M_{ik}, M_{wk} : country i and the world's *import* of product/industry k

M_i, M_w : country i and the world's *total imports*

The positive (*negative*) values of RTA_{ik}, $\ln(RXA_{ik})$ and RC_{ik}, captures the *comparative advantage* (*disadvantage*) for a commodity/industry in one country. The advantage of *logarithmic* form of $\ln RXA$ and RC is their *symmetry* property.

2.1.4. More specifications

2.1.4.1. International market share (IMS) index

International market share (IMS) reflects the market share of a country's commodity/industry occupying in the international market. Thus, the higher (*lower*) of IMS indicated the stronger (*weaker*) *international competitiveness* for that commodity/industry:

$$IMS_{ik} = \left(\frac{X_{ik}}{X_{wk}}\right) \times 100\% \tag{2.7}$$

where, IMS_{ik} : Commodity k's *international market share* in country i

X_{ik} : The export quantity/amount of commodity k in country i

X_{wk} : The world (w)'s export quantity/amount of commodity k

2.1.4.2. Revealed competitive advantage (CA) index

The CA index is obtained by not only considering the exports, but also the imports.

$$CA_{ik} = RCA_{ik} - [(M_{ik}/M_{it})/(M_{wk}/M_{wt})] \quad (2.8)$$

where, RCA_{ik} : revealed *comparative* advantage in export of k in country i

M_{ik}, M_{wk} : country i and the world (w)'s *import* of k industry

M_{it}, M_{wt} : country i and the world (w)'s *total imports*

$CA_{ik} > 0$: country i's k industry have *competitive advantage*.

$CA_{ik} < 0$: country i's k industry have *competitive disadvantage*.

Table 2.2 presented the *competitiveness* analysis approaches formerly discussed.

Table 2.2: The widely used approaches applied in the *competitiveness* literature

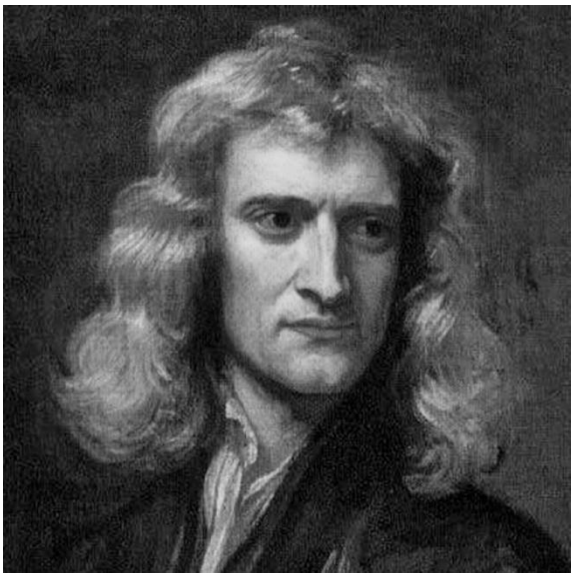
Revealed comparative advantage (RCA) index	
• Balassa's RCA index	$RCA_{ik} = (X_{ik}/X_{it})/(X_{wk}/X_{wt})$
• Revealed symmetric comparative advantage (RSCA) index or Normalized RCA (NRCA) index	$RSCA_{ik} = (RCA_{ik} - 1)/(RCA_{ik} + 1)$
• Bilateral revealed comparative advantage (BRCA) index or comparable net export (NTB) index	$BRCA_{ijk} = NTB_{ijk} = (X_{ijk} - M_{ijk})/(X_{ijk} + M_{ijk})$
Vollrath (1991)'s alternative specifications	
• First specification: Relative trade advantage (RTA) index	$RTA_{ik} = RXA_{ik} - RMA_{ik} = \frac{(X_{ik}/X_i)}{(X_{wk}/X_w)} - \frac{(M_{ik}/M_i)}{(M_{wk}/M_w)}$
• Second specification: Logarithm of the relative export advantage	$\ln(RXA_{ik}) = \ln\left[\frac{(X_{ik}/X_i)}{(X_{wk}/X_w)}\right]$
• Third specification: Revealed competiveness (RC) index	$RC_{ik} = \ln(RXA_{ik}) - \ln(RMA_{ik}) = \ln\left[\frac{(X_{ik}/X_i)}{(X_{wk}/X_w)}\right] - \ln\left[\frac{(M_{ik}/M_i)}{(M_{wk}/M_w)}\right]$
More specifications	
• International market share (IMS) index	$IMS_{ik} = \left(\frac{X_{ik}}{X_{wk}}\right) \times 100\%$
• Revealed competitive advantage (CA) index	$CA_{ik} = RCA_{ik} - [(M_{ik}/M_{it})/(M_{wk}/M_{wt})]$

Source: Own elaboration.

2.2. The ‘Gravity’ Model for International Trade

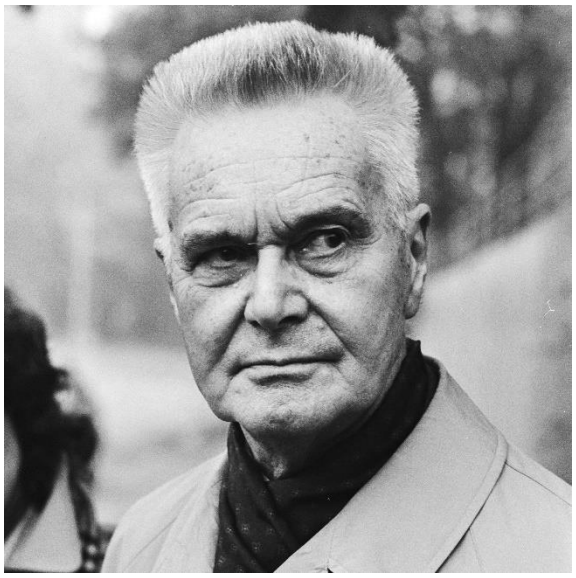
2.2.1. Overview

The ‘*gravity*’ model was fundamentally originates from the “*Newton’s law of universal gravitation*” in physics developed by Isaac Newton in 1686, which stated that *two items mutually attract each other as the product of their mass (in kilograms) divided by (the square of) the distance between them (in meters)* (Newton 1686). It was introduced to economics by the initial eminent study discovering the international trade performance of Jan Tinbergen dated back to the early 1960s: “*Shaping the world economy: Propositions for an international economic policy*” (Tinbergen 1962), and later Pentti Pöyhönen’s “*A tentative model for the volume of trade between countries*” (Pöyhönen 1963). However, the theoretical foundations of the model were not shaped until the end of the 1970s (Linnemann 1966 , Anderson 1979 , Bergstrand 1989 , Deardorff 1998 , Anderson and Wincoop 2003 , Bergstrand, Egger and Larch 2013 , Chaney 2018).



Isaac Newton (1642–1726/27)

A famous English physicist and mathematician



Jan Tinbergen (1903–1994)

1st Nobel Memorial Prize in Economics 1969

Figure 2.4: Isaac Newton and Jan Tinbergen

Source: www.google.com

The ‘*gravity*’ model has progressively established itself as the most fruitful and effective tools for the international trade studies and has been extensively utilized by scholars (Fan, Zhang, Liu and Pan 2016 , Kea, Li, Shahriar, Abdullahi, Phoak and Touch 2019 , Kohl 2019 , Shahriar, Qian and Kea 2019 , Shepherd 2019). The ‘basic’ functional

form of the '*gravity*' *trade model* was shown in Equation (2.9), illustrated that trade between countries is directly determined economic size (extensively proxied by GDP or GNP) while inversely proportional to distance (as proxied to the transportation costs). However, for avoiding the estimation issues, this equation was tranformed into linear form by putting natural logarithm function (ln) on both-sides of equation, as Equation (2.10):

$$T_{ijt} = \alpha\, GDP_{it}^{\beta_1} GDP_{jt}^{\beta_2} D_{ij}^{\beta_3} \varepsilon_{ijt} \tag{2.9}$$

$$\ln(T_{ijt}) = \beta_0 + \beta_1 \ln(GDP_{it}) + \beta_2 \ln\left(GDP_{jt}\right) + \beta_3 \ln\left(D_{ij}\right) + \varepsilon_{ijt} \tag{2.10}$$

where, i, j, t : indexes of exporting, importing economy and time period

T_{ijt} : Trade flow (in monetary term, usually USD) or volume (in weight amount in tons) between country i and j within period t

GDP_{it} : Gross domestic product (GDP) of country i within period t

GDP_{jt} : Gross domestic product (GDP) of country j within period t

D_{ij} : Goegraphical distance between country i and country j

$\alpha; \beta_s$: The constant term and the estimated coefficients.

ε_{ijt} : A lognormal distributed error term with $E(ln\, \varepsilon_{ijt}) = 0$

2.2.2. The modified forms of the gravity trade model

2.2.2.1. Augmented gravity model

Numerous researchers use *augmented gravity model* (adding the exogenous independent variables, usually the binery variables, to extend the *'basic' gravity model*) to define the influencing factors of trade and enlarge the model's explanatory power. Nevertheless, some limitations in the gravity model's specification were correspondingly addressed, including *heterogeneity* (Baldwin and Taglioni 2006 , Chen and Novy 2011), *heteroskedasticity* (Hurd 1979), *endogeneity* problems (Lee and Swagel 1997 , Baier and Bergstrand 2007), and "*zeros*" trade problem (Santos Silva and Tenreyro 2006 , Helpman, Melitz and Rubinstein 2008). Empirically, these variables would include:

- **Linkage variables**: shared border (Rahman 2010 , Salim, Kabir and Mawali 2011); common language (Elshehawy, Shen and Ahmed 2014); colonial links (Atif, Haiyun and Mahmood 2017); landlocked (Deluna and Cruz 2014).

- **Policy-oriented variables**: trading agreements (Li, Saghaian and Reed 2012 , Fan, Zhang, Liu and Pan 2016 , Atif, Haiyun and Mahmood 2017); trade openness (Elshehawy, Shen and Ahmed 2014); level of competitiveness (Tamini, Doyon and Simon 2016); exchange rate (Salim, Kabir and Mawali 2011 , Ahmad and Garcia 2012 , Irshad, Xin, Shahriar and Arshad 2018); tariff rate (Atif, Haiyun and Mahmood 2017); inflation rate (Rahman 2010).
- **Membership variables**: WTO (Zharikov, Kravchenko, Sergeeva and Stetsyuk 2016 , Irshad, Xin, Shahriar and Arshad 2018); APEC (Deluna and Cruz 2014); British Commonwealth (Ahmad and Garcia 2012); ASEAN; SAARC; EEC; NAFTA; Middle East (Rahman 2010).
- **'Production, supply, demand, price' factors**: land area (Deluna and Cruz 2014); population (Elshehawy, Shen and Ahmed 2014 , Tamini, Doyon and Simon 2016); commodity's price data (Salim, Kabir and Mawali 2011 , Ahmad and Garcia 2012); annual production/consumption (Tamini, Doyon and Simon 2016); existing stocks (Wang 2016); total export/import (Rahman 2010).
- **Index numbers**: e.g. property right index, freedom from corruption index, fiscal freedom index, business freedom index, labor freedom index, monetary freedom index, trade freedom index, investment freedom index, financial freedom index, government effectiveness, political stability (Deluna and Cruz 2014 , Fan, Zhang, Liu and Pan 2016).
- **Other factors**: endowment factors, regulations on market entry, natural resources, human resources, protection of intelligence property, etc. (Fan, Zhang, Liu and Pan 2016); economic recession; substitute products (Wang 2016); remittance variable (Gashi, Hisarciklilar and Pugh 2016); HACCP Certificate (Li, Saghaian and Reed 2012), etc.

2.2.2.2. Static and dynamic gravity model

Unlike '*static*' model, the '*dynamic*' gravity model is a kind of model that contains the *dynamic* dependent variables (e.g. lagged trade, initial trade, lagged export, initial export, etc.). '*Historical ties*' were the main engine sharpen the international trade (Eichengreen and Irwin 1998 , De Benedictis and Taglioni 2011). The countries with '*historical ties*' tend to continuously trade due to numerous connections (e.g. political ties). The imperative of '*historical effect*' on trade had been empirically investigated (e.g. Roberts and Tybout 1997 ,

Nguyen 2010 , Castillo, Villanueva and García-Cortijo 2016 , Gashi, Hisarciklilar and Pugh 2016 , Kahouli 2016 , Kea, Li, Shahriar, Abdullahi, Phoak and Touch 2019). Therefore, the '*historical effect*' would produce significant information.

2.2.2.3. Stochastic frontier gravity model

The '*stochastic frontier*' was traditionally applied in assessment of *production efficiency*. It was a concept at first proposed separately and independently by Aigner, Lovell and Schmidt (1977), and Meeusen and Broeck (1977).

Empirically, the *stochastic frontier model* had been broadly applied in firm performance analysis framework, by postulates the *production possibility frontiers* (PPF). For instance, agricultural farm (Battese, Rao and O'Donnell 2004 , Dudu, Cakmak and Öcal 2015), rice industry (Yao and Shively 2007 , Narala and Zala 2010 , Hossain, Kamil, Baten and Mustafa 2012), maize (Ali, Xuexi, Khan, Ali, Baz and Khan 2019), tea (Hong and Yabe 2015), coffee (Ngango and Kim 2019), soybean (Biam, Okorie and Nwibo 2016), cassava (Okoye, Abass, Bachwenkizi, Asumugha, Alenkhe, Ranaivoson, Randrianarivelo, Rabemanantsoa, Ralimanana and Elliott 2016), cotton (Theriault and Serra 2014), palm oil (Hasnah, Fleming and Coelli 2004), grain crops (Odeck 2007), milkfish (Chiang, Sun and Yu 2004), wine products (Piesse, Conradie, Thirtle and Vink 2018), meat products (Panagiotou and Stavrakoudis 2019), and milk products (Egger, Holzer, Segato, Werth, Schwienbacher, Peratoner, Andrighetto and Kasal 2007).

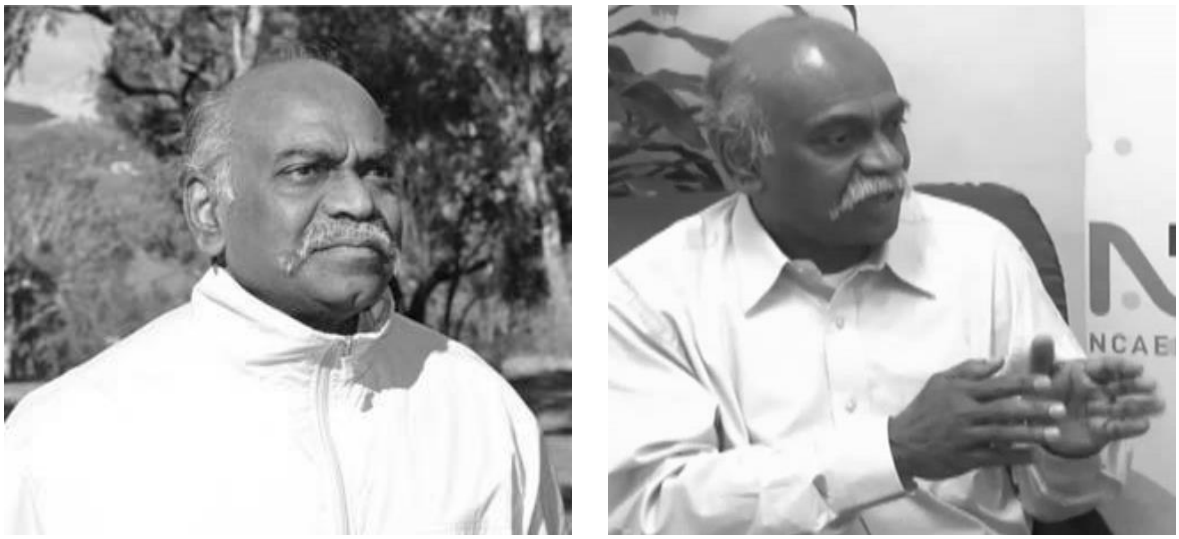


Figure 2.5: Kaliappa Kalirajan and the foundation of the '*stochastic frontier gravity model*'

Source: www.google.com

The '*stochastic frontier gravity model*' (hereafter, SFG) is the hybrid of the *gravity model* and the *stochastic frontier model*. It was originally brought into the economic literature by Kalirajan (2007) to examine the '*efficiency*' and '*potential*' of trade which could be derived from '*trade frontier*'. This model would allow researchers to capture the unobservable determinants that might affect the bilateral trade *efficiency* and *potential* (e.g. Ravishankar and Stack 2014 , Viorica 2015 , Fan, Zhang, Liu and Pan 2016 , Atif, Haiyun and Mahmood 2017 , Doan and Xing 2018 , Atif, Mahmood, Haiyun and Mao 2019).

2.2.3. 'Zero' trade problem of the gravity model

The log-form of the '*gravity*' *model* commonly suffers from '*zeros*' trade values, as $log(0)$ is undefined; thus, taking logarithms would drop such observations from the sample. Dropping zeros (observations) would lead to highly loss of hidden useful information behind them (Shepherd 2008). Therefore, the '*zeros*' problem in the (log-linearized version) gravity model had been paid great attentions by numerous scholars (e.g. Helpman, Melitz and Rubinstein 2008 , Eaton, Kortum and Kramarz 2011 , Haq, Meilke and Cranfield 2011 , Gómez-Herrera 2013 , Haq, Meilke and Cranfield 2013 , Gashi, Hisarciklilar and Pugh 2016 , Afesorgbor 2017 , Hwang and Lim 2017 , Ramzy and Zaki 2018). The most-empirical tactics commonly used to deal with this issue are: *Ad-hoc*; *PPML*, and the *Heckman* model.

2.2.3.1. Ad-hoc Solution

It should be noticed that $log(0)$ is undefined, but $log(0 + 0.0001)$ is not. One simple solution to 'zero' trade problem is adding a small, positive number to all trade flows, since $log(x + 0.0001) \approx log(x)$. Empirically, the *Ad-hoc* procedure is frequently utilized for *policy* investigation (e.g. Salim, Kabir and Mawali 2011 , Ahmad and Garcia 2012). Nevertheless, the discussions on its theoretical basis still not available yet.

2.2.3.2. PPML Approach

The benefits of its natural manner for dealing with '*zeros*' issue and *heteroskedasticity*, the *Pseudo-Maximum-Likelihood* (PML) was suggested for the '*gravity*' model by Santos Silva and Tenreyro (2006). Their evidences also revealed that the *Poisson PML* (i.e. PPML, included *fixed effects PPML* and *Gamma PPML*) is largely well-performed generated lesser-bias coefficients than *Tobit*, NLS (*nonlinear least-squares*) or OLS (*ordinary least-squares*) even when the dependent variable exists of a large '*zeros*' proportion (Santos Silva and Tenreyro 2006 , Santos Silva and Tenreyro 2010 , Santos Silva and Tenreyro 2011). Within

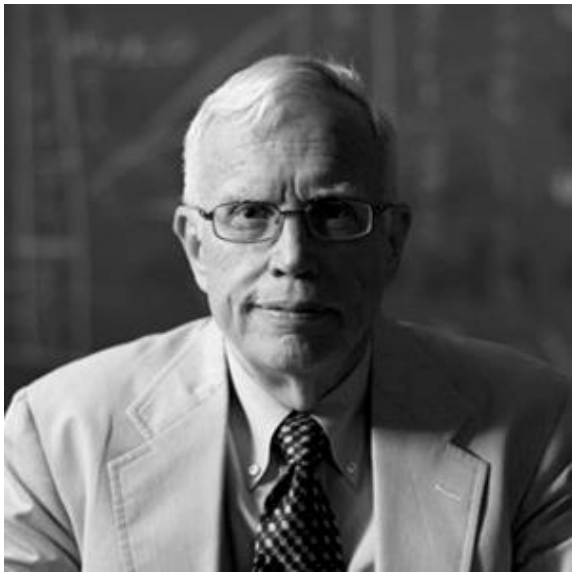
the PPML framework, the *dependent variable is expressed in non-logarithmic form*, i.e. $trade$, not $log(trade)$, while the *independent variables still expressed in logarithmic forms*.

J.M.C. Santos Silva

Silvana Tenreyro (Born 06.09.1973)

Figure 2.6: J.M.C. Santos Silva, Silvana Tenreyro, and the PPML foundation

Source: www.google.com



James J. Heckman (Born in 1944), a Nobel Prize Winning American Economist

Figure 2.7: James J. Heckman and Sample Selection Model

Source: www.google.com

2.2.3.3. Heckman Sample Selection Model

The PML estimation indirectly assumes that there is '*nothing special about zeros'*, as it is just trying to get them into the sample. Thus, the Heckman (1979)'s '*sample selection*' model had been used as an *alternative* approach to take '*something special about zeros'* into account. The *heckman* model consists of two equations, i.e. (**a**) the 0/1 '*Selection*' model, captures the *possibility* of trade (i.e. indicated the 'Yes/No' that the pair-countries choose to trade with each other), and (**b**) the *main (gravity) model*, execute on the basis of the model (**a**). Conversely, in practice, it is common to estimate both stages simultaneously via *Maximum Likelihood* (ML) approach, by ***heckman*** command in ***Stata*** software. See (Helpman, Melitz and Rubinstein 2008) and (Tamini, Doyon and Simon 2016) for further empirical example of the '*sample selection*' utilization.

2.3. Chapter summary

This chapter reviewed the literatures on the export competitiveness and the gravity trade model. *Competitiveness* is the root for accomplishment on the market competition for both local and international. Various types of RCA have been extensively applied in the empirical literature as a measure of *international competitiveness*. The gravity model was fundamentally originates from the '*Newton's law of universal gravitation*' in physics developed by Isaac Newton in 1686. This model was brought to international economic literature by Jan Tinbergen in 1962. Sice then, the gravity model was ameliorated by many scholars. The other alternative forms of the gravity trade model are (1) Augmented gravity model, (2) Static and dynamic gravity model and (3) Stochastic frontier gravity model (SFG). The bilateral trade data commonly suffers from 'zero' trade values, since the empirical gravity model usually express in log-linearized form. In order to deal with 'zero' problem, many studies have conducted serval methods, included: *Ad-hoc* solution, the PPML approach, *Heckman* sample selection model.

CHAPTER 3. THE WORLD MARKET OF RICE: CURRENT SITUATION AND TRENDS

This chapter provided an overview of the world market of rice and Cambodian rice economy. An inclusive circumstances and trends (included, the production, consumption, market and trade) of the world's rice, Asian rice, and the Cambodian rice economy were discussed in the first, second and third section, respectively, while the chapter summary was given in the fourth section.

3.1. The Global Rice Economy

3.1.1. World's rice production

In excess of three-fourths of the global fertile land is consisted of cereal crops (Panahi, Dehhaghi, Aghbashlo, Karimi and Tabatabaei 2020). Among voluminous cereals, rice is the most vital diet crops feeding over 50% of the humanities. The world's (un-milled) rice production has risen continually from 215 million tons (1961) to 740 million tons in 2016 (**Figure 3.1**). Over 90% of the global rice is cultivated, produced and consumed in the Asian Region (WRS 2018 , Nguyen Van, Tran Van, Meas, Tado, Kyaw and Gummert 2019).

China and India are the leading for both in terms of production and consumption of rice in Asia (Adjao and Staatz 2014 , Muthayya, Sugimoto, Montgomery and Maberly 2014). Furthermore, rice production of these two nations altogether with Indonesia, Bangladesh, Vietnam, Myanmar (Burma), Thailand, the Philippines, Japan, Pakistan, Cambodia, South Korea, Nepal, and Sri Lanka, collectively occupied around 90% of the worldwide production.

3.1.2. World's rice consumption

With the worldwide consumption of 475.7 million tons in 2013, rice is the world's most consumed food grain by more people (WRS 2018 , Kontgis, Schneider, Ozdogan, Kucharik, Tri, Duc and Schatz 2019). The global consumption of (milled) rice had an overall-increasing trend over the period of 1961-2013, particularly in Asian continent, while the world average of per-capita rice consumption was 50.5 kg/year (**Figure 3.2**). Asian per-capita rice consumption lay above the level of the world average (77.3 kg/year).

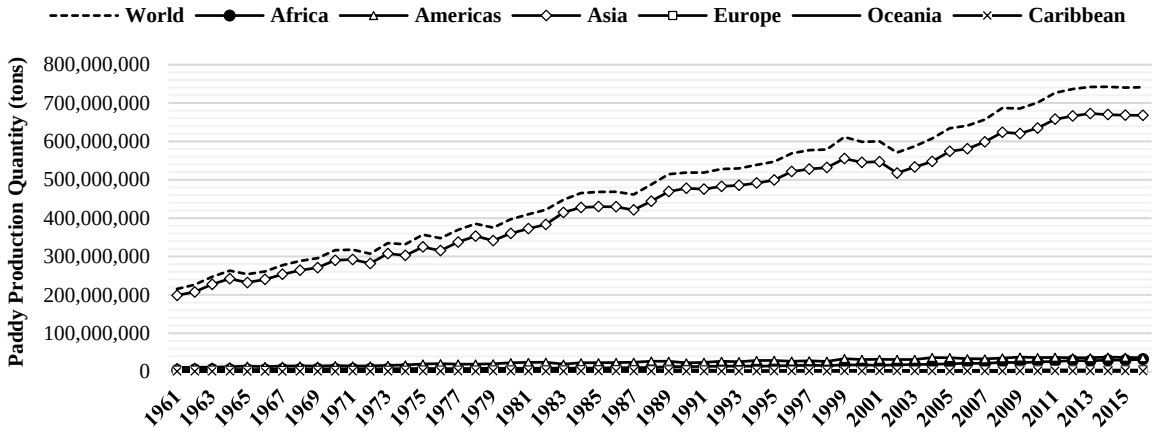
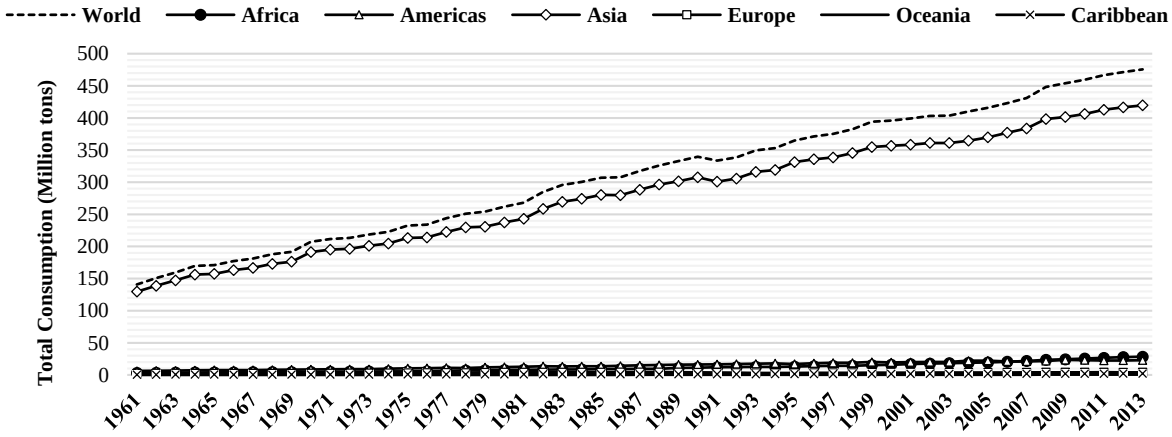
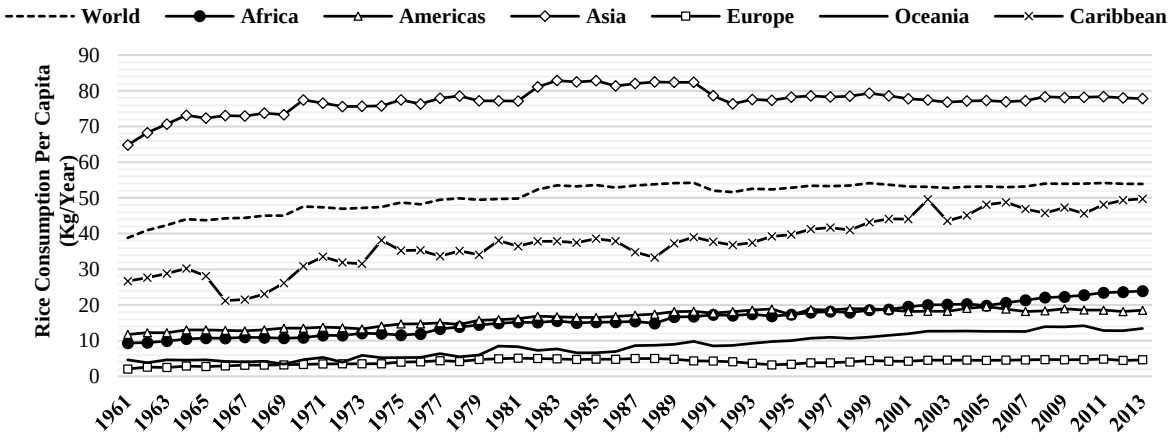


Figure 3.1: World's paddy (un-milled rice) production, 1961-2016

Source: World rice statistics database of IRRI (WRS 2018)



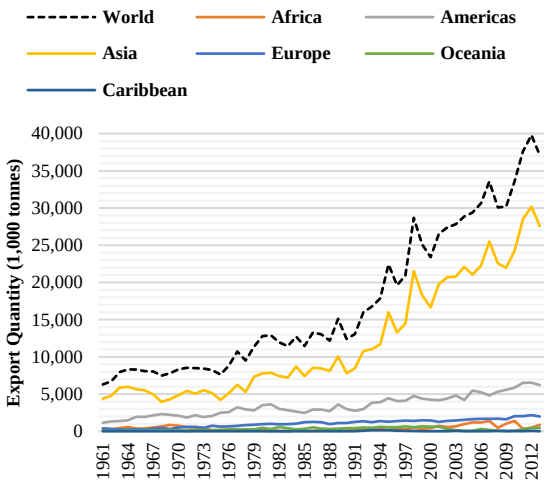
(a) World's total milled rice consumption



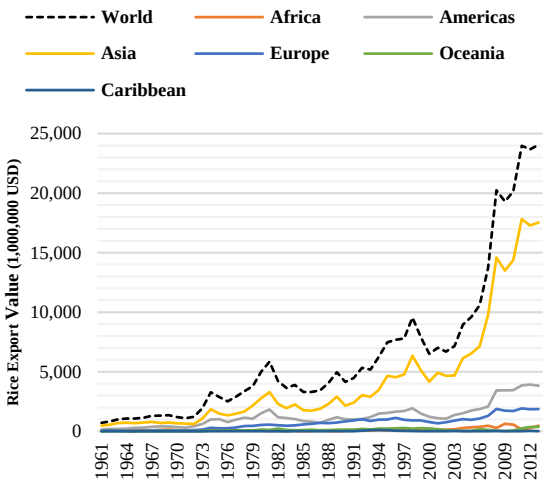
(b) World's rice consumption per capita

Figure 3.2: World's milled rice consumption, 1961-2013

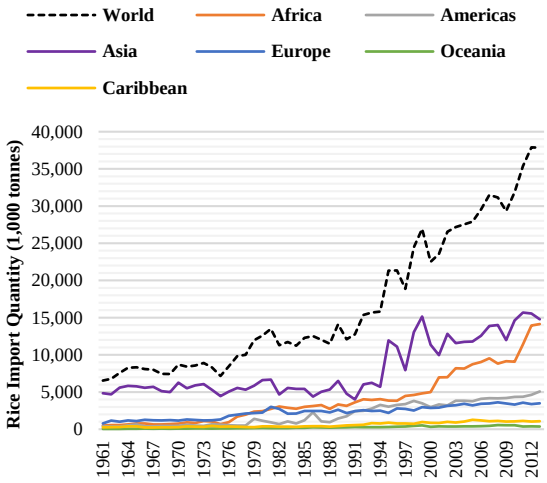
Source: World rice statistics database of IRRI (WRS 2018)



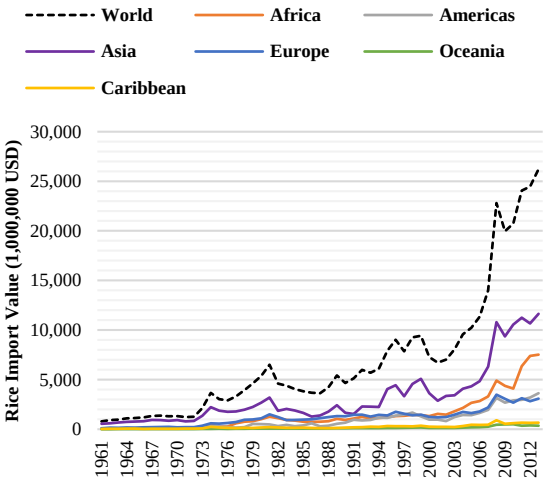
(a) World rice's export quantity



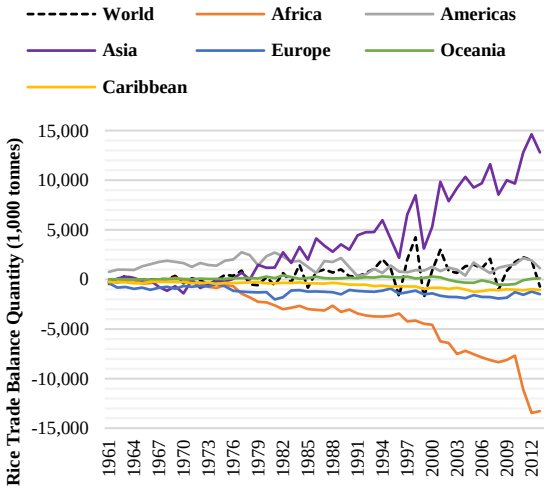
(b) World rice's export value



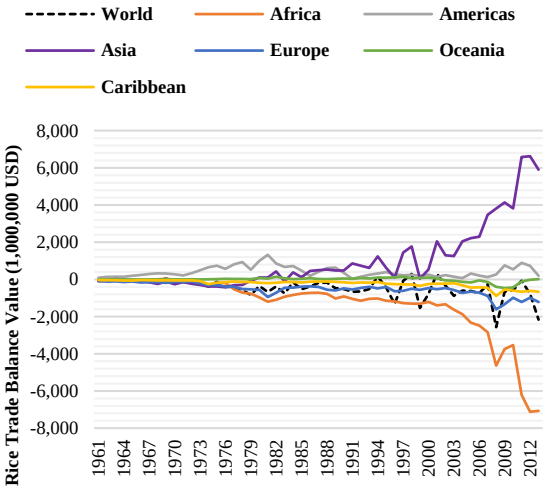
(c) World rice's import quantity



(d) World rice's import value



(e) World rice's trade balance quantity



(f) World rice's trade balance value

Figure 3.3: World rice's export, import and trade balance, 1961-2013

Source: World rice statistics database of IRRI (WRS 2018)

3.1.3. The international rice market

On the period of 1961-2013, the global rice exports-imports had an overall increasing trend for both quantity and value (**Figure 3.3**). Asian continent is the worldwide largest source for rice exports. Its rice exports had increased dramatically over the study period, particularly after 1990 and reached the utmost value of 30.2 million tons in 2012 (17.3 billion USD). However, the yearly exports of rice from the other continents (i.e. America, Africa, and Europe) seem to be slowly increasing. Their exports before 2004 only persisted lower than five million tons (≈1.5 billion USD) and increased to only 6.5 million tons in 2012 (WRS 2018). Rice imports of Asia were also remained the world's highest (reached the peak of 15 million tons in 1999). After that, it seemed to be slightly shrunk (to about 13 million tons/year) before reaching 15 million tons again in 2011.

Between the 1995-2018, the exports of rice in the international market are performing under the overall increasing trend (**Figure 3.4**). However, the numerous sharp-decreases had been shown during the crisis-dated (e.g. 1998 and 2008 financial crisis), indicated the negative impacts of these macroeconomic factors on the global market of rice.

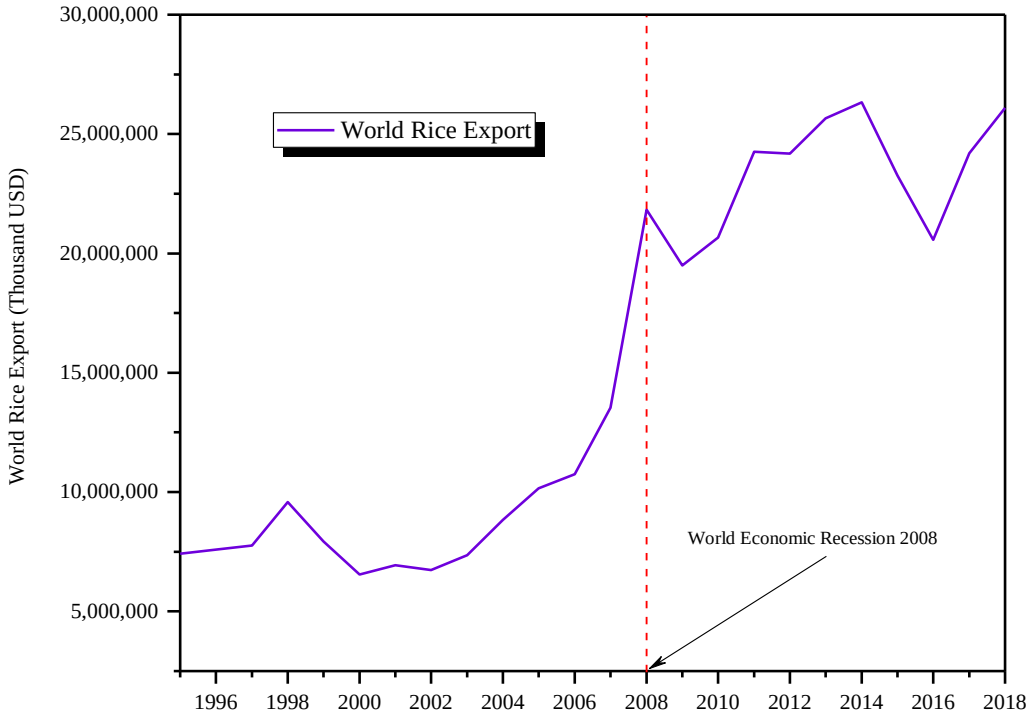


Figure 3.4: World's aggregate milled rice exports

Source: Own elaboration by Origin Pro v.2016, using data from UNCTAD (2019)

3.2. Asian Rice Economy

3.2.1. Rice production in Asia

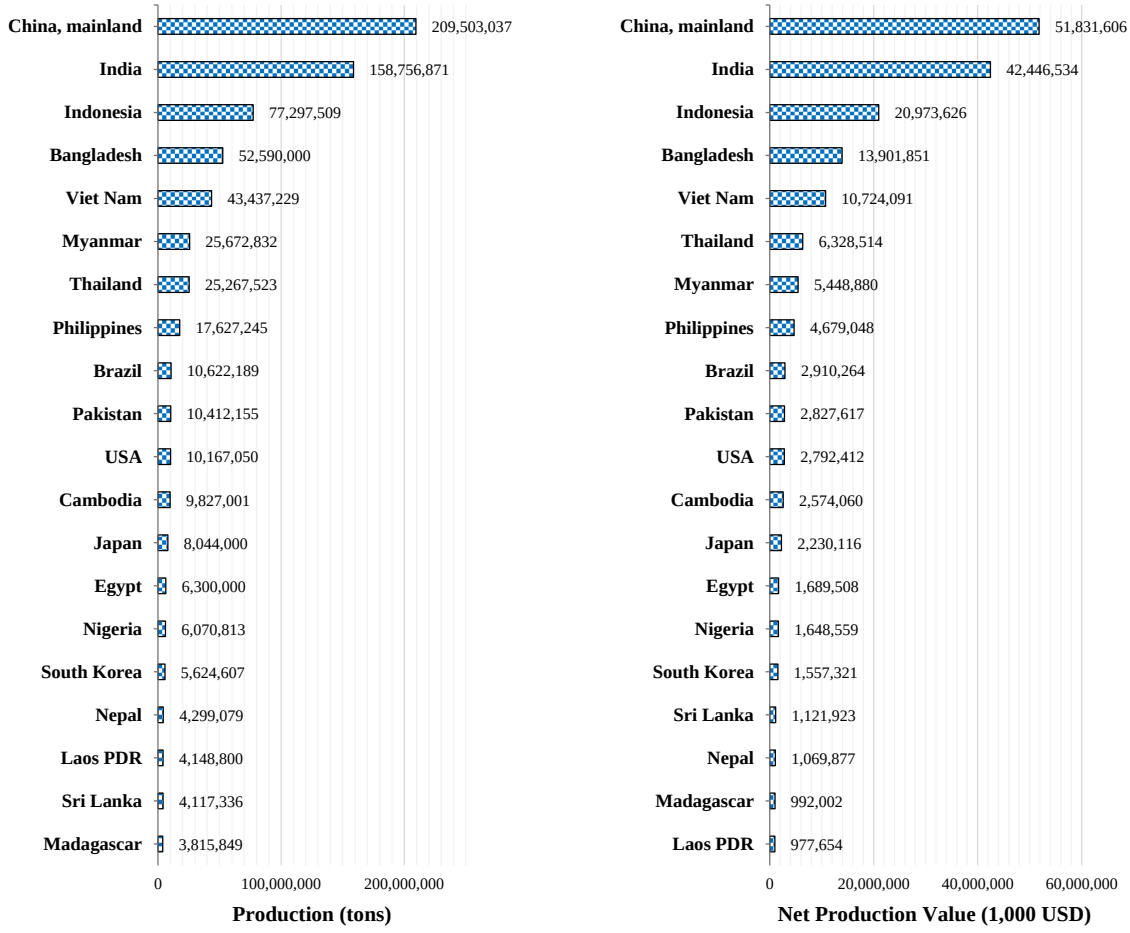
Asian continent is the home for the global rice, where around 90% of rice was grown, produced and consumed (Mariyono 2014 , WRS 2018 , FAOSTAT 2019). Furthermore, Asian countries exported averagely almost three-fourths of total rice in the world market (Narayan and Bhattacharya 2019). Thailand and India were the leading exporters of rice in Asia, which occupied almost half of the world market share in 2018 (UNCTAD 2019).

As the worldwide principal producers and consumers of rice, the production in China and India, correspondingly, reached 210 and 159 million tons in 2016 (**Figure 3.5**). Paddy and milled rice production in Asian region had correspondingly reached the peak value of 673 million tons and 449 million tons in 2013. In 2016, the Asian paddy production was reduced to just 668 million tons due to reduction of rice harvested area in the Southeast Asian region between 2013-2016 (WRS 2018).

Figure 3.6 and **3.7** exposed the key significant sources of rice production in Asian continent, i.e. (1) the South Asia, (2) the East Asia, and (3) the Southeast Asia. The West Asia and the Central Asia are just the minor producers of rice. If the harvested area of rice has been considered, the South Asian region occupied the biggest harvested area of 43% in Asia, increasing from 46.5 million hectares (43.5%) in 1961 to 60.2 million hectares (42.9%) in 2016 (**Figure 3.6.a**). Before 1985, the harvested area of rice in the East Asian region accounted for about 30%, ranked as the second largest in Asia. However, after the cool war, the rice harvested area in the Southeast Asia had been progressively and significantly expanded (while the harvested area in East Asia seemed to remaining steady). Therefore, after 1993, the Southeast Asia became the second largest rice harvest area of Asia (33.2% in 2016), followed by the East Asian region (23.6% in the same year).

If the production of *paddy* (un-milled rice) and milled rice have been considered, **Figure 3.6.b** indicated that before the year of 2013, the production for both *paddy* and milled rice of the East Asian region ranked as the largest rice producer among regions in Asia. However, after 2013, the production of rice in the South Asia, East Asia, and Southeast Asia came to the comparable stage (accounted for about 35%, 34%, 31% of the total production, respectively). The production trends of rice in other continents are given in **Appendix Figure A.1-A3**.

The largest source of world rice exports is the Southeast Asia, where production surpasses consumption (Hansen 2013 , Childs, Dyck and Hansen 2016). For the eight agricultural states of ASEAN [4] (included, Cambodia, Indonesia, Laos PDR, Malaysia, Myanmar, the Philippines, Thailand, and Vietnam), rice is not only the foundation for economic and social development, but also a vital-anchor ensuring the political stability, food security and fighting against poverty (Canoy and Belangel 2004 , Batello 2012 , Redfern, Azzu and Binamira 2012). Thailand, Vietnam and Indonesia are the majority of both rice production area and production quantity in the Southeast Asia [5].



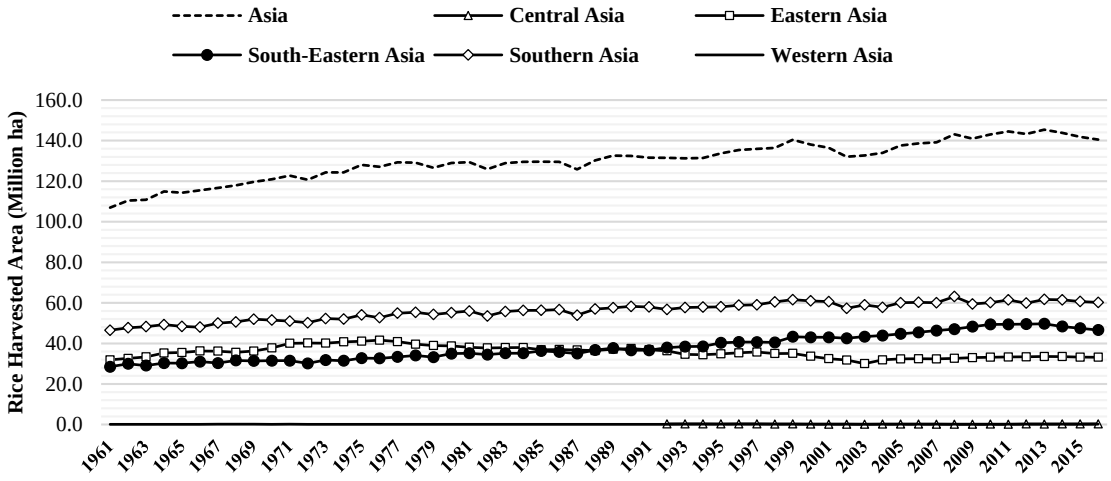
(a) Rice production quantity (b) Rice net production value

Figure 3.5: World's 20 largest rice producers, 2016

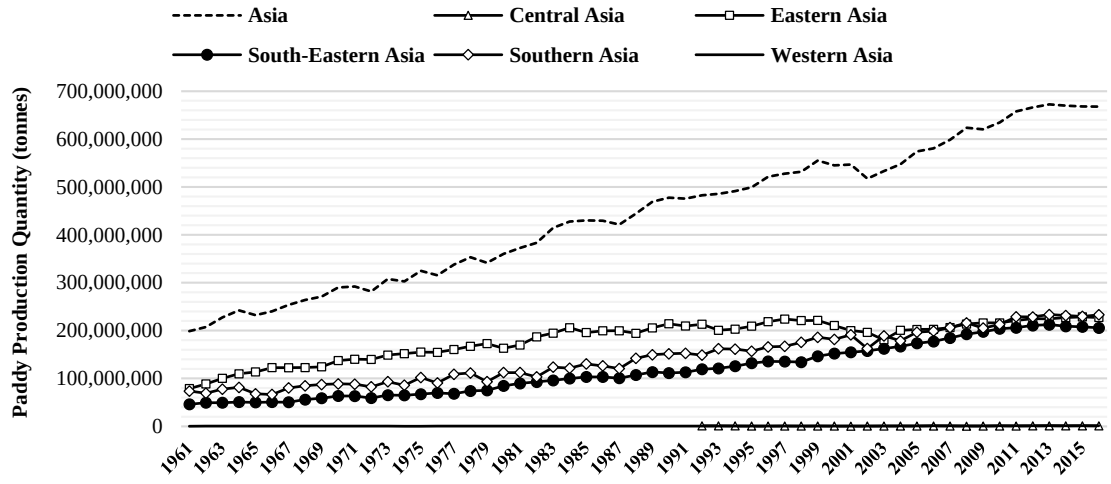
Source: Own elaboration, using the data from the FAOSTAT (2018)

[4] ASEAN: The Association of Southeast Asian Nations, founded on August 8, 1967 (*www.asean.org*).

[5] In the South Asian region, India and Bangladesh are the major rice producers, while in the East Asia, China and Japan are the major producers in the region.



(a) Asian rice harvested area



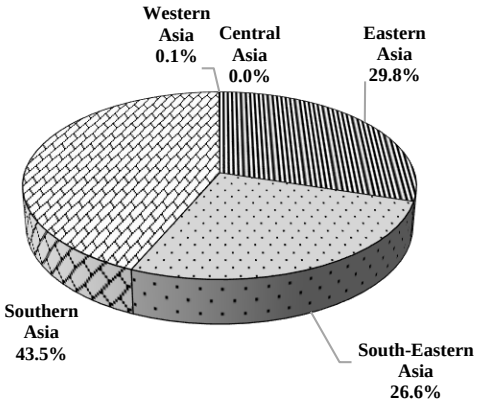
(b) Asian paddy production

Figure 3.6: Asian rice production, 1961-2016

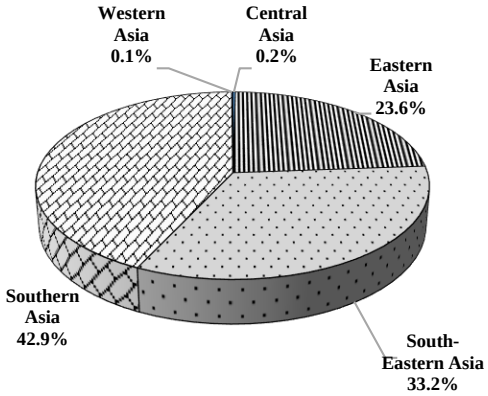
Source: World rice statistics database of IRRI (WRS 2018)

3.2.2. Rice consumption in Asia

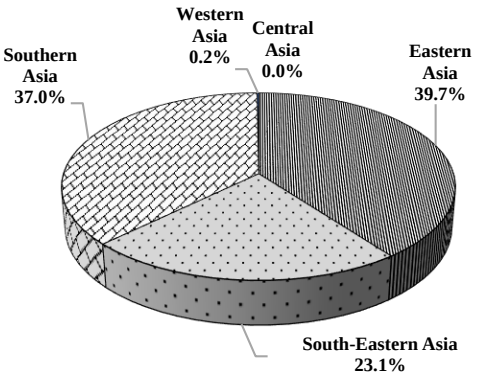
Rice is a staple food, provides two-thirds ($2/3$) of the calories intake, for approximately 2.4 billion people with rice-based diets in Asian region (except Pakistan and some parts of China and India). While the world's per-capita consumption of rice is just approximately 50-57 kg/year, most Asian people are consuming on average above 100 kg/year. More interestingly, the Southeast Asia was the highest among all regions in the world (122.23 kg/year of milled rice consumption), where Cambodia (292 kg), Laos PDR (289 kg) and Vietnam (217 kg) having among the highest per-capita consumption levels in the world (Adjao and Staatz 2014 , WRS 2018).



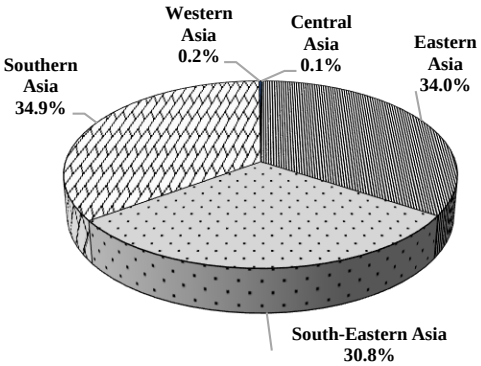
(a) Asian rice harvested area, 1961



(b) Asian rice harvested area, 2016



(c) Asian paddy production, 1961

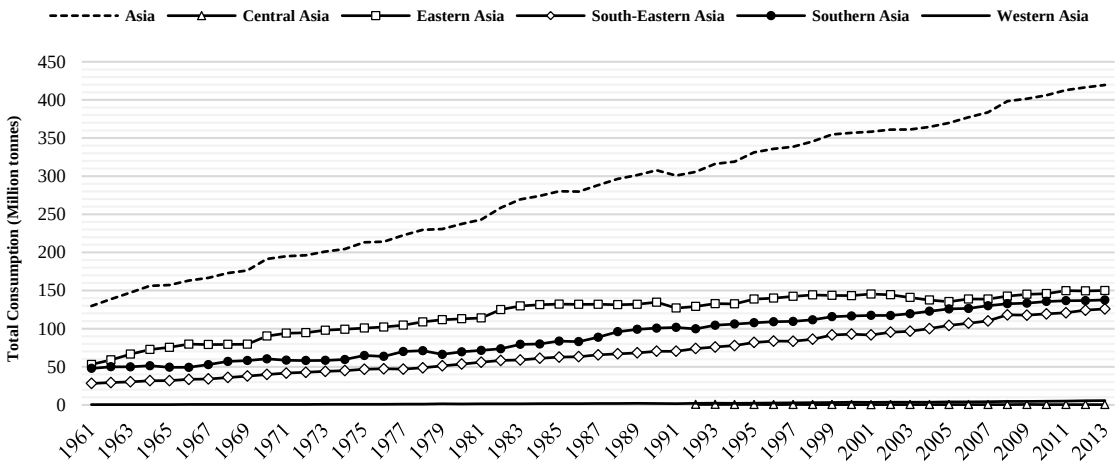


(d) Asian paddy production, 2016

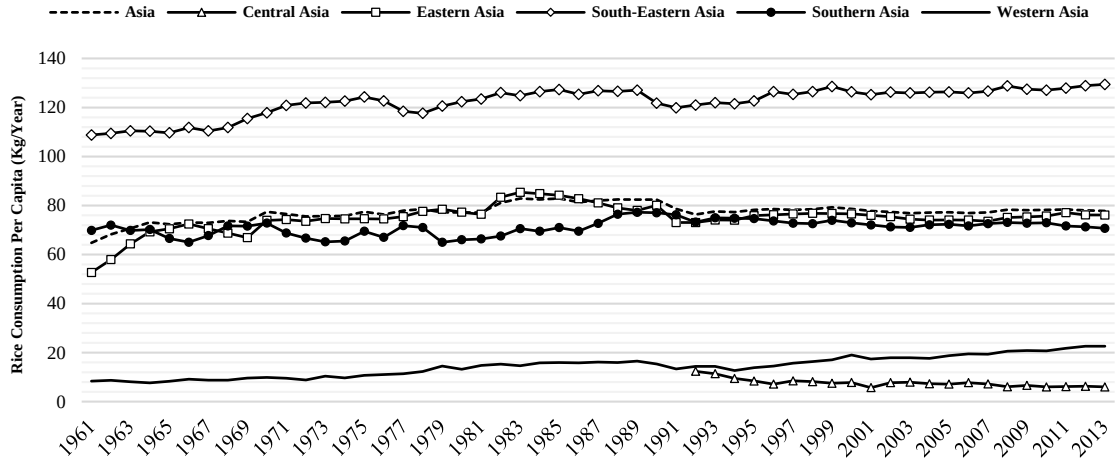
Figure 3.7: Asian rice production (%), 1961-2016

Source: World rice statistics database of IRRI (WRS 2018)

Asian contemporary-trends showed the enlargements in production and trade in rice while the consumption decreased by the income growth, in some Asian middle and high-income countries, e.g. *Japan*, *Taiwan* and the Republic of *Korea* (Abdullah, Ito and Adhana 2005 , Childs, Dyck and Hansen 2016). However, high population growth in numerous Asian low-income states (like *Afghanistan*, *North Korea*, and *Nepal*) would more rapidly increase the consumptions of rice in these countries (Kubo and Purevdorj 2004 , Abdullah, Ito and Adhana 2005). **Figure 3.8** illustrated the consumption trends of rice in Asia, while the trends in Africa, America and Europe are illustrated in **Appendix Figure A.4**.



(a) Asian total milled rice consumption



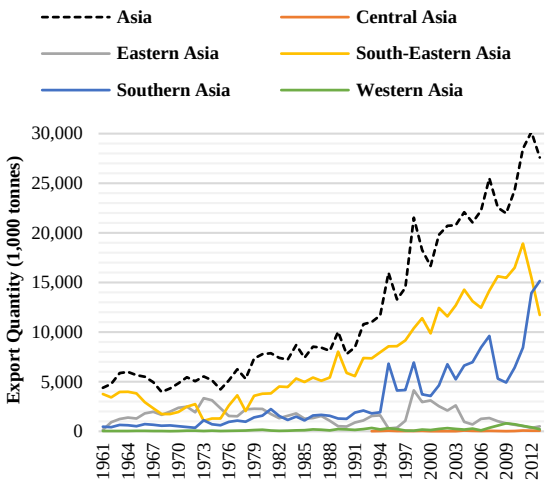
(b) Asian rice consumption per capita

Figure 3.8: Asian milled rice consumption, 1961-2013

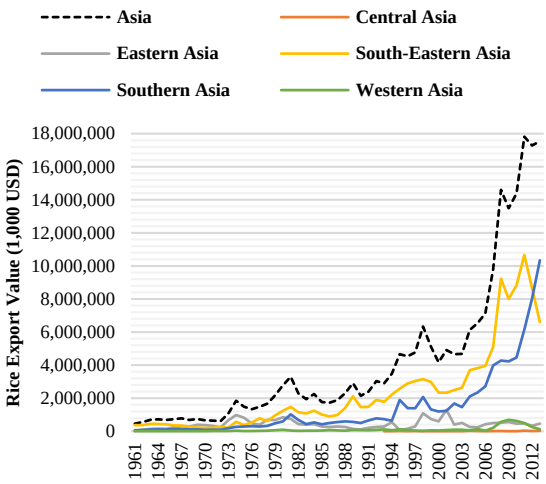
Source: World rice statistics database of IRRI (WRS 2018)

3.2.3. Rice market in Asia

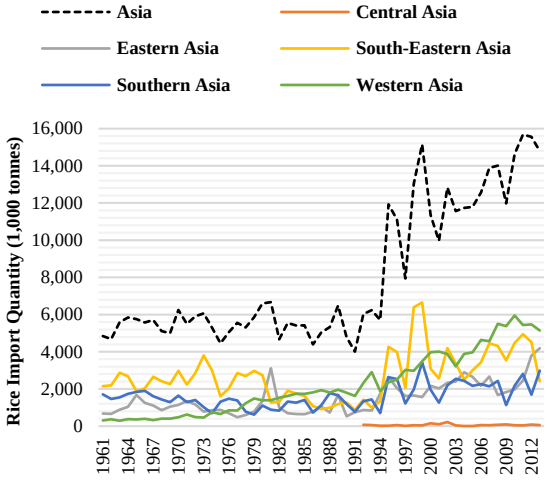
The Southeast and South Asia are the key sources of the worldwide rice exports, which had an enormous trade surplus (totally almost 23.2 million tons in 2013, see **Figure 3.9**). In term of rice imports, the West Asia is the biggest importer of rice, followed by the Southeast Asia. Unsurprisingly, the West Asia is the minor rice producer in Asia, therefore, this region have a huge rice deficit compared to other regions in Asia (**Figure 3.9**). The statistics on rice market in the other continents are given in **Appendix Figure A.5-A.7**.



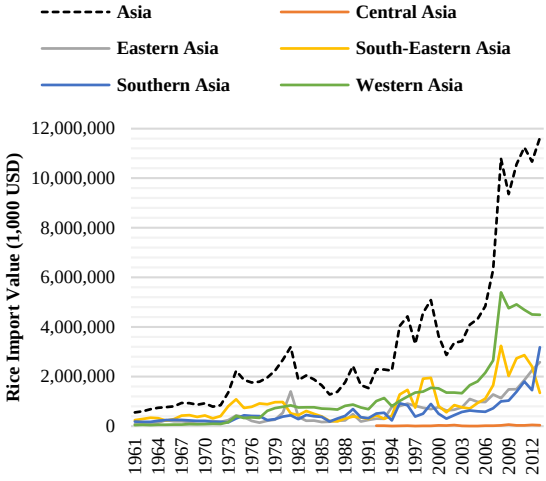
(a) Asian rice export quantity



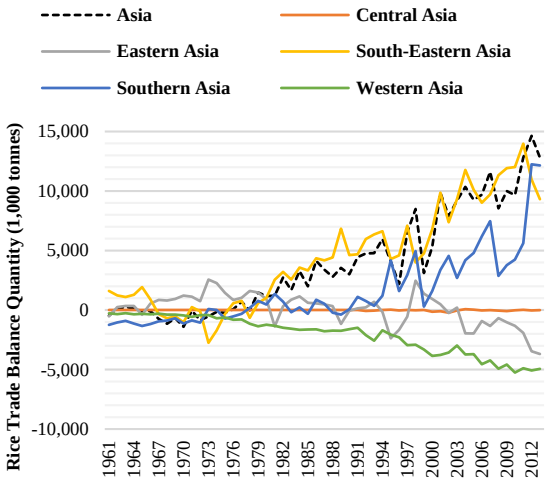
(b) Asian rice export value



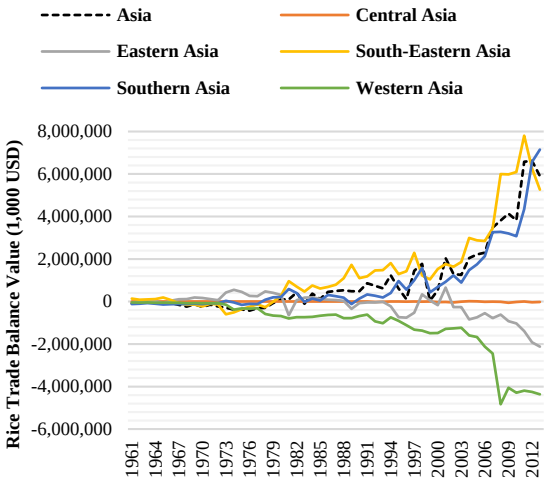
(c) Asian rice import quantity



(d) Asian rice import value



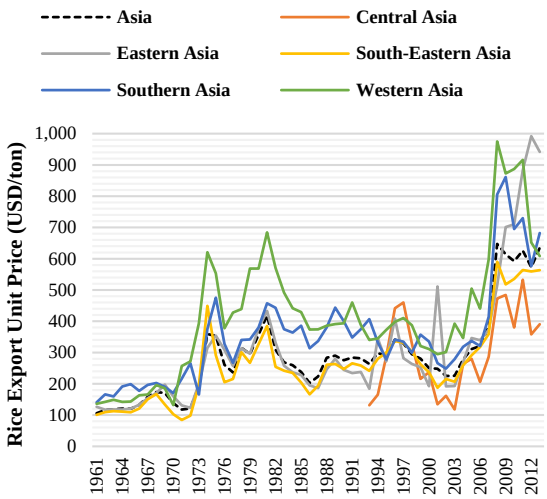
(e) Asian rice trade balance quantity



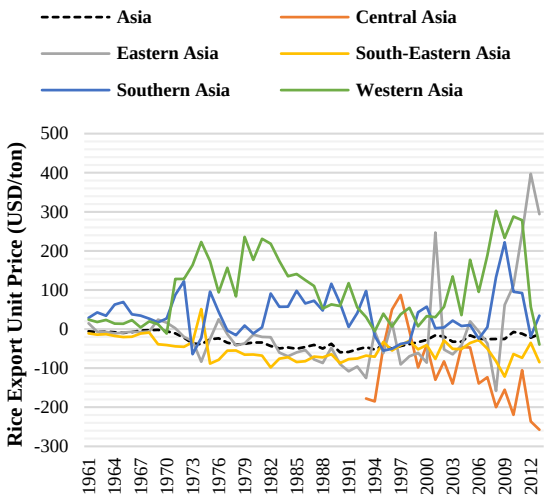
(f) Asian rice trade balance value

Figure 3.9: Asian rice export, import, trade balance, 1961-2013

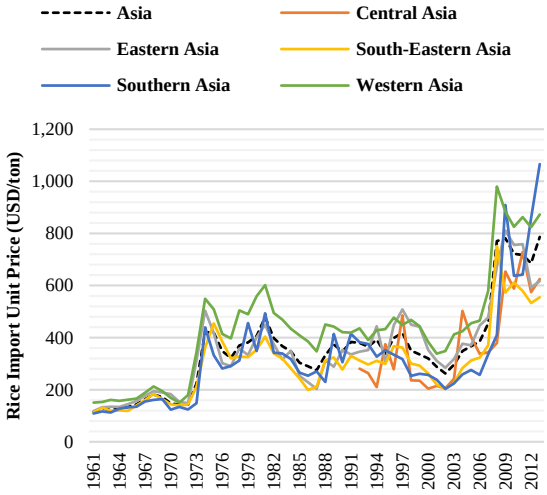
Source: World rice statistics database of IRRI (WRS 2018)



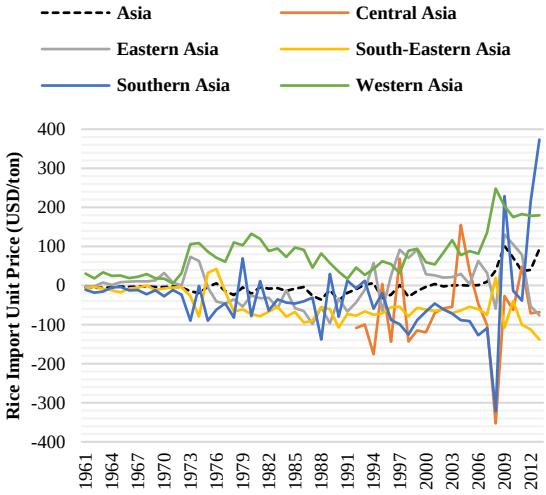
(a) Asian rice export unit price



(b) Export price compare to world average



(c) Asian rice import unit price

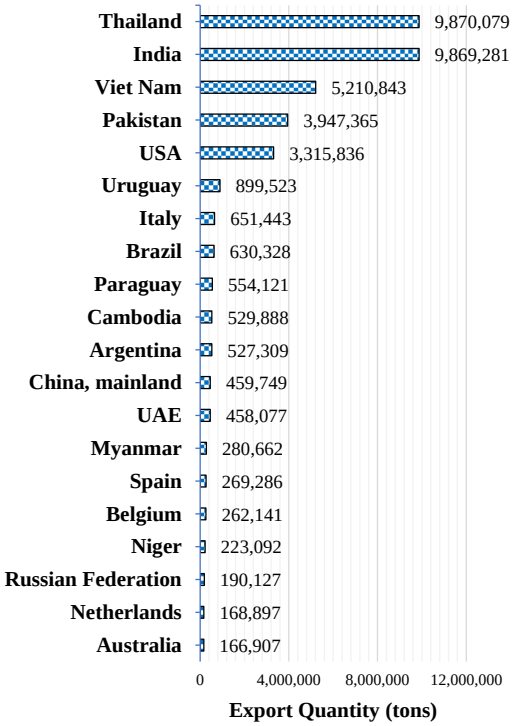


(d) Import price compare to world average

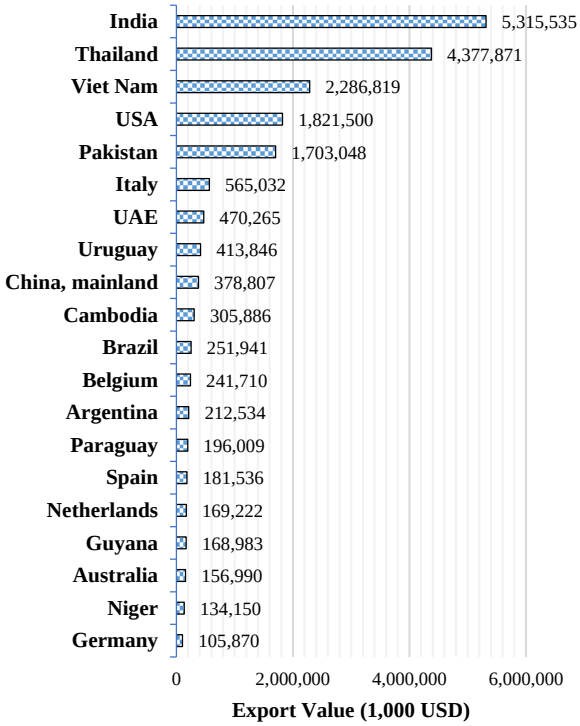
Figure 3.10: Asian's average export and import unit price of rice, 1961-2013

Source: World rice statistics database of IRRI (WRS 2018)

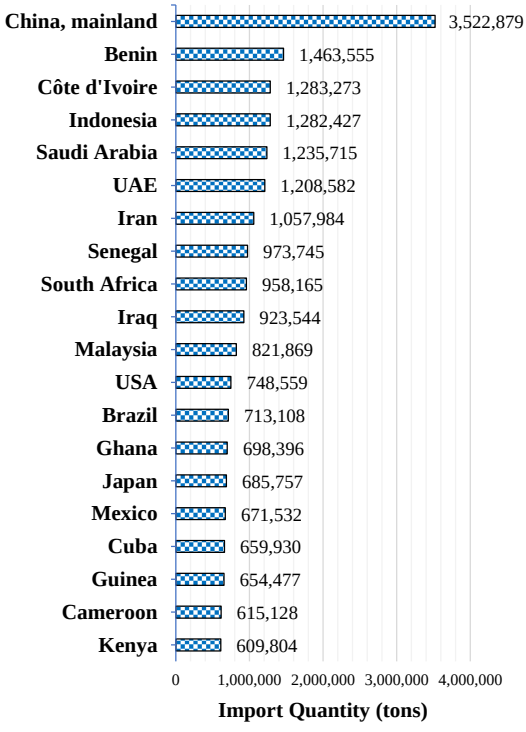
Figure 3.10 revealed that there are three Asian regions, i.e. West Asia, South Asia, and East Asia, that the average export price of rice was higher than the Asian and the world's average for almost throughout the period of 1961-2013. The higher export price of rice in West Asia would be explained by '*re-export*' of rice from other regions, since West Asia is a minor rice producer in Asia. Additionally, the higher export price in South Asia might be explained by the '*high demand*', as it is the world's most densely populated region (24% of the world's population) and rice is the primary foodstuffs for them (Rodgers 2019).



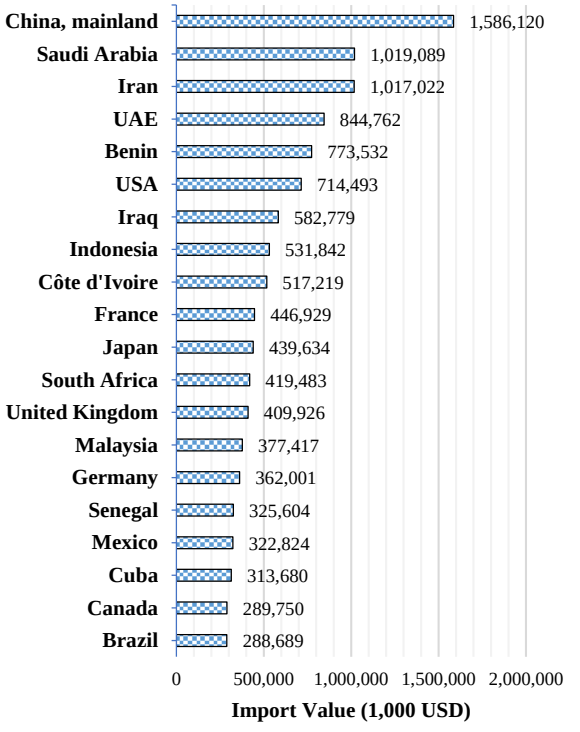
(a) Export quantity (milled rice equivalent)



(b) Export value (milled rice equivalent)



(c) Import quantity (milled rice equivalent)



(d) Import value (milled rice equivalent)

Figure 3.11: World's 20 largest rice exporters and importers, 2016

Source: Own elaboration, using the data from the FAOSTAT (2018)

The situation in the East Asian region, on the other hand, might be able to explained by two factors: (1) the '*high demand*', since China is the world's second populated country, after India. (2) the '*high quality improvement*' of rice varieties, as Japan, China and South Korea can be the cases. If the import price of rice has been considered, **Figure 3.10** also revealed that the West Asia and the Central Asia are having import price higher than the average level (for both Asian's and the world's). The average unit price of rice in Africa, America and Europe are illustrated in **Appendix Figure A.8** and **A.9**.

In term of rice quantity exported, Thailand was the worldwide largest exporter in 2016, while India was the second largest (altogether exported almost 20 million tons of rice to the world market, **Figure 3.11**). The India's exported value of rice in the same year (5.3 billion USD), however, had surpassed the Thailand's (4.4 billion USD) and ranked as the world's largest exporter, indicated that Indian rice (especially, *basmati* rice) could be sold at the higher price than Thai rice. Vietnam was ranked at the third place for both in term of exported quantity and value as the world's largest rice exporter (exported 5.2 million tons in 2016). China PRC (mainland China) is the world's biggest rice importer. In 2016, China had imported rice from the world around 3.5 million tons, which was equivalent to 1.57 billion USD (FAOSTAT 2019).

Cambodia was the Southeast Asia's third largest and the world's tenth largest rice exporter in 2016 (for both in term of exported quantity and value), where the quantity of rice exported surpassed 529 thousand tons (305.9 million USD, see **Figure 3.11)**. The figure also revealed that the exported quantity of rice from Myanmar to the globe reached an amount of 280 thousand tons in 2016, ranked at the fourth place in the region.

3.3. Cambodian Rice Economy

3.3.1. The country's profile

The Kingdom of Cambodia is situated on the coordinates 11°33′N 104°55′E in the southern portion of the Indochina Peninsula in the Southeast Asia, covering 181,035 square kilometers (km^2) of total area i.e. land 97.5% and water 2.5% (Wikipedia 2020). Cambodia is 293-times bigger than Singapore, or almost one-third the size of Thailand (Kea 2017), sharing the geographical borders with Thailand about 803 kilometers (km) to the North and West, Laos 541 km to the North, Vietnam 1,228 km to the East and Southeast, and 440 km of coastal border with the Gulf of Thailand to the Southwest (**Figure 3.12**).

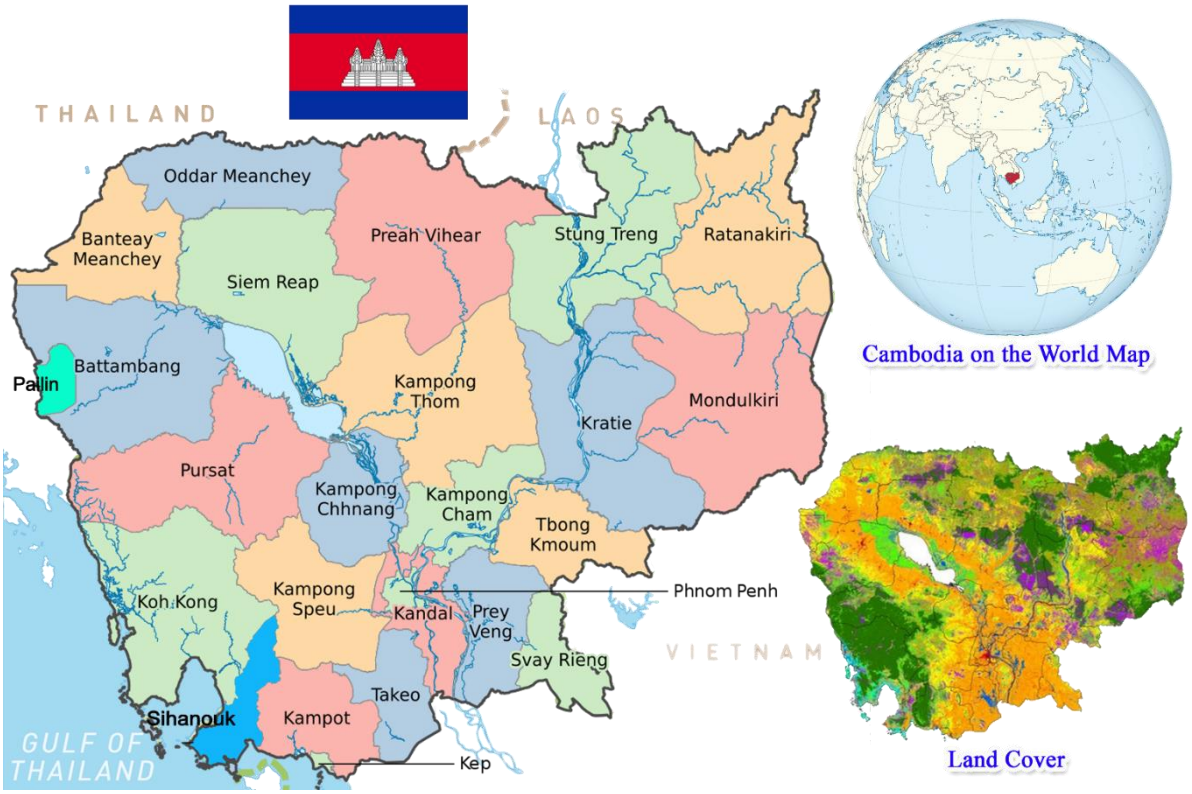


Figure 3.12: Map of Cambodia

Source: Wikipedia (2020) and created by ArcGIS software version 10.2.2.

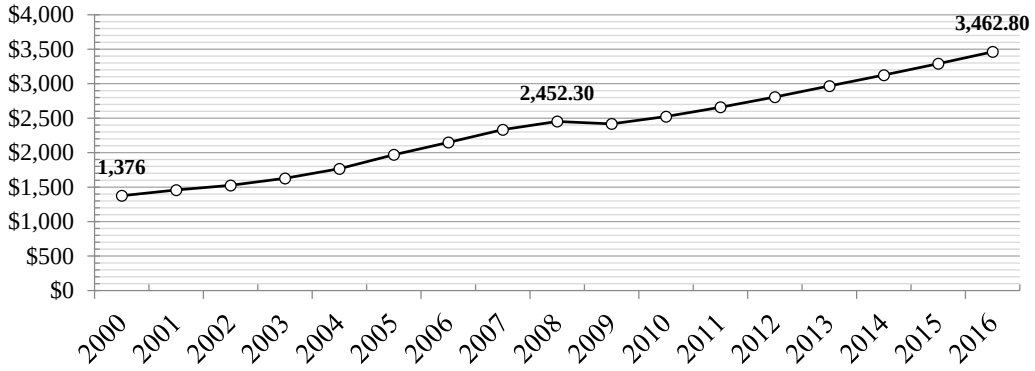
Cambodia is located in *tropical wet* climate zone, which is the agricultural favorable climate condition. It is endowed with a *great fertile plain* central around the *Great Lake* called "*Tonle Sap Lake*", which is a natural storage of *Mekong* river and a largest lake in the Southeast Asia. The size of *Tonle Sap Lake* is 270 km^2 in the dry season and 16,000 km^2 in the wet season (Saing, Hem, Ouch, Phann and Pon 2012). The *central plain* is a large fertile land ringed by the mountain ranges (*Dorngraek* and *Kravanh*).

Cambodia is categorized into six geographical regions (see, **Table 3.1**). The major regions for rice cultivation are the '*Tonle Sap river plain*' (famous for *rainy* season rice, well-known as the "*Rice Basket*" of Cambodia) and the '*Mekong river plain*' (leading in *dry* season rice production). The *Tonle Sap river plain* covered all provinces around the *Tonle Sap lake* (34.5% of total land area). The *Mekong river plain* occupied 12.4% in land area, covered all provinces in the lower *Mekong* river basin from the Capital of Phnom Penh to the border of Cambodia-Vietnam. Plenty water resources, rich availability of irrigation systems, and favorable land type in this region had promoted the populations to crop multiple times per year, allows this region to be a leading *dry* season rice production area of the kingdom.

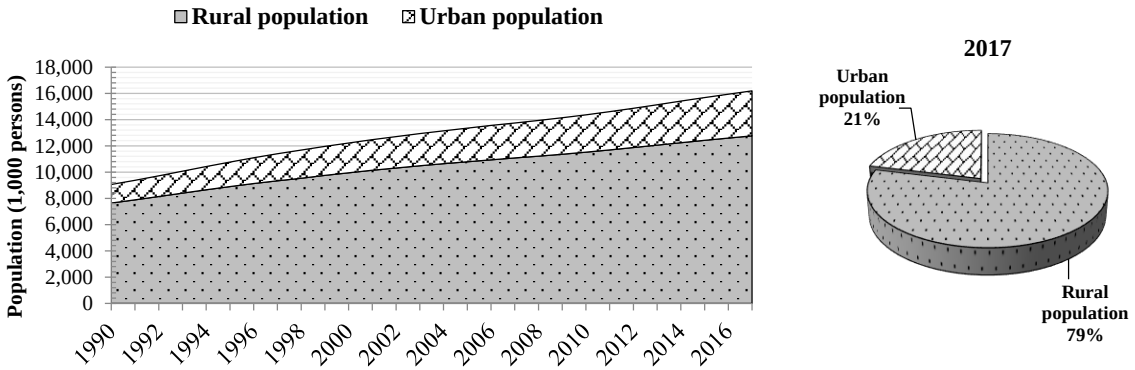
Table 3.1: Geographical regions in Cambodia

Nº	Region	Area (km²)	%Area
1	**Municipality:** Phnom Penh	678.46	0.38 %
2	**Tonle Sap plain:** 7 provinces Banteay Meanchey, Battambang, Kampong Chhnang, Kampong Thom, Pailin, Pursat, and Siem Reap	61,510	34.54 %
3	**Mekong plain:** 5 provinces Kampong Speu, Kandal, Prey Veng, Svay Rieng, Takéo	21,997	12.35 %
4	**Mekong plateau:** 4 provinces Kampong Cham, Kratié, Stung Treng, Tbong Kmom*	31,663	17.78 %
5	**Mountain region:** 4 provinces Mondulkiri, Ratanakiri, Preah Vihear, Otdar Meanchey	45,016	25.28 %
6	**Coastal region:** 4 provinces Kampot, Koh Kong, Kep, and Preah Sihanouk	17,237	9.68 %

Source: Kea (2017)[24]; **Note:** * A new province created in 2013 divided from Kampong Cham.



(a) GDP per capita, PPP (constant 2011 price)



(b) Population

Figure 3.13: Economic indicators of Cambodia, 1990-2017

Source: Own elaboration, using data from FAOSTAT (2018) and UNCTAD (2019)

Although population had surpassed 16 million in 2017, the urban-rural ratio still not greatly fluctuated. The greatest Cambodian people still living in the rural area, with the agro-based livelihood (especially, rice sector, **Figure 3.13**). Agriculture was a largest sector of the Cambodian economy, accounting for 45-50% of real GDP. Its rice production had enlarged steadily and Cambodia were able to change the position from a '*food deficit*' to '*self-sufficient*' nation which could be guarantee for fulfilling its own food demand, due to result of relaxing in internal political conflicts and policies reforms (Nesbitt 1997 , Sareth 2015). In 2004, the country was turned out to be a '*net*' exporters of rice in the region. The per capita income of Cambodian have been increasing from almost 1,500 USD/year in 2000 to approximately 3,500 USD/year in 2016 (**Figure 3.13**).

3.3.2. Rice production in Cambodia

Cambodian rice economy has some turns and twists due to the domestic and international political instabilities (**Figure 3.14**). The country successfully gained its independence on November 9, 1953 after experienced almost 90 years of the French colonial rule (1863-1953). It was subsequently pulled into the *French-Indochina war 1947–1954* and the US bombardments during the *US-Vietnam war 1955–1975* (Hill and Menon 2013 , Hill and Menon 2014 , Soeng and Cuyvers 2018).

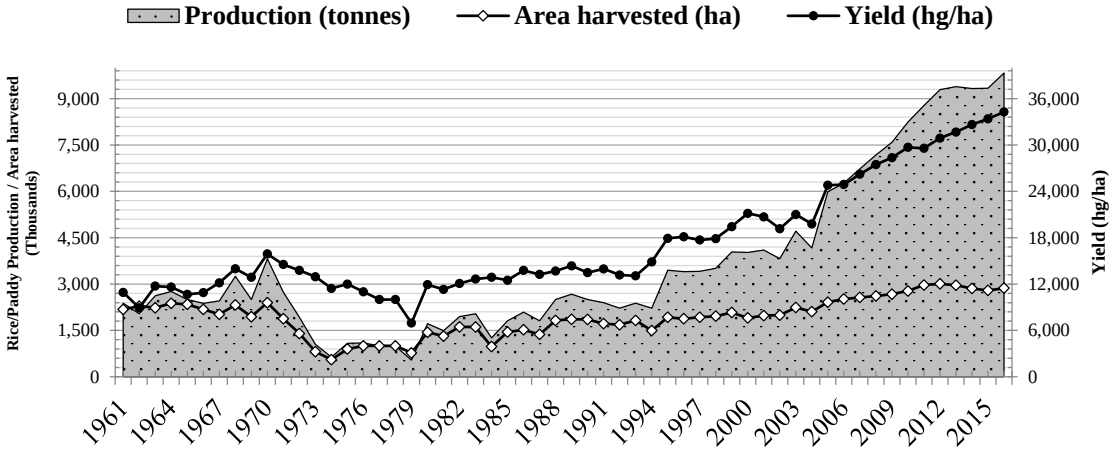


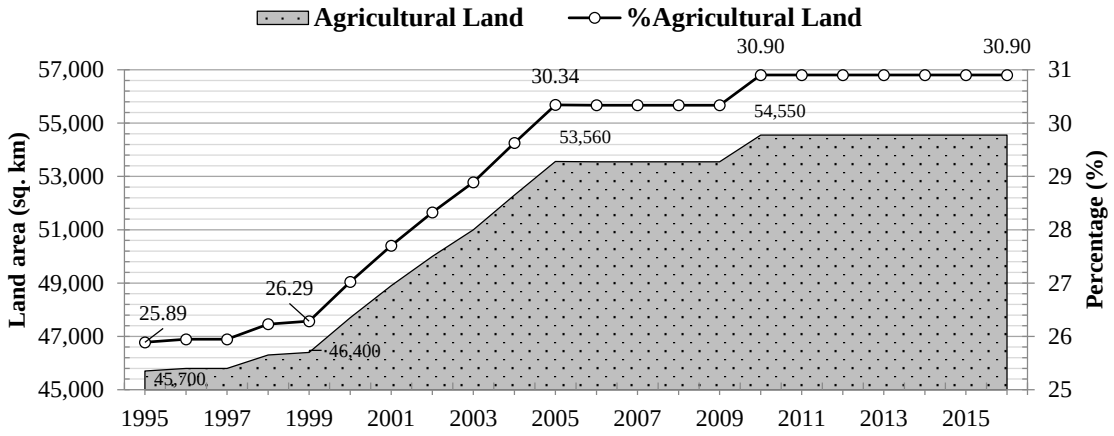
Figure 3.14: Cambodia rice production 1961-2016

Source: Own elaboration, using data from FAOSTAT (2019)

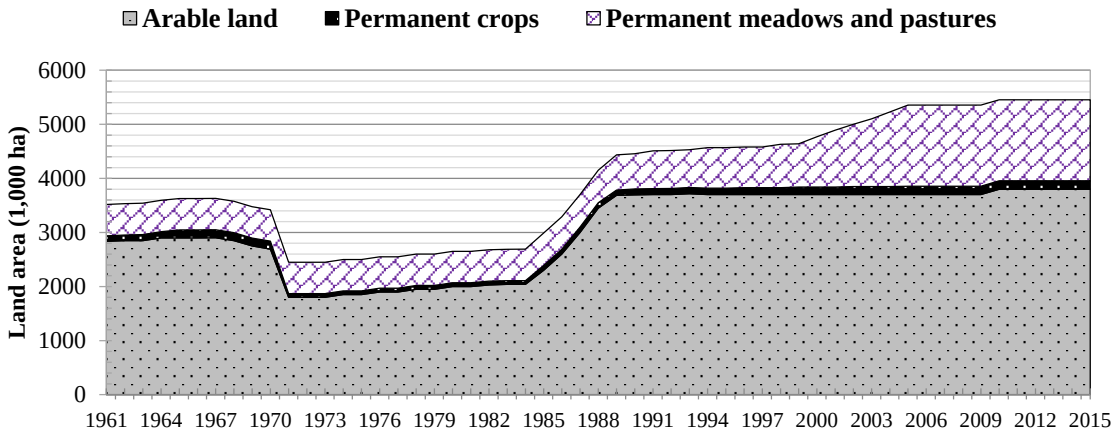
In the 1960s, Cambodia used to be the extensively recognized as one of the "*Rice Basket*" of the Southeast Asia and also a leading rice exporter worldwide (Sareth 2015). The *coups d'état* in 1970 of the *General Lon Nol*, however, had put Cambodia into the civil war

that lasted for a period of three decades (1970s-1990s). As a consequence, the production of rice dropped dramatically from 3.8 to only 0.6 million tons between 1970-1974.

The *communist era* in Cambodia (1970s-1990s) was started by the *Khmer Rouge* regime (1975–1979), known as the "genocidal killings and violence" era. An estimated two million people were killed or died of hungers, diseases or forced overworks and the large proportions of the national's infrastructures and institutions (included, roads, bridges, buildings, financial, educational and health systems, etc.) were almost destroyed before the demission of the regime on January 7, 1979 (Turner, Korm and Veara 2017 , Delano and Knottnerus 2018 , Soeng and Cuyvers 2018). The harshly dropped in the agricultural land and labor force resulted in sharply decreased in rice production to the bottom-level since its independence (in 1953).



(a) Total agricultural land, 1995-2016



(b) Agricultural land use, 1961-2015

Figure 3.15: Agricultural land of Cambodia, 1961-2016

Source: Own elaboration, using data from WDI (2018) and FAOSTAT (2018)

Cambodia conducted its first national reforms in 1989. However, Cambodia continued to suffer from the international burden and embargo until the '*Paris Peace Accord*' in 1991. The ending of the *Cambodian communist era* in 1993 (first election), had leaded to the '*open the door*' economy, which brought the great changes in this nation's economy. However, Cambodia had to recover its economic foundations from the '*zero-stage*' through foreign aids and international trade integration. Since then, *trade* had recognized as the core driver for growths, due to the hidden trade potential, particularly agriculture trade (Sanjuán-López and Dawson 2010 , Atif, Haiyun and Mahmood 2017 , Mahmood and Munir 2017).

After the second national election in 1998, Cambodia national-wide came into totally peace (Roberts and Bilginsoy 2016). The work of mines and un-explosive elements clearance started in the subsequent year, leaded to an expansion of cultivated land proportion in Cambodia from 46.4 to 53.5 thousand km^2 between 1999-2005.

Almost 31% of the Cambodian land resources was covered by agricultural land (FAOSTAT 2018). Arable land shared a large percentage ($\approx$70%) of agro-land, while *permanent meadows and pastures* land area accounted for another 27% (**Figure 3.15**). Applications of the *Nitrogen* (N) nutrient had increased notably in the recent year (particularly, between 2010-2014), while there was not much fluctuated for the consumptions of the *Phosphate* (P_2O_5) nutrient (**Figure 3.16**). Moreover, the consumptions of the *Potash* (K_2O) nutrient still remaining in the lowest proportion compared to *N* and P_2O_5.

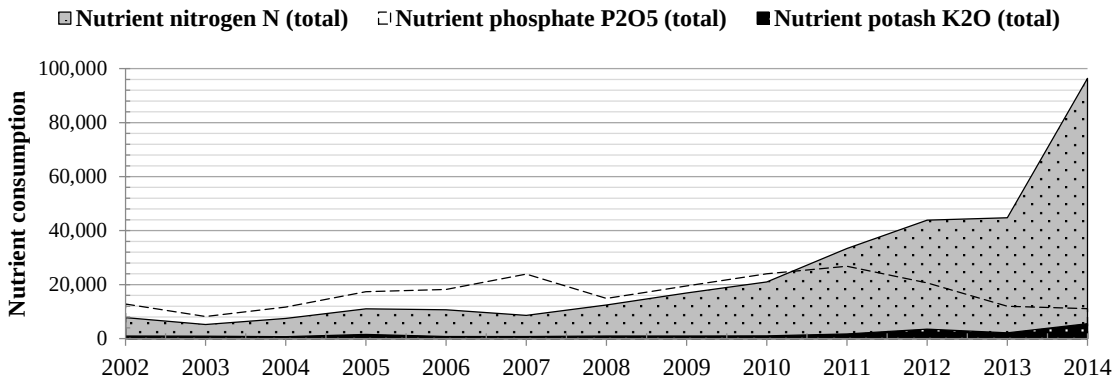
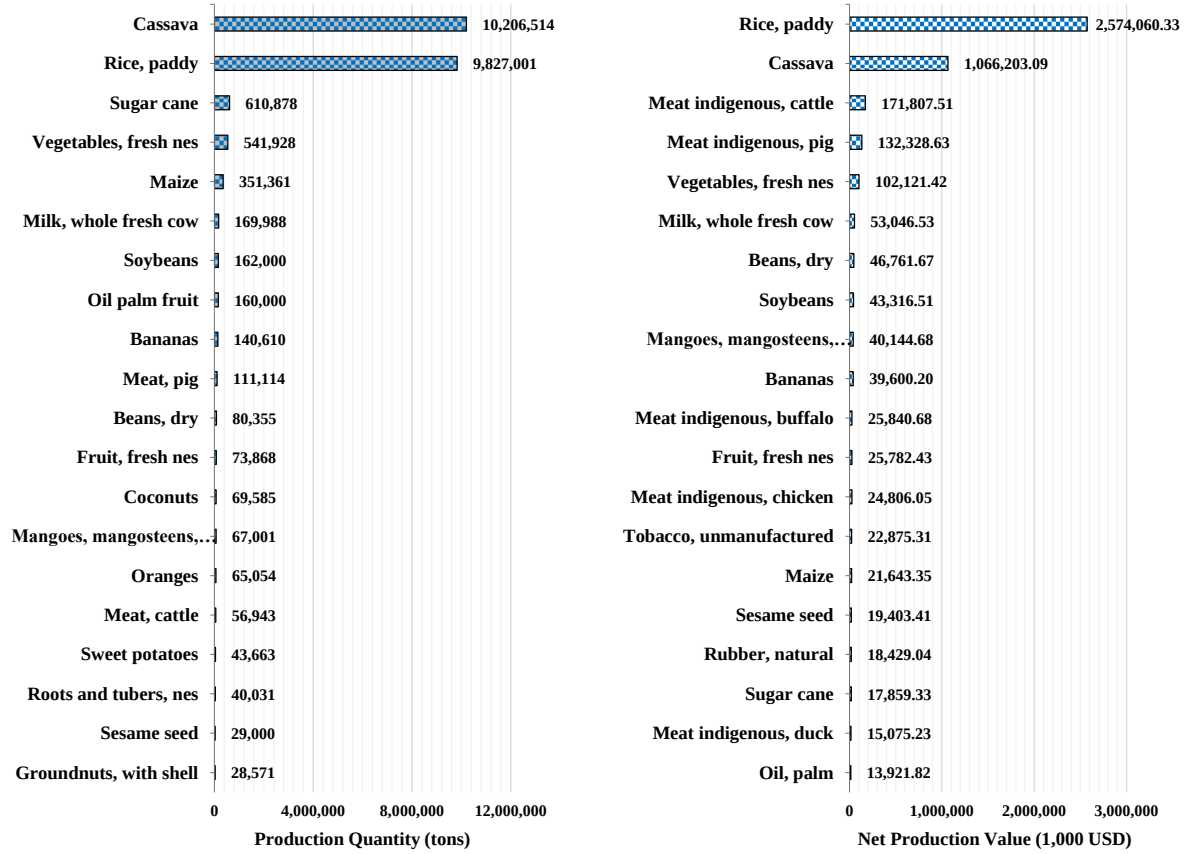


Figure 3.16: Agricultural fertilizer consumption in nutrients 2002-2014

Source: Own elaboration, using data from FAOSTAT (2018)

As one of the most vital crops in the Cambodian society, the production of rice reached 9.83 million tons in 2016 (equivalent to 2.6 billion USD, see **Figure 3.17**). The province of

Prey Veng and *Takéo* are famous for the production of *dry* season rice (or "*Srov Praing*" in Khmer language), while *Battambang* province is well-known as the '*Rice Bowl*' of Cambodia famous for *rainy* season rice (i.e. "*Srov Vorsa*" in Khmer). *Srov Vorsa* occupied about 3/4 of total rice production (MAFF 2016). The statistics of provincial rice production in Cambodia, are given in **Table 3.2-3.4**.



(a) Production quantity (b) Net production value

Figure 3.17: The production of 20 major agro-products of Cambodia, 2016

Source: Own elaboration, using data from FAOSTAT (2019)

3.3.3. Rice Consumption in Cambodia

On the period of 2006-2015 (10-years), rice cultivated area in Cambodia increased from 2.54 million hectares (2006) to 3.05 million hectares (2015), see **Table 3.5**. Production of rice increased from 6.26 million tons (2006) to 9.34 million tons (2015). Annual average consumption was approximately 2.1 million tons/year (2.05 million tons in 2006 increased to 2.2 million tons in 2015). The table also indicated that the average (milled) rice surplus was 2.5 million tons/year (enlarged from 1.4 to 3 million tons between 2006-2015).

Table 3.2: Annual provincial production of rice in Cambodia, 2010-2015

№	Provinces	Area (km²)	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	Average	Rank
1	Banteay Meanchey	6,679	629,686	633,358	608,412	628,869	699,326	710,720	651,729	6
2	Battambang	11,702	799,605	785,351	881,773	795,611	766,143	861,506	814,998	**3**
3	Kampong Cham	4,549	769,399	776,108	781,717	780,282	467,823	412,692	664,670	**4**
4	Kampong Chhnang	5,521	386,660	449,216	503,187	511,458	511,858	493,324	475,951	9
5	Kampong Speu	7,017	300,053	357,613	343,789	357,370	308,818	339,617	334,543	13
6	Kampong Thom	13,814	540,636	549,071	688,400	691,389	725,267	723,228	652,999	**5**
7	Kampot	4,873	401,454	428,566	437,998	454,245	436,704	470,014	438,164	10
8	Kandal	3,568	387,878	394,323	400,021	398,376	402,895	343,284	387,796	11
9	Koh Kong	11,160	23,679	25,262	26,947	28,866	29,031	29,659	27,241	23
10	Kratié	11,094	130,686	136,772	155,236	149,454	148,107	142,090	143,724	17
11	Mondulkiri	14,288	37,132	57,721	45,782	56,798	54,068	54,289	50,965	20
12	Phnom Penh	678.46	13,566	35,094	37,537	39,827	36,639	35,964	33,105	22
13	Preah Vihear	13,788	116,978	145,307	163,215	213,758	209,304	229,417	179,663	15
14	Prey Veng	4,883	1,098,348	1,153,782	1,194,432	1,260,911	1,257,545	1,266,426	1,205,241	**1**
15	Pursat	12,692	311,783	308,422	416,011	389,612	386,653	379,162	365,274	12
16	Ratanakiri	10,782	65,858	72,004	66,047	55,510	63,453	52,693	62,594	19
17	Siem Reap	10,299	520,497	544,513	559,231	560,109	551,854	539,486	545,948	7
18	Preah Sihanouk	868	37,211	38,764	50,235	48,625	46,885	45,689	44,568	21
19	Stung Treng	11,092	62,628	75,490	73,680	65,483	73,121	74,794	70,866	18
20	Svay Rieng	2,966	469,320	505,499	522,331	539,202	541,620	528,672	517,774	8
21	Takéo	3,563	967,546	1,105,031	1,147,194	1,161,479	1,115,722	1,126,470	1,103,907	**2**
22	Otdar Meanchey	6,158	145,345	163,977	150,876	164,011	151,450	158,925	155,764	16
23	Kep	336	9,608	10,653	11,282	11,414	11,418	11,699	11,012	25
24	Pailin	803	23,896	27,468	25,607	27,302	21,284	15,124	23,447	24
25	Tbong Kmom *	4,928	-	-	-	-	307,428	290,340	298,884	14

Source: Data on area gathered from Kea (2017)[23]. Data on production gathered from various reports of MAFF (MAFF 2011 , MAFF 2012 , MAFF 2013 , MAFF 2014 , MAFF 2015 , MAFF 2016). **Note:** Unit in tons. * Tbong Kmom: a new province created in 2013 by divided from Kampong Cham province.

Table 3.3: Annual provincial harvested area of rice in Cambodia, 2010-2015

Nº	Provinces	Area (km²)	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	Average	Rank
1	Banteay Meanchey	6,679	224,930	219,051	228,878	218,743	254,904	258,149	234,109	**5**
2	Battambang	11,702	279,231	265,620	303,857	280,634	297,089	294,959	286,898	**3**
3	Kampong Cham	4,549	217,853	210,886	218,868	219,593	129,972	118,788	185,993	7
4	Kampong Chhnang	5,521	129,024	136,341	156,117	154,363	157,361	156,608	148,302	9
5	Kampong Speu	7,017	111,452	114,980	114,045	116,269	108,273	112,935	112,992	12
6	Kampong Thom	13,814	213,288	199,316	251,597	251,630	257,613	257,424	238,478	**4**
7	Kampot	4,873	132,300	137,972	140,357	144,810	141,623	146,274	140,556	10
8	Kandal	3,568	105,891	103,455	107,851	105,919	105,285	90,861	103,210	13
9	Koh Kong	11,160	9,057	9,421	9,843	10,353	10,401	10,405	9,913	23
10	Kratié	11,094	44,258	42,886	46,893	45,200	45,771	45,624	45,105	19
11	Mondulkiri	14,288	17,382	22,031	20,027	22,893	22,730	22,929	21,332	20
12	Phnom Penh	678.46	4,650	12,177	12,919	13,581	12,717	12,273	11,386	22
13	Preah Vihear	13,788	44,965	54,106	59,881	74,469	74,431	83,406	65,210	18
14	Prey Veng	4,883	353,275	345,460	358,917	371,092	364,778	364,224	359,624	**1**
15	Pursat	12,692	112,254	96,904	121,282	114,416	119,684	119,665	114,034	11
16	Ratanakiri	10,782	26,343	27,695	27,623	25,197	25,918	261,022	65,633	17
17	Siem Reap	10,299	195,235	184,985	198,700	197,105	201,810	206,205	197,340	6
18	Preah Sihanouk	868	14,042	14,055	16,070	16,483	16,567	16,614	15,639	21
19	Stung Treng	11,092	25,773	25,897	26,910	25,429	26,960	281,747	68,786	15
20	Svay Rieng	2,966	183,418	183,761	187,380	186,713	186,464	187,605	185,890	8
21	Takéo	3,563	264,708	285,671	295,275	298,098	296,739	295,843	289,389	**2**
22	Otdar Meanchey	6,158	58,031	62,981	66,090	64,521	71,974	72,150	65,958	16
23	Kep	336	3,100	3,330	3,530	3,550	3,506	3,620	3,439	25
24	Pailin	803	6,863	7,636	7,387	7,906	7,124	5,607	7,087	24
25	Tbong Kmom *	4,928	-	-	-	-	89,142	88,693	88,918	14

Source: Data on area gathered from Kea (2017)[23]. Data on production gathered from various reports of MAFF (MAFF 2011 , MAFF 2012 , MAFF 2013 , MAFF 2014 , MAFF 2015 , MAFF 2016). **Note:** Unit in hectares. * Tbong Kmom: a new province created in 2013 by divided from Kampong Cham province.

Table 3.4: Annual provincial rice production yield in Cambodia, 2010-2015

Nº	Provinces	Area (km²)	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	Average	Rank
1	Banteay Meanchey	6,679	2.799	2.891	2.658	2.875	2.743	2.753	2.79	16
2	Battambang	11,702	2.864	2.957	2.902	2.835	2.579	2.921	2.84	15
3	Kampong Cham	4,549	3.532	3.680	3.572	3.553	3.599	3.474	3.57	**3**
4	Kampong Chhnang	5,521	2.997	3.295	3.223	3.313	3.253	3.150	3.21	7
5	Kampong Speu	7,017	2.692	3.110	3.015	3.074	2.852	3.007	2.96	12
6	Kampong Thom	13,814	2.535	2.755	2.736	2.748	2.815	2.809	2.73	21
7	Kampot	4,873	3.034	3.106	3.121	3.137	3.084	3.213	3.12	11
8	Kandal	3,568	3.663	3.812	3.709	3.761	3.827	3.778	3.76	**2**
9	Koh Kong	11,160	2.614	2.681	2.738	2.788	2.791	2.850	2.74	19
10	Kratié	11,094	2.953	3.189	3.310	3.307	3.236	3.114	3.18	10
11	Mondulkiri	14,288	2.136	2.620	2.286	2.481	2.379	2.368	2.38	23
12	Phnom Penh	678.46	2.917	2.882	2.906	2.933	2.881	2.930	2.91	13
13	Preah Vihear	13,788	2.602	2.686	2.726	2.870	2.812	2.751	2.74	20
14	Prey Veng	4,883	3.109	3.340	3.328	3.398	3.447	3.477	3.35	**5**
15	Pursat	12,692	2.777	3.183	3.430	3.405	3.231	3.169	3.20	9
16	Ratanakiri	10,782	2.500	2.600	2.391	2.203	2.448	2.025	2.36	25
17	Siem Reap	10,299	2.666	2.944	2.814	2.842	2.735	2.616	2.77	18
18	Preah Sihanouk	868	2.650	2.758	3.126	2.950	2.830	2.750	2.84	14
19	Stung Treng	11,092	2.430	2.915	2.738	2.575	2.712	2.602	2.66	22
20	Svay Rieng	2,966	2.559	2.751	2.788	2.888	2.905	2.818	2.78	17
21	Takéo	3,563	3.655	3.868	3.885	3.896	3.760	3.808	3.81	**1**
22	Otdar Meanchey	6,158	2.505	2.604	2.283	2.542	2.104	2.203	2.37	24
23	Kep	336	3.099	3.199	3.196	3.215	3.257	3.232	3.20	8
24	Pailin	803	3.482	3.597	3.466	3.453	2.988	2.697	3.28	6
25	Tbong Kmom *	4,928	-	-	-	-	3.449	3.274	3.36	**4**

Source: Data on area gathered from Kea (2017)[23]. Data on production gathered from various reports of MAFF (MAFF 2011 , MAFF 2012 , MAFF 2013 , MAFF 2014 , MAFF 2015 , MAFF 2016). **Note:** Unit in tons per hectare. * Tbong Kmom: a new province created in 2013 by divided from Kampong Cham province.

Table 3.5: The 10-year rice production of Cambodia, 2006-2015

Indicators	Unit	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average
Cultivated Area	**ha**	**2,541,433**	**2,585,905**	**2,615,741**	**2,719,080**	**2,795,892**	**2,968,529**	**3,007,545**	**3,052,420**	**3,055,507**	**3,051,412**	**2,839,346**
Rainy season	ha	2,212,015	2,241,114	2,255,104	2,334,228	2,391,016	2,496,569	2,512,038	2,567,723	2,564,572	2,561,957	2,413,634
Dry season	ha	329,418	344,791	360,637	384,852	404,876	471,960	495,507	484,697	490,935	489,455	425,713
Harvested Area	**ha**	**2,516,415**	**2,566,952**	**2,613,363**	**2,674,603**	**2,777,323**	**2,766,617**	**2,980,297**	**2,968,967**	**3,028,836**	**3,025,630**	**2,791,900**
Rainy season	ha	2,188,726	2,222,596	2,252,733	2,290,552	2,372,519	2,294,784	2,484,832	2,485,521	2,537,976	2,536,175	2,366,641
Dry season	ha	327,689	344,356	360,630	384,051	404,804	471,833	495,465	483,446	490,860	489,455	425,259
Production Yield	**tons / ha**	**2.489**	**2.621**	**2.746**	**2.836**	**2.970**	**3.173**	**3.117**	**3.163**	**3.079**	**3.085**	**2.928**
Rainy season	tons / ha	2.272	2.413	2.540	2.620	2.760	2.920	2.872	2.925	2.815	2.827	2.696
Dry season	tons / ha	3.938	3.959	4.030	4.126	4.201	4.406	4.349	4.383	4.443	4.422	4.226
Annual Production Quantity	**tons**	**6,264,123**	**6,727,127**	**7,175,473**	**7,585,870**	**8,249,452**	**8,779,365**	**9,290,940**	**9,389,961**	**9,324,416**	**9,335,284**	**8,212,201**
Rainy season	tons	4,973,694	5,363,690	5,722,142	6,001,385	6,548,709	6,700,439	7,136,139	7,271,251	7,143,521	7,170,684	6,403,165
Dry season	tons	1,290,429	1,363,437	1,453,331	1,584,485	1,700,743	2,078,926	2,154,801	2,118,710	2,180,896	2,164,600	1,809,036
Annual Consumption	**tons**	**2,053,983**	**2,096,025**	**1,970,270**	**1,979,214**	**2,076,542**	**2,108,022**	**2,142,178**	**2,137,878**	**2,178,050**	**2,222,078**	**2,096,424**
Rice Surplus (milled rice)	**tons**	**1,433,880**	**1,649,640**	**2,025,033**	**2,244,598**	**2,516,752**	**2,780,328**	**3,031,017**	**3,090,452**	**3,013,783**	**2,975,809**	**2,476,129**
Rice Surplus (un-milled rice)	**tons**	**2,240,438**	**2,577,562**	**3,164,114**	**3,507,185**	**3,932,425**	**4,344,263**	**4,735,964**	**4,828,832**	**4,709,036**	**4,649,702**	**3,868,952**

Source: Ministry of Agriculture, Forestry and Fisheries (MAFF 2016 [85]).

Table 3.6: Annual milled rice consumption in Cambodia, 2010-2015 (tons)

Nº	Provinces	Area (km²)	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	Average	Rank
1	Banteay Meanchey	6,679	106,623	108,790	110,975	105,862	107,418	109,098	108,128	10
2	Battambang	11,702	161,067	164,227	167,417	163,175	166,096	169,170	165,192	**4**
3	Kampong Cham	4,549	249,543	249,561	249,475	253,544	146,338	147,756	216,036	**2**
4	Kampong Chhnang	5,521	73,311	74,417	75,503	76,352	77,917	79,615	76,186	14
5	Kampong Speu	7,017	109,799	110,926	112,017	109,166	110,312	111,571	110,632	8
6	Kampong Thom	13,814	95,649	96,274	96,860	100,496	102,295	104,227	99,300	11
7	Kampot	4,873	87,703	88,080	88,496	88,205	88,963	89,829	88,546	12
8	Kandal	3,568	195,061	160,875	173,016	160,301	161,022	161,848	168,687	**3**
9	Koh Kong	11,160	19,026	19,596	18,104	17,623	17,764	18,007	18,353	21
10	Kratié	11,094	50,131	51,087	52,035	49,963	50,718	51,584	50,920	16
11	Mondulkiri	14,288	10,094	10,450	10,813	10,754	11,127	11,614	10,809	24
12	**Phnom Penh**	**678.46**	**224,623**	**271,096**	**271,289**	**247,039**	**252,820**	**258,836**	**254,284**	**1**
13	Preah Vihear	13,788	26,528	26,926	27,328	35,802	38,082	40,609	32,546	19
14	Prey Veng	4,883	140,235	140,256	140,311	172,014	178,877	186,115	159,635	**5**
15	Pursat	12,692	60,876	61,610	64,905	63,443	64,616	65,913	63,561	15
16	Ratanakiri	10,782	23,786	24,254	24,725	27,317	28,407	29,641	26,355	20
17	Siem Reap	10,299	142,958	146,431	149,904	132,752	133,522	134,397	139,994	6
18	Preah Sihanouk	868	35,372	36,273	39,260	36,649	37,543	38,560	37,276	17
19	Stung Treng	11,092	17,554	17,899	18,258	17,893	18,233	18,680	18,086	22
20	Svay Rieng	2,966	71,539	71,607	71,701	85,694	88,788	92,094	80,237	13
21	Takéo	3,563	125,531	125,744	126,005	134,393	136,785	139,320	131,296	7
22	Otdar Meanchey	6,158	31,286	32,511	33,733	34,541	36,058	37,741	34,312	18
23	Kep	336	5,740	5,923	6,126	5,622	5,710	5,901	5,837	25
24	Pailin	803	12,506	13,210	13,922	9,279	9,151	9,378	11,241	23
25	Tbong Kmom *	4,928	-	-	-	-	109,488	110,574	110,031	9

Source: Ministry of Agriculture, Forestry and Fisheries (MAFF 2011 , MAFF 2012 , MAFF 2013 , MAFF 2014 , MAFF 2015 , MAFF 2016).
Note: * Tbong Kmom: a new province created in 2013 by divided from Kampong Cham province.

At the provincial level, the capital city of *Phnom Penh* ranked at the first area of the highest average rice consumption between 2010-2015 (from 224,623 tons to 258,836 tons), followed by *Kampong Cham* province (249,543 tons to 147,756 tons) [6], *Kandal* province (195,061 tons to 89,829 tons) and *Battambang* province (161,067 tons to 169,170 tons), see further **Table 3.6**.

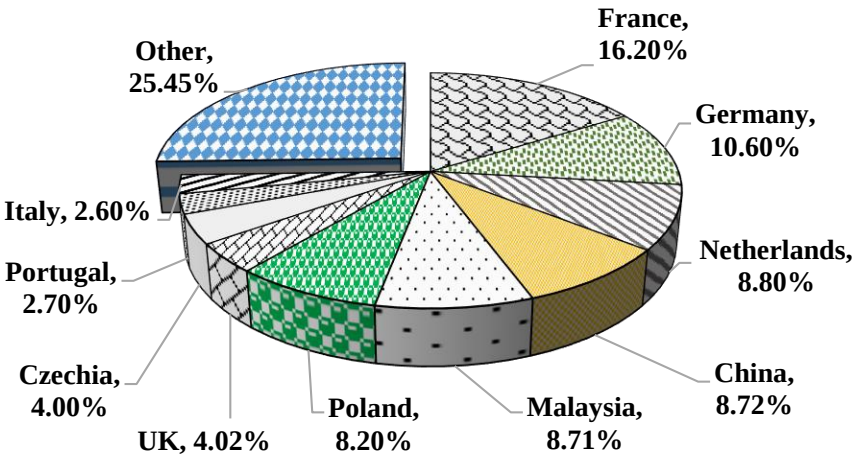
3.3.4. Rice Market of Cambodia

Rice and milled rice are the foremost exportable agro-commodities. UNCTAD (2019) revealed that Cambodia had currently exported its rice commodities to in total of 92 countries/economies worldwide. In 1995, Cambodia exported rice to only three countries, i.e. Indonesia (2,083,116 USD), Qatar (10,368 USD) and Russian Federation (6,962 USD). Fifteen years later (in 2010), the countries imported rice from Cambodia had increased to 28 countries, included Australia, Angola, Belarus, Belgium, Canada, China, Czechia (or Czech Republic), Estonia, France, Gambia, Germany, Italy, Latvia, Lithuania, Malaysia, Netherland, Niue, Poland, Portugal, Russian Federation, Singapore, Spain, Sweden, Thailand, Togo, UK, USA, and Vietnam with total rice export of almost 40 million USD. More interestingly, in 2016 (just six years later), Cambodian rice commodities had exported to more than 70 countries around the world.

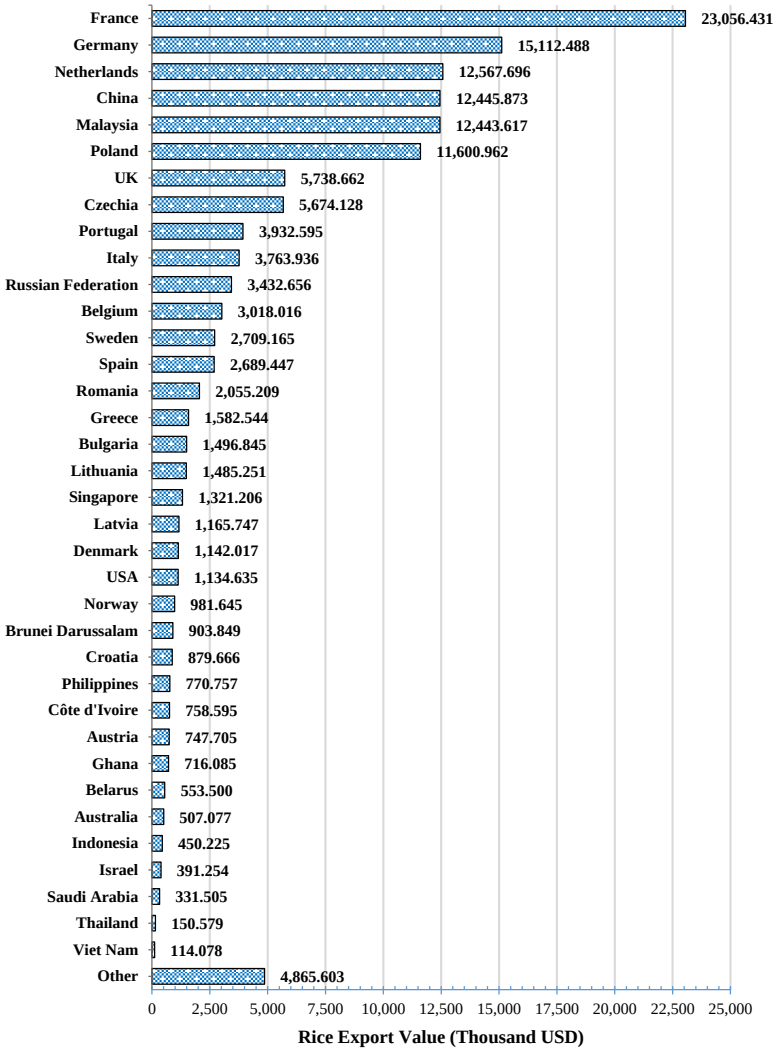
On the basis of Cambodia's average export values of rice between 1995-2016, a ranking of its export destinations is shown in **Figure 3.18**. The European Union (EU) is the biggest international market for the Cambodian rice exports, where France, Germany, Netherlands, and Poland are the major export destinations (over 62 million USD annually, accounted for 44% of the entire market share).

Figure 3.19 illustrated the export trends of the Cambodian rice to its 10 largest regular partners between 2000-2016. It is revealed that after the 2008 economic recession, France is the largest regular rice trading partner of Cambodia (80 thousand tons in 2016), followed by Poland (60 thousand tons) and Netherlands (40 thousand tons). The China (included, mainland China, Hong Kong, Macao and Taiwan) had progressively turned into another major international market for Cambodian rice, which increased forcefully from lower than 30 to over 125.2 thousand tons between 2013 and 2016.

[6] In 2013, while *Kampong Cham* province was sub-divided into two new provinces, the total rice consumption of rice in *Kampong Cham* province was also divided into two.



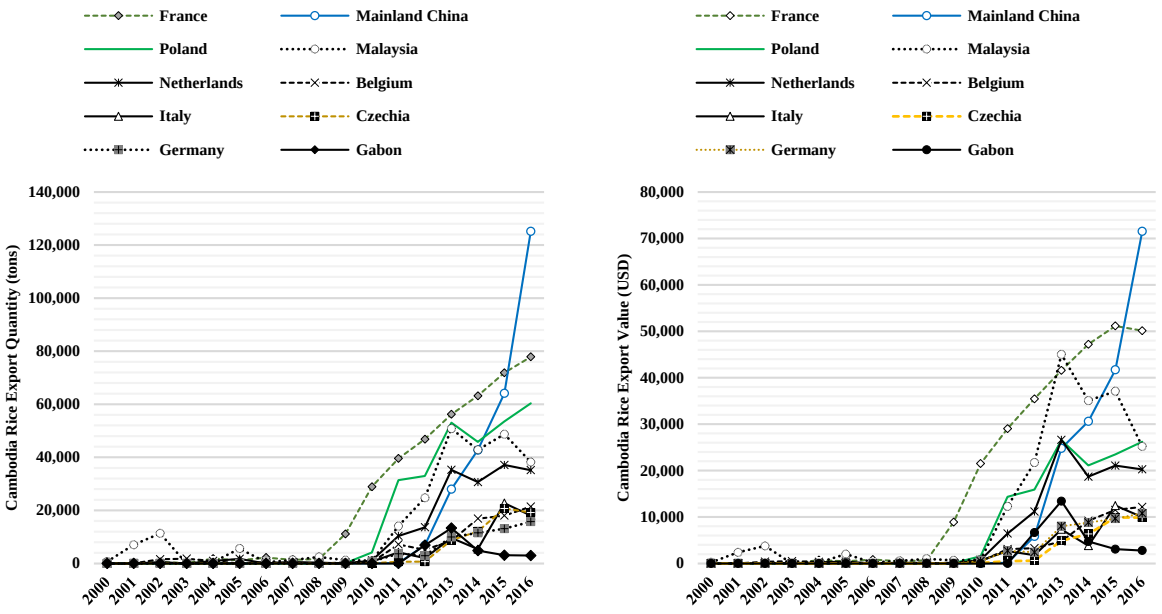
(a) Cambodia's 10 largest rice export destinations (%)



(b) Cambodia's average rice exports flows

Figure 3.18: The export destinations of Cambodian rice, 1995–2016

Source: Authors' calculation based on the UNComtrade (2018)



(a) Export Quantity (b) Export Value

Figure 3.19: Export trends of Cambodian rice to top-10 regular destinations

Source: Authors' calculation based on the UNComtrade (2018)

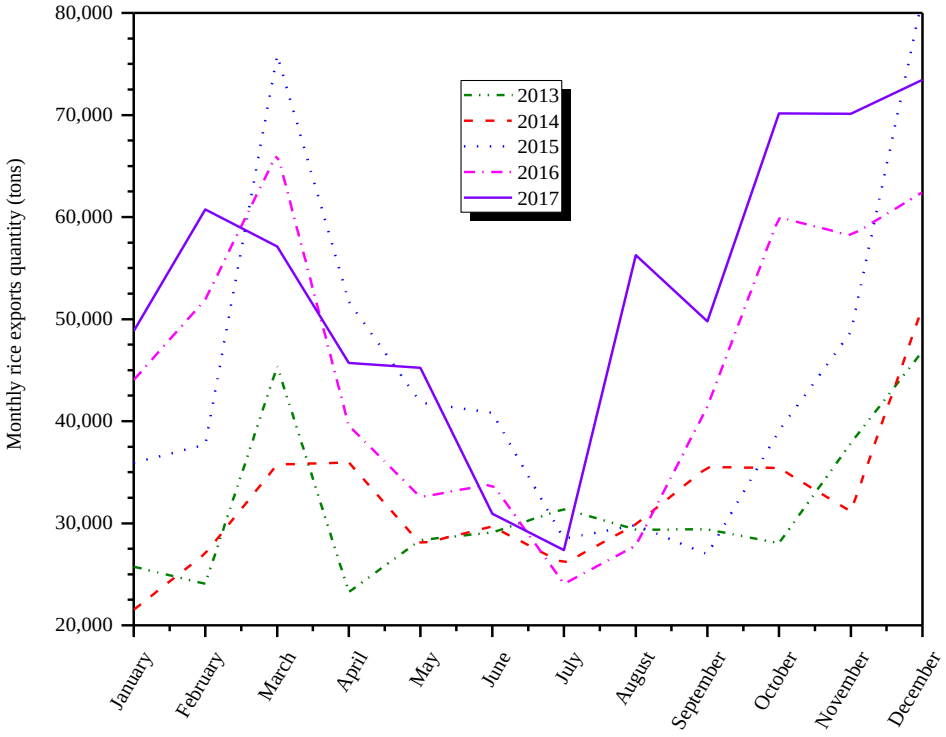
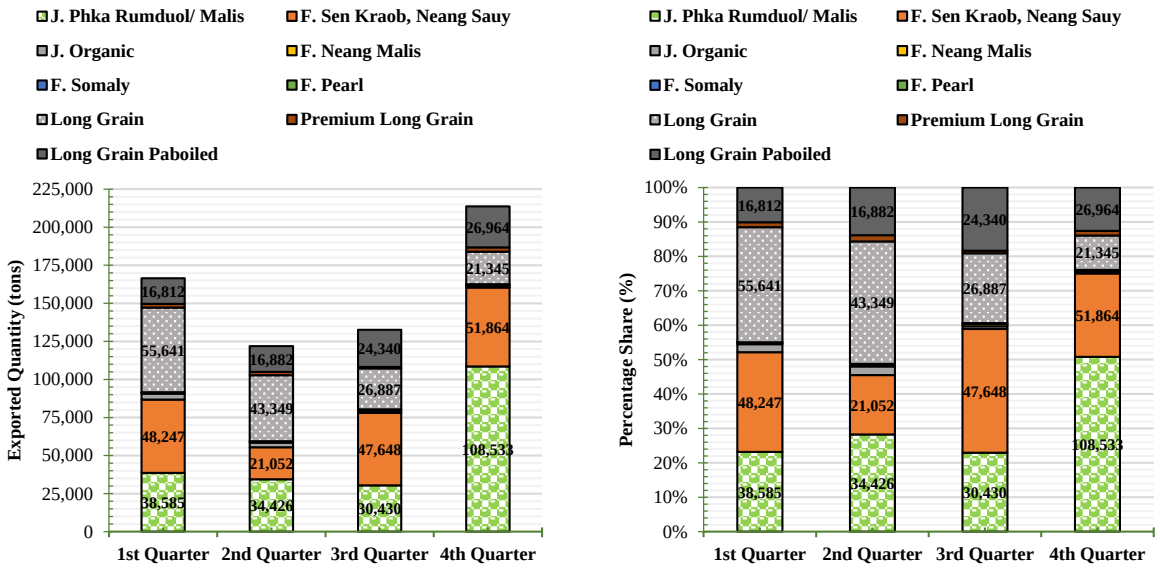


Figure 3.20: Monthly rice exports quantity of Cambodia, 2013-2017

Source: Own elaboration by Origin Pro v.2016, using data from Cambodian Ministry of Agriculture, Forestry and Fisheries (MAFF 2018)

There are two specific seasons in Cambodia, i.e. *rainy* (*wet*) and *dry* season. The rainy season rice varieties (*Srov Vorsa*) are grown after the '*Khmer New Year*' when it is starting to rain (end of April or beginning of May) and harvest in November or December. The dry season rice varieties (*Srov Praing*) are required shorter cultivating period, typically being grown in December (after harvested *Srov Vorsa*) and harvest in March (JICA 2009a , JICA 2009b). **Figure 3.20** revealed that the exports of Cambodian rice frequently reached the peak volume during the harvest season, indicated the limited post-harvest capacity. Rice exports seem to be relatively low in June and July, then increased sharply during the harvest period of both seasons rice, i.e. March (harvest period of *dry* season rice) and December (the harvest period of *rainy* season rice). Therefore, strengthening the technical post-harvest capacity to store the surplus amount of rice for supplying to the world market during the non-harvest season, or process it before rice have been shipped to the international market, might be another gaps for Cambodia to generate extra added values to improve its competitiveness in rice industry.



(a) Type of Cambodian rice exported (b) %Type of Cambodian rice exported

Figure 3.21: Cambodian rice exported by types in 2017

Source: Own elaboration by Origin Pro v.2016, using data from Cambodian Ministry of Agriculture, Forestry and Fisheries (MAFF 2018)

There are nine main varieties of rice had been currently exported from Cambodia to the world market (**Figure 3.21**). Among them, there are four varieties that export quantity

relatively high in all quarters, i.e. *Long Grain*, *Fragrant Sen Kraob* and *Neang Sauy*, *Jasmine Phka Rumduol* or *Phka Malis* and *Long Grain Parboiled*.

3.4. Chapter summary

This chapter provided an overview of the world market of rice, as well as the current situation and trends of Cambodian rice economy. Asia is the world's '*Rice Basket*', where the production of China, India, Indonesia, Bangladesh, Vietnam, Myanmar/Burma, Thailand, the Philippines, Japan, Pakistan, Cambodia, the Republic of Korea, Nepal, and Sri Lanka occupied almost 90% of total production. Asian countries exported averagely almost three-fourths $(3/4)$ of rice in the international market, where Thailand and India are the largest exporters.

Cambodia is the third largest rice exporter in the Southeast Asia, after Thailand and Vietnam (the tenth largest exporter in the world rice market), with the annual average (milled) rice surplus of 2.5 million tons. In 2016, the production of rice reached 9.83 million tons (2.6 billion USD). The *Mekong river plain* and *Tonle Sap river plain* are the two major rice producing zones in Cambodia, where *Prey Veng*, *Takéo* and *Battambang* province are the *rice bowls* of Cambodia.

Cambodia's top 10 rice export destinations are France, Germany, Netherlands, China (included mainland China, Hong Kong, Macao and Taiwan), Malaysia, Poland, the United Kingdom, Czechia or Czech Republic, Portugal and Italy (nearly 75% of Cambodia's total rice exports). Furthermore, rice exports of Cambodia seem to be relatively low in June and July, and increases sharply especially during the harvest period of both seasons rice, i.e. March (*Srov Praing*) and December (*Srov Vorsa*), indicating the limited post-harvest capacity.

CHAPTER 4. TRADE-RELATED POLICIES AND THEIR IMPACTS ON CAMBODIAN RICE ECONOMY

This chapter provides an overview of various trade-related policies, such as the Royal Government of Cambodia (RGC)'s local policies (i.e. *Rectangular Strategy* and *Rice export policy*), as well as the foreign initiatives like the European Union's "*Everything but Arms*" initiative (EBA), and the China's "*Belt & Road*" initiative (BRI). Moreover, the chapter also trying to discuss the impacts and potential effects of these policies and initiatives on Cambodian rice economy.

4.1. RGC's Rectangular Strategy

4.1.1. Rectangular Strategy: Phase I

"*The Rectangular Strategy for growth, employment, equity and efficiency in Cambodia*" (hereafter, *Rectangular Strategy*, RS) was initially introduced by *Samdech Akka Moha Sena Padei Techo Hun Sen*, the Cambodian Prime Minister, in the third legislature 2003-2008 of the national assembly in July 2004 (RGC 2004). He strongly convinced that "*reform is the life-death issue for Cambodia*" i.e. it is needed for comprehensive and deepening reform programs for attaining poverty alleviation, development, prosperity, national harmony and happiness of the people, and boosting up Cambodia to be a strong nation as it used to be (during Angkor era). Therefore, the *Rectangular Strategy* was the "*economic policy agenda*" and an imperative instrument to support the implementation of the "*political platform*" of the third legislature (2003-2008) of the Royal government.

The *Rectangular Strategy* is the replacement of the "*Triangular Strategy*" [7], as an integrated structure of interlocking rectangles, which picked out core elements from numerous policies, strategies, plans and various reform programs (such as, the *Socio-Economic Development Program*, the *Millennium Development Goals*, the *National Poverty Reduction Strategy*, etc.), see further, RGC (2004). The structure of the "*Rectangular Strategy*" was illustrated in **Figure 4.1**, which consists of *one core* element "Good governance", *four* reform areas (included, *anti-corruption*; reform of *justice* and *law*; *public administration* i.e. decentralization and de-concentration; and *armed forces*), *four*

[7] The "*Triangular Strategy*" was the "*political platform*" of the RGC's second legislature (1998-2003).

implemented *environment, four* "*growth rectangles*" and each strategic rectangle has *four sides*.

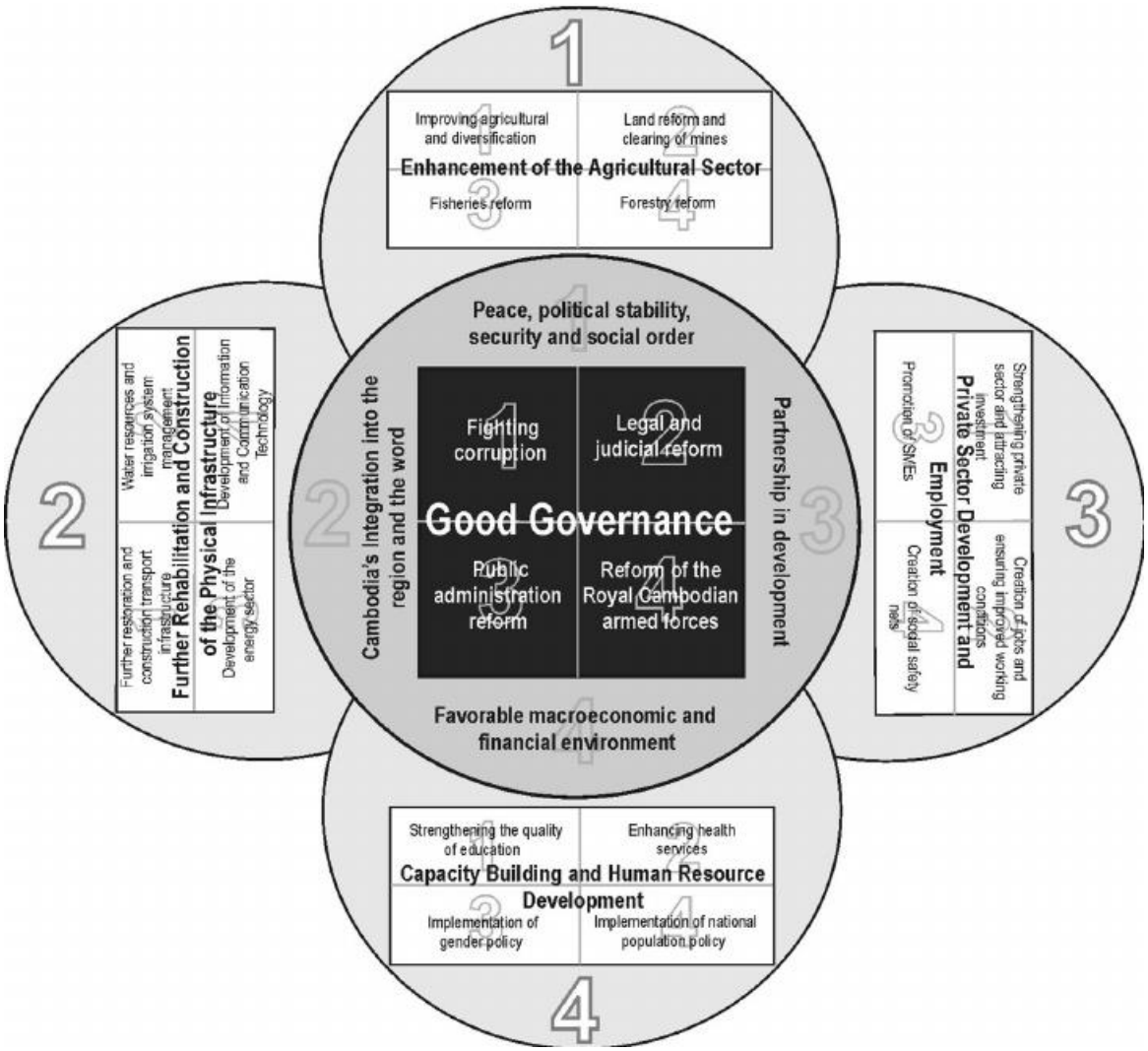


Figure 4.1: Structure of "*Rectangular Strategy*"

Source: RGC (RGC 2004 , RGC 2008 , RGC 2013)

4.1.2. Rectangular Strategy: Phase II

Rectangular Strategy: Phase II (RS-II) modified the foregoing Phase (RS-I) based on the contemporary needs of Cambodia in the fourth legislature of the Royal government 2008-2013 (RGC 2008). The *priority goals* in the Royal government's fourth legislature was sharpened as follows:

1) Ensuring *peace, political stability, security* and *social order* (by promoting the rule of law, and protecting of human rights, dignity and democracy).
2) Ensuring sustainable for the *long-term growth* (≥7% annually).

3) Guaranteeing *poverty alleviation* and improving *main social indicators* (i.e. education, health and gender equity).
4) Reinforce the public services' *effectiveness, quality* and *reliability*.

As the fruits of RGC's "*Win-Win*" policy, Cambodia has been enjoying peace and full territorial unity, integrity, and well-integrated itself into the region and the world, since *trade* was identified as a *main source for economic growth* and *poverty reduction*. Therefore, RGC would further strides on the path of trade liberalization, encouraging free-movement (remove all barriers and obstacles) of goods/services within the local and global markets.

4.1.3. Rectangular Strategy: Phase III

In the fifth legislature of the national assembly 2013-2018, the *Rectangular Strategy*: Phase III (RS-III) restated the missions of the Royal government and continued to further sharpen the four "*strategic rectangles*", expanded scopes, *refined* and *reprioritized sides*, and improved policies/mechanisms and made them more effective (RGC 2013). In July 2014, the "*National Strategic Development Plan 2014-2018*" was further signed as the implemented tool to support this phase of the *Rectangular Strategy* (RGC 2014).

"*Promotion of agriculture sector*" was the first priority rectangle among the four strategic rectangles, since agriculture would continue to be an engine for economic growth, ensuring equity, food security, and the rural development. As one of the main crops in Cambodia, formal *rice export* reached 200,000 metric tons in 2012, and securing the national food security (RGC 2013 , RGC 2014). RGC stated that the implementation of the "*Policy on the promotion of paddy production and rice export*" (RGC 2010) had significantly contributed to these achievements.

4.1.4. Rectangular Strategy: Phase IV

The new phase of *Rectangular Strategy*: Phase IV (RS-IV) was announced in September 2018, as the "*political platform*" of the sixth legislature of the national assembly (2018-2023), for obtaining the Cambodia vision 2050, and sets out strategic goals, prioritized policies, sectoral growth, and precise measures to be implemented from 2019 onwards (RGC 2018). The diagram of RS-IV is given in **Figure 4.2**.

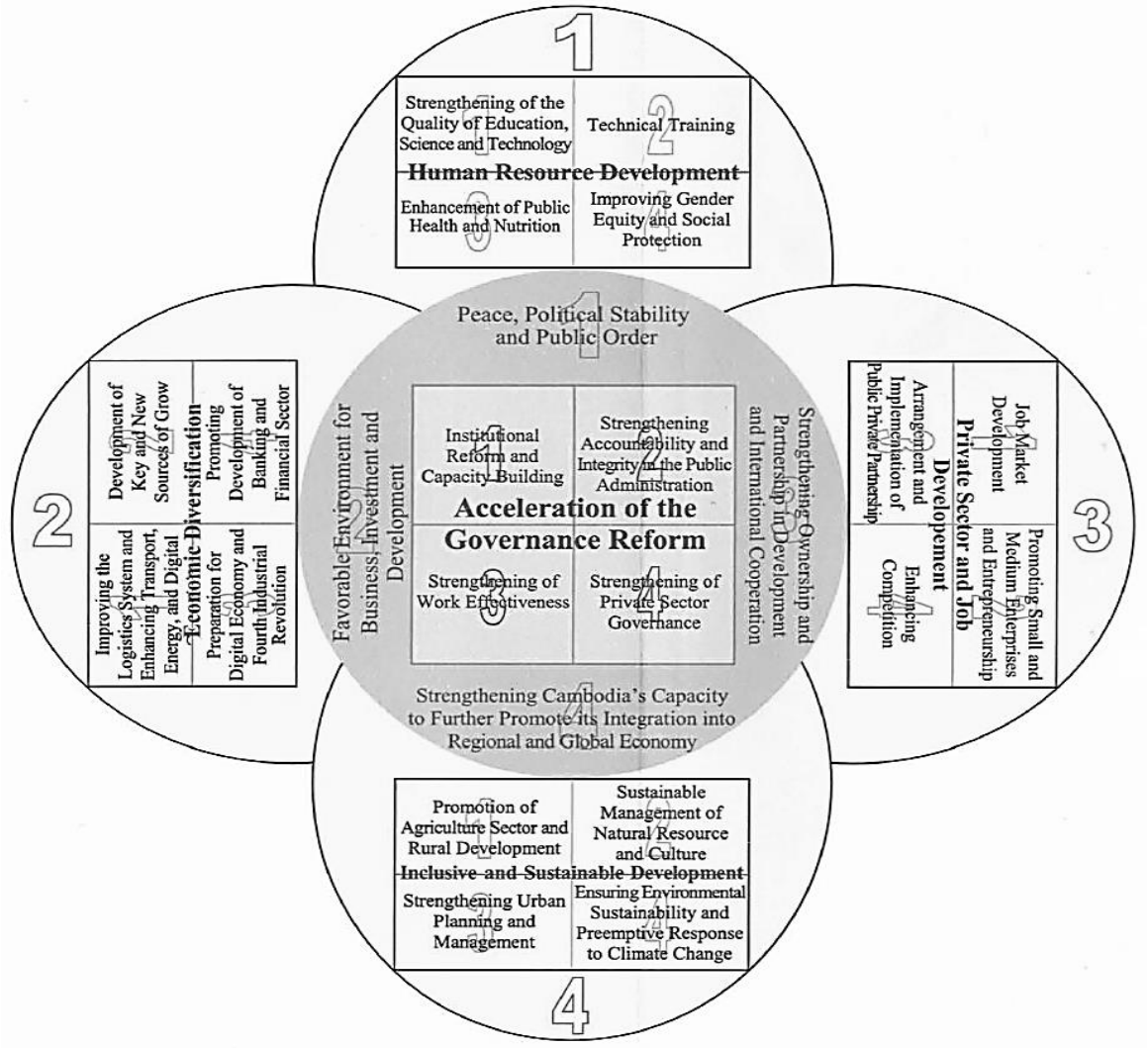


Figure 4.2: Diagram of "*Rectangular Strategy*: Phase IV"

Source: RGC (2018)

The "*4 strategic goals*" of the RS-IV were set as: (1) Ensuring *sustainable economic growth* (≈7%/year); (2) *Jobs creation* for Cambodian people; (3) *Poverty alleviation* (target at <10%); (4) *Strengthening the public institutions' capacity* and *governance* (both national & sub-national).

In the RS-I and RS-II, RGC identified "*4 priority areas*", i.e. (1) *road*, (2) *water*, (3) *electricity* and (4) *people*. In the RS-III, *people* became the first priority (1), followed by (2) *road*, (3) *electricity* and (4) *water*. RGC still give the top priority to *people* in the Phase IV, and the "*4 strategic rectangles*" which reflect these "*4 priority areas*" are as follows: Rectangle (1): *Human resource development*; Rectangle (2): *Economic Diversifications*; Rectangle (3): *Private sector development and employment*; Rectangle (4): *Comprehensive and sustainable development* (RGC 2018).

4.2. Rice export policy (2010)

'*Rice*' is treasured as '*white gold*' in Cambodia (RGC 2010 , Cramb 2020). The "*Policy on the promotion of paddy production and rice export*" (hereafter, *Rice export policy*) revealed the ambition of the Royal government to turn Cambodia into a "*Rice Basket*" as the world's *major rice exporter* (RGC 2010). In this regards, RGC had set 2015 as the target year to achieve (1) *paddy surplus* **>4 million tons**; (2) *milled rice export* **≥1 million ton**; (3) ensure the **international recognition** of Cambodian rice.

The status of Cambodian rice exports between 1995 and 2018 is given in **Figure 4.3**, revealed that the exports of Cambodian rice started to growth after 2008 (the announcement of *Rectangular Strategy*: Phase II) and the growth seem to be faster as the result of the application of the "*Rice export policy*". The policy had further indicated numerous elements in the development of the country's rice economy, such as key principles, strategic tools, challenges and opportunities, as well as the measurement tools of the policy (RGC 2010).

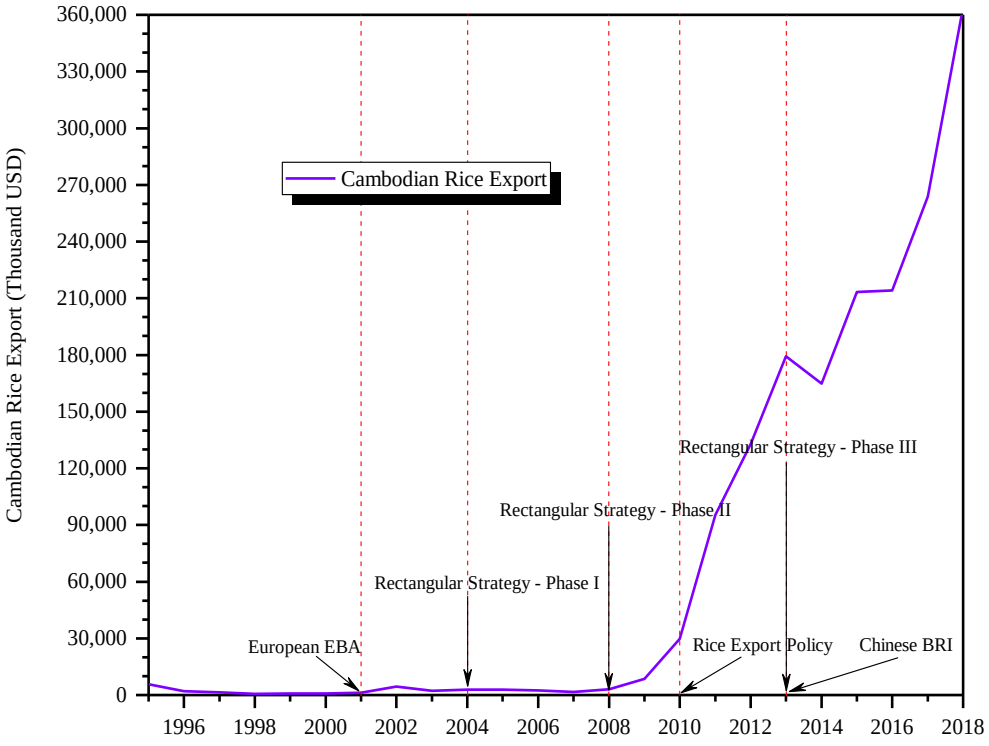


Figure 4.3: Export volume of Cambodian milled rice in the world market, 1995-2018

Source: Own elaboration by Origin Pro v.2016, using data from UNCTAD (2019)

4.3. The 'Everything but Arms' (EBA)

4.3.1. What is EBA?

By the European Union (EU)'s council regulation No. 416/2001 (EC 2001), the '*Everything but Arms*' (EBA) was introduced as a new *generalized system of preference* (GSP) regulation (Cernat, Laird, Monge-Roffarello and Turrini 2004). It aims at growth enhancement of the world's LDCs (*Least developed countries*) through *job creation, poverty reduction*, and *trade liberalization* by allows their all exports (except arms, ammunition) with '*Duty-free, Quota-free*' (DFQF) to the EU market (Gradeva and Martinez-Zarzoso 2016 , Kopp, Prehn and Brummer 2016 , Sorgho and Tharakan 2019).

As determined by *Committee for Development Policy* of United Nations, LDCs are classified based on three criteria, and the countries may "*graduate*" [8] out of the list when indicators exceed criteria: (1) **Low-income:** 3-year average per capita GNI <905 USD, but must >1,086 USD to *graduate*; (2) **Economic vulnerability:** agricultural production/exports instability, export awareness, economic importance of non-traditional activities, and the population percentage vulnerable to natural disasters; (3) **Human resources weakness:** based on '*Human Assets Index*', included education, health, nutrition, and adult literacy (see further, Aiello and Cardamone 2011 , Gradeva and Martinez-Zarzoso 2016 , Sorgho and Tharakan 2019). Currently, there are 49 countries in the LCDs list (**Table 4.1**), which 40 of them are the *African, Caribbean and Pacific* (ACP) and *Cotonou agreement*'s signatories, except *Afghanistan*, *Bangladesh*, *Bhutan*, *Cambodia*, *Laos PDR*, *Maldives*, *Myanmar*, *Nepal* and *Yemen* (Gibb 2006 [5]).

4.3.2. EBA's coverage

EBA covers about 7,200 product tariff-lines, principally are agricultural products like fruits, vegetables, dairy products, meat, beverages, etc. (MOC 2014). Compared to the GSP, EBA covers extra 919 HS-8 agro-product lines (Cernat, Laird, Monge-Roffarello and Turrini 2004 , Yu and Jensen 2005 , Gradeva and Martinez-Zarzoso 2016). Of them, 876 HS-8 is granted DFQF with immediate effect, while the remaining 43 lines are considered '*sensitive products*' (Bananas, Sugar and Rice) and be progressively liberalized, as follows:

[8] Two countries of *Botswana* and *Cape Verde* had graduated from LDCs since 1994 and 2007 respectively.

- **Bananas** – Duties gradually be eliminated by a 20% annual reduction, starting from January 1, 2002, and all duties be eliminated from January 1, 2006 (Cernat, Laird, Monge-Roffarello and Turrini 2004).
- **Sugar** – The market used to be regulated and strongly protected (tariff rates range 75-103%), accounted for about $2/3$ of all protections between EU and LDCs (Conforti, Ford, Hallam, Rapsomanikis and Salvatici 2007). Full liberalization was phased in between July 1, 2006 and July 1, 2009 with '*duty-free, limited quota*' (DFLQ). Market access for sugar was fully liberalized by October 2009.
- **Rice** – Before EBA, import tariff of rice were above 87%. Full liberalization was gradually phased DFLQ in between September 1, 2006 and September 1, 2009, i.e. -20% in 2007, -50% in 2008 and -80% in 2009 (see further, Yu and Jensen 2005 , Lincoln 2008).

4.3.3. Cambodia and EBA

EU-Cambodia trade and investment relations are typically categorized into industrial products (≈97% for Cambodia's exports and 60.6% for EU's exports, **Table 4.2**). Although the performances are basically ensured under *EU-ASEAN Cooperation Agreement* framework, the EBA allows all exports (except arms/ammunition) DFQF from Cambodia to EU. Thus, for almost two decades, EBA had significantly contributed to the country's economy, especially the textile and clothing sector (ECs 2019a).

EU is the main export destination for Cambodia (40% of overall exports). Cambodian exports to the EU have risen sharply (227%) between 2011-2016 and 95.5% of all Cambodia's EBA-eligible exports were made under EBA schema. The total exports to the EU reached 5 and 5.4 billion euro in 2017 and 2018 respectively, placing it second amongst all EBA beneficiaries. (**Figure 4.4**). **Table 4.3** indicated that '*textiles and textile articles*' shared a highly proportion (74.1%) of Cambodia's total exports to EU in 2018, followed by '*footwear, hats and other headgear*' (12.8%) and '*transport equipment*' (6.1%). Instead, Cambodia import from EU mostly are '*raw hides and skins, and saddlery*' (30%) and '*machinery and appliances*' (15%). See ECs (2019c) for further statistics.

Table 4.1: LDCs classification as of January 29, 2009

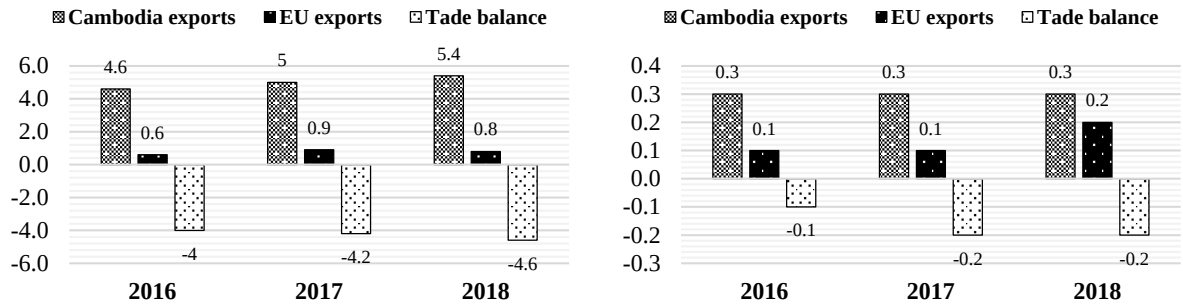
No.	LDCs	Year*	No.	LDCs	Year*
1	Afghanistan	1971	26	Malawi	1971
2	Angola	1994	27	Maldives	1971
3	Bangladesh	1975	28	Mali	1971
4	Benin	1971	29	Mauritania	1986
5	Bhutan	1971	30	Mozambique	1988
6	Burkina Faso	1971	31	Myanmar	1987
7	Burundi	1971	32	Nepal	1971
8	Cambodia	1991	33	Niger	1971
9	Central African Republic	1975	34	Rwanda	1971
10	Chad	1971	35	Samoa	1971
11	Comoros	1977	36	Sao Tome & Principe	1982
12	Democratic Republic of Congo	1991	37	Senegal	2000
13	Djibouti	1982	38	Sierra Leone	1982
14	Equatorial Guinea	1982	39	Solomon Islands	1991
15	Eritrea	1994	40	Somalia	1971
16	Ethiopia	1971	41	Sudan	1971
17	Gambia	1975	42	Tanzania	1971
18	Guinea	1971	43	Timor-Leste	2003
19	Guinea-Bissau	1981	44	Togo	1982
20	Haiti	1971	45	Tuvalu	1986
21	Kiribati	1986	46	Uganda	1971
22	Lao PDR	1971	47	Vanuatu	1985
23	Lesotho	1971	48	Yemen	1971
24	Liberia	1990	49	Zambia	1991
25	Madagascar	1991		**Total (January 29, 2009):**	**49**

Source: Lincoln (2008), Aiello and Cardamone (2011). **Note:** * Year listed as LDC.

Table 4.2: Cambodia-EU trade relation by product groups, 2018

Product	Cambodia Exports 2018		EU Exports 2018	
	Value (million euro)	%Total	Value (million euro)	%Total
Agricultural products	173	3.2	305	39.4
Fishery products	0	0.0	0	0.0
Industrial products	5,187	96.8	469	60.6
Total	**5,360**	**100.0**	**774**	**100.0**

Source: European Commission ECs (2019c)



(a) Trade in goods (b) Trade in services

Figure 4.4: Cambodia-EU trade relation in billion euro, 2016-2018

Source: European Commission ECs (2019a)

Table 4.3: Top 5 products for Cambodia-EU trade relation by HS sections, 2018

Product		**Value (million euro)**	**%Total**
Cambodia Exports 2018			
XI	Textiles and textile articles	3,972	74.1
XII	Footwear, hats and other headgear	688	12.8
XVII	Transport equipment	327	6.1
II	Vegetable products	166	3.1
VIII	Raw hides and skins, and saddlery	129	2.4
EU Exports 2018			
VIII	Raw hides and skins, and saddlery	230	29.7
XVI	Machinery and appliances	115	14.9
XVII	Transport equipment	69	8.9
XIV	Pearls, precious metals and articles thereof	69	8.9
VI	Products of the chemical or allied industries	68	8.8

Source: European Commission ECs (2019c).

As one of the *sensitive product* in EBA, EU rice market has been strictly regulated. In January 2019, European Commission ECs (2019b) found a significant growth of *Indica* rice imports from Cambodia and Myanmar into the EU market (increased 89% in the past five growing seasons) and the prices were considerably lower than those on the EU market, which caused economic damage to EU producers (their market shares dropped from 61% to

29%). Therefore, the EU Commission had decided to *re-introduce import duties on rice* that came into effect by January 18, 2019. In this regards, the customs duty on *Indica* rice imports from Cambodia and Myanmar is 175 euro/ton in year one, then reduce to 150 euro/ton in year two, and 125 euro/ton in year three.

4.3.4. Empirical literature of EBA

The impact of EBA schema on LDCs' exports have been widely investigated by scholars (Brenton 2003 , Yu and Jensen 2005 , Nilsson 2011 , Cirera 2014). The empirical literature on the EBA impact can be divided in two different strands: **First,** application of ***computable general equilibrium (CGE) models*** and ***partial equilibrium model***, which usually employed to forecast the future impact of given policies on the exports and welfare of LDCs and the EU (Cernat, Laird, Monge-Roffarello and Turrini 2004 , Fontagne, Laborde and Mitaritonna 2011 , Gotor and Tsigas 2011). See also, Evenett (2009) for the further comprehensive survey on the *general equilibrium model*. **Second,** to evaluate the initiative's effects on trade through the ***gravity trade model***. However, this kind of study seems to slightly limited in quantity (Aiello and Cardamone 2011 , Gradeva and Martinez-Zarzoso 2016 , Kopp, Prehn and Brummer 2016 , Sorgho and Tharakan 2019). It is noted that numerous studies use EBA as a binary variable in the gravity model. See, Persson (2015) for further literature surveys.

4.4. The 'Belt & Road' initiative (BRI)

4.4.1. What is BRI?

The '*Belt & Road*' initiative (hereafter, BRI, called "一带一路 *yīdài yīlù*" in Chinese) was initially announced in 2013 by the Chinese President, *Xi Jinping*, which aims at further integration of Asia, Africa and Europe through (1) *infrastructure development or facilities connectivity*, (2) *expanded investment and trade*, (3) *financial integration*, (4) *policy coordination*, and (5) *people-to-people ties* (Xi 2013 , Chaisse and Matsushita 2018). In this regards, BRI can be interpreted as a manifestation of China's efforts to shape (a Chinese form of) globalization (Yiwei 2016 , Shahriar 2019c) or a strategy to create a Sino-centric regional or even global order (Callahan 2016 , Nordin and Weissmann 2018). Some other scholars (Ferdinand 2016 , Summers 2016 , Silove 2018 , Summers 2019) interpreted BRI as an extension of the framework of '*Develop the west*' policy (first lunched in 1999-2000) and the '*Going out*' strategy (initiated in 2002 mainly to promote overseas investment activities).

4.4.2. BRI's coverage

'Belt & Road' initiative (BRI) consists of two parts: (1) **'Belt'** refers to the **'Silk Road Economic Belt'** (丝绸之路经济带 *sīchóu zhīlù jīngjìdài*), connects the China and Europe across the central Asia (Eurasian) through three routes:

a) North: *China – Kazakhstan – Southern Russia – Ukraine, Belarus – Poland – Germany*.
b) Middle: *China–Kyrgyzstan, Tajikistan, Uzbekistan –Turkmenistan – Turkey*.
c) South: *China – Afghanistan, Pakistan–Iran/Egypt – Arabian Peninsula/North Africa*.

(2) **'Road'** refers to the **'21st Century Maritime Silk Road' (**21 世纪海上丝绸之路 *21shìjì hǎishàng sīchóu zhīlù*), connect the *South China Sea* to the *Indian Ocean*, and then to the *Mediterranean*, **Figure 4.5** (NDRC 2015 , Ramasamy and Yeung 2019 , Summers 2019).

The BRI 65 countries which classified into six economic corridors (see, **Table 4.4** and **Figure 4.6**). The total trade volume between China and BRI countries in 2016 accumulate to 953.59 billion dollars i.e. 25.7% of China's total trade (Chong, Qin and Pan 2018).

4.4.3. Sino-Cambodia relationship & the BRI

Southeast Asia is a vital stop and hub for the *Chinese Maritime Silk Route*, and until now, China has continuously maintained close economic, trade, and cultural ties with countries in this region, included Cambodia (Zheng 2018 , Hu, Zhang, Hu and Cook 2019 , Summers 2019). The Sino-Cambodia's formal diplomatic-relations had been established for six decades.

During the *Prime Minister Hun Sen*'s visit to China in 2010, "*Sino-Cambodian comprehensive strategic cooperative partnership*"[9] was initially announced to enhance the bilateral cooperation. Numerous wide-range agreements were progressively signed, included, cooperation on infrastructure, production, trade, finance, tourism, etc. (Chheang 2017 , Hing 2017). As the co-founders of the *Asian Infrastructure Investment Bank* (AIIB)[10], Cambodia is also one of the BRI's most supporter. The geographical location of Cambodia in the Southeast Asia, also makes it strategically important as a transport-hub of BRI (Hu, Zhang, Hu and Cook 2019). Therefore, there were notable FDI flows from China into Cambodia in the recent year.

[9] "中柬全面战略合作伙伴关系 *zhōng jiǎn quánmiàn zhànlüè hézuò huǒbàn guānxì*" in Chinese.

[10] AIIB was established on December 25, 2015 for providing finance to projects within the BRI.

Figure 4.5: The geographical coverage of the BRI

Source: Sidaway and Woon (2017)[2]

Table 4.4: Classification of 64 countries involved in the '*Belt & Road*' initiative

Classification	Countries			#Countries
East Europe	• Poland • Montenegro • Macedonia • Bosnia and Herzegovina • Albania • Lithuania	• Latvia • Estonia • The Czech Republic • The Slovak Republic • Hungary	• Slovenia • The Croatia Republic • Romania • Bulgaria • Serbia	16
West Asia & North Africa	• Bahrain • Egypt • Iran • Iraq • Israel • Jordan	• Kuwait • Lebanon • Oman • Palestine • Qatar • Saudi Arabia	• Syria • The United Arab Emirates • Turkey • Yemen	16
Southeast Asia	• Brunei Darussalam • Cambodia • East Timor	• Indonesia • Laos • Malaysia • Myanmar	• Philippines • Singapore • Thailand • Vietnam	11
South Asia	• Nepal • Bhutan • Maldives	• Afghanistan • Pakistan • India	• Bangladesh • Sri Lanka	8
Central Asia, Russia & Mongolia	• Mongolia • Russian Federation	• Kazakhstan • Kyrgyzstan • Tajikistan	• Turkmenistan • Uzbekistan	7
CIS countries & Georgia	• Armenia • Azerbaijan	• Belarus • Georgia	• Moldova • Ukraine	6

Source: Yiwei (2016)[76], Shahriar (2019c)[54]. **Note:** China is not included in this list.

New Eurasia Land Bridge (NELB)

China–Central Asia–West Asia (CA/WA)

China–Pakistan (CP)

Bangladesh–China–India–Myanmar (BCIM)

China–Mongolia–Russia (CMR)

China–Indochina Peninsula (Indochina)

Figure 4.6: The New Silk Road's economic corridors

Sources: OBOReurope (2020)

4.4.4. Empirical literature of BRI

In the economic literature, the impact of BRI's implementation had been broadly investigated by scholars (e.g. Cheng 2016 , Huang 2016 , Summers 2016 , Mohan Malik 2018 , Yiwei 2018).

The '*BRI-related*' *gravity model* was widely applied by scholars, in trade studies (e.g. Kohl 2019 , Li, Sun and Long 2019), commodity-specific trade (e.g. Kea, Li, Shahriar, Abdullahi, Phoak and Touch 2019 , Shahriar, Qian and Kea 2019), foreign direct investment (e.g. Fan, Zhang, Liu and Pan 2016 , Ramasamy and Yeung 2019), financial banking and currency flows (Zhang, Yu, Yu and Jin 2017 , Liu, Wang and Woo 2019) and the tourism flows (Huang, Han, Gong and Liu 2019).

4.5. Chapter Summary

EU is the biggest market for Cambodian rice exports (≈40% of the overall exports). As one of the world's LDCs, EBA has brought significant welfares to the Cambodian economy, particularly the country's textile and clothing sector. Cambodian exports to the EU have risen sharply in recent years, reached 5.4 million euro in 2018. BRI consists of the '*Silk Road Economic Belt*' and the '*21st Century Maritime Silk Road*' was announced in late 2013, promoting the integration of Asia, Europe and Africa. Since Sino-Cambodia had long-historical formal bilateral relations, Cambodia is one of the most supportive countries of BRI, and also an important transport-hub of BRI.

CHAPTER 5. RELATIVE EXPORT COMPETITIVENESS OF THE CAMBODIAN RICE SECTOR [11]

This chapter derive time-varying *Relative Export Competitiveness* (REC) of the Cambodian rice sector from 1995 to 2018, and examine the key determinants of the REC. Three different REC indexes were calculated in this study. The *Relative Symmetric Export Competitiveness* (RSEC) index were also developed for calculation of comparative advantage. The *Short-Run Regression* (SRR) model was applied for capturing the determinants of the REC. The results reveal that Cambodia's rice exports became relatively competitive over time. The key findings suggest the Cambodian REC were strengthened as a result of a successful implementation of the *Rectangular Strategy* and *Rice export policy*. The benefits gained from EBA and BRI were found to be the factors contributed to the REC. REC was positively influencing by income per capita, but negatively affecting by higher local prices in numerous development phases. The research enriches the literature on the agricultural trade and provides a basis for further studies. This work makes a few contributions. **First**, it is the first study on the REC analysis for the Cambodian rice sector. **Second**, the latest 24-years data sets were covered. **Third**, a wide range of comparisons of REC among the world's top rice exporters was provided following implications of the various economic policies and foreign policy strategies, such as *Rectangular Strategy*, *Rice export policy*, *EBA* and *BRI*.

5.1. Introduction

Food is a basic need for the human on earth (Maslow 1943). Nonetheless, the question of how to feed the world is still an energetically debated question. A recent study by Tamburino, Bravo, Clough and Nicholas (2020) discovered that population, per capita consumption, and total production are three main factors determining the accomplishment of the worldwide food needs. Since rice is the an important staple food for humanity, the impact of rice on the global food security had been widely taken into account by numerous scholars (e.g. Durand-Morat, Nalley and Thoma 2018 , Zhang 2019). Approximately 90% of the global rice is produced and consumed in the Asian region, whereas China and India are

[11] The manuscript of this chapter entitled "*Relative export competitiveness of the Cambodian rice sector*" was published in **British Food Journal (BFJ)**, a 120-year old SCI-indexed Journal of Emerald Insight, on April 30, 2020.

the largest producers (Adjao and Staatz 2014 , Muthayya, Sugimoto, Montgomery and Maberly 2014). The production in these two countries altogether with Indonesia, Bangladesh, Vietnam, Myanmar/Burma, Thailand, the Philippines, Japan, Pakistan, Cambodia, the Republic of Korea, Nepal, and Sri Lanka, accounted for 90% of the world's rice production (WRS 2018).

In the Southeast Asian region, rice is not only a staple food of about 557 million people, but also is the fundamental subject of economic policy, a determinant of national objectives, and an essential anchor in the maintenance of political stability (Batello 2012 , Redfern, Azzu and Binamira 2012), where Cambodia has no exception. Rice is an important cash crop of Cambodia, which serves as a main source for foreign exchange earnings and makes a significant contribution to the national economic development. Furthermore, it is a strategic tool used by the *Royal Government of Cambodia* (RGC) to fulfil the domestic food demand and guarantee for national food security (RGC 2010). Cambodia is the third producer and exporter of rice in the Southeast Asia after Thailand and Vietnam, and the world's tenth largest exporter (in 2016) after Thailand, India, Vietnam, Pakistan, the United States of America (USA), Uruguay, Italy, Brazil, and Paraguay (FAOSTAT 2019).

In this study, we aim to focus on the issue of the *Relative Export Competitiveness* (REC) in Cambodian rice sector, by deriving REC from the measurement of its share to the world market for milled rice against share of world exports of other commodities. We also examine the certain factors, such as supply and demand capacity, price factors, domestic and foreign policies, trading agreements, etc. which might explain the REC of rice sector for the period 1995–2018.

Our study contributes to the agricultural trade literature in several ways. **First**, to the authors' knowledge, it is the first study focusing on the analysis of the REC and its determinants for the Cambodian rice sector. **Second**, the paper utilizes the available data sets for a period of 24-years (1995-2018). **Third**, authors also provide a wide range of comparison regarding RECs for the Cambodian rice industry to other world's top rice exporters (cover 20 world's largest exporters). Moreover, our research is policy relevant. In the analysis of potential influencing determinants of REC, four relevant local policies, i.e. RS-I (RGC 2004), RS-II (RGC 2008), RS-III (RGC 2013), *Rice export policy* RP2010 (RGC 2010), and two imperative foreign policies, i.e. the European '*Everything but Arms*' EBA

(Aiello and Cardamone 2011) and the Chinese '*Belt & Road*' initiative BRI (Shahriar 2019c), were taken into account.

The remaining parts of the chapter are structured as follows. The next section introduces the theories and empirical models of REC, and provides the estimation results of the REC for the Cambodian rice industry. Further empirical analysis on the potential determinants of REC are given in the third section. The concluding remarks and policy recommendations are provided in the last section.

5.2. Relative Export Competitiveness (REC)

5.2.1. Theories and Methods

What is *Relative Export Competitiveness* (REC)? The REC derived in this study is based on the groundbreaking work of Balassa (1965) on the *Revealed Comparative Advantage* (RCA) index, which is an indicator that have been widely applied by many researchers (Supongpan Kuldilok 2013 , Laursen 2015 , Balogh and Jambor 2017 , Pascucci 2018 , Rahman, Shahriar and Kea 2019) to measure the *comparative advantages* for different goods. RCA index is also known as the *Balassa index* or *Revealed export advantage* index (Rossato, Susaeta, Adams, Hidalgo, de Araujo and de Queiroz 2018). By avoiding the problematic of double-counts in *Balassa's RCA index*, the current study adopted the similar index to Vollrath (1991)'s, see also (Fagerberg, Srholec and Knell 2007 , Narayan and Bhattacharya 2019). The REC index is given by the following expression:

$$REC_{ict} = \left(X_{ict} \Big/ \sum_{w,w \neq c} X_{iwt} \right) \Big/ \left(\sum_{k,k \neq i} X_{kct} \Big/ \sum_{k,k \neq i} \sum_{w,w \neq c} X_{kwt} \right) \tag{5.1}$$

where, X refers to exports; i is exported commodity (i.e. rice in this study); k is other commodities beside i; t denotes time; c and w present Cambodia and the rest of the world, respectively. The REC index is defined as the ratio of Cambodia's exports of (milled) rice in the world rice market to Cambodia's share in the world exports of other commodities (Frohberg and Hartmann 1997). The index captures Cambodia's export competitiveness in world rice market relative to its other exports in the global market.

In the second stage, we modified Equation (5.1) to develop another two REC indexes, namely, REC_WF_{ict} and REC_WM_{ict}. Unlike Narayan and Bhattacharya (2019) [12], REC_WF_{ict} captures the *competitiveness* of Cambodia's export share of rice in the world rice market relative to its market share in the world exports of all food items other than rice (WFX_{kwt}):

$$REC\_WF_{ict} = \left(X_{ict} \Big/ \sum_{w,w \neq c} X_{iwt} \right) \Big/ \left(\sum_{k,k \neq i} X_{kct} \Big/ \sum_{k,k \neq i} \sum_{w,w \neq c} WFX_{kwt} \right) \quad (5.2)$$

REC_WM_{ict} measures Cambodia's export competitiveness of rice in the world rice market relative to Cambodia's share in the world exports of merchandise other than rice (WMX_{kwt}):

$$REC\_WM_{ict} = \left(X_{ict} \Big/ \sum_{w,w \neq c} X_{iwt} \right) \Big/ \left(\sum_{k,k \neq i} X_{kct} \Big/ \sum_{k,k \neq i} \sum_{w,w \neq c} WMX_{kwt} \right) \quad (5.3)$$

X_{kct} in Equation (5.2) is Cambodia's total exports of all food items excluding exports of rice, while in Equation (5.3) it denotes Cambodia's total merchandise exports other than exports of rice. Therefore, Cambodia would have *competitiveness* if index of $REC > 1$ at any point in time, while a $REC < 1$ indicates the loss of export *competitiveness*.

Nevertheless, several restrictions linked to REC index had been addressed. First, the factors involved in export competitiveness might not be explained (Rossato, Susaeta, Adams, Hidalgo, de Araujo and de Queiroz 2018). Second, trade distortion factors, such as tariff and non-tariff barriers, subsidies, trade agreements, etc. are not considered. Third, issue of *asymmetric* (a value between zero and infinity), in which the *Revealed Symmetric Comparative Advantage* (RSCA) was later suggested for dealing with this by Dalum, Laursen and Villumsen (1998), expressed as follows:

$$RSCA_{ict} = (RCA_{ict} - 1)/(RCA_{ict} + 1) \quad (5.4)$$

where, the subscript t is time; the value of RSCA index varies between -1 and 1.

$0 < RSCA_{ict} \leq 1$: Country c has a *comparative advantage* for product i

[12] The authors used REC_WA to capture the *competitiveness* of India's top agricultural exports (rice, wheat, cotton and sugar) against India's share of *world agricultural exports* (WA) from 1961 to 2012.

$-1 \leq RSCA_{ict} < 0$: Country c has a *comparative disadvantage* for product i

Based on this concept, in the third stage we developed the *Relative Symmetric Export Competitiveness* (RSEC) index as follows:

$$RSEC_{ict} = (REC_{ict} - 1)/(REC_{ict} + 1) \quad (5.5)$$

$$RSEC\_WF_{ict} = (REC\_WF_{ict} - 1)/(REC\_WF_{ict} + 1) \quad (5.6)$$

$$RSEC\_WM_{ict} = (REC\_WM_{ict} - 1)/(REC\_WM_{ict} + 1) \quad (5.7)$$

where, the subscript t is time, i is rice and c is Cambodia in this study; the terms WF and WM correspondingly indicate the world's export of *all food items* and *merchandise* other than rice.

The REC and RSEC indexes provide useful guidance in identifying underlying comparative advantage and offer further insight into the export competitiveness (Laursen 2015 , Rossato, Susaeta, Adams, Hidalgo, de Araujo and de Queiroz 2018).

5.2.2. REC of the Cambodian rice industry

To calculate the indexes of REC (REC_{ict}; REC_WF_{ict}; REC_WM_{ict}) and RSEC ($RSEC_{ict}$; $RSEC\_WF_{ict}$; $RSEC\_WM_{ict}$) for Cambodian rice industry, we use annual time series data available from 1995 to 2018, included total rice exports, total all food items exports, and total merchandise and services exports for the world and Cambodia's, which captured by SITC [13] code 0, 1, 22, and 4, sourced in *Data Center* of the UNCTAD (2019) in (or converted into) thousand USD.

Table 5.1 presented the average share of rice exports by the 20 largest rice exporters to the world rice market, world food market, world merchandise market, and the world's total exports market between 1995 and 2018. Thailand, India, and Vietnam are the world's top-3 rice exporters in the world, made up to 60% of the total rice exports between 2015-2018. Cambodia alternatively occupies the average market share of around 1.1% in the recent years. Although it seems to be tiny compared to Thailand and India, the market shares of Cambodian rice sector have been gradually enlarged from the average of 0.03% (1995-2004) to 0.25% (2005-2014) and 1.1% between 2015 and 2018.

[13] SITC: The Standard International Trade Classification commodity code of the United Nations (UN)

Table 5.1: Average rice exports share of the world's 20 largest rice exporters (%)

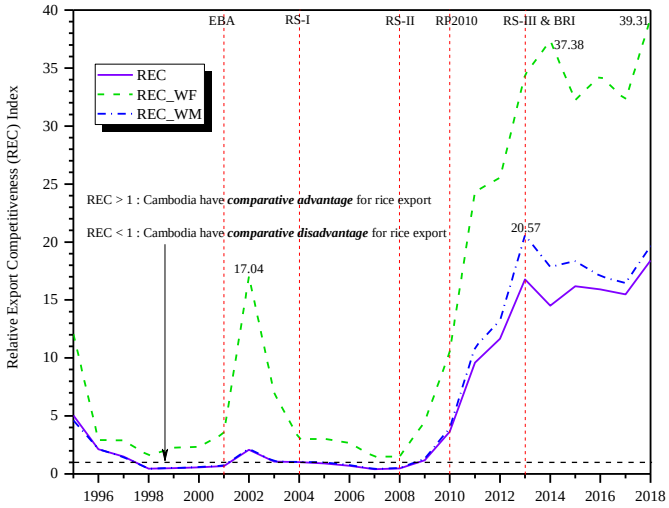
No.	Rice Exporters	% World Rice Exports			% World Food Exports			% World Merchandise Exports			% World Total Exports		
		1995-04	2005-14	2015-18	1995-04	2005-14	2015-18	1995-04	2005-14	2015-18	1995-04	2005-14	2015-18
1	Thailand	25.347	23.606	20.784	0.401	0.405	0.335	0.032	0.029	0.028	0.025	0.023	0.021
2	India	12.812	18.748	27.663	0.204	0.321	0.447	0.016	0.024	0.037	0.013	0.019	0.029
3	Vietnam	10.135	13.226	11.504	0.162	0.227	0.186	0.013	0.017	0.016	0.010	0.013	0.012
4	Pakistan	7.083	9.416	7.860	0.112	0.161	0.127	0.009	0.012	0.011	0.007	0.009	0.008
5	USA	12.533	10.071	7.718	0.199	0.171	0.124	0.016	0.012	0.010	0.013	0.010	0.008
6	Uruguay	2.543	2.052	1.744	0.041	0.035	0.028	0.003	0.003	0.002	0.003	0.002	0.002
7	Italy	4.596	3.391	2.527	0.073	0.057	0.041	0.006	0.004	0.003	0.005	0.003	0.003
8	Brazil	0.079	1.295	1.210	0.001	0.023	0.020	0.000	0.002	0.002	0.000	0.001	0.001
9	Paraguay	0.024	0.323	0.684	0.000	0.006	0.011	0.000	0.000	0.001	0.000	0.000	0.001
10	Cambodia	0.030	0.253	1.111	0.000	0.004	0.018	0.000	0.000	0.001	0.000	0.000	0.001
11	Argentina	1.599	1.179	0.754	0.026	0.020	0.012	0.002	0.001	0.001	0.002	0.001	0.001
12	China PRC *	5.128	2.240	1.900	0.084	0.038	0.031	0.006	0.003	0.003	0.005	0.002	0.002
13	UAE **	1.131	2.488	1.989	0.018	0.044	0.032	0.001	0.003	0.003	0.001	0.003	0.002
14	Myanmar	0.472	1.006	3.160	0.007	0.017	0.051	0.001	0.001	0.004	0.000	0.001	0.003
15	Spain	1.834	0.909	0.734	0.029	0.015	0.012	0.002	0.001	0.001	0.002	0.001	0.001
16	Belgium	1.736	1.260	1.038	0.027	0.021	0.017	0.002	0.002	0.001	0.002	0.001	0.001
17	Niger	0.017	0.037	0.224	0.000	0.001	0.004	0.000	0.000	0.000	0.000	0.000	0.000
18	Russia	0.059	0.287	0.357	0.001	0.005	0.006	0.000	0.000	0.000	0.000	0.000	0.000
19	Netherlands	1.269	1.021	1.071	0.020	0.017	0.017	0.002	0.001	0.001	0.001	0.001	0.001
20	Australia	2.386	0.871	0.691	0.039	0.015	0.011	0.003	0.001	0.001	0.003	0.001	0.001

Source: Own elaboration using data from UNCTAD (2019). Note: * China PRC: The People Republic of China (i.e. mainland China), ** UAE: United Arab Emirates.

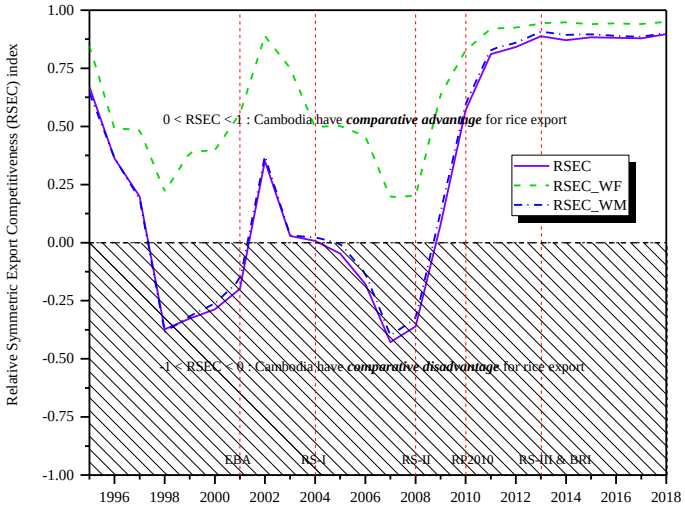
Table 5.2: Descriptive statistics on Cambodia's REC in rice industry, 1995–2018

Cambodia	REC	REC_WF	REC_WM
Mean	5.869	14.086	6.537
Median	1.788	5.739	1.805
Minimum	0.400	1.481	0.430
Maximum	18.394	39.307	20.569
Standard Error	1.375	2.873	1.565
Standard Deviation	6.735	14.074	7.667
Sample Variance	45.354	198.079	58.784
Obs.	24	24	24

Source: Own elaboration using data from UNCTAD (2019)



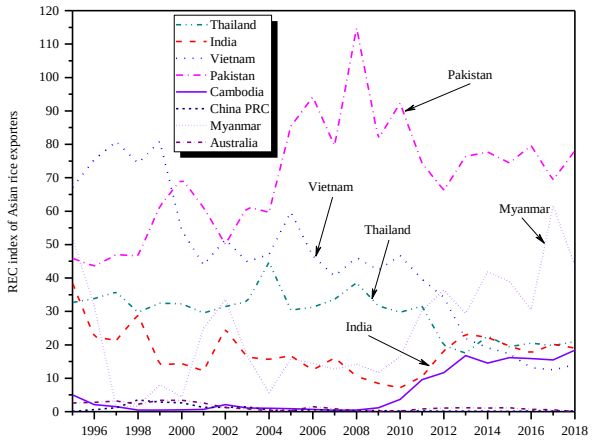
(a) REC of Cambodian rice sector



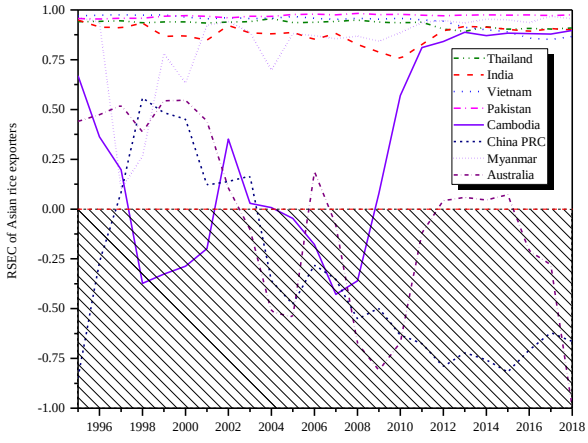
(b) RSEC of Cambodian rice sector

Figure 5.1: REC and RSEC of Cambodian rice industry, 1995-2018

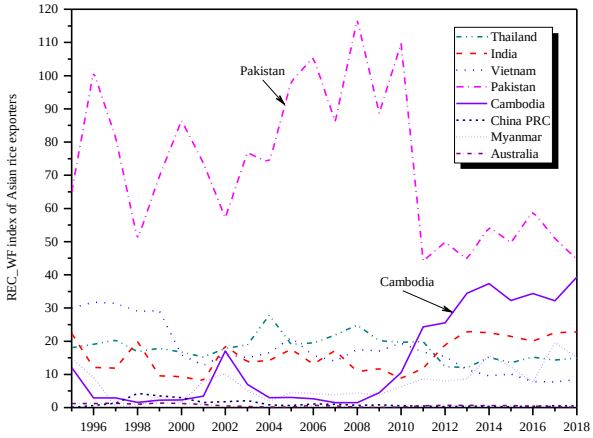
Source: Own elaboration by Origin Pro v.2016, using data from UNCTAD (2019)



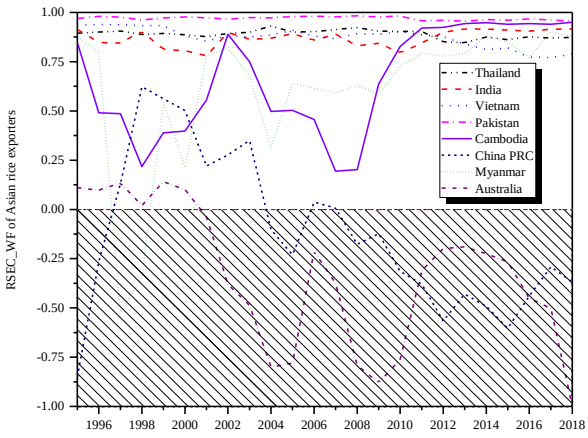
(a) REC_{ict}



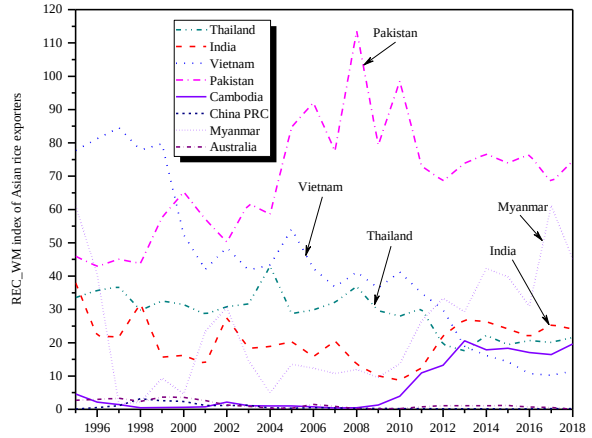
(b) $RSEC_{ict}$



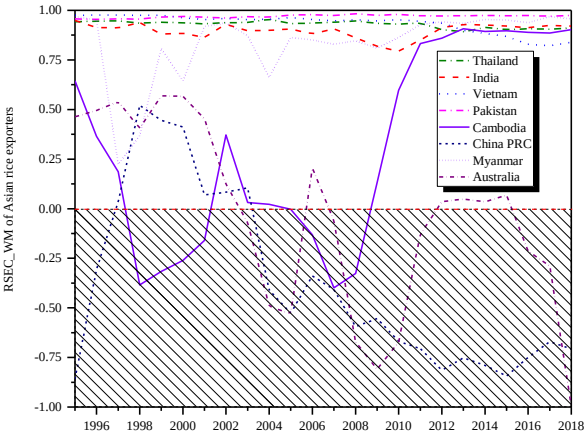
(c) REC_WF_{ict}



(d) $RSEC\_WF_{ict}$



(e) REC_WM_{ict}



(f) $RSEC\_WM_{ict}$

Figure 5.2: REC and RSEC of Asian largest rice exporters, 1995-2018

Source: Own elaboration by Origin Pro v.2016, using data from UNCTAD (2019)

Table 5.3: REC, REC_WF, and REC_WM of the world's 20 largest rice exporters, 1995-2018

No.	Rice Exporters	REC			REC_WF			REC_WM		
		1995-2004	2004-2014	2015-2018	1995-2004	2005-2014	2015-2018	1995-2004	2005-2014	2015-2018
1	Thailand	33.536	28.685	20.172	18.876	18.438	14.491	33.368	27.458	20.432
2	India	20.850	14.564	19.095	13.988	15.557	21.690	22.372	17.668	23.888
3	Vietnam	62.022	39.714	14.256	22.734	15.797	8.522	62.921	35.184	11.648
4	Pakistan	54.636	84.246	75.343	73.563	79.840	51.111	52.834	83.806	73.308
5	USA	1.153	1.179	*0.814*	1.231	1.171	*0.886*	1.285	1.342	*0.942*
6	Uruguay	60.988	48.163	34.281	13.196	6.921	6.007	74.963	55.979	43.404
7	Italy	1.151	1.142	*0.984*	1.408	1.103	*0.881*	1.158	1.115	*0.918*
8	Brazil	*0.094*	1.130	1.154	*0.023*	*0.247*	*0.235*	0.086	1.041	1.031
9	Paraguay	*0.626*	8.791	16.407	*0.101*	*0.877*	1.788	0.631	7.737	14.145
10	Cambodia	1.503	5.985	16.494	5.452	14.544	34.528	1.480	7.057	17.878
11	Argentina	4.001	3.079	2.362	0.*622*	*0.409*	*0.313*	3.781	2.888	2.237
12	China PRC	1.537	*0.285*	*0.177*	1.908	*0.618*	*0.412*	1.385	*0.250*	*0.149*
13	UAE *	1.789	2.222	1.175	2.708	3.855	1.990	1.498	1.855	1.086
14	Myanmar	17.982	22.337	43.707	5.484	6.825	13.703	19.298	20.324	44.279
15	Spain	*0.831*	*0.463*	*0.384*	*0.502*	*0.260*	*0.214*	*0.971*	*0.537*	*0.422*
16	Belgium	*0.560*	*0.469*	*0.440*	*0.462*	*0.371*	*0.361*	*0.543*	*0.453*	*0.431*
17	Niger	4.215	6.449	41.829	1.346	3.560	17.668	4.010	5.794	39.051
18	Russian Federation	*0.041*	*0.120*	*0.200*	*0.190*	*0.304*	*0.276*	*0.038*	*0.107*	*0.178*
19	Netherlands	*0.347*	*0.268*	*0.293*	*0.162*	*0.137*	*0.153*	*0.346*	*0.274*	*0.300*
20	Australia	2.258	*0.721*	*0.593*	*0.920*	*0.405*	*0.322*	2.381	*0.723*	*0.587*

Source: Own elaboration. **Note:** * UAE: United Arab Emirates. *The highlighted cells, indicate value of indexes smaller than unity*.

Rice exports of Cambodia had an overall increasing trend, especially after the implementation of *Rice export policy* or RP2010 (RGC 2010), where the net *production* value reached 2.57 billion USD in 2016 and the *exports* value of milled rice reached 360 million USD in 2018 (UNCTAD 2019). **Table 5.2** showed the descriptive statistics of Cambodia's REC indexes, while **Figure 5.1** presented the trends of REC and RSEC indexes of Cambodian rice industry between 1995 and 2018. The two indexes show the similar trends.

Before the internal political-instability of 1997-1998 [14], Cambodia had successfully gained its competitiveness in the international market. However, Cambodia lost its overall competitiveness of rice exports after 1997 until 2009 (**Figure 5.1**). Unfavorable weather conditions (e.g. frequent occurrence of floods and droughts between 2000-2007) had limited the *competitiveness* for Cambodia (Chhinh and Millington 2015). Subsequently, the application of '*RP2010*' had given Cambodia a great opportunity to *re-gain* its *competitiveness* in the global market. REC_{ict} of Cambodian rice increased rapidly from 1 in 2009 to 16.2 in 2013 and 18.4 in 2018 (**Figure 5.1.a**). The trends of REC_WF_{ict} and $RSEC\_WF_{ict}$ index, on the other hand, indicate that Cambodia is playing an important role in the world food market (**Figure 5.1.b**). Throughout the study period, REC_WF_{ict} of Cambodia were greater than unity. Nonetheless, before 2008 (except in 2002), the value of this index was below 3.5. Consequently, after the post-implementation of RGC (2010), REC_WF_{ict} increased rapidly and reached the peak of 37.4 in 2014, indicates the positive effect of RGC (2010)'s implementation to pushed Cambodia to the greater position as one of the world rice exporter. In the recent years, REC of Cambodian rice exports is at the comparable level to Thailand, India and Vietnam, but much lower than Pakistan and Myanmar (**Figure 5.2**). However, in the world food market, the values of Cambodian RECs were higher than other Asian rice exporters, except only Pakistan (**Figure 5.2.c**). Several deductions of Cambodian RECs after 2014 had been shown, before re-reached the peak value again in 2018 (39.3). Nevertheless, the figure of RSEC (**Figure 5.1.b**) did not show any vast fluctuations after 2013 and the value of these RSECs remained close to unity,

[14] In 1997, one year before the second election of Cambodian national assembly, there was an internal political conflict between the in-power government party and the opposite party, which caused most of local economic activities to stuck for almost two-year period until the election of 1998.

reveals the great export competitiveness of Cambodian rice industry in the international market, particularly in the world food market.

As shown in **Table 5.3**, the countries with REC's value greater than unity in all periods included Thailand, India, Vietnam, Pakistan, Uruguay, Argentina, and Myanmar. Cambodia is gradually improving its export competitiveness in the rice market. In 2018, REC of Cambodia was 18.4, comparable to Thailand, India, Vietnam, and Paraguay. However, it was still much lower in comparison to the emerging competitors such as Myanmar, which require more attentions to further develop in this sector. REC_WF_{ict} of Cambodia rice reached 39.3 in 2018, which was the second largest among the 20 countries after Pakistan (44.7), revealing the important role of Cambodia as the world's leading food producer and exporter.

5.3. Factors influencing of Cambodian rice REC

5.3.1. Theoretical Evidence

What are the factors that may potentially affect REC of rice industry in Cambodia? In the light of existing literature, the potential determinants of REC could be classified as follows:

(1) International and local supply / demand capacity capture by GDP per capita and trade agreements.
(2) Price factors, such as domestic price or export price.
(3) Foreign and domestic policies.
(4) Factor endowments which captured by the factors of production, such as labor, capital investment, farm size, etc.

Data limitation for crops factor endowments could not allowed us to develop *crop-specific factor endowment* (CFE) model to consider the effect of these endowment factors (like labor, capital, or farm size) on the REC indexes in this study. We, therefore, investigate the potential determinants of REC by estimating *Short-Run Regression* (SRR) model, which has the following form:

$$Y_t^i = \alpha + \beta \Delta \ln GDPPC_t + \gamma \Delta \ln PRICE_t^i + \delta TA_t + \theta LP_t + \vartheta FP_t + \varepsilon_t \quad (5.8)$$

where, Y_t^i is the REC indexes derived as REC_{ict}; REC_WF_{ict}; REC_WM_{ict} at time t, and i is the exported commodity (that is, rice in this study). The α is a constancy and

β; γ; δ; θ; ϑ; τ are estimated coefficients, and ε_t indicates the error term. The effect of Cambodia's GDP per capita at time t is captured by $GDPPC_t$, while $PRICE_t^i$ denotes the annual free market commodity prices indices at time t (2015=100 is base year). Both $GDPPC_t$ and $PRICE_t^i$ are sourced by UNCTAD (2019). **Table 5.4** detailed the data source for variables used in this study. The term TA_t; LP_t; FP_t are binary variables capture the effects of trade agreements, local policies, and foreign policies, respectively. The effect of trade arrangements are captured as one variable, TA_t in Equation (5.8) and takes the value of one since 1999 or zero otherwise.

By incorporating all trade agreements, the different phases or types of the foreign and domestic policies as one variable, Equation (5.8) might fail to account for the possibility of different implications on the REC between phases or types of agreements and policies. Therefore, Equation (5.8) was modified for taking the different phases/types of agreements/policies into account, as:

$$\begin{aligned} Y_t^i = \; & \alpha + \beta \Delta \ln GDPPC_t + \gamma \Delta \ln PRICE_t^i + \delta_1 ASEAN_t + \delta_2 WTO_t \\ & + \delta_3 ASEAN\_CN_t + \delta_4 ASEAN\_JP_t + \delta_5 ASEAN\_KO\_IND\_AUS_t \\ & + \theta_1 RS\_I_t + \theta_2 RS\_II_t + \theta_3 RS\_III_t + \theta_4 RP2010_t + \vartheta_1 EBA_t \\ & + \vartheta_2 BRI_t + \varepsilon_t \end{aligned} \tag{5.9}$$

In Equation (5.9), five TA_t variables, namely $ASEAN_t$, WTO_t, $ASEAN\_CN_t$, $ASEAN\_JP_t$, $ASEAN\_KO\_IND\_AUS_t$ were taken into account, respectively, denote the membership of Cambodia in ASEAN (April 30, 1999), World Trade Organization WTO (October 13, 2004), and the year that free trade agreements (FTAs) entry came into force of ASEAN – China (in 2005), ASEAN – Japan (in 2008), ASEAN – Republic of Korea (in 2010), ASEAN – India (in 2010), and ASEAN – Australia – New Zealand (in 2010). Due to ASEAN signed FTAs with Korea, India, and Australia – New Zealand in the same year, we combine these three FTAs into only one variable, $ASEAN\_KO\_IND\_AUS_t$. The summary of Cambodian trading agreements is given in **Table 5.5**. Moreover, four local policies (LP_t) variables, namely RS_I_t, RS_II_t, RS_III_t, $RP2010_t$, captures the effect of implementation of the three different phases of the RGC's *Rectangular Strategy* (RGC 2004 , RGC 2008 , RGC 2013), and '*Rice export policy* 2010' (RGC 2010), respectively. Considering the effects of foreign policies on Cambodian rice export, the other two FP_t variables, namely EBA_t and

BRI_t, denote the European '*Everything but Arms*' (EBA) [15] (Aiello and Cardamone 2011) and the Chinese '*Belt & Road*' initiative BRI (Yiwei 2016 , Shahriar 2019c) respectively, are also considered. These binary variables take value of 1 for the year of these agreements or policies come to force and after, and 0 otherwise.

5.3.2. Empirical Evidence of the SRR Model

The estimation of the *Short-Run Regression* (SRR) model [Equation (5.8) and (5.9)] of REC_{ict}, REC_WF_{ict}, and REC_WM_{ict} in Cambodia rice industry between 1995 and 2018 are given in **Table 5.6**. The results are explained mainly by Model III and IV where the R^2 value were the biggest.

Income per capita – Supply capacity and degree of demand are two important aspects of *competitiveness* (Fagerberg, Srholec and Knell 2007 , Ismail and Mahyideen 2015). In this study, Cambodian per capita GDP was used as a proxy for the country's supply capacity and domestic demand. Our results reveal that income per capita has positive significant effects on REC_{ict} and REC_WM_{ict} of Cambodian rice sector at 5% and 10%, respectively, but insignificantly affect REC_WF_{ict}. The coefficient of $\Delta \ln GDPPC_t$ was 14.7 and 14.2, indicated that 1% increase in income per capita growth could lead to expansion of REC_{ict} and REC_WM_{ict} by 14%. Positive significant effect of per capita income on consumers preferences was also proofed by Demont, Fiamohe and Kinkpé (2017).

Price factors – Theoretically, the higher domestic production cost associates to higher domestic prices, and often reduce export competitiveness (Srinivasan and Jha 2001 , Fagerberg, Srholec and Knell 2007). The coefficients of variable of $\Delta \ln PRICE_t^i$ which capture the effect of price factors on Cambodian REC in rice industry were also showing negative signs in all models. However, these coefficients have had weak significant effect on REC_{ict} and REC_WM_{ict}, and still remain insignificant for REC_WF_{ict}.

Trade agreements – Free trade agreements (FTAs) are considered as important trade promotion tools, which are likely to improve the trade relations, long term partnerships, and easier access to the external markets. Theoretically, it is believed that FTAs improve the economic welfare of the partnering states. Cambodia joint as a member state of ASEAN on

[15] All the products included in EBA are agricultural products (e.g. fruits, vegetables, meat, beverages, dairy products, etc.) are granted DFQF access to EU market, after entered into force on March 5, 2001. Only three products have not been liberalized immediately: bananas, rice and sugar. All duties on rice was eliminated after September 1, 2009. Therefore, the EBA_t in this study takes value 1 for the year of 2009 and after, and 0 otherwise.

April 30, 1999 and the WTO on October 13, 2004. Subsequently, the ASEAN have signed five FTAs with China, Japan, Republic of Korea, India, Australia and New Zealand (ASEAN 2019 , WTO 2019a , WTO 2019b). However, these FTAs collectively did not show any significant effect on REC of Cambodian rice sector.

Domestic policies – The findings reveal that RS-I and RS-II did not have any significant effect on REC_{ict} and REC_WM_{ict}. However, RS-I was unexpectedly have significant negative effect on REC_WF_{ict} at 10% level. More interestingly, the RS-III and RP2010 were strongly significant (at 1%) and positively affect all REC indexes of Cambodia rice sector in all models, indicating the successful implementation of these two policies. The coefficient of both policy variables were around 7.0, which reveals that the application of these two policies could push an enlargement of REC of Cambodian rice by about 7% annually.

Foreign policies –EU and China are two main foreign markets for Cambodia rice exports. Thus, the effect of EBA and BRI have been investigated in this study. The estimated coefficient of both EBA_t and BRI_t had positive sign, indicates the encouraging effect on REC of Cambodian rice exports. The significant positive sign of EBA_t on REC_WF_{ict} with coefficient value of 7.2, indicates that with EBA, Cambodia could widen the REC_WF_{ict} and its position as the world's major food exporter through exporting of rice into the international food market by 7.2% annually. The BRI_t in this study shows a positive significant (at 1%) effect on all REC indexes of Cambodian rice industry, reveals that China would increasingly become an important international market for the Cambodian rice.

Table 5.4: Data source for variables used in the study of competitiveness

Variables	Unit	Year	Source
Total exports of rice for Cambodia and the world	Thousand USD	1995-2018	UNCTAD (2019)
Total all food items (SITC 0, 1, 22, 4) exports of Cambodia and the world	Thousand USD	1995-2018	UNCTAD (2019)
Total merchandise and services exports for Cambodia and the world	Thousand USD	1995-2018	UNCTAD (2019)
GDP per capita of Cambodia (2010 = 100)	Million USD	1994-2017	UNCTAD (2019)
Annual free market commodity prices indices for Cambodia (2015 = 100)	(None)	1995-2018	UNCTAD (2019)

Source: Own elaboration.

Table 5.5: Trade agreements and memberships of Cambodia

Trade Agreements	Date of into force
ASEAN – Australia – New Zealand	January 01, 2010
ASEAN – India	January 01, 2010
ASEAN – Republic of Korea	January 01, 2010
ASEAN – Japan	December 01, 2008
ASEAN – China	January 01, 2005
Membership of Cambodia in WTO	October 13, 2004
Membership of Cambodia in ASEAN	April 30, 1999
ASEAN Free Trade Area (AFTA)	January 01, 1993

Source: ASEAN (2019), WTO (2019a), WTO (2019b).

Table 5.6: SRR determinants of REC, REC_WF and REC_WM for Cambodia rice, 1995–2018

Variables	REC				REC_WF				REC_WM			
	I	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**
$\Delta \ln GDPPC_t$	18.606	11.982*	14.739**	14.739**	36.654	29.659	29.963	29.963	18.612	11.642	14.159*	14.159*
	(0.111)	(0.085)	(0.039)	(0.039)	(0.170)	(0.117)	(0.114)	(0.114)	(0.170)	(0.145)	(0.093)	(0.093)
$\Delta \ln PRICE_t^i$	-15.032**	-5.463	-6.394	-6.394	-27.320	-10.749	-12.216	-12.216	-17.426**	-6.512	-7.388	-7.388
	(0.043)	(0.239)	(0.162)	(0.162)	(0.104)	(0.392)	(0.322)	(0.322)	(0.046)	(0.228)	(0.181)	(0.181)
TA_t			-2.454	-2.454			-3.970	-3.970			-2.311	-2.311
			(0.107)	(0.107)			(0.328)	(0.328)			(0.202)	(0.202)
$ASEAN_t$	-2.088				0.034				-1.936			
	(0.287)				(0.994)				(0.398)			
WTO_t	0.286				-3.152				0.477			
	(0.927)				(0.664)				(0.897)			
$ASEAN\_CN_t$	-0.496				-0.928				-0.412			
	(0.878)				(0.901)				(0.914)			
$ASEAN\_JP_t$	2.328				4.755				2.498			
	(0.400)				(0.457)				(0.442)			
$ASEAN\_K\_I\_A_t$	10.130***				22.199 ***				11.560 ***			
	(0.001)				(0.001)				(0.001)			
RS_I_t		-1.360	-1.026	-1.026		-4.846	-7.738*	-7.738*		-1.142	-0.894	-0.894
		(0.262)	(0.450)	(0.450)		(0.150)	(0.051)	(0.051)		(0.414)	(0.585)	(0.585)
RS_II_t		1.162	1.393	1.393		2.992	3.108	3.108		1.242	1.455	1.455
		(0.468)	(0.371)	(0.371)		(0.494)	(0.466)	(0.466)		(0.504)	(0.439)	(0.439)
RS_III_t		6.936***	6.852***			12.985***	12.816***			8.026***	7.946***	
		(0.000)	(0.000)			(0.002)	(0.003)			(0.000)	(0.000)	
$RP2010_t$		7.074***	6.999***	6.999***		16.292***	16.202***	16.202***		8.002***	7.932***	7.932***
		(0.000)	(0.000)	(0.000)		(0.001)	(0.001)	(0.001)		(0.000)	(0.001)	(0.001)
EBA_t			0.8928	0.8928			7.1626*	7.1626*			0.9519	0.9519
			(0.554)	(0.554)			(0.099)	(0.099)			(0.602)	(0.602)
BRI_t				6.852***				12.816***				7.946***
				(0.000)				(0.003)				(0.000)
_cons	1.070	0.636	1.5005	1.5005	2.540	3.539*	3.2899	3.2899	0.877	0.594	1.3759	1.3759
	(0.480)	(0.400)	(0.107)	(0.107)	(0.470)	(0.098)	(0.191)	(0.191)	(0.621)	(0.498)	(0.214)	(0.214)
R-squared	**0.872**	**0.949**	**0.959**	**0.959**	**0.845**	**0.914**	**0.930**	**0.930**	**0.867**	**0.948**	**0.955**	**0.955**

Source: Own elaboration. **Note:** Numbers in the bracket are *p-value*. *, **, ***: significant at 10%, 5%, and 1% respectively.

5.4. Chapter Summary

This study measures the REC for Cambodian rice sector between 1995 and 2018. The findings suggest a gradually improvement of Cambodian *rice export competitiveness*, particularly after 2010. Therefore, a sustainable growth in the rice sector is attainable in Cambodia. When we compare Cambodian rice sector's REC with that of a large number of rice exporters and has found that REC of Cambodia is much lower than those of its competitors during the prior of the study. However, the situation has been improved after 2010. Cambodia's RECs after 2010 are at the comparable level to those of Thailand, India, Vietnam and Paraguay. This study contributes to the understanding of the Cambodian rice competitiveness. As a result, the policy makers and rice industry experts would get some innovative insights from this empirical modelling. The regression analysis of the Cambodian rice sector and its REC determinants reveals the important effects of the implementation of the local policies and foreign initiatives on the Cambodian rice sector. The positive significant effect of GDP per capita revealed that local supply/demand management would be a major source for ensuring the *competitiveness* for the Cambodian rice exports.

CHAPTER 6. THE MAJOR DETERMINANTS OF CAMBODIAN RICE EXPORTS: DYNAMIC GRAVITY MODEL [16]

This chapter aims to identify the foremost determinant features influencing the performance of Cambodian rice exports. The *dynamic panel gravity model* was purposively applied to the current analysis with a dataset contains 880 observations (22-year panel 1995-2016 × 40 selected trading partners). The issue of '*zeros*' trade observations had been addressed, and resolved through the application of *Generalized Least Square* (GLS), *Poisson Pseudo-Maximum-Likelihood* (PPML) and *Heckman's Sample Selection*. The results revealed the positive significant impact of the historical ties, exchange rate policy and agricultural land reform. The export expansions to the major markets (e.g. EU, China and ASEAN countries) are particularly emphasized. Special attentions had also been paid to the macroeconomic issues and resistance factors (such as, economic recession).

6.1. Introduction

Rice is a vital source of foreign currencies in many rice producing countries; especially, in the Southeast Asian nations, included Cambodia. The production of rice is one of the most important agricultural activities due to the fact that more than half of the global population consume rice at least once a day. Although consumers in many countries rely on imported rice to meet their daily needs, domestic rice markets are highly protected and strictly regulated (Chen and Saghaian 2016). As one of the imperative state's economic foundation, rice is highly engaging into Cambodian rural population's *day-to-day* livelihoods as a principle source of income, and had been extensively recognized as the '*white gold*' of Cambodia (RGC 2010). Furthermore, rice is used as a powerful weapon to alleviate poverty and ensure national food security.

In the economic literatures, exports, particularly agricultural exports had been largely witnessed as engines of growth and development in most developing countries like Cambodia, due to the allocation of inadequate resources which enable them to generate the

[16] The manuscript of this chapter entitled "*Factors influencing Cambodian rice exports: An application of the dynamic panel gravity model*" was published in **Emerging Markets Finance and Trade (EMFT)**, a SSCI-indexed Journal of Taylor & Francis, Inc. on November 6, 2019.

comparative advantage in this sector (Johnston and Mellor 1961 , Giles and Williams 2000a , Giles and Williams 2000b , Singh 2010). The incomes generated from agricultural exports (e.g. rice exports in particular) would surely contribute to the Cambodian growth. Rice exports, moreover, had welfare influences on the households' earnings (Porto 2006 , Ha, Nguyen, Kompas, Che and Trinh 2015 , Hoang, Pham and Ulubaşoğlu 2016). However, to the best of our knowledge, there is no major academic work regarding the determinants of Cambodian rice exports in the existing literature. Only few studies had been found concerning the Cambodian trade (French 2002 , Huot and Kakinaka 2007 , Asuyama, Chhun, Fukunishi, Neou and Yamagata 2013 , Flor, Maat, Hadi, Kumar and Castilla 2019 , Lak 2019) and rice trade (Sareth 2015 , Turner, Korm and Veara 2017 , Bojan, Stanislav, Mirko and Boris 2018 , Cosslett and Cosslett 2018 , Sun and Li 2018). Despite this, the core influencing factors of Cambodian rice exports have not yet been explored. The study is, therefore, designed to fill this gap.

The rest of the chapter is structured as follows. The next section discussed the research methodology, including the theoretical framework of the gravity model, empirical model specifications, '*zero*' trade problem, sample selection and data sources. Empirical results and discussion are presented in the third section. Finally, the conclusion remarks are given in the chapter summary section.

6.2. Methodology

6.2.1. The theoretical framework of the trade gravity model

The trade gravity model has established itself as the most successful empirical tool for international trade studies. Originates from the Newton (1686)'s theory of the *universal gravity* in physics, the model was initially applied to the international trade study by Tinbergen (1962). Later, Pöyhönen (1963) and Pulliainen (1963) independently developed the econometric equations of the bilateral trade. The gravity model of trade states that trade flows between two countries are determined positively by their income and negatively by the distance between them (Chaney 2008 , Chaney 2018), which could be expressed as follows:

$$X_{ij} = \alpha\, Y_i^{\beta_1}\, Y_j^{\beta_2}\, D_{ij}^{\beta_3} \tag{6.1}$$

where, X_{ij} is the flow of exports into country j from country i, Y_i and Y_j are country i's and country j's *Gross Domestic Products* (GDP) and D_{ij} is the geographical distance between the countries' capitals. The logarithmic form of Equation (6.1) is as follows:

$$\ln(X_{ijt}) = \alpha + \beta_1 \ln(Y_i) + \beta_2 \ln(Y_j) + \beta_3 \ln(D_{ij}) \quad (6.2)$$

Linnemann (1966) used the gravity in an extensive empirical anaysis in the light of a *Partial Equilibrium Model* (or *Quasi-Walrasian General Equilibrium Model*) of export supply and import demand, by adding *population* variable for reflecting the economy of scale. Anderson (1979) used the aggregate equations of *product differentiation* and *utility function* to modified the *gravity equations* (with *Cobb-Douglas* or CES: *constant elasticity of substitution*'s assumption). Helpman (1984), and Helpman and Krugman (1985) similarly applied the this model with IRS (*increasing returns to scale*) assumption to the *gravity*, while the *monopolistic competition model* was eventually applied by Helpman (1987). Bergstrand (1985), Bergstrand (1989), Bergstrand (1990), on the other hand, used the *monopolistic competition models* to explore the *micro-economic equations* of trade, and argued that the *gravity* model is a compact-form of the *general equilibrium model*. Mátyás (1998) proposed to incorporate the trading bloc dummy variable(s), and time specific effects into the specification of the gravity models. Researchers (e.g. Helpman and Krugman 1985 , Helpman 1987 , Helpman and Krugman 1987 , Eaton and Kortum 1997 , Deardorff 1998 , Evenett and Keller 2002) also argued that the standard form of the gravity model could be derived from different trade theories, such as the Ricardo (1817)'s *comparative advantage*, the Heckscher-Ohlin (H-O theory), the IRS, etc.

Egger (2002) initially applied the gravity equation with the panel data. Anderson and Wincoop (2003) argued the inclusion of *multilateral resistance factors* (MRFs) to the gravity model, for more reliable and efficient of the model. Helpman, Melitz and Rubinstein (2008) derived the gravity equation of Anderson and Wincoop (2003) and addressed issues of '*Zeros*' trade, *heterogeneity* and *asymmetry* of the export flows from *i* to *j* and *j* to *i*. The *heterogeneity of firm* was also addressed by Chaney (2008). He also argued the *extensive* of margin (vary of the set of exporters) over the *intensive* of margin (change the size of exports), when the *transportation costs* were taken into account. The importance of the *gravity* model as the '*workhorse*' for international trade studies had been proved by scholars (Head and Mayer 2014 , Shepherd 2016 , Chaney 2018). Moreover, the *structural gravity model* introduced by Yotov, Piermartini, Monteiro and Larch (2016) was also an imperative

tool for trade policy analysis. The theoretical foundation of the gravity model are explained in the literatures (Shahriar, Qian, Kea and Abdullahi 2019).

So, it is clear from the above discussions that the prior studies provided the grounds for making the key assumption of the gravity model that are in line with the theorical approaches such as H-O model, Ricardian model, monopolistic competition, '*new trade*' theory, etc.

6.2.2. Generalized gravity model of Cambodian rice exports

The dynamic gravity model of Cambodian rice exports in this study take form as follows:

$$\begin{aligned}\ln(X_{ijt}) = \alpha &+ \beta_1 \ln(X_{ij,t-1}) + \beta_2 \ln(GDP_{it}.GDP_{jt}) + \beta_3 \ln(pcGDP_{it}.pcGDP_{jt}) \\ &+ \beta_4 \ln(dpcGDP_{ijt}) + \beta_5 \ln(D_{ij}) + \beta_6 \ln(exc_{ijt}) + \beta_7 \ln(land_{it}) \\ &+ \beta_8 \ln(RM_{jt}) + \gamma_1 border_{ij} + \gamma_2 colony_{ij} + \gamma_3 landlocked_j \\ &+ \gamma_4 WTO_{jt} + \gamma_5 ASEAN_{jt} + \gamma_6 BRI_{jt} + \gamma_7 crisis_{2008} + \gamma_8 EU_{jt} \\ &+ \gamma_9 Africa_j + \delta_1 tariff_j + \varepsilon_{ijt}\end{aligned} \tag{6.3}$$

where, the $\ln(.)$ is logarithm form. The detail description and expected sign of dependent variables are given in **Table 6.1**. α denotes the intercept term, while β_s, γ_s, δ_s are estimated coefficients, and ε_{ijt} is the statistical error term, $E(ln\,\varepsilon_{ijt}) = 0$.

6.2.3. 'Zeros' trade problem

The issue of 'zeors' trade had been addressed, since the log of 'zeros' is undefined which is often problematic for the log-form of the *gravity* equation (e.g. Shepherd 2008 , Haq, Meilke and Cranfield 2011 , Santos Silva and Tenreyro 2011 , Haq, Meilke and Cranfield 2013 , Afesorgbor 2017 , Hwang and Lim 2017 , Ramzy and Zaki 2018). The most-commonly used approaches in the *gravity* literature to deal with this issue, included the Santos Silva and Tenreyro (2006)'s PPML and the Heckman (1979)'s *sample selection model*, had been applied for this study. The PPML model of this study could be written as:

$$\begin{aligned} X_{ijt} = \alpha &+ \beta_1 \ln(X_{ij,t-1}) + \beta_2 \ln(GDP_{it}.GDP_{jt}) + \beta_3 \ln(pcGDP_{it}.pcGDP_{jt}) \\ &+ \beta_4 \ln(dpcGDP_{ijt}) + \beta_5 \ln(D_{ij}) + \beta_6 \ln(exc_{ijt}) + \beta_7 \ln(land_{it}) \\ &+ \beta_8 \ln(RM_{jt}) + \gamma_1 border_{ij} + \gamma_2 colony_{ij} + \gamma_3 landlocked_j \\ &+ \gamma_4 WTO_{jt} + \gamma_5 ASEAN_{jt} + \gamma_6 BRI_{jt} + \gamma_7 crisis_{2008} + \gamma_8 EU_{jt} \\ &+ \gamma_9 Africa_j + \delta_1 tariff_j + \varepsilon_{ijt} \end{aligned} \quad (6.4)$$

The Heckman selection model consists of two diffferent equations, namely, *sample selection equation* and *outcome equation*. The *sample selection equation* take form as:

$$t^*_{ijt} = \eta' Z_{ijt} + \mu_{ijt} \quad (6.5)$$

where, t^*_{ijt} is a latent variable and it is not observed but we do observe if countries trade or not (i.e. the possibility of trade between a paire of countries), such that $t_{ijt} = 1$ if $t^*_{ijt} > 0$ and $t_{ijt} = 0$ if $t^*_{ijt} = 0$ and Z_{ijt} is a vector of variables that affects t^*_{ijt}. μ_{ijt} is the random error term. In this study, we included other five new variables to the existing explanatory variables as the Z_{ijt} factors that might affects t^*_{ijt}. The description and expected sign of these five variables are given in **Table 6.2**. Thus, Equation (6.5) can be written in details as:

$$\begin{aligned} t^*_{ijt} = \eta_0 &+ \eta_1 \ln(GDP_{it}.GDP_{jt}) + \eta_2 \ln(pcGDP_{it}.pcGDP_{jt}) + \eta_3 \ln(dpcGDP_{ijt}) \\ &+ \eta_4 \ln(D_{ij}) + \eta_5 \ln(exc_{ijt}) + \eta_6 \ln(land_{it}) + \eta_7 \ln(RM_{jt}) \\ &+ \eta_8 border_{ij} + \eta_9 colony_{ij} + \eta_{10} landlocked_j + \eta_{11} WTO_{jt} \\ &+ \eta_{12} ASEAN_{jt} + \eta_{13} BRI_{jt} + \eta_{14} crisis_{2008} + \eta_{15} Africa_j \\ &+ \eta_{16} \ln(RX_{jt}) + \eta_{17} EN_j + \eta_{18} CN_j + \eta_{19} Asia_j + \eta_{20} Europe_j + \mu_{ijt} \end{aligned} \quad (6.6)$$

The *outcome equation* of the Heckman selection model takes the same form as the gravity model in Eqation (6.3), which can be written as Equation (6.7) below:

$$\begin{aligned}\ln(X_{ijt}) = \alpha &+ \beta_1 \ln(X_{ij,t-1}) + \beta_2 \ln(GDP_{it}.GDP_{jt}) + \beta_3 \ln(pcGDP_{it}.pcGDP_{jt}) \\ &+ \beta_4 \ln(dpcGDP_{ijt}) + \beta_5 \ln(D_{ij}) + \beta_6 \ln(exc_{ijt}) + \beta_7 \ln(land_{it}) \\ &+ \beta_8 \ln(RM_{jt}) + \gamma_1 border_{ij} + \gamma_2 colony_{ij} + \gamma_3 landlocked_j \\ &+ \gamma_4 WTO_{jt} + \gamma_5 ASEAN_{jt} + \gamma_6 BRI_{jt} + \gamma_7 crisis_{2008} + \gamma_8 EU_{jt} \\ &+ \gamma_9 Africa_j + \delta_1 tariff_j + \varepsilon_{ijt}\end{aligned} \tag{6.7}$$

In the econometrics assessment, the regressors selection and model specifications are frequently challenging, which should be cautiously made based on the economic theories and statistical evidences, as well as the accuracy functional form and the validity of the error-term's assumption (Bera and Jarque 1982 , Wooldridge 2002). The current study, therefore, followed and relied on these guidelines/instructions, trade and economic theories and the preceding empirical works for our empirical models' specifications and variables selection.

Table 6.1: Description of empirical models' independent variables

Variable	Description	References	Ep. Sign
$X_{ij,t-1}$	Dynamic (lagged) rice export flow in previous period $t-1$.	Nguyen (2010), Gashi, Hisarciklilar and Pugh (2016), Kahouli (2016), Shahriar, Qian and Kea (2018)	$+$
$GDP_{it}.GDP_{jt}$	Combined effect of GDP of Cambodia & partners in period t.	Narayan and Nguyen (2016)	$+$
$pcGDP_{it}.pcGDP_{jt}$	Combined effect of per capita GDP of Cambodia & partners.	Popova and Rasoulinezhad (2016)	$+$
$dpcGDP_{ijt}$	Absolute difference between per capita GDP of Cambodia and partners in period t.	Rasoulinezhad and Kang (2016), Irshad, Xin, Shahriar and Arshad (2018)	$+/-$
D_{ij}	Distance from Phnom Penh to partner's capital city in km.	Marti, Puertas and García (2014)	$-$
exc_{ijt}	Bilateral exchange rate of "riels" against partner j's currency in period t.	Rasoulinezhad and Wei (2017), Irshad, Xin, Shahriar and Ali (2018)	$+$
$land_{it}$	Cambodian agricultural land in km^2 proxies for production capacity.	Wang (2016), Thuong (2018)	$+$
RM_{jt}	Total annual rice imported value of country j, is proxied to j's demand capacity.	Wang (2016)	$+$
$border_{ij}$ dummy	1: country j share land border to Cambodia, 0: otherwise.	Fan, Zhang, Liu and Pan (2016), Zhou, Li and Lei (2018)	$+/-$
$colony_{ij}$ dummy	1: country j used to be colonized by France, 0: otherwise.	Santos Silva and Tenreyro (2006), Lee and Pyun (2018)	$+$
$landlocked_j$ dummy	1: country j is a landlocked country, 0: otherwise.	Carrère (2006), Martínez-Zarzoso and Johannsen (2017)	$-$
WTO_{jt} dummy	1: country j is a member of WTO in period t, 0: otherwise.	Lien and Lo (2017), Rasoulinezhad and Popova (2017)	$+$
$ASEAN_{jt}$ dummy	1: is a member of ASEAN in period t, 0: otherwise.	Soeng and Cuyvers (2018), Li, Sun and Long (2019)	$+$
BRI_{jt} dummy	1: country along BRI project from 2013, 0: otherwise.	Shahriar (2019c), Shahriar, Qian and Kea (2019)	$+$
$crisis_{2008}$ dummy	1: for period from 2008 to 2016 (include 2008), 0: otherwise.	Kahouli (2016)	$-$
EU_{jt} dummy	1: j is a member of European Union, 0: otherwise.	Kahouli and Omri (2017)	$+$
$Africa_j$ dummy	1: j is in the Africa continent, 0 otherwise.	Bui and Chen (2017)	$+/-$
$tariff_j$	Average tariff rate compose by country j during the study period.	Miankhel, Kalirajan and Thangavelu (2014), Thuong (2018)	$-$

Source: Own Elaboration. **Note**: "Ep. Sign" = Expected Sign.

Table 6.2: Description of the 5 newly included independent variables

Variable	Description	References	Exp. Sign
RX_{jt}	Total annual rice export value of trading partner country j	Wang (2016)	−
EN_j	1: if English is country j's official language, 0: otherwise	Atif, Haiyun and Mahmood (2017)	+
CN_j	1: if Chinese is country j's official language, 0: otherwise	Ji and Yoo (2018)	+
$Asia_j$	1: if country j located in Asia-Pacific region, 0: otherwise	Bui and Chen (2017)	+
$Europe_j$	1: if country j located in Europe continent, 0: otherwise	Kahouli and Omri (2017)	+

Source: Own Elaboration. **Note**: "Exp. Sign" = Expected Sign.

Table 6.3: Sample countries and economies of the study

Continents	Country / Economies	No. of Country
Asia & Pacific	Australia, Brunei Darussalam, Mainland China, Hong Kong, Macao, Taiwan, Indonesia, Israel, Laos, Malaysia, Philippines, Russian Federation, Saudi Arabia, Singapore, Thailand, Vietnam.	16
Europe	Austria, Belarus, Belgium, Bulgaria, Croatia, Czech Republic (Czechia), Denmark, France, Germany, Greece, Italy, Latvia, Lithuania, Netherland, Norway, Poland, Portugal, Romania, Spain, Sweden, United Kingdom (UK).	21
Africa	Côte d'Ivoire, Ghana	02
America	United States of America (USA)	01
	Total number of the countries included in the sampling frame :	**40**

Source: Own Elaboration. **Note:** "No. of Country" = Number of country.

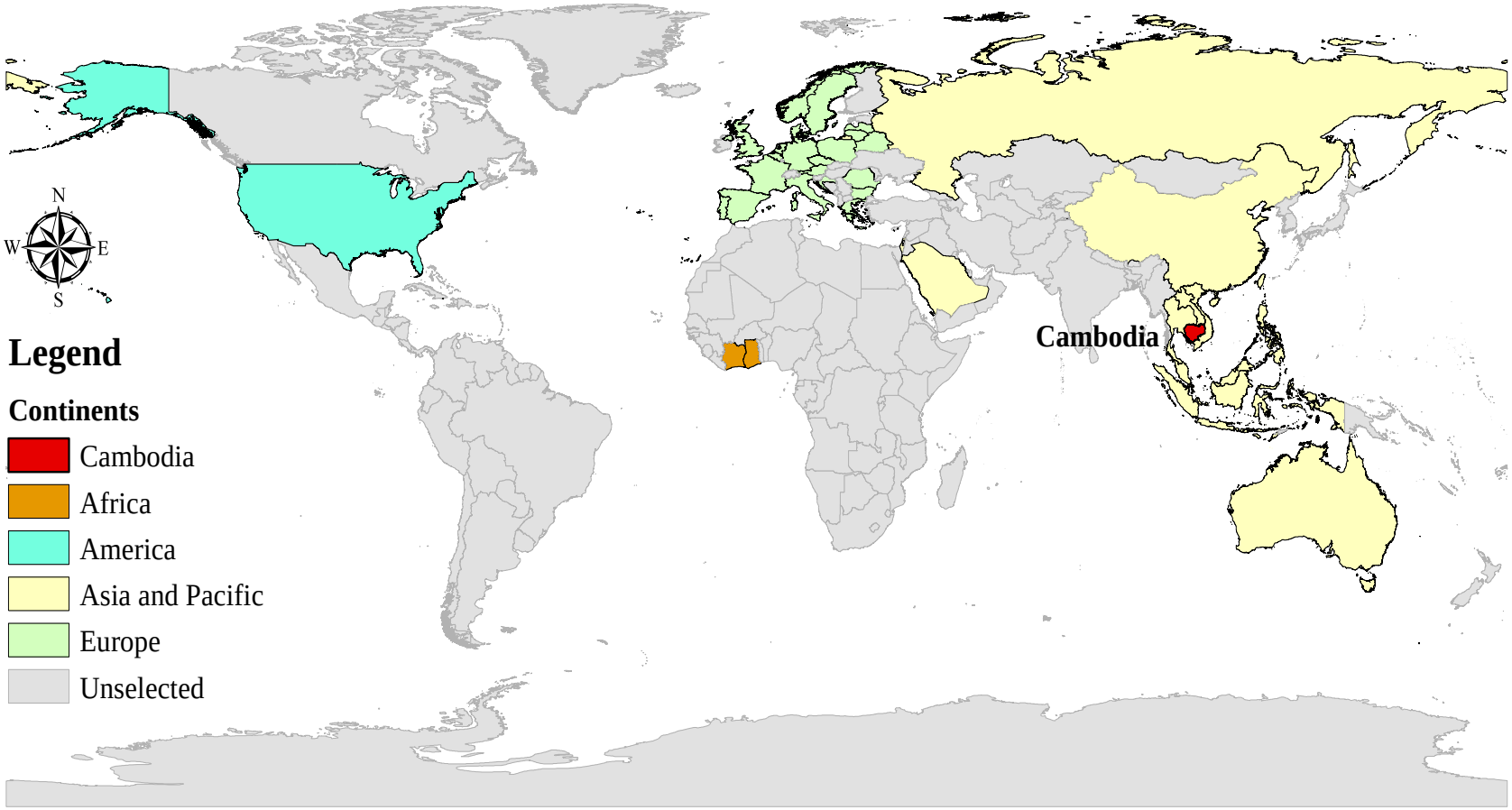


Figure 6.1: The countries included in the sampling frame on the World map

Source: Authors' own elaboration, using ArcGIS software version 10.2.2.

Table 6.4: Data sources of variables used in this study

Variables	Description	Unit	Data Sources
X_{ijt}; $X_{ij,t-1}$	Bilateral rice export	Thousand USD	UNCTAD* (www.unctad.org)
$GDP_{it}.GDP_{jt}$	Aggregate Income	Million USD	UNCTAD
$pcGDP_{it}.pcGDP_{jt}$	Per capita income	USD	UNCTAD
$dpcGDP_{ijt}$	Absolute difference of per capita GDP	USD	Calculate
D_{ij}	Distance	Kilometers	Distance Calculator of www.timeanddate.com
exc_{ijt}	Bilateral exchange rate	Riels / j's currency	UNCTAD
$land_{it}$	Total agricultural land area	Square Kilometers	WDI** (databank.worldbank.org)
RM_{jt} ; RX_{jt}	Total rice import and export	Thousand USD	UNCTAD
$border_{ij}$	The common border	1/0 Dummy	CEPII*** Database (www.cepii.fr)
$colony_{ij}$	The colonial ties	1/0 Dummy	CEPII Database
$landlocked_j$	The landlocked country	1/0 Dummy	CEPII Database
WTO_{jt}	The WTO membership	1/0 Dummy	www.wto.org
$ASEAN_{jt}$	The ASEAN membership	1/0 Dummy	www.asean.org
BRI_{jt}	The countries along the BRI project	1/0 Dummy	Yiwei (2016)[76], Shahriar (2019c)[54]
EU_{jt}	The EU membership	1/0 Dummy	europa.eu
$crisis_{2008}$	The 2008 economic recession	1/0 Dummy	Year
EN_j ; CN_j	The official language(s)	1/0 Dummy	CEPII Database
$Africa_j$; $Asia_j$; $Europe_j$	The geographical information	1/0 Dummy	CEPII Database
$tariff_j$	The average tariff rate	Percentage (%)	The Heritage Foundation (www.heritage.org)

Source: Own Elaboration. **Note:** * UNCTAD: The United Nations Conference on Trade and Development; ** WDI: World Development Indicator; *** CEPII: Centre for International Prospective Studies and Information (English) or Centre d'Etudes Prospectives et d'Informations Internationales (French)

Table 6.5: Descriptive statistics of the explanatory variables

Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Variable	Obs.	Mean	Std. Dev.	Min.	Max.
X_{ijt}	880	1,831.0870	7,347.4693	0.0000	73,814.9420	$colony_{ij}$	880	0.0750	0.2635	0.0000	1.0000
$X_{ij,t-1}$	880	1,827.7481	7,347.6397	0.0000	73,814.9420	$landlocked_j$	880	0.0750	0.2635	0.0000	1.0000
$ln(GDP_{it}.GDP_{jt})$	880	21.0341	2.0783	15.1676	26.6407	WTO_{jt}	880	0.8648	0.3422	0.0000	1.0000
$n(pcGDP_{it}.pcGDP_{jt})$	880	15.5723	1.6290	11.0776	18.4793	$ASEAN_{jt}$	880	0.1727	0.3782	0.0000	1.0000
$ln(dpcGDP_{ijt})$	880	9.0758	1.7771	0.6774	11.5322	BRI_{jt}	880	0.0909	0.2876	0.0000	1.0000
$ln(D_{ij})$	880	8.5419	0.9157	6.2860	9.3896	$crisis_{2008}$	880	0.0909	0.2876	0.0000	1.0000
$ln(exc_{ijt})$	880	6.3337	2.7299	-1.7062	10.5047	EU_{jt}	880	0.3864	0.4872	0.0000	1.0000
$ln(land_{it})$	880	10.8439	0.0688	10.7299	10.9069	$Africa_j$	880	0.0500	0.2181	0.0000	1.0000
$ln(RM_{jt})$	880	10.8702	1.6933	3.9368	14.4868	$tariff_j$	880	2.6826	2.3897	0.0000	12.0317
$border_{ij}$	880	0.0750	0.2635	0.0000	1.0000						

Source: Own Elaboration. **Note:** "Obs." = Number of observations, "Std. Dev." = Standard Deviation, "Min." = Minimum, "Max." = Maximum.

Table 6.6: Selection Equation estimated by Heckman Selection Model, Eq.(6)

Variable	Coefficient	P>|z|	Variable	Coefficient	P>|z|
$ln(GDP_{it}.GDP_{jt})$	−0.0979	0.4700	$ASEAN_{jt}$	0.3798	0.3950
$ln(pcGDP_{it}.pcGDP_{jt})$	1.9496 ***	0.0000	BRI_{jt}	0.1466	0.5580
$ln(dpcGDP_{ijt})$	−1.3144 ***	0.0000	$crisis_{2008}$	−1.2966 ***	0.0000
$ln(D_{ij})$	0.1683	0.6640	$Africa_j$	1.2699	0.1010
$ln(exc_{ijt})$	−0.0583	0.3320	$ln(RX_{jt})$	0.1387 ***	0.0030
$ln(land_{it})$	0.0507	0.3270	EN_j	−0.7454 ***	0.0010
$ln(RM_{jt})$	0.1835 **	0.0390	CN_j	1.6677 ***	0.0000
$border_{ij}$	0.6822	0.4310	$Asia_j$	0.2614	0.6660
$colony_{ij}$	−2.3642 ***	0.0010	$Erope_j$	0.2470	0.6410
$landlocked_j$	−0.8662 ***	0.0060	$constant$	−22.4581 ***	0.0000
WTO_{jt}	0.2696	0.4110			
/athrho	0.2835	0.2360	#Obs.	752	
/lnsigma	0.4063 ***	0.0000	Log-likelihood:	−649.2421	
rho (ρ)	0.2762		Wald chi2	352.4400	
sigma (σ)	1.5012		Prob. > chi2	0.0000 ***	
lambda (λ)	0.4146				

Source: Own Elaboration. **Note:** *, **, *** indicates significant at 10%, 5% and 1% respectively. "P>|z|" = Probability. "#Obs." = Number of Observations.

Table 6.7: Empirical gravity model estimated by GLS, PPML and Heckman model

Variable	GLS Approach, Eq.(3) $\ln(X_{ijt})$		PPML Approach, Eq.(4) X_{ijt}		Heckman Model, Eq.(7) $\ln(X_{ijt})$	
	Coefficient	**P>|z|**	**Coefficient**	**P>|z|**	**Coefficient**	**P>|z|**
$ln(X_{ij,t-1})$	0.4024 ***	0.0000	0.0000 ***	0.0000	0.4276 ***	0.0000
$ln(GDP_{it}.GDP_{jt})$	−0.0452	0.7900	0.3200 ***	0.0000	0.0406	0.7790
$ln(pcGDP_{it}.pcGDP_{jt})$	1.4450 ***	0.0050	0.8568 ***	0.0050	1.5879 ***	0.0020
$ln(dpcGDP_{ijt})$	−1.1654 **	0.0200	−0.9089 ***	0.0030	−1.2383 ***	0.0090
$ln(D_{ij})$	0.0435	0.9120	−0.9273 ***	0.0000	−0.2330	0.5100
$ln(exc_{ijt})$	−0.1140	0.3050	0.1563 ***	0.0070	−0.0964	0.3090
$ln(land_{it})$	−1.4393	0.8180	31.6277 ***	0.0040	1.2428	0.8350
$ln(RM_{jt})$	0.4676 ***	0.0090	0.3372 ***	0.0000	0.3709 **	0.0170
$border_{ij}$	−2.7643 **	0.0250	−4.7370 ***	0.0020	−3.3444 ***	0.0010
$colony_{ij}$	−0.6126	0.5630	0.4875	0.5680	−0.3689	0.6840
$landlocked_j$	−0.4883	0.4360	−0.0983	0.7610	−0.5675	0.2830
WTO_{jt}	−0.1033	0.8970	−2.1480 ***	0.0010	−0.0115	0.9870
$ASEAN_{jt}$	1.6899 *	0.0510	0.2536	0.5420	1.3773 *	0.0520
BRI_{jt}	0.1319	0.6800	0.5542 **	0.0260	0.1260	0.6720
$crisis_{2008}$	−0.9078 *	0.0700	−1.5669 ***	0.0030	−1.0586 **	0.0380
EU_{jt}	2.0167 ***	0.0000	2.7279 ***	0.0000	2.0350 ***	0.0000
$Africa_j$	−2.1310	0.1930	−0.7435	0.3640	−2.0558	0.1230
$tariff_j$	0.1422	0.4390	0.1445	0.1140	0.2075	0.1740
$constant$	2.0140	0.9750	−346.8720 ***	0.0040	−27.9411	0.6540
Number of Observations	248		880		752	
Log-likelihood:	-		−543,683.2700		−649.2421	
R^2	0.6384		0.7944		-	

Source: Own Elaboration. **Note:** *, **, *** indicates significant at 10%, 5% and 1% respectively. "P>|z|" = Probability.

6.2.4. Sample size and data sources

A dynamic panel commodity-specific gravity model was purposively considered for addressing the research question of "What are the foremost elements influencing the rice exports of Cambodia?". In line with the literature (e.g. Egger 2002 , Baltagi 2005 , Baltagi, Egger and Pfaffermayr 2013 , Baltagi, Egger and Pfaffermary 2015 , Pesaran 2015 , Mátyás 2017 , Baltagi, Egger and Kesina 2018 , Shepherd 2019), the panel data had been proved to benefit over the cross-sectional and time-series. Thus, the panel dataset was also applied to the current analytical framework, which consiss of 880 observations (22 years panel spanning from 1995 to 2016, $T = 22$, and the 40 selected major partners out of the total of 95 countries, i.e. $N = 40$, accounted for 97% of the Cambodia's total rice exported value on the same period), see further (UNComtrade 2018 , UNComtrade 2019).

Table 6.3 showed the full list of the countries and economies included in the sample, while **Figure 6.1** illustrated them on the world map. The sources of data for variables used were mentioned in **Table 6.4**, and **Table 6.5** presented the descriptive statistics of the variables. The *Stata* version 14.0 software was used for our study.

6.3. Results and Discussion

Table 6.6 illustrated the factors affecting the possibilities of the Cambodian rice exports, showed a numbers of influencing factors, included GDP per capita, absolute different of GDP per capita, total rice export/import, and the factors of common languages, common colony, landlocked, and economic recession. Four out of these, involved (1) per capita GDP ($pcGDP_{it}.pcGDP_{jt}$), (2) total rice import (RM_{jt}), (3) total rice export (RX_{jt}), and (4) Chinese language (CN_j), were found to be positively significant at different significant-levels.

The per capita GDP, total rice export, and Chinese language are highly significant at 1%, while total rice import is significant at 5%, revealed that the richer nations have more potensive for rice export. It is also indicated that the greater volume of rice exports or imports of the importing country j would lead to opportunity intensification for rice exported from Cambodia. More interestingly, our findings also revealed that the *Chinese* language was progressively becoming an imperative instrument for encouraging further rice exportation of country j. This finding supported the statement urged by Melitz (2008) which

stated that the two countries' *bilateral trade* are often endorsed by *language* as a tool of communication. The emprical estimations of our *dynamic panel gravity model* for Cambodian rice exports are given in **Table 6.7**, analyzed througt an application of *Stata* software with the GLS, PPML, Heckman specifications. The estimated coefficients signs are consistent with the statistical significance at the conventional levels, and the results of the PPML and Heckman approaches are more significant in comparison with the GLS model. We find two income variables, i.e. per capita income ($pcGDP_{it}.pcGDP_{jt}$), and absolute different of per capita income ($dpcGDP_{ijt}$), to be significant in all the models with different coefficient signs and significant level, while the aggregate income ($GDP_{it}.GDP_{jt}$) and distance (D_{ij}) are significant at 1% level with diffferent signs in the PPML but remain insignificant in GLS and Heckman models. The positive significant signs of aggregate and per capita income show that wealthier countries tend to trade. The previous studies (e.g. Filippini and Molini 2003 , Shahriar, Qian and Kea 2019) also reported the similar results.

The performance of rice exports of Cambodia seem to follow the Linder (1961)'s *hypothesis* (as captured by the negatively siginificant at 1% of $dpcGDP_{ijt}$), which stated that the comparable earnings phase of two countries, would leaded them to have the similar characteristics as well as the supply-demand capacity. These features, therefore, be likely to drive further trade between them. A number of studies had correspondingly providing empirical evidences to support the *Linder hypothesis* (e.g. Thursby and Thursby 1987 , Bergstrand 1990 , Ul Haq and Meilke 2011 , Ganguli 2013). *Distance* is frequently engaged as a alternative to *trade/transportation costs*, as one of numerous key trade resistance factors, in the *gravity* studies (see further, Marti and Puertas 2019 , Shahriar, Qian and Kea 2019 , Shahriar, Qian, Kea and Abdullahi 2019). It is revealed that *distance* often diminish bilateral exports, as well as rice exports. The PPML framework of our dynamic panel gravity model showed the strong negative-significant impact (at 1%) of distance variable on Cambodian rice exports. The value of -0.93 of $ln(D_{ij})$'s coefficient, revealed that the rice exports of Cambodia would drop by 0.93% if the *distance* between Cambodia and its trading partner (i.e. country *j*) increased by 1%. This result is in line with the prior studies of rice trade (e.g. Sareth 2015 , Irshad, Xin and Arshad 2018).

The *historical ties* had been urged to be a main driver shaping the international trade's direction (Eichengreen and Irwin 1998 [55]). The robust positive-significant (at 1% level in all the models) of our lagged rice exports ($X_{ij,t-1}$) variable, indicated the important of *historical*

ties in the Cambodia rice economy, and Cambodia would continuously expand its rice exports to its historical trading partners. The former studies also provided empirical evidences to support the importance of history in the performace of trade (e.g. Martínez-Zarzoso, Felicitas and Horsewood 2009 , Bergstrand, Larch and Yotov 2015 , Gashi, Hisarciklilar and Pugh 2016 , Kahouli 2016 , Stack, Ackrill and Bliss 2018). Additionaly, the scholars also stated that *borders* outline the local trade-networks and accumulation patterns, which would resulted in changes in the accomplishments of the economic assembly (Carter and Goemans 2018 [45]). Our *border* dummy, however, turns to be negative and significant at 5% in all the models. The explanation is that Cambodia tends to export the relatiuvely less amount of rice to its neighboring nations, i.e. Thailand, Laos and Vietnam. The main reason is that Thailand and Vietnam are the first and the third largest net rice-exporter countries in the global market.

The *agricutural land* of Cambodia ($land_{it}$) is a proxy to the supply capacity of rice. It is positively significant at 1% level in the PPML estimation, but insignificant in the GLS and the Heckman models, and the coefficient shows that a 1% increase in supply would raise rice exports by 31.63%. Wang (2016) added land variable to capture the effect of Japan's soybean supply ability on its soybean imports between 1995 and 2011. He did not found any significant result in his GLS gravity model. The total rice import value of importing countries j (RM_{jt}), on the other hand, is a proxy to the demand capacity of rice. It is positively significant in all models at the different levels, indicating that whenever the demand for rice in importing countries increase, they are likely to increase their imports of rice from Cambodia. As shown in **Table 6.7**, 1% increase in demand will raise the Cambodian rice exports by 0.39%.

The European Union (EU) is the largest destination for the Cambodian rice. The EU_{jt} dummy is strongly significant at 1% with the positive sign in the three models. This result is consistent with the findings of Kahouli and Omri (2017) who found the positive impact of EU membership on trade. The $ASEAN_{jt}$ is positive significant at 10% level in GLS and Heckman models, but insignificant in PPML model. From this result, we can draw the inference that there are some gaps for Cambodia to expand its rice exports to other ASEAN rice-importing members, such as Malaysia, Philippines, Singapore, etc. The study by Li, Sun and Long (2019) similarly found positive effect of ASEAN membership on export flows.

The Chinese market (included the Mainland China, Hong Kong, Macao and Taiwan) was progressively developed as the second largest export-destination for the Cambodian rice (after the EU), particularly after the declaration of the BRI initiative. Under this framework, China is building the *cross-border ties* by means of the six economic corridors (Shahriar 2019a , Shahriar 2019c). The Sino-Cambodia relations in the BRI's Maritime Silk Road (MSR) framework had been further investigated (Ciorciari 2014 , Chen 2016 , Chen 2018 , Hu, Zhang, Hu and Cook 2019). The literatures revealed that investment and trade (especially, agricultural trade) were core cooperative aspects between China and Cambodia. The two coutries is working together in numberous core projects, such as, the *Mekong River Development Plan*, *Sihanoukville Special Economic Zone* and *Koh Kong Special Economic Zones* (Chen 2018). Our empirical models also showed the positively significant (at 5% level for the PPML framework, but statistically insignificant in the GLS and Heckman) of variable of BRI_{jt}, i.e. BRI membership of country j, revealed the cumulative important of Chinese market as well as BRI for the exports of Cambodian rice. Similarly, Shahriar, Qian and Kea (2019) reports the positive significance of BRI on bilateral export flows of the Chinese meat industry.

Unexpectedly, the *dynamic panel gravity model* of our study disclosed the robust negative significant (at 1% level) of WTO_{jt}. This result revealed that the country j's membership in WTO give the impression of the shrinkage source for rice exports of Cambodia. Soeng and Cuyvers (2018) urges that Cambodia's membership of the WTO did promote the country's exports. In case of rice, however, membership in WTO might increase in competitive challenges in the world rice market for Cambodia by other net-rice exporter nations, such as Thailand, India, and Vietnam.

The exc_{ijt} which is proxies exchange rate policy is positively significant at 1% level in the PPML model, but insignificance in the GLS and the Heckman models. The coefficient of exc_{ijt} reveals that a 1% increase in exc_{ijt} leads to an increase of the Cambodian rice exports by 0.16%. Along with the Cambodian *free market reform* in 1993, the gap between the *official rate* and the *market rate* was rigorously regulatated[17] and accomplished under NBC (National Bank of Cambodia). The prior studies also indicated the important impact of exchange rate policy on rice exports (e.g. Bui and Chen 2017 , Irshad, Xin and Arshad

[17] Since 1995, NBC keep the gap <1% between the official exchange rate and the market rate [134] HILL H, MENON J. Cambodia: Rapid growth with weak institutions [J]. Asian Econ Policy R, 2013, 8(1): 46-65..

2018). The $crisis_{2008}$ is negatively significant at different level in all models, reveals that the economic recession has had serious consequences in terms of rising unemployment, slowing growth, sluggish export growth. Huot and Kakinaka (2007) and Kahouli (2016) also found the significant negative impact of '*crisis*' variable on the overall trade flows and exports.

6.4. Chapter Summary

This study aims to study the determinants of Cambodian rice exports under the dynamic panel gravity model with three analytical approaches of GLS, PPML, and Heckman selection model. This analysis is based on a panel dataset from 1995 to 2016 (22 years) for a total of 40 selected largest rice importing partners. The contributions and implications of this study are threefold. **First**, the data used in the article is unique. The authors made a panel data set of 880 observations (22 years × 40 countries), to overcome the various econometric issues, such as *heteroscedasticity*, *multicollinearity* or *serial correlations*. **Second**, the study is the first study on the investigation of the exports determinants of Cambodian rice throught an application of the trade gravity model (or the *dynamic penel commodity-specifiy gravity model*, in specific). **Third**, the present study is a novel work in the sense that Cambodia's major trading partners are covered in the sampling framework.

Several main points could be derived from the findings of the study: (1) The historical ties play important role in Cambodia rice exports; (2) The EU countries such as France, Germany, Netherlands, Poland, etc., ASEAN (Malaysia, Singapore, etc.), China (mainland China, Hong Kong, Macao and Taiwan), and countries along with the BRI are the important market for Cambodian rice exports; (3) Cambodia rice export is sensitive to the macroeconomic factors; and (4) The exchange rate policy and agricultural land expansion are one of the core influencing factors promoting rice exports.

A few recommentadations could be put forward for the development of the rice sector in several ways. **First,** the RGC would continue to build up the bilateral relations with the existing rice trading partners by implementation of the trade promotion policies and other trade promotion tools such as bilateral or regional trading agreements. **Second,** Cambodia might need to reform its institutional and monetarial systems to reduce sensitiveness and self-strengthening capabilities for dealing with the influences of a plethora of external factors and shocks like the economic recession. **Third**, strengthening of the exchange rate and

agricultural land policies could boost up the country's rice exports. Last but not least, further studies may examine the extensions of our model(s) for other agricultural products of Cambodia. The researchers could also include both agricultural-commodities imports and exports equations altogether in a study. For the purpose of comparative studies of rice economies, more research efforts are needed to combine the results from the gravity models, comparative advantage measurements, and competitiveness of rice in the global markets.

CHAPTER 7. 'GREEN' TRADE BARRIERS AND CAMBODIAN RICE EXPORTS [18]

This chapter aims to explores how the '*Green*' *trade barriers* (GTBs) in general or the *Sanitary and Phyto-Sanitary* (SPS) measures as a kind of "*Food Safety Standards*" (FSS) in particular might affect rice exports of Cambodia. The *SPS gravity model* with different estimation approaches to handle zero-trade flows (GLS, PPML, Heckman) were applied using data of Cambodia's rice exports to its 38 major trading partners over 23-year period (1996–2018). Our results reveal that SPS measures have high negative impact on Cambodian rice exports. In the high-income markets, e.g. EU, the Cambodian rice seem to have higher popularity. Moreover, Cambodia seems to have greater trade with the SPS-required countries (on rice exports) rather than those which do not. The research enriches the literature on GTBs, trade in agro-products, and provides a basis for future studies, as it is the first study on the impact of SPS on Cambodian agro-exports (particularly, rice exports).

7.1. Introduction

In the new century, '*going green*' had gradualy become a major social concerns. Along with the rapid growth of the global economy, numberous environmental concerns (e.g. air, land, water pollution, waste, acid rains, deforestation, etc.) had been gradually addressed. Worldwide evidences had also indicated the shifting of people's consumption behavior toward *eco-friendly* and *safety of food* (Polonsky 1994 , Nagaraju and H.D. 2016 , Shahriar 2019b).

'*Going green*' had paved a road for a new form of '*Green*' *trade barriers* (GTBs) [19], i.e. called "*Food Safety Standards*" (FSS). FSS had gradually become the effective "*umbrella*" of the numerous developed nations for protecting their economic welfares behind the '*green*' (Ferro, Otsuki and Wilson 2015 , Chandra 2016 , Xu, Liu and Yang 2018). Moreover, the FSS (e.g. SPS) are also becoming the major barriers to agricultural trade, including rice (Peterson, Grant, Roberts and Karov 2013 , WTO 2019c).

[18] The manuscript of this chapter entitled "*Food safety standards and Cambodian rice exports: An application of the gravity model*", was submitted and *under review* for publication in the scientific journal.

[19] GTBs are new kinds of *Non-tariff barriers* (NTBs) within the WTO framework [342] WTO. Geneva, Switzerland: World Trade Organization (WTO), 2012..

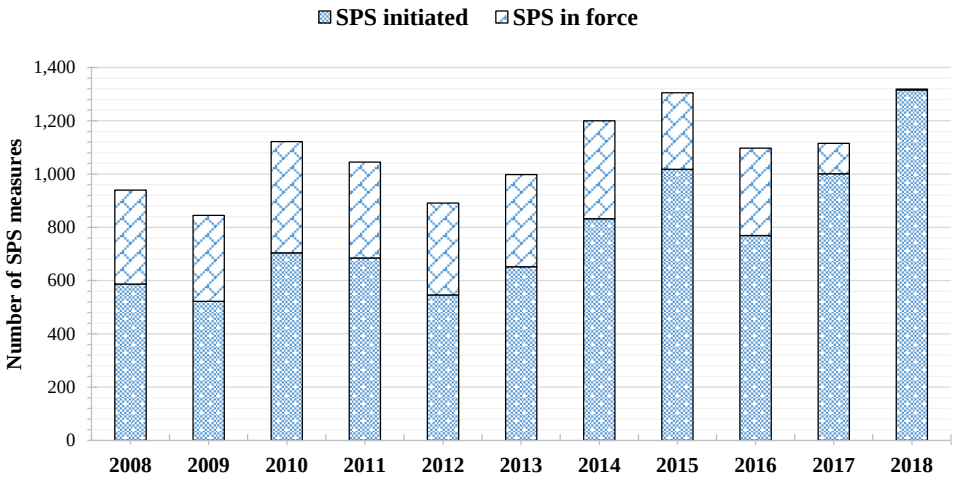


Figure 7.1: SPS measures initiated and in force, 2008-2018

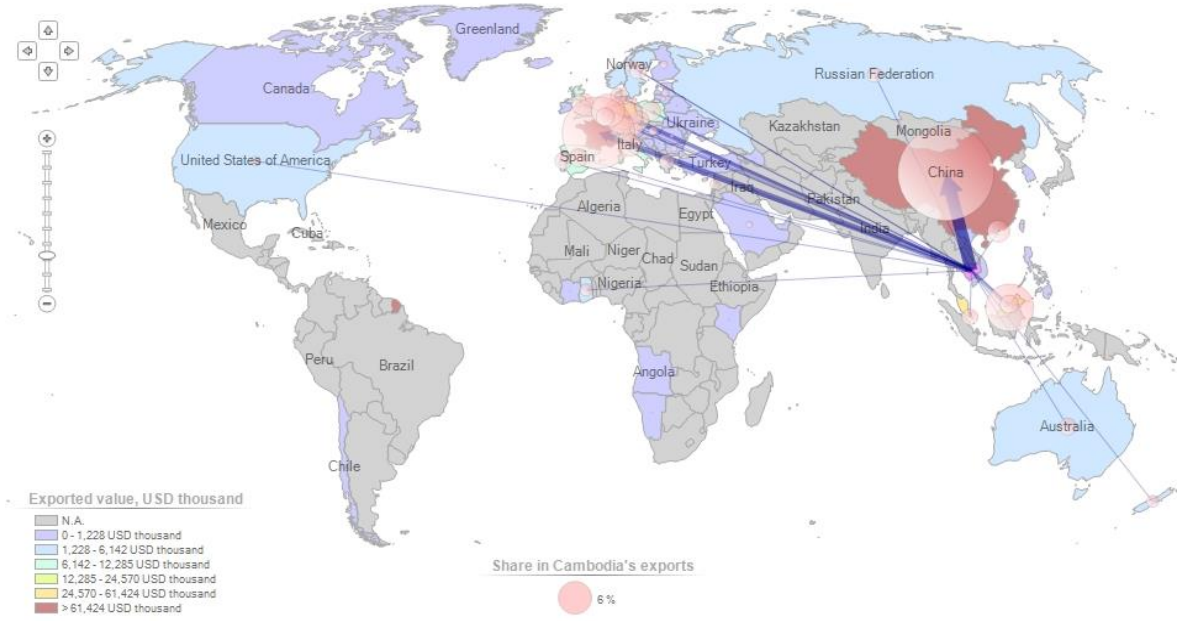
Source: World Trade Organization, WTO (2020)

Between 1996-2009, the global average tariff rates on agro-products declined from 14.6% to 10.8%. However, the agricultural products (HS01-HS24)'s all types SPS had considerably enlarged, from 136 to 564 between 1996 and 2009 (Wei, Huang and Yang 2012b , WTO 2020). **Figure 7.1** showed that total SPS measures as of June 30, 2019 was 18,637, indicated that FSS had become stricter in many importing countries, increasingly becoming the '*trade barriers*'.

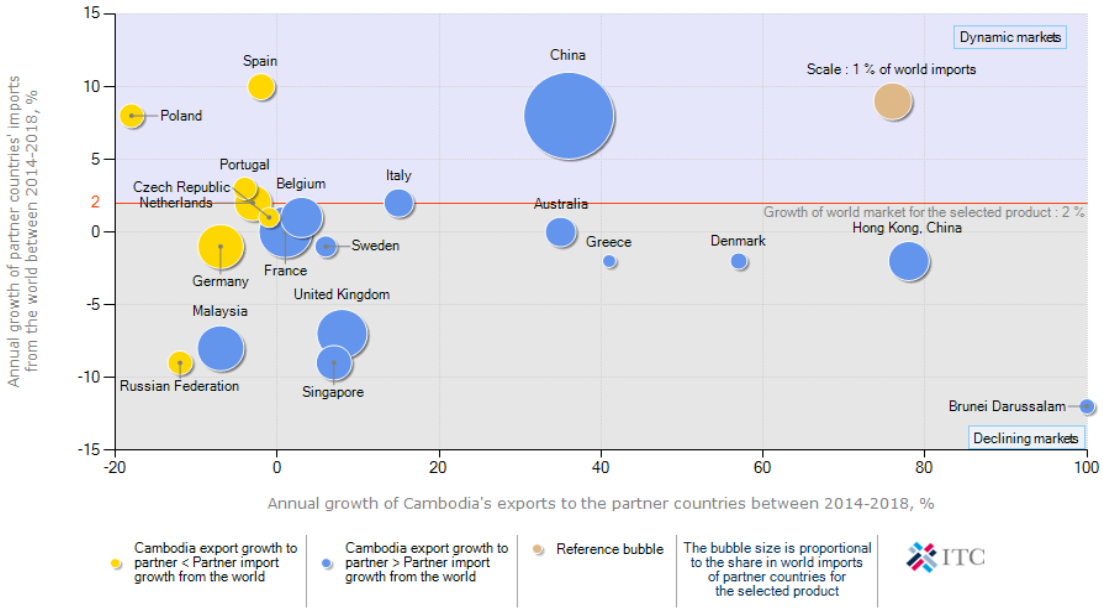
The importance of FSS has been emphasized and investigated by several studies (e.g. Otsuki, Wilson and Sewadeh 2001a , Otsuki, Wilson and Sewadeh 2001b , Disdier, Fontagne and Mimouni 2008 , Anders and Caswell 2009 , Minten, Randrianarison and Swinnen 2009 , Lang 2012 , Khoi and Thuy 2014 , Kareem 2016 , Bui and Chen 2017). Nonetheless, it is notably narrow in quantity of the study on impact investigation of the FSS (i.e. kinds of GTBs) on the Cambodian agricultural exports, although GTBs had been gradually attached attentions by researchers. For instance, the impacts of GTBs on agricultural exports (e.g. Lang 2012 , Khoi and Thuy 2014 , Kuppusamy and Gharleghi 2014 , Ferro, Otsuki and Wilson 2015 , Kareem 2016 , Tao 2016), textile exports (Xu, Liu and Yang 2018), rice (Thuong 2018), sea food (Shepotylo 2015 , Shepotylo 2016), tea (Wei, Huang and Yang 2012b), and vegetables (Chen, Yang and Findlay 2008 , Li and Zhang 2012 , Dou, Yanagishima, Li, Li and Nakagawa 2015).

Cambodia is the Southeast Asia's third largest rice producer and exporter and the world's tenth leading-exporter in 2016 (Kea, Li, Shahriar, Abdullahi, Phoak and Touch 2019

, FAOSTAT 2020 , Kea, Li, Shahriar and Abdullahi 2020). Currently, Cambodia occupied the average market share in the global rice market around 1.1% (2015-2018), increased from ≈0.03% in the previous decade (UNCTAD 2020). The EU and China PRC are currently the largest foreign market for Cambodian rice exports (**Figure 7.2**).



(a) Major markets for Cambodian rice, 2018



(b) Growth in demand for Cambodian rice, 2018

Figure 7.2: Importing markets for Cambodian rice in 2018

Source: www.trademap.org, based on UNComtrade (2020)

Widely known as "*white gold*" in Cambodia, rice is the main source of foreign earnings (RGC 2010 , Nou and Heng 2020). Hence, it is importance to ask as to how the implementations or changes in FSS might affect the exports flows of the Cambodian rice? This study, therefore, aimed to examine the relationship between the FSS (proxies by SPS) and the overall exports of Cambodian rice, with an application of the *SPS gravity model*.

The remaining of this chapter are categorized as follows. The discussions to "What is GTBs?" are given in the next section. The third section discusses the empirical model based on the gravity model framework which was used to assess the effect of SPS measures on the Cambodian rice exports. The descriptions and data sources of this study are also given in this section. The key findings and the model's estimated results were presented in the fourth section. The conclusion and some recommendations had been made in the final section.

7.2. Sustainable Development and GTBs

Establishment of '*sustainable development*' theory offers a new growth model for economic development transformation. It was dated back to 1987, when a report entitled "*Our Common Future*" was submitted to the *UN General Assembly* by the WECD members (*World Commission on Environment and Development* founded in 1983), see further UN-WCED (1983) and Brundtland (1987). The '*sustainable development*' was defined in the report as "*both meet the needs of modern people and no harm to the development of future generations to meet their needs*". It did not only stressed "*once the people fulfil their own needs by consuming the natural resources, they should also realize that they are sharing the natural resources with their future-generations*", but also emphasized "*while the safe and healthy foodstuffs are being considered, keeping balance and harmonious on natural resources should also be focused*". Thus, it is imperative to '*going green*'.

Food signifies everyday needs and from this point of view is stable and computable demand on the consumer market (Kubicová, Kádeková, Turčeková and Bielik 2019). Abraham Maslow (1943)'s *Hierarchy of Needs* indicated that whenever that basic needs (e.g. food, shelter, etc.) were achieved, the further needs concerns (e.g. *safety needs*, belonging, esteem, self-actualization) would be progressively dedicated (**Figure 7.3**).

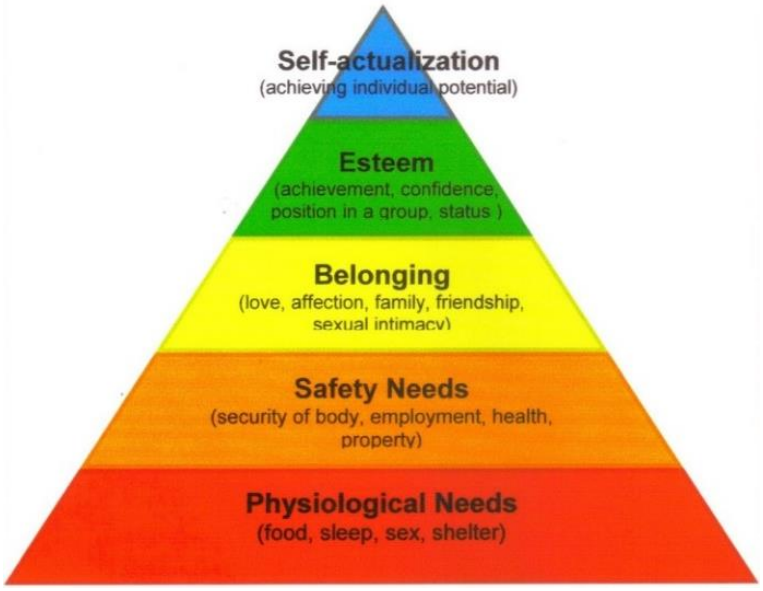


Figure 7.3: Abraham Maslow's hierarchy of needs

Source: Maslow (1943)

GTBs [20] focuses on *human health* and '*going green*', is an effective measure of *trade protection* within WTO's rules influencing international trade (since it can resist imports or increase the cost of import goods) and have been widely used in developed countries (Chandra 2016). GTBs would affect the *international competitiveness* of industries/products, since countries implementing GTBs augment their '*sustainable development*', protection of the natural environment, ecology, human health, and rapidly extend series of GTBs systems and standards for their imports (Esty and Geradin 1998 , Tussie 1999 , Xu, Liu and Yang 2018).

7.3. Methodology

7.3.1. Model specifications

Three commonly-used techniques for GTBs analysis in the empirical trade literature are (1) the *Computable General Equilibrium* (CGE), (2) the *Partial Equilibrium*, and (3) the *econometric framework of the gravity model's application* (see further, Maskus, Wilson and Otsuki 2000 , Otsuki, Wilson and Sewadeh 2001a , Otsuki, Wilson and Sewadeh 2001b). The (1) & (2) rely on the parameter assumption for demand/supply elasticities, which would lead to lacking of the statistical foundations of the estimated results. Otsuki, Wilson and Sewadeh (2001a) also pointed out the advantages of using an *econometric approach* when

[20] GTBs is also called *Environmental Trade Barriers* (ETBs), form a new kind of *Non-Tariff Technical Barriers* (NTBs).

direct measures of (GTBs) standards are available. **First**, it is not required to impose the effect's direction of standards (*positive* or *negative*), which would allow for hypothesis testing and the estimating of GTBs' elasticity on trade. **Second**, the variation of trade flows could be determined with numerous factors (e.g. geographic distance, GDP). Thus, impact of various types and levels of (GTBs) standards could be investigated across different countries.

The traditional gravity model was initially introduced based on Newton (1686)'s gravity law by Tinbergen (1962) to regulate the levels of bilateral trade ties with the absenteeism of selective trade barriers. In the '*basic*' gravity model, three main explanatory variables, included GNP of exporters and importers, and the transportation cost (proxies by distance) were presented. However, the theoretical-basics of the model were not developed afore Anderson (1979). Later, numerous improvements had been gradually made by scholars (Helpman and Krugman 1985 , Bergstrand 1989 , Bergstrand 1990 , Eaton and Kortum 1997 , Deardorff 1998 , Mátyás 1998 , Evenett and Keller 2002 , Anderson and Wincoop 2003 , Bergstrand, Egger and Larch 2013 , Head and Mayer 2014 , Shepherd 2016 , Yotov, Piermartini, Monteiro and Larch 2016 , Mátyás 2017 , Chaney 2018). The '*gravity*' model, consequently, become an effective tool for international trade studies (e.g. trade determinants, policy analysis, impact of RTAs and PTAs, etc.). More importantly, the application of the '*gravity*' schema was correspondingly the most efficient approach broadly-used for impacts investigation of the '*product standards*' (e.g. *aflatoxin standards*, *drug residue standards*, etc.) on agricultural trade. For instance, in overall agricultural trade (Ferro, Otsuki and Wilson 2015), foodstuffs (Otsuki, Wilson and Sewadeh 2001a), sea foods (Shepotylo 2015 , Shepotylo 2016), beef (Wilson, Otsuki and Majumdsar 2003), tea (Wei, Huang and Yang 2012b), banana (Wilson and Otsuki 2004), vegetables (Chen, Yang and Findlay 2008 , Li and Zhang 2012 , Dou, Yanagishima, Li, Li and Nakagawa 2015) and so on.

As a type of major GTBs to rice exports, the SPS was taken into account in this study. The *empirical SPS gravity models* of this study are as follows:

$$\begin{aligned}\ln(X_{ijt}) = {} & \beta_0 + \beta_1 \ln(GDP_{j,t-1}) + \beta_2 \ln(POP_{jt}) + \beta_3 \ln(DIS_{ij}) + \beta_4 \ln(LAND_{jt} + 1) \\ & + \beta_5 \ln(POP_{it}) + \beta_6 \ln(PROD_{i,t-1}) + \beta_7 \ln(Price_t) \\ & + \beta_8 \ln(Tariff_{jt} + 1) + \beta_9 SPS_{jt} + \beta_{10}[SPS_{jt} * \ln(GDP_{j,t-1})] + \varepsilon_{ijt}\end{aligned} \tag{7.1}$$

where, i, j, t : exporting country (Cambodia), importing countries and trade year (coverd 23-year of 1996-2018) respectively.

β : the estimated coefficients.

X_{ijt} : the real export value of rice from Cambodia to country j in year t.

$GDP_{j,t-1}$: the real GDP of country j in year $t-1$ (captures the demand-side effect and purchasing power).

POP_{it} : the population of Cambodia (captures domestic consumption).

POP_{jt} : the population of country j (determined market size).

DIS_{ij} : the bilateral distance between the capital cities of Cambodia and j used as resistance factor.

$LAND_{jt}$: the total agricultural land of country j in year t.

$PROD_{i,t-1}$: Cambodia's total rice production lagged by one year, captures the supply side effect on rice exports.

$Price_t$: the average import rice price in the world market, proxies by Thailand's FOB export price of *white milled 5% broken*.

$Tariff_{jt}$: the weighted average import tariff rates imposed by country j on rice exports.

SPS_{jt} : a binery variable (1: if country j enforces SPS on rice, and 0: otherwise). Interaction of SPS_{jt} and $GDP_{j,t-1}$ is introduced to investigate the simultaneous-effects of SPS_{jt} and GDP_{jt} on rice exported from Cambodia.

ε_{ijt} : the error term (assumed to be normal-distribution with zero-mean)

7.3.2. Data sources

Rice exports data were collected from the code of HS1006, UNCTAD (2020) in thousand USD. Data for GDP (in USD) and population are from the WDI (2020) database of the World Bank. The bilateral distance between Phnom Penh, the capital city of Cambodia, and the importers' capital were taken from the *Distance Calculator* of *www.timeanddate.com*. Data of agricultural land and total rice production are from FAOSTAT (2020) of Food and Agriculture Organization (FAO). Price data (in USD/ton) were taken from UNCTAD (2020). Tariff rates set by importing countries on rice exported from Cambodia were taken from TRAINS (2020) of the UNCTAD. SPS data were collected from the WTO-I-TIP (2020).

7.4. Empirical results and discussion

The log-form of the '*gravity*' equations often suffer from '*zeros*' trade issue (as '*zeros*' become missing data points which might be ignoring some beneficial facts). Dealing with this issue, the PPML developed by Santos Silva and Tenreyro (Santos Silva and Tenreyro 2006 , Santos Silva and Tenreyro 2010 , Santos Silva and Tenreyro 2011) and the Heckman (1979) sample selection model were simultaneously applied, while the GLS was also adopted for a comparative analyses. **Table 7.1** indicated that the coefficient values of the explanatory variables had similar sign across various estimations. Overall, SPS measures have negatively affected rice's exports of Cambodia with high estimated coefficients of -16.2 (GLS), -18.2 (PPML) and -12.3 (Heckman). This indicated that imposing of SPS by the importing countries might result in decreasing in Cambodian rice exports by 15.6% on average. The finding was in line with the situation in Vietnam (Thuong 2018).

The elasticities of importers' GDPs (without SPS measures) are statistically significant and equal to ≈ 0.25. This result indicated that Cambodia's rice is a favourite or popular commodity in the markets of the higher-income countries, as 1% increase in income of importers *j* would cause trade extension by almost 0.25%, *ceteris paribus*.

Stimulatingly, in all specifications of our empirical *SPS gravity model*, indicated the positive-significant of interaction term of $SPS_{jt}{*}GDP_{j,t-1}$, revealed that 1% increased of importers' GDPs using SPS measures, would increase their imports of rice from Cambodia by 0.85% on average ($0.837 = 0.132 + 0.705$ by PPML and $0.862 = 0.364 + 0.498$ by Heckman), expended more than countries that do not apply SPS measures by 0.6% ($0.85\% - 0.25\%$), which indicated that the SPS's marginal effect seem to decline with the GDP growth of importers. The similar result had been showed in the preceding studies by (Schlueter, Wieck and Heckelei 2009 , Peterson, Grant, Roberts and Karov 2013 , Kareem 2016 , Wood, Wu, Li and Kim 2017 , Thuong 2018).

The coefficient of POP_{jt} were statistically significant in both PPML (-0.13) and Heckman model (-0.35), revealed that an additional percentage increase in *j*'s population would deduct the demand by an average of 24% $[\big((-0.13) + (-0.35)\big)/2]$. These results are in contrast to the findings of the Vietnamese rice which is an interior good and more-popular in the lower-income and more-populated market (Thuong 2018).

Table 7.1: Econometric estimation results

Variables	GLS		PPML		Heckman (main)		Heckman (selection)	
	Coefficient	P>|z|	Coefficient	P>|z|	Coefficient	P>|z|	Coefficient	P>|z|
$\ln(GDP_{j,t-1})$	0.186	0.386	0.132 **	0.019	0.364 ***	0.008	0.177 ***	0.003
$\ln(POP_{jt})$	−0.305	0.089	−0.128 **	0.016	−0.350 ***	0.004	−0.112 **	0.040
$\ln(DIS_{ij})$	0.135	0.634	−0.326 ***	0.002	0.082	0.649	−0.370 ***	0.000
$\ln(LAND_{jt}+1)$	−0.033	0.436	−0.001	0.965	−0.066	0.111	0.003	0.917
$\ln(POP_{it})$	−8.049	0.203	−1.174	0.848	−8.254	0.244	4.484	0.056
$\ln(PROD_{i,t-1})$	6.625 ***	0.001	6.547 ***	0.003	7.159 ***	0.002	1.671 **	0.022
$\ln(price_t)$	−1.307	0.059	−0.601	0.356	−1.576 **	0.043	−0.206	0.416
$\ln(Tariff_{jt}+1)$	−0.316 **	0.002	−0.030	0.840	−0.204	0.057	−0.072	0.076
SPS_{jt}_dummy	−16.157 **	0.018	−18.229 ***	0.000	−12.294 ***	0.005	−4.891 **	0.012
$SPS_{jt} * \ln(GDP_{j,t-1})$	0.649 **	0.011	0.705 ***	0.000	0.498 ***	0.002	0.211 ***	0.005
$\_cons$	40.073	0.598	−72.989	0.310	33.204	0.701	−98.430 ***	0.001
EU_dummy	No		No		No		Yes	
#Observation	417		874		874			
R-square	0.296		0.665					
Log-likelihood			−1,002,590.600		−1,292.245			

Source: Own elaboration, estimated by Stata software v.14. **Note:** *, **, *** indicated significance at 10%, 5% and 1%, respectively.

The remoteness importers unsurprisingly have lower trade with Cambodia than the others. The estimated elasticities is just about -0.33 for PPML estimator. Furthermore, the importer's *agricultural land* ($LAND_{jt}$) and the Cambodian *population* (POP_{it}) did not shown any significant results in all specifications, indicating that the importers' local supplies of rice and the Cambodian's local demand did not statistically significant influence on Cambodian rice exports. It would be enlightened by the supply side's surplus.

The lag-production of rice in Cambodia ($PROD_{i,t-1}$) was found to be positively significant in all specifications. This emphasized the imperative role of the domestic production capacity to enhance the exports growth of Cambodian rice. An extra percentage of $PROD_{i,t-1}$, would enlarge exports of rice by 7% on average.

The -1.6 coefficient value of rice's import price ($price_t$) negatively significant in Heckman model, revealed that rice exports would be reduced by 1.6% when price increased. Moreover, bilateral tariff rate ($Tariff_{jt}$) imposed by country *j* was found to be statistically negative-significant, indicated the impact of tariffs on agricultural commodities like rice.

7.5. Chapter Summary

The current study took the SPS measures (proxies for *food safety standards* and GTBs) into account, by applied the *SPS gravity model* for investigating their impacts on Cambodian rice exports. The data sets contain the total observations of 874, for 23-year (1996-2018) and 38 importing partners.

The study would enrich the literature on SPS impacts on Cambodian rice economy. The innovative insights of the study's empirical modelling would give further benefits for policy-makers and numerous relevant experts. SPS had found to be highly negative impact on Cambodian rice exports. Cambodian rice tended to increase its popularity in the higher-income markets (e.g. EU) than others. The *average marginal effect* of SPS was captured by the interact-term of $SPS_{jt} * GDP_{j,t-1}$. Our SPS gravity model revealed that the SPS's marginal effect seem to decrease with the expansion of the importer's economic size, captured by GDP, indicating the further chances for market expansions of Cambodia (if experiences could be successfully accumulated, and consider for fulfilling the higher *standards* requirements ahead of market access).

Several applications resulting from the study are as follows: **First,** it is expected for the increasing in popularity of the different FSS, e.g. SPS, in the world's food markets, due to the growing concerns for '*going green*'. This would result in increasing challenges for agro-exports from the world's LDCs like Cambodia, which are the major food suppliers. **Second,** the stricter SPS would be gradually imposed. This implying the urgent needs of resilience responses to the FSS (e.g. lower-cost technology, premium-quality advancement, etc.). **Third,** while the *domestic production capacity* could boost the *growth* of rice exports, it is also significant to extend knowledge and experiences on FSS, and call for extra investment expansion in food production/processing technology before exporting rice to the higher-income market which generally strictly require for FSS, like EU.

CHAPTER 8. RESEARCH SUMMARY AND POLICY RECOMMENDATIONS

8.1. Research Summary

Rice is feeding most Asian countries, where Cambodia has no exception. As the world's "*rice basket*", almost 3/4 of rice in the global market were exported from Asia every year (WRS 2018 , FAOSTAT 2019 , UNCTAD 2019). Being the Southeast Asian third-largest rice producer and exporter, and the world's tenth-biggest exporter (in 2016), Cambodia is one of the major rice exporters (see further, RGC 2004 , RGC 2005 , RGC 2008 , RGC 2010 , RGC 2013 , RGC 2014 , RGC 2018). The man purpose to this research is to investigate the *export competitiveness*, and to find out the *determinants/factors influencing Cambodian rice exports*, focusing on aspects as follows:

1) Economic important assessment of rice to Cambodian society, and the exploration of the current development stage and trends of the Cambodian rice sector (chapter 3).
2) Discussion on '*trade-related*' policies' impacts, i.e. *Rectangular Strategy*, *Rice export policy*, the EU's *EBA* and the China's *BRI*, on Cambodian rice exports (see, chapter 4).
3) Calculation of *Relative Export Competitiveness* (REC) of Cambodian rice and identification for the REC's determinants. The *short-run regression* (SRR) model was estimated for identifying the potential determinants of the Cambodian rice's REC. The data sets used covered from 1995 to 2018 (24-year) and the world's 20 major rice exporters, see chapter 5.
4) Assessment on *determinant factors of rice exports of Cambodia* through an application of the *dynamic panel gravity model*. Several approaches included, GLS, PPML and Heckman model, were applied with a data set contained a total of 880 observations: 22-year panel data from 1995-2016 and 40 selected regular-partners (chapter 6).
5) Impacts examination of the *Food Safety Standards* proxies by SPS (*Sanitary and Phyto-Sanitary*) measures on Cambodian rice exports with an application of *SPS gravity model* through GLS, PPML, and Heckman approaches. The data sets

contained a total observations of 874 (23-year from 1996-2018 × 38 importing major partners), see chapter 7.

8.2. Key findings

- **Major export destinations:** EU is the biggest market for Cambodian rice. China (involved China mainland, Hong Kong, Macao and Taiwan) is the second market. The third market is the ASEAN, and the BRI countries would gradually be another market for Cambodian rice. Cambodia's top 10 rice export destinations are France, Germany, Netherlands, China, Malaysia, Poland, the United Kingdom, Czech Republic (*Czechia*), Portugal, and Italy.
- **Relative Export Competitiveness (REC):** Our findings suggest a gradually increasing trends of Cambodian *export competitiveness* in the world's rice market, particularly after the implementation of *Rice export policy* RP2010 (RGC 2010), which had pushed the Cambodia's REC from the very lower stage to the comparable (stage) of other world's largest rice exporters, such as Thailand, India, Vietnam and Paraguay. Thus, it is attainable to expect sustainable growth in rice sector of Cambodia. SRR model reveals the important effects of local policies' implementation (i.e. RP2010 and RS-III in particular) on the country's rice sector. EBA and BRI are also positive-significantly influencing the Cambodian rice's REC, revealing the domestic supply/demand management may be another important source for maintaining the REC of rice sector in Cambodia.
- **Determinants of Cambodian rice exports:** The historical ties played important role in Cambodia rice exports. Cambodian rice exports were sensitive to the macroeconomic factors. The exchange rate policy and agricultural land expansion were another core influencing factors promoting rice exports.
- **Impacts of Food Safety Standards (FSS):** SPS gravity model revealed the highly negative-influences of the SPS (i.e. proxies to the *food safety satandars* as a new form of GTBs in the international trade studies) on Cambodian rice exports. Cambodian rice seemed to increase its popularity in the high-income markets (like EU, than others). The coefficient for the $SPS_{jt}{*}GDP_{j,t-1}$ interaction revealed that typical marginal outcome of SPS measures declines with the growth of importer's GDPs, indicated that there should be excessive opportunities for Cambodia to

enlarge its market shares if the higher standards required by SPS and other kinds of FSS could be fulfilled beforehand of market access through the accumulation of experiences and product quality development.

- **Challenges of Cambodian rice exports:** (1) Institutional constraints, included weak governances and institutional supports, (2) Finance shortage, (3) Lack of an efficient marketing system, farmer have less bargaining power than intermediaries, (4) Limited post-harvest capacity, (5) Limited/poor investment in rice-processing sector, (6) Insufficient infrastructure, included insufficient irrigation facilities, inadequate fertilizer usage, etc., (7) Poor performance in regional trade / cross border trade, (8) Speculative land price distortions, (9) Underperforming *Economic Land Concessions* (ELC), (10) Insufficient skilled labors, and (11) Intractable "*Sanitary and Phyto-Sanitary*" (SPS) issues. See also, Hing and Nou (2006), Siphana, Sotharith and Vannarith (2011), Saing, Hem, Ouch, Phann and Pon (2012), World_Bank (2017), for further discussions.

8.3. Policy Recommendations

Aims at the development of Cambodian rice sector, some recommentadations and applications could be put forward, as follows:

- **Strengthening international cooperation:** is a critical element of successful regulation enforcement and reform programs. RGC would continue to build up relations with the existing rice trading partners (e.g. EU, China, ASEAN, BRI, etc.) throuht *trade promotion policies* and *tools* (e.g. RTAs or PTAs). Rice has good prospects for production expansions and exports, which will in turn help raise farmers' incomes and improve the country's national development. The rice trade potential could be fully achieved with numerous concise and comprehensive policies that address the major constrains and challenges.
- **Institutional and financial reforms:** Cambodia might need a good institutional and financial reform for *self-strengthening capabilities* and to *reduce sensitiveness* exterior issues (e.g. economic recession or crisis).
    - Gorgeous commercial environment and policies stabilization would promote the country's high growth.

- The percise procedures should be provided for coordinating and supporting the policies' implementation.
- The exchange rate and agricultural land policy-reform would be another sources enhancing rice exports of Cambodia.
- Cambodia's National Bank (CNB) should manage the exchange rate movement more efficiently in order to boost rice exports of Cambodia.

- **Human resources development:** It is important for RGC to pay more attentions on the development of human resources, as it is expected for the growing-needs for skilled workers/labors in the near future.

- **Resources management and utilized efficiently:** Resource mobilization needs to be strengthened, which can be done through either increasing government funding or seeking more development assistance from donors.

- **Self-strengthening for GTBs and Food Safety Standards (FSS):**

  - It is expected for the increasing in popularity of GTBs and FSS in the global food markets, due to the growing concerns for '*green*', especially the developed nations. This will result in increasing challenges for Cambodian agricultural exports in general or the country's rice exports in specific.
  - The stricter FSS (e.g. SPS) would be gradually imposed. It is importance to seeking resillience responses to FSS (such as, low-cost technology, high-quality advancement).
  - Since the domestic production capacity can boost the rapid growth for rice exports of Cambodia, it would be importance to extend the understanding of FSS and call for extra investment expansion in food production/processing technology before exporting rice to the higher-income market which generally strictly require for FSS, like EU.

8.4. Scope and Limitation of Research

The current research focus mainly on *Cambodian rice exports*, by focusing on five different aspects, as mentioned previously in this chapter. Therefore, the study did not consider for the exports of other agro-products of Cambodia, such as cassava, sugarcane, corn, rubber, and so on. Our data sets spanned from 1995-2018, with the total number of Cambodian rice's importing partners of 40 countries.

8.5. Future Research Prospective

Last but not least, the further researches might be needed in the following directions:

- The further studies may examine the extensions of our models based on more disaggregated data for other agricultural products of Cambodia, e.g. cassava, corn, rubber or other agro-products.
- The researchers could also include both agricultural-commodities imports and exports equations altogether in a study.
- For the purpose of comparative studies of rice economies, more research efforts are needed to combine the results from the *gravity models*, *comparative advantage* measurements, and *competitiveness* of rice in the global markets.
- The further focuses on other agro-products of Cambodia might be considered.
- Other types of FSS measures rather than SPS should be taken into account in light of the data availability.

REFERENCES

[1] ABDULLAH A B, ITO S, ADHANA K. Japan: Tottori University, 2005.

[2] ADJAO R T, STAATZ J M. Asian rice economy changes and implications for Sub-Saharan Africa [J]. Global Food Security, 2014, 5(1): 50-5.

[3] AFESORGBOR S K. Revisiting the effect of regional integration on African trade: evidence from meta-analysis and gravity model [J]. The Journal of International Trade & Economic Development, 2017, 26(2): 133-53.

[4] AHMAD B, GARCIA R J. Measuring commodity-specific trade determinants and export potential: A gravity model of Pakistan's rice exports [J]. Journal of International Agricultural Trade and Development, 2012, 8(2): 125-48.

[5] AIELLO F, CARDAMONE P. Analysing the impact of Everything but Arms initiative using a gravity model [M]//DE BENEDICTIS L, SALVATICI L. The trade impact of European Union preferential policies: An analysis through gravity models. Berlin, Heidelberg; Springer. 2011: 127-50.

[6] AIGNER D, LOVELL C A K, SCHMIDT P. Formulation and estimation of stochastic frontier production function models [J]. Journal of Econometrics, 1977, 6(1): 21-37.

[7] ALI I, XUEXI H, KHAN I, et al. Technical efficiency of hybrid maize growers: A stochastic frontier model approach [J]. Journal of Integrative Agriculture, 2019, 18(10): 2408–21.

[8] AMIN M R, ZHANG J B, YANG M M. Effects of Climate Change on the Yield and Cropping Area of Major Food Crops: A Case of Bangladesh [J]. Sustainability, 2015, 7(1): 898-915.

[9] ANDERS S M, CASWELL J A. Standards as barriers versus standards as catalysts: Assessing the impact of HACCP implementation on U.S. seafood imports [J]. American Journal of Agricultural Economics, 2009, 91(2): 310-21.

[10] ANDERSON J E. A theoretical foundation for the gravity equation [J]. American Economic Review, 1979, 69(1): 106-16.

[11] ANDERSON J E, WINCOOP E V. Gravity with gravitas: A solution to the border puzzle [J]. American Economic Review, 2003, 93(1): 170-92.

[12] ASEAN. ASEAN member states [M]. Association of Southeast Asian Nations (ASEAN). 2019.

[13] ASUYAMA Y, CHHUN D, FUKUNISHI T, et al. Firm dynamics in the Cambodian garment industry: firm turnover, productivity growth and wage profile under trade liberalization [J]. J Asia Pac Econ, 2013, 18(1): 51-70.

[14] ATIF R M, HAIYUN L, MAHMOOD H. Pakistan's agricultural exports, determinants and its potential: an application of stochastic frontier gravity model [J]. The Journal of International Trade & Economic Development, 2017, 26(3): 257-76.

[15] ATIF R M, MAHMOOD H, HAIYUN L, et al. Determinants and efficiency of Pakistan's chemical products' exports: An application of stochastic frontier gravity model [J]. Plos One, 2019, 14(5): e0217210.

[16] BAIER S L, BERGSTRAND J H. Do free trade agreements actually increase members' international trade? [J]. Journal of International Economics, 2007, 71(1): 72-95.

[17] BALASSA B. Trade liberalisation and "revealed" comparative advantage [J]. The Manchester School, 1965, 33(2): 99-123.

[18] BALASSA B. 'Revealed' comparative advantage revisited: An analysis of relative export shares of the industrial countries, 1953–1971 [J]. The Manchester School, 1977, 45(4): 327-44.

[19] BALASSA B, NOLAND M. "Revealed" comparative advantage in Japan and the United States [J]. Journal of International Economics Integration, 1989, 4(2): 8-22.

[20] BALDWIN R, TAGLIONI D, CEPR Working Paper No. 5850 [R]: Centre for Economic Policy Research (CEPR), 2006.

[21] BALLANCE R H, FORSTNER H, MURRAY T. Consistency tests of alternative measures of comparative advantage [J]. The Review of Economics and Statistics, 1987, 69(1): 157-61.

[22] BALOGH J M, JAMBOR A. The global competitiveness of European wine producers [J]. British Food Journal, 2017, 119(9): 2076-88.

[23] BALTAGI B H. Econometric analysis of panel data, 3rd edition [M]. USA: John Wiley & Sons, Ltd., 2005.

[24] BALTAGI B H, EGGER P, PFAFFERMARY M. Panel data gravity models of international trade [M]//BALTAGI B H. The Oxford handbook of panel data. UK, Oxford; Oxford University Press. 2015: 608-41.

[25] BALTAGI B H, EGGER P, PFAFFERMAYR M. A generalized spatial panel data model with random effects [J]. Econometric Rev, 2013, 32(5-6): 650-85.

[26] BALTAGI B H, EGGER P H, KESINA M. Generalized spatial autocorrelation in a panel-probit model with an application to exporting in China [J]. Empirical Economics, 2018, 55(1): 193-211.

[27] BATELLO C, FAO & OECD Working Paper [R]. Rome, Italy: Food and Agriculture Organization of the United Nations (FAO) and Organization for Economic Co-operation and Development (OECD), 2012.

[28] BATTESE G E, RAO D S P, O'DONNELL C J. A metafrontier production function for estimation of technical efficiencies and technology gaps for firms operating under different technologies [J]. J Prod Anal, 2004, 21(1): 91-103.

[29] BERA A K, JARQUE C M. Model specification tests: A simultaneous approach [J]. Journal of Econometrics, 1982, 20(1): 59-82.

[30] BERGSTRAND J H. The gravity equation in international trade: Some microeconomic foundations and empirical evidence [J]. The Review of Economics and Statistics, 1985, 67(3): 474-81.

[31] BERGSTRAND J H. The generalized gravity equation, monopolistic competition, and the factor-proportions theory in international trade [J]. The Review of Economics and Statistics, 1989, 71(1): 143-53.

[32] BERGSTRAND J H. The Heckscher-Ohlin-Samuelson model, the Linder hypothesis and the determinants of bilateral intra-industry trade [J]. Economic Journal, 1990, 100(403): 1216-29.

[33] BERGSTRAND J H, EGGER P, LARCH M. Gravity Redux: Estimation of gravity-equation coefficients, elasticities of substitution, and general equilibrium comparative statics under asymmetric bilateral trade costs [J]. Journal of International Economics, 2013, 89(1): 110-21.

[34] BERGSTRAND J H, LARCH M, YOTOV Y V. Economic integration agreements, border effects, and distance elasticities in the gravity equation [J]. European Economic Review, 2015, 78(307-27.

[35] BIAM C K, OKORIE A, NWIBO S U. Economic efficiency of small scale soyabean farmers in Central Agricultural Zone, Nigeria: A Cobb-Douglas stochastic frontier cost function approach [J]. Journal of Development and Agricultural Economics, 2016, 8(3): 52-8.

[36] BOEREMA A, PEETERS A, SWOLFS S, et al. Soybean trade: Balancing environmental and socio-economic impacts of an intercontinental market [J]. Plos One, 2016, 11(5): e0155222.

[37] BOJAN M, STANISLAV Z, MIRKO S, et al. Trade of agri-food products in the EU enlargement process: Evidence from the Southeastern Europe [J]. Agricultural Economics (Zemědělská ekonomika), 2018, 64(No. 8): 357-66.

[38] BOJNEC S, FERTO I. Drivers of the duration of comparative advantage in the European Union's agri-food exports [J]. Agr Econ-Czech, 2018, 64(2): 51-60.

[39] BOWEN H P. On the theoretical interpretation of indices of trade intensity and revealed comparative advantage [J]. Weltwirtschaftliches Archiv, 1983, 119(3): 464-72.

[40] BRENTON P. Integrating the Least Developed Countries into the world trading system: The current impact of EU preferences under Everything but Arms [J]. Journal of World Trade, 2003, 37(3): 623-46.

[41] BRUNDTLAND, UN Documents: Gathering a Body of Global Agreements [R]. Brussels: United Nations (UN), 1987.

[42] BUI T H H, CHEN Q. An analysis of factors influencing rice export in Vietnam based on gravity model [J]. Journal of the Knowledge Economy, 2017, 8(3): 830-44.

[43] CALLAHAN W A. China's "Asia Dream": The Belt Road initiative and the new regional order [J]. Asian Journal of Comparative Politics, 2016, 1(3): 226-43.

[44] CANOY J J R, BELANGEL C S, AFA and ASIA ADHRRA Issue Paper [R]. Quezon, Philippines: AFA (Asian Farmers' Association for Sustainable Rural Development) and AsiaDHRRA (Asian Partnership for the Development of Human Resources in Rural Asia) with support from Agriterra and SEACA, 2004.

[45] CARRÈRE C. Revisiting the effects of regional trade agreements on trade flows with proper specification of the gravity model [J]. European Economic Review, 2006, 50(2): 223-47.

[46] CARTER D B, GOEMANS H E. International trade and coordination: Tracing border effects [J]. World Politics, 2018, 70(1): 1-52.

[47] CASTILLO J S, VILLANUEVA E C, GARCÍA-CORTIJO M C. The international wine trade and its new export dynamics (1988–2012): A gravity model approach [J]. Agribusiness, 2016, 32(4): 466-81.

[48] CERNAT L, LAIRD S, MONGE-ROFFARELLO L, et al. The EU Everything but Arms initiative and the LDCs [M]//GUHA-KHASNOBIS B. The WTO, developing countries and the Doha development agenda: Prospects and challenges for trade-led growth. London; Palgrave Macmillan UK. 2004: 219-60.

[49] CHAISSE J, MATSUSHITA M. China's Belt and Road initiative: Mapping the world trade normative and strategic implications [J]. Journal of World Trade, 2018, 52(1): 163-85.

[50] CHANDRA P. Impact of temporary trade barriers: Evidence from China [J]. China Economic Review, 2016, 38(1): 24-48.

[51] CHANEY T. Distorted gravity: The intensive and extensive margins of international trade [J]. American Economic Review, 2008, 98(4): 1707-21.

[52] CHANEY T. The gravity equation in international trade: An explanation [J]. Journal of Political Economy, 2018, 126(1): 150-77.

[53] CHANG C L, MCALEER M, NGUYEN D K. US antidumping petitions and revealed comparative advantage of shrimp-exporting countries [J]. Rev Aquac, 2019, 11(3): 782-92.

[54] CHEN B, SAGHAIAN S. Market integration and price transmission in the world rice export markets [J]. J Agric Resour Econ, 2016, 41(3): 444-57.

[55] CHEN C, YANG J, FINDLAY C. Measuring the effect of food safety standards on China's agricultural exports [J]. Review of World Economics, 2008, 144(1): 83-106.

[56] CHEN N, NOVY D. Gravity, trade integration, and heterogeneity across industries [J]. Journal of International Economics, 2011, 85(2): 206-21.

[57] CHEN S A. China-Cambodia relation in the Maritime Silk Road era: A risk analysis of foreign aid relation (in Chinese) [J]. Southeast Asian Affairs, 2016, 4(1): 92-102.

[58] CHEN S A. The development of Cambodia–China relation and its transition under the OBOR Initiative [J]. The Chinese Economy, 2018, 51(4): 370-82.

[59] CHENG L K. Three questions on China's "Belt and Road initiative" [J]. China Economic Review, 2016, 40(1): 309–13.

[60] CHHEANG V. Japan: ISEAS – Yusof Ishak Institute Analyse Current Events, 2017.

[61] CHHINH N, MILLINGTON A. Drought monitoring for rice production in Cambodia [J]. Climate, 2015, 3(4): 792-811.

[62] CHIANG F-S, SUN C-H, YU J-M. Technical efficiency analysis of milkfish (Chanos chanos) production in Taiwan—an application of the stochastic frontier production function [J]. Aquaculture, 2004, 230(1-4): 99-116.

[63] CHILDS N, DYCK J, HANSEN J. Southeast Asia projected to remain top rice exporter [M]. USDA Economic Research Service (ERS). 2016.

[64] CHONG Z, QIN C, PAN S. The evolution of the Belt and Road trade network and its determinant factors [J]. Emerging Markets Finance and Trade, 2018, 1-12.

[65] CIORCIARI J D. A Chinese model for patron-client relations? The Sino-Cambodian partnership [J]. Int Relat Asia-Pac, 2014, 15(2): 245-78.

[66] CIRERA X. Who captures the price rent? The impact of European Union trade preferences on export prices [J]. Review of World Economics, 2014, 150(3): 507-27.

[67] CONFORTI P, FORD D, HALLAM D, et al. Rome, Italy: Universita degli Studi del Molise, 2007.

[68] COSSLETT T L, COSSLETT P D. Sustainable development of rice and water resources in mainland Southeast Asia and Mekong river basin [M]. Singapore: Springer Nature Singapore Pte Ltd, 2018.

[69] CRAMB R. White Gold: The Commercialisation of Rice Farming in the Lower Mekong Basin [M]. Singapore; Palgrave Macmillan. 2020.

[70] DAL BIANCO A, BOATTO V L, CARACCIOLO F, et al. Tariffs and non-tariff frictions in the world wine trade [J]. European Review of Agricultural Economics, 2016, 43(1): 31-57.

[71] DALUM B, LAURSEN K, VILLUMSEN G. Structural change in OECD export specialisation patterns: De-specialisation and 'stickiness' [J]. International Review of Applied Economics, 1998, 12(3): 423-43.

[72] DASCAL D, MATTAS K, TZOUVELEKAS V. An analysis of EU wine trade: A gravity model approach [J]. International Advances in Economic Research, 2002, 8(2): 135-47.

[73] DE BENEDICTIS L, TAGLIONI D. The gravity model in international trade [M]//DE BENEDICTIS L, SALVATICI L. The trade impact of European Union preferential policies: An analysis through gravity models. Berlin, Heidelberg; Springer Berlin Heidelberg. 2011: 55-89.

[74] DE BENEDICTIS L, TAMBERI M. Overall specialization empirics: Techniques and applications [J]. Open Economies Review, 2004, 15(4): 323-46.

[75] DEARDORFF A V. Determinants of bilateral trade: Does gravity work in a Neoclassical world? [M]//FRANKEL J A. The regionalization of the world economy. Chicago and London; University of Chicago Press. 1998: 7-32.

[76] DELANO D L, KNOTTNERUS J D. The Khmer Rouge, ritual and control [J]. Asian Journal of Social Science, 2018, 46(1): 79-110.

[77] DELUNA R S, CRUZ E D. Philippine export efficiency and potential: An application of stochastic frontier gravity model [J]. World Journal of Economic and Finance, 2014, 1(2): 006-15.

[78] DEMONT M, FIAMOHE R, KINKPÉ A T. Comparative advantage in demand and the development of rice value chains in West Africa [J]. World Development, 2017, 96(1): 578-90.

[79] DISDIER A, FONTAGNE L, MIMOUNI M. The impact of regulations on agricultural trade: Evidence from the SPS and TBT agreements [J]. American Journal of Agricultural Economics, 2008, 90(2): 336-50.

[80] DOAN T N, XING Y Q. Trade efficiency, free trade agreements and rules of origin [J]. Journal of Asian Economics, 2018, 55(1): 33-41.

[81] DOU L, YANAGISHIMA K, LI X, et al. Food safety regulation and its implication on Chinese vegetable exports [J]. Food Policy, 2015, 57(1): 128-34.

[82] DUDU H, CAKMAK E, ÖCAL N. Drivers of farm efficiency in Turkey: A stochastic frontier analysis [J]. World Journal of Applied Economics, 2015, 1(1): 45.

[83] DURAND-MORAT A, NALLEY L L, THOMA G. The implications of red rice on food security [J]. Global Food Security, 2018, 18(1): 62-75.

[84] EATON J, KORTUM S, KRAMARZ F. An anatomy of international trade: Evidence from French firms [J]. Econometrica, 2011, 79(5): 1453-98.

[85] EATON J, KORTUM S S, NBER Working Paper, No. 6253 [R]. Cambridge, MA: National Bureau of Economic Research (NBER), 1997.

[86] EC. Council Regulation (EC) No. 416/2001 of February 28, 2001 (Amending EC No. 2820/98) [M]. Brussels; European Community (EC). 2001.

[87] ECS. Cambodia-EU trade relation, European Commission (ECs) [M]. European Commission (ECs); European Commission (ECs). 2019a.

[88] ECS. EU imposes safeguard measures on rice from Cambodia and Myanmar, European Commission (ECs) [M]. European Commission (ECs), Brussels; European Commission (ECs). 2019b.

[89] ECS. European Union, trade in goods with Cambodia, European Commission (ECs) [M]. European Commission (ECs), Brussels; European Commission (ECs). 2019c.

[90] EGGER P. An econometric view on the estimation of gravity models and the calculation of trade potentials [J]. The World Economy, 2002, 25(2): 297-312.

[91] EGGER P, HOLZER G, SEGATO S, et al. Effects of oilseed supplements on milk production and quality in dairy cows fed a hay-based diet [J]. Ital J Anim Sci, 2007, 6(4): 395-405.

[92] EICHENGREEN B, IRWIN D A. The role of history in bilateral trade flows [M]//FRANKEL J A. The regionalization of the world economy. Chicago and London; University of Chicago Press. 1998: 33-62.

[93] ELSHEHAWY M A, SHEN H, AHMED R A. The factors affecting Egypt's exports: Evidence from the gravity model analysis [J]. Open Journal of Social Sciences, 2014, 2(11): 138-48.

[94] ESTY D C, GERADIN D. Environmental protection and international competitiveness: A conceptual framework [J]. Journal World Trade, 1998, 32(Feb): 70-2.

[95] ETUK E A, OHEN S B. Revealed comparative advantage and competitiveness: The case of palm oil exports from Nigeria, Ghana and Côte d'Ivoire [J]. IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS), 2017, 10(7): 36-40.

[96] EVENETT S J, CEPR Working Paper [R]. London, England: Centre for Economic Policy Research (CEPR), 2009.

[97] EVENETT S J, KELLER W. On theories explaining the success of the gravity equation [J]. Journal of Political Economy, 2002, 110(2): 281-316.

[98] FAGERBERG J, SRHOLEC M, KNELL M. The competitiveness of nations: Why some countries prosper while others fall behind [J]. World Development, 2007, 35(10): 1595-620.

[99] FAN Z, ZHANG R, LIU X, et al. China's outward FDI efficiency along the Belt and Road: An application of stochastic frontier gravity model [J]. China Agricultural Economic Review, 2016, 8(3): 455-79.

[100] FAOSTAT. FAOSTAT Online Database 2018 [M]. Food and Agriculture Organization of the United Nations (FAO). 2018.

[101] FAOSTAT. FAOSTAT online database 2019 [M]. Food and Agriculture Organization of the United Nations (FAO). 2019.

[102] FAOSTAT. FAOSTAT online database 2020 [M]. Food and Agriculture Organization of the United Nations (FAO). 2020.

[103] FERDINAND P. Westward Ho—the China Dream and 'One Belt, One Road': Chinese foreign policy under Xi Jinping [J]. International Affairs, 2016, 92(4): 941-57.

[104] FERRO E, OTSUKI T, WILSON J S. The effect of product standards on agricultural exports [J]. Food Policy, 2015, 50(1): 68-79.

[105] FERTÖ I, HUBBARD L J. Revealed comparative advantage and competitiveness in Hungarian agri–food sectors [J]. The World Economy, 2003, 26(2): 247-59.

[106] FILIPPINI C, MOLINI V. The determinants of East Asian trade flows: A gravity equation approach [J]. Journal of Asian Economics, 2003, 14(5): 695-711.

[107] FLOR R J, MAAT H, HADI B A R, et al. Do field-level practices of Cambodian farmers prompt a pesticide lock-in? [J]. Field Crops Research, 2019, 235(1): 68-78.

[108] FONTAGNE L, LABORDE D, MITARITONNA C. An impact study of the economic partnership agreements in the six ACP regions [J]. J Afr Econ, 2011, 20(2): 179-216.

[109] FRENCH L. From Politics to Economics at the Thai–Cambodian Border: Plus Ça Change [J]. International Journal of Politics, Culture, and Society, 2002, 15(3): 427-70.

[110] FROHBERG K, HARTMANN M, Discussion paper No. 2 [R]. Halle (Saale), Germany: Institute of Agricultural Development in Central and Eastern Europe (IADCEE), provided in cooperation with Leibniz Institute of Agricultural Development in Transition Economies (IAMO), 1997.

[111] GANGULI A. Green productivity and bilateral trade flows in an augmented gravity model – A panel data analysis [J]. The Journal of International Trade & Economic Development, 2013, 22(8): 1161-82.

[112] GASHI P, HISARCIKLILAR M, PUGH G. Kosovo – EU trade relations: A dynamic panel poisson approach [J]. Applied Economics, 2016, 49(27): 2642-54.

[113] GHAZALIAN P L, TAMINI L D, LARUE B, et al. A gravity model to account for vertical linkages between markets with an application to the cattle/beef sector [J]. The Journal of International Trade & Economic Development, 2012, 21(4): 579-601.

[114] GIBB R. The European Union's 'Everything but Arms' development initiative and sugar: Preferential access or continued protectionism? [J]. Applied Geography, 2006, 26(1): 1-17.

[115] GILES J A, WILLIAMS C L. Export-led growth: A survey of the empirical literature and some non-causality results. Part 1 [J]. The Journal of International Trade & Economic Development, 2000a, 9(4): 261-337.

[116] GILES J A, WILLIAMS C L. Export-led growth: A survey of the empirical literature and some non-causality results. Part 2 [J]. The Journal of International Trade & Economic Development, 2000b, 9(4): 445-70.

[117] GÓMEZ-HERRERA E. Comparing alternative methods to estimate gravity models of bilateral trade [J]. Empirical Economics, 2013, 44(3): 1087-111.

[118] GOTOR E, TSIGAS M E. The impact of the EU sugar trade reform on poor households in developing countries: A general equilibrium analysis [J]. Journal of Policy Modeling, 2011, 33(4): 568-82.

[119] GOYAL K A, VAJID A. Revealed comparative advantage of India's rice export with selected countries (A case study) [J]. Pacific Business Review International, 2017, 9(9): 51-6.

[120] GRADEVA K, MARTINEZ-ZARZOSO I. Are trade preferences more effective than aid in supporting exports? Evidence from the "Everything but Arms' preference scheme [J]. The World Economy, 2016, 39(8): 1146-71.

[121] HA P V, NGUYEN H T M, KOMPAS T, et al. Rice production, trade and the poor: Regional effects of rice export policy on households in Vietnam [J]. Journal of Agricultural Economics, 2015, 66(2): 280-307.

[122] HAMMARLUND C, ANDERSSON A. What’s in it for Africa? European Union fishing access agreements and fishery exports from developing countries [J]. World Development, 2019, 113(1): 172-85.

[123] HANSEN J. Southeast Asia projected to remain top rice exporter [M]. Feature: International Markets & US Trade. USA; United States Department of Agriculture (USDA). 2013.

[124] HAQ Z U, MEILKE K, CRANFIELD J, CATPRN Working Paper 2011-02 [R]. Canada: Canadian Agricultural Trade Policy and Competitiveness Research Network (CATPRN) and the Ontario Ministry of Food, Agriculture and Rural Affairs, 2011.

[125] HAQ Z U, MEILKE K, CRANFIELD J. Selection bias in a gravity model of agrifood trade [J]. European Review of Agricultural Economics, 2013, 40(2): 331-60.

[126] HASNAH, FLEMING E, COELLI T J. Assessing the performance of a nucleus estate and smallholder scheme for oil palm production in West Sumatra: a stochastic frontier analysis [J]. Agricultural Systems, 2004, 79(1): 17-30.

[127] HEAD K, MAYER T. Gravity equations: Workhorse, toolkit, and cookbook [M]//GOPINATH G, HELPMAN E, ROGOFF K. Handbook of international economics. AE Amsterdam, The Netherlands; North-Holland, Elsevier. 2014: 131-95.

[128] HECKMAN J J. Sample selection bias as a specification error [J]. Econometrica, 1979, 47(1): 153-61.

[129] HELPMAN E. Increasing returns, imperfect markets, and trade theory [M]. Handbook of International Economics. Elsevier. 1984: 325-65.

[130] HELPMAN E. Imperfect competition and international trade: Evidence from fourteen industrial countries [J]. Journal of the Japanese and International Economies, 1987, 1(1): 62-81.

[131] HELPMAN E, KRUGMAN P R. Market structure and foreign trade: Increasing returns, imperfect competition, and the international economy [M]. Cambridge, Massachusetts; London, England: The MIT Press, 1985.

[132] HELPMAN E, KRUGMAN P R. Market structure and foreign trade [M]. Cambridge, Massachusetts; London, England: The MIT Press, 1987.

[133] HELPMAN E, MELITZ M, RUBINSTEIN Y. Estimating trade flows: Trading partners and trading volumes [J]. The Quarterly Journal of Economics, 2008, 123(2): 441-87.

[134] HILL H, MENON J. Cambodia: Rapid growth with weak institutions [J]. Asian Econ Policy R, 2013, 8(1): 46-65.

[135] HILL H, MENON J. Cambodia: Rapid growth in an open, post-conflict economy [J]. The World Economy, 2014, 37(12): 1649-68.

[136] HILLMAN A L. Observations on the relation between “revealed comparative advantage” and comparative advantage as indicated by pre-trade relative prices [J]. Review of World Economics, 1980, 116(2): 315-21.

[137] HING V. Cambodia-China relations in the context of the Belt and Road initiative (in Chinese) [J]. Around Southeast Asia, 2017, 6(1): 32–9.

[138] HING V, NOU K. Phnom Penh, Cambodia: Cambodia Development Resource Institute (CDRI), 2006.

[139] HINLOOPEN J, VAN MARREWIJK C. On the empirical distribution of the Balassa index [J]. Weltwirtschaftliches Archiv, 2001, 137(1): 1-35.

[140] HOANG T X, PHAM C S, ULUBAŞOĞLU M A. The role of rice in poverty dynamics in rural Vietnam: 2002–2008 [J]. J Asia Pac Econ, 2016, 21(1): 132-50.

[141] HONG N B, YABE M. Resource use efficiency of tea production in Vietnam: Using translog SFA model [J]. Journal of Agricultural Science, 2015, 7(9): 160-72.

[142] HOSSAIN M K, KAMIL A A, BATEN M A, et al. Stochastic frontier approach and data envelopment analysis to total factor productivity and efficiency measurement of Bangladeshi rice [J]. Plos One, 2012, 7(10): e46081.

[143] HU F, ZHANG X K, HU M M, et al. Chinese enterprises' investment in infrastructure construction in Cambodia [J]. Asian Perspect-Seoul, 2019, 43(1): 177-207.

[144] HUANG X Y, HAN Y J, GONG X H, et al. Does the belt and road initiative stimulate China's inbound tourist market? An empirical study using the gravity model with a DID method [J]. Tourism Economics, 2019, 25.

[145] HUANG Y. Understanding China's Belt & Road Initiative: Motivation, framework and assessment [J]. China Economic Review, 2016, 40(1): 314-21.

[146] HUOT N, KAKINAKA M. Trade structure and trade flows in Cambodia: A gravity model [J]. ASEAN Economic Bulletin, 2007, 24(3): 305-19.

[147] HURD M. Estimation in truncated samples when there is heteroscedasticity [J]. Journal of Econometrics, 1979, 11(2): 247-58.

[148] HWANG C W, LIM S S. Effect of non-tariff measures on international tea trades [J]. J Korea Trade, 2017, 21(4): 309-23.

[149] IGNJATIJEVIC S, MILOJEVIC I, ANDZIC R. Economic analysis of exporting Serbian honey [J]. Int Food Agribus Manag Rev, 2018, 21(7): 929-44.

[150] IRSHAD M S, XIN Q, ARSHAD H. Competitiveness of Pakistani rice in international market and export potential with global world: A panel gravity approach [J]. Cogent Economics & Finance, 2018, 6(1): 1-18.

[151] IRSHAD M S, XIN Q, SHAHRIAR S, et al. South Korea’s potential export flow: A panel gravity approach [J]. Asian Journal of Empirical Research, 2018, 8(4): 124-39.

[152] IRSHAD M S, XIN Q, SHAHRIAR S, et al. A panel data analysis of China's trade pattern with OPEC members: Gravity model approach [J]. Asian Economic and Financial Review, 2018, 8(1): 103-16.

[153] ISMAIL N W, MAHYIDEEN J M, Working paper No. 553 [R]. Tokyo, Japan: Asian Development Bank (ADB), 2015.

[154] JI S, YOO J. A study on the changes of agricultural import structure according to implementation of FTAs in South Korea [J]. J Korea Trade, 2018, 22(1): 2-16.

[155] JICA. Japan: Japan International Cooperation Agency (JICA) and Ministry of Water Resources and Meteorology, Kingdom of Cambodia, 2009a.

[156] JICA. Japan: Japan International Cooperation Agency (JICA) and Ministry of Water Resources and Meteorology, Kingdom of Cambodia, 2009b.

[157] JOHNSTON B F, MELLOR J W. The role of agriculture in economic development [J]. American Economic Review, 1961, 51(4): 566-93.

[158] KAHOULI B. Regional integration agreements, trade flows and economic crisis: A static and dynamic gravity model [J]. International Economic Journal, 2016, 30(4): 450-75.

[159] KAHOULI B, OMRI A. Foreign direct investment, foreign trade and environment: New evidence from simultaneous-equation system of gravity models [J]. Research in International Business and Finance, 2017, 42(1): 353-64.

[160] KALIRAJAN K. Regional Cooperation and Bilateral Trade Flows: An Empirical Measurement of Resistance [J]. The International Trade Journal, 2007, 21(2): 85-107.

[161] KANAT S. Analysis of the competitiveness of the Turkish textile and clothing sector in the European Union market [J]. Fibres Text East Eur, 2019, 27(2): 9-18.

[162] KAREEM O I. Food safety regulations and fish trade: Evidence from European Union-Africa trade relations [J]. Journal of Commodity Markets, 2016, 2(1): 18-25.

[163] KEA S. Cambodian rice production technical efficiency and its determinant [M]. Deutschland, Germany: LAP Lambert Academic Publishing, 2017.

[164] KEA S, LI H, SHAHRIAR S, et al. Relative export competitiveness of the Cambodian rice sector [J]. British Food Journal, 2020, 1-22.

[165] KEA S, LI H, SHAHRIAR S, et al. Factors influencing Cambodian rice exports: An application of the dynamic panel gravity model [J]. Emerging Markets Finance and Trade, 2019, 55(15): 1-22.

[166] KHAC L B, NHA H H T, THAN H B. Factor substitution in rice production function: The case of Vietnam [J]. Economic Research-Ekonomska Istrazivanja, 2019, 31(1): 1807-25.

[167] KHOI N V, THUY L T T. Green trade barriers and Vietnam's agricultural and fishery export [J]. Journal of Globalization Studies, 2014, 5(2): 69–80.

[168] KOHL T. The Belt and Road Initiative’s effect on supply-chain trade: Evidence from structural gravity equations [J]. Cambridge Journal of Regions, Economy and Society, 2019, 12(1): 77-104.

[169] KONTGIS C, SCHNEIDER A, OZDOGAN M, et al. Climate change impacts on rice productivity in the Mekong river delta [J]. Applied Geography, 2019, 102(1): 71-83.

[170] KOPP T, PREHN S, BRUMMER B. Preference erosion: The case of Everything but Arms and sugar [J]. World Economy, 2016, 39(9): 1339-59.

[171] KUBICOVÁ Ľ, KÁDEKOVÁ Z, TURČEKOVÁ N, et al. Consumption of food in relation to income and saturation limit of Slovak households [J]. Agricultural Economics – Czech, 2019, 65(1): 560-8.

[172] KUBO M, PUREVDORJ M. The future of rice production and consupmtion [J]. Journal of Food Distribution Research, 2004, 35(1): 1-15.

[173] KUPPUSAMY M, GHARLEGHI B. Green barriers and China's agricultural product export: Is there any relationship? [J]. Asian Social Science, 2014, 10(16): 34-41.

[174] LAK C. The Belt and Road Initiative and Cambodia's infrastructure connectivity development: A Cambodian perspective [M]//CHEUNG F M, HONG Y-Y. Regional connection under the Belt and Road Initiative: The prospects for economic and financial cooperation. London and New York; Routledge Taylor & Francis Group. 2019: 134-63.

[175] LANG N T. Green barriers to Vietnamese agricultural products exported to EU: Challenges and opportunities [M]. Journal of Engineering Technology and Education: The 2012 International Conference on Green Technology and Sustainable Development (GTSD2012). 2012: 179-87.

[176] LAOSUTSAN P, SHIVAKOTI G P, SONI P. Comparative advantage and export potential of Thai vegetable products following the integration into the ASEAN Economic Community [J]. Int Food Agribus Manag Rev, 2017, 20(4): 575-90.

[177] LARCH M, WANNER J, YOTOV Y V, et al. Currency Unions and Trade: A PPML Re-assessment with High-dimensional Fixed Effects [J]. Oxford Bulletin of Economics and Statistics, 2018, 81(3): 487-510.

[178] LAURSEN K, DRUID Working Paper No. 98-30 [R]. Aalborg: Danish Research Unit for Industrial Dynamics (DRUID), 1998.

[179] LAURSEN K. Revealed comparative advantage and the alternatives as measures of international specialization [J]. Eurasian Bus Rev, 2015, 5(1): 99–115.

[180] LEE J-W, PYUN J H. North Korea's economic integration and growth potential [J]. Asian Economic Journal, 2018, 32(3): 301-25.

[181] LEE J, SWAGEL P. Trade barriers and trade flows across countries and industries [J]. The Review of Economics and Statistics, 1997, 79(3): 372-82.

[182] LEE M, TCHA M. Pass-through elasticity, substitution and market share: The case for sheep meat exports [J]. The Journal of International Trade & Economic Development, 2005, 14(2): 209-28.

[183] LI L, SUN Z, LONG X. An empirical analysis of night-time light data based on the gravity model [J]. Applied Economics, 2019, 51(8): 797-814.

[184] LI S, ZHANG Y H. The effect of green trade barriers on China's vegetable exports [M]. 2012 International Conference on Management Science & Engineering (19th). Dallas, USA. 2012: 1044-9.

[185] LI X, SAGHAIAN S, REED M. The impact of HACCP on U.S. seafood exports: The case of fish, mollusks, and shellfish other than mollusks [J]. Journal of International Agricultural Trade and Development, 2012, 8(2): 111-23.

[186] LIEN D, LO M. Economic impacts of cultural institutes [J]. The Quarterly Review of Economics and Finance, 2017, 64(1): 12-21.

[187] LINCOLN D. Drawing the EBA (Everything but arms) map: Least developed country classification and the case of EBA sugar [J]. Area, 2008, 40(2): 218-27.

[188] LINDER S B. An essay on trade and transformation [M]. New York: John Wiley, 1961.

[189] LINNEMANN H. An econometric study of international trade flows [M]. Amsterdam. North-Holland Pub. Co., 1966.

[190] LIU T, WANG X, WOO W T. The road to currency internationalization: Global perspectives and Chinese experience [J]. Emerging Markets Review, 2019, 38(1): 73-101.

[191] MAFF. Phnom Penh, Cambodia: The Royal Government of Cambodia (RGC), Ministry of Agriculture, Forestry and Fisheries (MAFF), 2011.

[192] MAFF. Phnom Penh, Cambodia: The Royal Government of Cambodia (RGC), Ministry of Agriculture, Forestry and Fisheries (MAFF), 2012.

[193] MAFF. Phnom Penh, Cambodia: The Royal Government of Cambodia (RGC), Ministry of Agriculture, Forestry and Fisheries (MAFF), 2013.

[194] MAFF. Phnom Penh, Cambodia: The Royal Government of Cambodia (RGC), Ministry of Agriculture, Forestry and Fisheries (MAFF), 2014.

[195] MAFF. Phnom Penh, Cambodia: The Royal Government of Cambodia (RGC), Ministry of Agriculture, Forestry and Fisheries (MAFF), 2015.

[196] MAFF. Phnom Penh, Cambodia: The Royal Government of Cambodia (RGC), Ministry of Agriculture, Forestry and Fisheries (MAFF), 2016.

[197] MAFF. The report on Cambodian rice export status in year, 2017 (in Khmer) [M]. Ministry of agriculture, forestry and fishery (MAFF), Secretariat of one window service for rice export formality (SOWS-REF). 2018.

[198] MAHMOOD K, MUNIR S. Agricultural exports and economic growth in Pakistan: An econometric reassessment [J]. Quality & Quantity, 2017, 52(4): 1561-74.

[199] MARIYONO J. Rice production in Indonesia: Policy and performance [J]. Asia Pacific Journal of Public Administration, 2014, 36(2): 123-34.

[200] MARTI L, PUERTAS R. Factors determining the trade costs of major European exporters [J]. Maritime Economics and Logistics, 2019, 21(3): 324-33.

[201] MARTI L, PUERTAS R, GARCÍA L. Relevance of trade facilitation in emerging countries' exports [J]. The Journal of International Trade & Economic Development, 2014, 23(2): 202-22.

[202] MARTÍNEZ-ZARZOSO I, FELICITAS N-L D, HORSEWOOD N. Are regional trading agreements beneficial? Static and dynamic panel gravity models [J]. N Am J Econ Financ, 2009, 20(1): 46-65.

[203] MARTÍNEZ-ZARZOSO I, JOHANNSEN F. The gravity of arms [J]. Defence and Peace Economics, 2017, 30(1): 2-26.

[204] MASKUS K E, WILSON J S, OTSUKI T, Policy Research Working Paper WP2512 [R]. Washington, DC, USA: The World Bank Development Research Group, 2000.

[205] MASLOW A H. A theory of human motivation [J]. Psychological Review, 1943, 50(4): 370-96.

[206] MÁTYÁS L. The gravity model: Some econometric considerations [J]. The World Economy, 1998, 21(3): 397-401.

[207] MÁTYÁS L. The econometrics of multi-dimensional panels: Theory and applications [M]//BALTAGI B H, HONG Y, KOOP G, et al. Advanced studies in theoretical and applied econometrics. Cham, Switzerland; Springer. 2017.

[208] MEEUSEN W, BROECK J V D. Efficiency estimation from Cobb-Douglas production functions with composed error [J]. International Economic Review, 1977, 18(2): 435-44.

[209] MELITZ J. Language and foreign trade [J]. European Economic Review, 2008, 52(4): 667-99.

[210] MIANKHEL A K, KALIRAJAN K, THANGAVELU S M. Australia's export potential: An exploratory analysis [J]. J Asia Pac Econ, 2014, 19(2): 230-46.

[211] MINTEN B, RANDRIANARISON L, SWINNEN J F M. Global retail chains and poor farmers: Evidence from Madagascar [J]. World Development, 2009, 37(11): 1728-41.

[212] MISHRA A K, BAIRAGI S, VELASCO M L, et al. Impact of of access to capital and abiotic stress on production efficiency: Evidence from rice farming in Cambodia [J]. Land Use Policy, 2018, 79(1): 215-22.

[213] MOC. What is everything but arms (EBA)? What are the benefits of this preferential treatment for Cambodia regarding a number of potential sectors including garment, textile and agriculture? [M]. Europe Middle-East Asia and Africa Department of Ministry of Commerce of Cambodia (MOC), Phnom Penh, Cambodia; Europe Middle-East Asia and Africa Department of Ministry of Commerce of Cambodia (MOC). 2014.

[214] MOHAN MALIK J. Myanmar's role in China's Maritime Silk Road initiative [J]. Journal of Contemporary China, 2018, 27(111): 362-78.

[215] MUTHAYYA S, SUGIMOTO J D, MONTGOMERY S, et al. An overview of global rice production, supply, trade, and consumption [J]. Annals of the New York Academy of Sciences, 2014, 1324(1): 7-14.

[216] NAGARAJU B, H.D. T. A study on consumer attitude towards eco-friendly FMCG products with reference to Hubli city in Karnataka [J]. IOSR Journal of Business and Management (IOSR-JBM), 2016, 18(11): 58-63.

[217] NARALA A, ZALA Y. Technical efficiency of rice farms under irrigated conditions in Central Gujarat [J]. Agricultural Economics Research Review, 2010, 23(2): 375-81.

[218] NARAYAN S, BHATTACHARYA P. Relative export competitiveness of agricultural commodities and its determinants: Some evidence from India [J]. World Development, 2019, 117(1): 29-47.

[219] NARAYAN S, NGUYEN T T. Does the trade gravity model depend on trading partners? Some evidence from Vietnam and her 54 trading partners [J]. International Review of Economics & Finance, 2016, 41(1): 220-37.

[220] NATALE F, BORRELLO A, MOTOVA A. Analysis of the determinants of international seafood trade using a gravity model [J]. Marine Policy, 2015, 60(1): 98-106.

[221] NDRC. Vision and actions on jointly building Silk Road Economic Belt and 21st-Century Maritime Silk Road [M]. The National Development and Reform Commission (NDRC), Ministry of Foreign Affairs, and Ministry of Commerce of the People's Republic of China, with State Council authorization. 2015.

[222] NESBITT H J. Rice production in Cambodia [M]. Cambodia-IRRI-Australia project 1997. Manila, Philippines; International Rice Research Institute (IRRI). 1997.

[223] NEWTON I. Philosophiæ naturalis principia mathematica [M]. London: Encyclopædia Britannica, 1686.

[224] NGANGO J, KIM S G. Assessment of technical efficiency and its potential determinants among small-scale coffee farmers in Rwanda [J]. Agriculture-Basel, 2019, 9(7): 12.

[225] NGUYEN B X. The determinants of Vietnamese export flows: Static and dynamic panel gravity approaches [J]. International Journal of Economics and Finance, 2010, 2(4): 122-9.

[226] NGUYEN VAN H, TRAN VAN T, MEAS P, et al. Best practices for paddy drying: Case studies in Vietnam, Cambodia, Philippines, and Myanmar [J]. Plant Prod Sci, 2019, 22(1): 107-18.

[227] NIK ROZANA N M M, SUNTHARALINGAM C, OTHMAN M F. Competitiveness of Malaysia's fruits in the global market: Revealed comparative advantage analysis [J]. Malaysian Journal of Mathematical Sciences, Special Issue: Conference on Agriculture Statistics 2015 (CAS 2015), 2017, 11(S): 143–57.

[228] NILSSON L. European Union preferential trading arrangements: Evolution, content and use [M]//DE BENEDICTIS L, SALVATICI L. The trade impact of European Union preferential policies: An analysis through gravity models. Berlin, Heidelberg; Springer Berlin Heidelberg. 2011: 15-35.

[229] NORDIN A, WEISSMANN M. Will Trump make China great again? The belt and road initiative and international order [J]. International Affairs, 2018, 94(2): 231-49.

[230] NOU K, HENG M. Contract farming of high-quality rice in Kampong Speu [M]//CRAMB R. White Gold: The Commercialisation of Rice Farming in the Lower Mekong Basin. Singapore; Springer Singapore. 2020: 327-44.

[231] OBOREUROPE. The New Silk Road Corridors [M]. Paris, France; One Belt One Road Europe (OBOReurope). 2020.

[232] ODECK J. Measuring technical efficiency and productivity growth: A comparison of SFA and DEA on Norwegian grain production data [J]. Applied Economics, 2007, 39(20): 2617-30.

[233] ODURO A D, OFFEI E L. Investigating Ghana's revealed comparative advantage in agro-processed products [J]. Modern Economy, 2014, 5(4): 384-90.

[234] OKOYE B C, ABASS A, BACHWENKIZI B, et al. Differentials in technical efficiency among smallholder cassava farmers in Central Madagascar: A Cobb Douglas stochastic frontier production approach [J]. Cogent Economics & Finance, 2016, 4(1): 1143345.

[235] OTSUKI T, WILSON J S, SEWADEH M. Saving two in a billion: quantifying the trade effect of European food safety standards on African exports [J]. Food Policy, 2001a, 26(5): 495-514.

[236] OTSUKI T, WILSON J S, SEWADEH M. What price precaution? European harmonisation of aflatoxin regulations and African groundnut exports [J]. European Review of Agricultural Economics, 2001b, 28(3): 263-84.

[237] PANAGIOTOU D, STAVRAKOUDIS A. A stochastic frontier analysis approach for estimating market power in the major US meat export markets [J]. Journal of Industry, Competition and Trade, 2019, 1-18.

[238] PANAHI H K S, DEHHAGHI M, AGHBASHLO M, et al. Conversion of residues from agro-food industry into bioethanol in Iran: An under-valued biofuel additive to phase out MTBE in gasoline [J]. Renewable Energy, 2020, 145(1): 699-710.

[239] PASCUCCI F. The export competitiveness of Italian coffee roasting industry [J]. British Food Journal, 2018, 120(7): 1529-46.

[240] PERSSON M. Trade preferences from a policy perspective [M]//MORRISSEY O R, LOPEZ R A, SHARMA K. Handbook on trade and development Cheltenham; Edward Elgar. 2015: 111–28.

[241] PESARAN M H. Time series and panel data econometrics [M]. Oxford: Oxford University Press, 2015.

[242] PETERSON E B, GRANT J H, ROBERTS D, et al. Evaluating the trade restrictiveness of phytosanitary measures on U.S. fresh fruit and vegetable imports [J]. American Journal of Agricultural Economics, 2013, 95(4): 842-58.

[243] PIESSE J, CONRADIE B, THIRTLE C, et al. Efficiency in wine grape production: comparing long-established and newly developed regions of South Africa [J]. Agricultural Economics, 2018, 49(2): 203-12.

[244] POLONSKY M J. An introduction to green marketing [J]. Electronic Green Journal, 1994, 1(2): 1-11.

[245] POPOVA L, RASOULINEZHAD E. Have sanctions modified Iran’s trade policy? An evidence of Asianization and De-Europeanization through the gravity model [J]. Economies, 2016, 4(4): 24.

[246] PORTO G G. Using survey data to assess the distributional effects of trade policy [J]. Journal of International Economics, 2006, 70(1): 140-60.

[247] PÖYHÖNEN P. A tentative model for the volume of trade between countries [J]. Weltwirtschaftliches Archiv, 1963, 90(1): 93-100.

[248] PULLIAINEN K. A world trade study: An econometric model of the pattern of the commodity flows in international trade in 1948-1960 [J]. Ekonomiska Samfundets Tidskrift, 1963, 16(1): 69-77.

[249] RAHMAN M M. The factors affecting Bangladesh's exports: Evidence from the gravity model analysis [J]. The Journal of Developing Areas, 2010, 44(1): 229-44.

[250] RAHMAN R, SHAHRIAR S, KEA S. Determinants of exports: A gravity model analysis of the Bangladeshi textile and clothing industries [J]. FIIB Business Review, 2019, 8(3): 229–44.

[251] RAMASAMY B, YEUNG M C H. China's one belt one road initiative: The impact of trade facilitation versus physical infrastructure on exports [J]. World Economy, 2019, 42(6): 1673-94.

[252] RAMZY M, ZAKI C. Do environment regulations matter for EU-MENA trade? [J]. Applied Economics, 2018, 50(39): 4197-221.

[253] RASOULINEZHAD E, KANG G S. A panel data analysis of South Korea’s trade with OPEC member countries: The gravity model approach [J]. Iranian Economic Review, 2016, 20(2): 203-24.

[254] RASOULINEZHAD E, POPOVA L. An estimation of the impact of economic sanctions and oil price shocks on Iran-Russian trade: Evidence from a gravity-VEC approach [J]. Iranian Economic Review, 2017, 21(3): 469-97.

[255] RASOULINEZHAD E, WEI W. China's trade with OPEC member countries: A panel-gravity model approach [J]. The Chinese Economy, 2017, 50(1): 339-55.

[256] RAVISHANKAR G, STACK M M. The gravity model and trade efficiency: A stochastic frontier analysis of Eastern European countries' potential trade [J]. The World Economy, 2014, 37(5): 690-704.

[257] REDFERN S K, AZZU N, BINAMIRA J S. Rice in Southeast Asia: Facing risks and vulnerabilities to respond to climate change [M]. Building Resilence for Adaptation to Climate Change in the Agriculture Sector. Philippines; FAO IPM Program. 2012: 295-314.

[258] RGA: Ricegrowers’ Association of Australia Inc (RGA), 2013.

[259] RGC. “Rectangular Strategy” for growth, employment, equity and efficiency, Phase I (in English and Khmer) [M]. Phnom Penh, Cambodia; The Royal Government of Cambodia (RGC). 2004: 1-39.

[260] RGC. National Strategic Development Plan (NSDP) 2006-2010 (in Khmer and English) [M]. Phnom Penh, Cambodia; The Royal Government of Cambodia (RGC). 2005.

[261] RGC. “Rectangular Strategy” for growth, employment, equity and efficiency, Phase II (in English and Khmer) [M]. Phnom Penh, Cambodia; The Royal Government of Cambodia (RGC). 2008: 1-43.

[262] RGC. Policy paper on the promotion of paddy production and rice export [M]//MINISTERS A B C O. Phnom Penh, Cambodia; The Royal Government of Cambodia (RGC). 2010.

[263] RGC. “Rectangular Strategy” for growth, employment, equity and efficiency, Phase III (in English and Khmer) [M]. Phnom Penh, Cambodia; The Royal Government of Cambodia (RGC). 2013.

[264] RGC. National Strategic Development Plan (NSDP) 2014-2018 (in Khmer and English) [M]. Phnom Penh, Cambodia; The Royal Government of Cambodia (RGC). 2014.

[265] RGC. “Rectangular Strategy” for growth, employment, equity and efficiency, Phase IV (in English and Khmer) [M]. Phnom Penh, Cambodia; The Royal Government of Cambodia (RGC). 2018.

[266] RICARDO D. On the principles of political economy and taxation [M]. Canada: Republished in 2001 by Batoche Books Kitchener, 1817.

[267] RICHARDSON J D, ZHANG C, NBER Working Paper 7212 [R]. Cambridge: National Bureau of Economic Research (NBER), 1999.

[268] ROBERTS M J, TYBOUT J R. The decision to export in colombia: An empirical model of entry with sunk costs [J]. The American Economic Review, 1997, 87(4): 545-64.

[269] ROBERTS W, BILGINSOY C. Risking life and limb in the global economy: Scrap metal price and landmine/UXO incidents in Cambodia [J]. World Development Perspectives, 2016, 1(1): 15-22.

[270] RODGERS G. What is South Asia? All about South Asia: The location and some interesting facts [M]. Tripsavvy; Tripsavvy, a part of the Dotdash publishing family. 2019.

[271] ROSSATO F G F S, SUSAETA A, ADAMS D C, et al. Comparison of revealed comparative advantage indexes with application to trade tendencies of cellulose production from planted forests in Brazil, Canada, China, Sweden, Finland and the United States [J]. Forest Policy and Economics, 2018, 97(1): 59-66.

[272] SAING C, HEM S, OUCH C, et al., CDRI Working Paper Series No. 60 [R]. Phnom Penh, Cambodia: Cambodia's leading independent development policy research institute (CDRI); Food and Agriculture Organization of the United Nations (FAO), 2012.

[273] SALIM R A, KABIR M M, MAWALI N A. Does more trade potential remain in Arab States of the Gulf ? [J]. Journal of Economic Integration, 2011, 26(2): 217-43.

[274] SANJUÁN-LÓPEZ A I, DAWSON P J. Agricultural exports and economic growth in developing countries: A panel cointegration approach [J]. Journal of Agricultural Economics, 2010, 61(3): 565-83.

[275] SANTOS SILVA J M C, TENREYRO S. The log of gravity [J]. The Review of Economics and Statistics, 2006, 88(4): 641-58.

[276] SANTOS SILVA J M C, TENREYRO S. On the existence of the maximum likelihood estimates in poisson regression [J]. Economics Letters, 2010, 107(2): 310-2.

[277] SANTOS SILVA J M C, TENREYRO S. Further simulation evidence on the performance of the poisson pseudo-maximum likelihood estimator [J]. Economics Letters, 2011, 112(2): 220-2.

[278] SARETH V. The study on rice trade between Cambodia and the Greater Mekong Subregion: China, Thailand and Vietnam [D]. China; Chinese Academy of Agricultural Sciences Dissertation, 2015.

[279] SCHIERHORN F, MEYFROIDT P, KASTNER T, et al. The dynamics of beef trade between Brazil and Russia and their environmental implications [J]. Global Food Security, 2016, 11(1): 84-92.

[280] SCHLUETER S W, WIECK C, HECKELEI T. Regulatory policies in meat trade: Is there evidence for least trade-distorting sanitary regulations? [J]. American Journal of Agricultural Economics, 2009, 91(5): 1484-90.

[281] SEMYKINA A, WOOLDRIDGE J M. Estimation of dynamic panel data models with sample selection [J]. Journal of Applied Econometrics, 2013, 28(1): 47-61.

[282] SHAHRIAR S. Literature survey on the “Belt and Road” initiative: A bibliometric analysis [M]//ANNA V, MILTIADIS L, XI Z, et al. Foreign business in China and opportunities for technological innovation and sustainable economics. Hershey, PA, USA; IGI Global. 2019a: 79-115.

[283] SHAHRIAR S. A study on meat consumption among the Chinese youth [D]; College of Economics and Management, Northwest Agriculture and Forestry University, Yangling, Shaanxi, China, 2019b.

[284] SHAHRIAR S. Understanding China's Belt & Road Initiative: The institutional economics approach [M]. Beau Bassin, Mauritius: Lambert Academic Publishing, 2019c.

[285] SHAHRIAR S, QIAN L, KEA S. China’s economic integration with the Greater Mekong Sub-region: An empirical analysis by a panel dynamic gravity model [J]. Economics Discussion Paper, 2018, 44(1): 1-45.

[286] SHAHRIAR S, QIAN L, KEA S. Determinants of exports in China’s meat industry: A gravity model analysis [J]. Emerging Markets Finance and Trade, 2019, 55(11): 2544–65.

[287] SHAHRIAR S, QIAN L, KEA S, et al. The gravity model of trade: A theoretical perspective [J]. Review of Innovative and Competitiveness: A Journal of Economic and Social Research, 2019, 5(1): 21-42.

[288] SHEPHERD B. Dealing with zero trade flows [M]. ARTNeT Capacity Building Workshop for Trade Research: “Behind the Border” Gravity Modeling. ARTNeT. 2008.

[289] SHEPHERD B. The gravity model of international trade: A user guide (An updated version) [M]. Bangkok, Thailand: United Nations Economic and Social Commissions for Asia and the Pacific, 2016.

[290] SHEPHERD B. Mega-regional trade agreements and Asia: An application of structural gravity to goods, services, and value chains [J]. Journal of the Japanese and International Economies, 2019, 51(1): 32-42.

[291] SHEPOTYLO O, NUPI Working Paper 856 [R]. Oslo, Norway: Norwegian Institute of International Affaires (NUPI), Department of International Economics, 2015.

[292] SHEPOTYLO O. Effect of non-tariff measures on extensive and intensive margins of exports in seafood trade [J]. Marine Policy, 2016, 68(1): 47-54.

[293] SHUJAH UR R, CHEN S, SAUD S, et al. Nexus between financial development, energy consumption, income level, and ecological footprint in CEE countries: do human capital and biocapacity matter? [J]. Environmental science and pollution research international, 2019,

[294] SIDAWAY J D, WOON C Y. Chinese narratives on "One Belt, One Road" (一带一路) in geopolitical and imperial contexts [J]. The Professional Geographer, 2017, 69(4): 591-603.

[295] SILOVE N. Beyond the Buzzword: The three meanings of "Grand Strategy" [J]. Security Studies, 2018, 27(1): 27-57.

[296] SINANAN D, HOSEIN R. Transition probability matrices and revealed comparative advantage persistence in a small hydrocarbon-based economy [J]. The West Indian Journal of Engineering, 2012, 34(1/2): 16-29.

[297] SINGH T. Does international trade cause economic growth? A survey [J]. The World Economy, 2010, 1517-64.

[298] SIPHANA S, SOTHARITH C, VANNARITH C, CICP Working paper No. 37 [R]. Phnom Penh, Cambodia: Cambodia Institute for Cooperation and Peace (CICP), 2011.

[299] SMITH A. The wealth of nations [M]. Kraków, Poland: Republished in 2010 by Mark Biernat, 1776.

[300] SOENG R, CUYVERS L. Domestic institutions and export performance: Evidence for Cambodia [J]. The Journal of International Trade & Economic Development, 2018, 27(4): 389-408.

[301] SORGHO Z, THARAKAN J. Assessing the impact of unilateral trade policies EBA and AGOA on African beneficiaries' exports using matching econometrics [J]. World Economy, 2019, 33(1): 1-54.

[302] SRINIVASAN P V, JHA S. Liberalized trade and domestic price stability. The case of rice and wheat in India [J]. Journal of Development Economics, 2001, 65(2): 417-41.

[303] STACK M M, ACKRILL R, BLISS M. Sugar trade and the role of historical colonial linkages [J]. European Review of Agricultural Economics, 2018, 46(1): 79-108.

[304] SUMMERS T. China's 'New Silk Roads': sub-national regions and networks of global political economy [J]. Third World Quarterly, 2016, 37(9): 1628-43.

[305] SUMMERS T. The belt and road initiative in Southwest China: responses from Yunnan province [J]. The Pacific Review, 2019, 24.

[306] SUN Z-L, LI X-D. The trade margins of Chinese agricultural exports to ASEAN and their determinants [J]. Journal of Integrative Agriculture, 2018, 17(10): 2356-67.

[307] SUPONGPAN KULDILOK K. The export competitiveness of the tuna industry in Thailand [J]. British Food Journal, 2013, 115(3): 328-41.

[308] TAMBURINO L, BRAVO G, CLOUGH Y, et al. From population to production: 50 years of scientific literature on how to feed the world [J]. Global Food Security, 2020, 24(1): 100346.

[309] TAMINI L D, DOYON M, SIMON R. Analyzing trade liberalization effects in the egg sector using a dynamic gravity model [J]. Canadian Journal of Agricultural Economics, 2016, 64(2): 383-411.

[310] TAO L. Green trade barriers with our country agricultural product export trade [J]. Science Innovation, 2016, 4(3): 168.

[311] THERIAULT V, SERRA R. Institutional environment and technical efficiency: A stochastic frontier analysis of cotton producers in West Africa [J]. Journal of Agricultural Economics, 2014, 65(2): 383-405.

[312] THUONG N T T. The effect of sanitary and phytosanitary measures on Vietnam's rice exports [J]. EconomiA, 2018, 19(2): 251-65.

[313] THURSBY J G, THURSBY M C. Bilateral trade flows, the Linder hypothesis, and exchange risk [J]. The Review of Economics and Statistics, 1987, 69(3): 488-95.

[314] TINBERGEN J. Shaping the world economy [J]. The International Executive, 1962, 5(1): 27-30.

[315] TRAINS. Trade analysis information system (TRAINS), UNCTAD [M]. Geneva, Switzerland; United Nations Conference on Trade and Development (UNCTAD). 2020.

[316] TURNER M, KORM R, VEARA K. Government policy and private sector development in post-conflict states: Growing Cambodia's rice production and export industries [J]. Econ Labour Relat Re, 2017, 28(2): 252-69.

[317] TUSSIE D. The environment and international trade negotiations: Open loops in the developing world [J]. The World Economy, 1999, 22(4): 535-45.

[318] UL HAQ Z, MEILKE K D. Does the Linder effect hold for differentiated agri-food and beverage product trade? [J]. Applied Economics, 2011, 43(27): 4095-109.

[319] UN-WCED. Report of the World Commission on Environment and Development [M]. United Nations (UN). 1983.

[320] UNCOMTRADE. UN Comtrade Database, the International Trade Statistics Database of the United Nations 2018 [M]. The United Nations (UN). 2018.

[321] UNCOMTRADE. UN Comtrade Database, the International Trade Statistics Database of the United Nations 2019 [M]. United Nations. 2019.

[322] UNCOMTRADE. UN Comtrade Database, the International Trade Statistics Database of the United Nations 2020 [M]. 2020.

[323] UNCTAD. Data center of the United Nations Conference on Trade and Development (UNCTAD) online database 2019 [M]. 2019.

[324] UNCTAD. Data center of the United Nations Conference on Trade and Development (UNCTAD) online database 2020 [M]. United Nations Conference on Trade and Development (UNCTAD). 2020.

[325] VIORICA E D. Econometric analysis of foreign trade efficiency of EU members using gravity equations [J]. Procedia Economics and Finance, 2015, 20(1): 670-8.

[326] VOLLRATH T L, Economic Research Service Staff Report No. AGES861030 [R]. Washington DC, USA: US Department of Agriculture, Washington DC, 1987.

[327] VOLLRATH T L, USDA Bulletin No. 567 [R]. Washington DC, USA: Economic Research Service, US Department of Agriculture (USDA), 1989.

[328] VOLLRATH T L. A theoretical evaluation of alternative trade intensity measures of revealed comparative advantage [J]. Weltwirtschaftliches Archiv, 1991, 127(2): 265-80.

[329] WANG J. Analysis of the factors influencing Japan’s soybean import trade: Based on gravity model [J]. American Journal of Industrial and Business Management, 2016, 6(2): 109-16.

[330] WDI. World development indicators (WDI) online database of the World Bank [M]. World Bank. 2018.

[331] WDI. Data bank of the World Development Indicators (WDI) 2020 [M]. World Bank Group. 2020.

[332] WEI G, HUANG J, YANG J. Honey safety standards and its impacts on China's honey export [J]. Journal of Integrative Agriculture, 2012a, 11(4): 684-93.

[333] WEI G, HUANG J, YANG J. The impacts of food safety standards on China's tea exports [J]. China Economic Review, 2012b, 23(2): 253-64.

[334] WIKIPEDIA. Cambodia [M]. Wikimedia Foundation, Inc. 2020.

[335] WILSON J S, OTSUKI T. To spray or not to spray: pesticides, banana exports, and food safety [J]. Food Policy, 2004, 29(2): 131-46.

[336] WILSON J S, OTSUKI T, MAJUMDSAR B. Balancing food safety and risk: Do drug residue limits affect international trade in beef? [J]. The Journal of International Trade & Economic Development, 2003, 12(4): 377-402.

[337] WOOD J, WU J, LI Y, et al. TBT and SPS impacts on Korean exports to China: empirical analysis using the PPML method [J]. Asian-Pac Econ Lit, 2017, 31(2): 96-114.

[338] WOOLDRIDGE J M. Econometric analysis of cross section and panel data, 1st edition [M]. Cambridge, Massachusetts; London, England: The MIT Press, 2002.

[339] WORLD_BANK, 1729-2638 [R]. Washington, DC, USA: The World Bank, 2017.

[340] WRS. World Rice Statistics Database (WRS) [M]. Philippines; International Rice Research Institution (IRRI). 2018.

[341] WTO-I-TIP. Integrated trade intelligence portal (I-TIP) improving the transparency of trade policy measures [M]. World Trade Organization (WTO). 2020.

[342] WTO. Geneva, Switzerland: World Trade Organization (WTO), 2012.

[343] WTO. Cambodia's regional trade agreement (RTAs) [M]. World Trade Organization (WTO). 2019a.

[344] WTO. Members and observers of the World Trade Organization (WTO) [M]. World Trade Organization (WTO). 2019b.

[345] WTO. The Uruguay round [M]. World Trade Organization (WTO). 2019c.

[346] WTO. All WTO member countries: Number of measures, Measures initiated and in force from 2008-2019 [M]. World Trade Organization (WTO); World Trade Organization (WTO). 2020.

[347] XI J. Promote friendship between our people and work together to build a bright future [M]//CHINA M O F A O T P S R O. Speech at Nazarbayev University, Astana, September 7, 2013; Ministry of Foreign Affairs of the People's Republic of China. 2013.

[348] XIONG B, CHEN S. Estimating gravity equation models in the presence of sample selection and heteroscedasticity [J]. Applied Economics, 2014, 46(24): 2993-3003.

[349] XU J Q, LIU Y, YANG L L. A comparative study of the role of China and India in sustainable textile competition in the US market under green trade barriers [J]. Sustainability, 2018, 10(5): 1-21.

[350] YAO R T, SHIVELY G E. Technical change and productive efficiency: Irrigated rice in the Philippines* [J]. Asian Economic Journal, 2007, 21(2): 155-68.

[351] YEATS A J. On the appropriate interpretation of the revealed comparative advantage index: Implications of a methodology based on industry sector analysis [J]. Weltwirtschaftliches Archiv, 1985, 121(1): 61-73.

[352] YIWEI W. The Belt and Road Initiative: What will China offer the world in its rise [M]. Beijing, China: New World Press, 2016.

[353] YIWEI W. Belt and Road initiative: Mutual connectivity of the world [J]. China and the World, 2018, 1(4): 1850023.

[354] YOTOV Y V, PIERMARTINI R, MONTEIRO J-A, et al. An advanced guide to trade policy analysis: The structural gravity model [M]. Geneva, Switzerland: United Nations; The World Trade Organization, 2016.

[355] YU W S, JENSEN T V. Tariff preferences, WTO negotiations and the LDCs: The case of the 'Everything but Arms' initiative [J]. World Economy, 2005, 28(3): 375-405.

[356] ZHANG F, YU M, YU J, et al. The effect of RMB internationalization on Belt and Road Initiative: Evidence from bilateral swap agreements [J]. Emerging Markets Finance and Trade, 2017, 53(12): 2845-57.

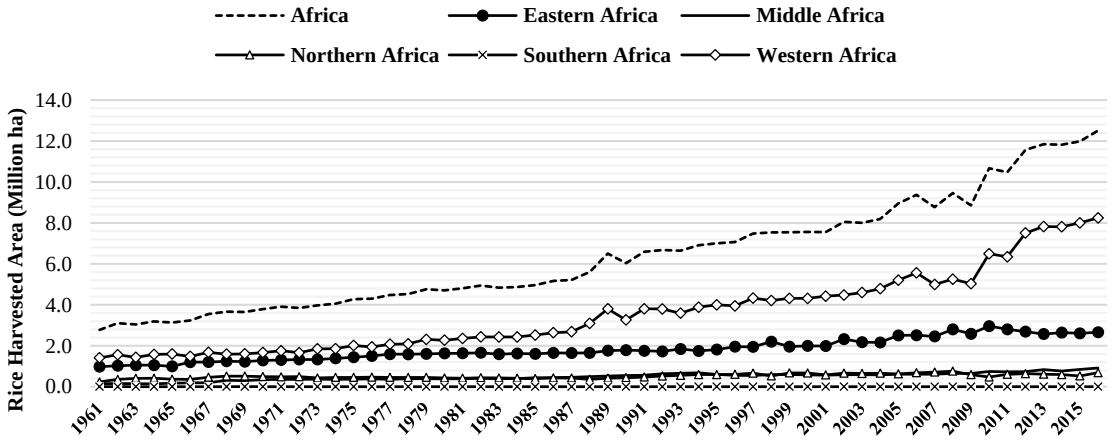
[357] ZHANG H. Securing the ‘rice bowl’: China and global food security [M]. Singapore: Palgrave Macmillan 2019.

[358] ZHARIKOV E P, KRAVCHENKO A A, SERGEEVA O O, et al. Econometric estimation of bilateral transboundary trade between Russia and China [J]. International Journal of Economics and Financial Issues, 2016, 6(3): 1068-71.

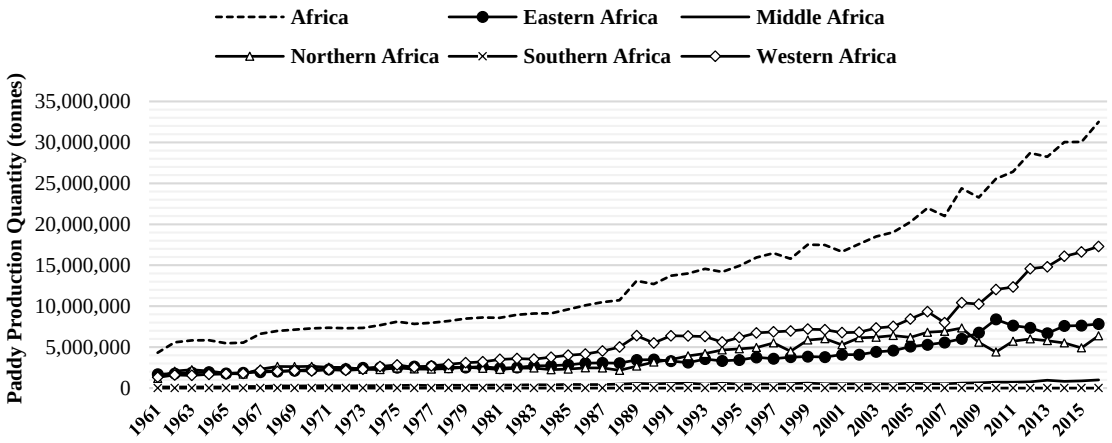
[359] ZHENG Z. The driving factors of China’s outward foreign direct investment under the strategy of “One Belt One Road” (in Chinese) [J]. Journal of Contemporary Financial Research, 2018, 1(1): 107-19.

[360] ZHOU L, LI L, LEI L. Avian influenza, non-tariff measures and the poultry exports of China [J]. Aust J Agr Resour Econ, 2018, 63(1): 72-94.

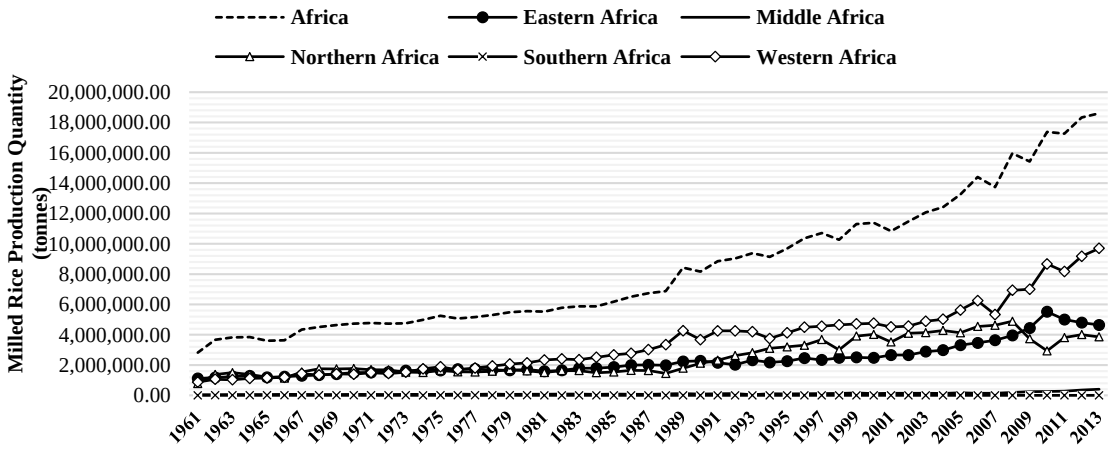
APPENDIX



(a) African rice harvested area



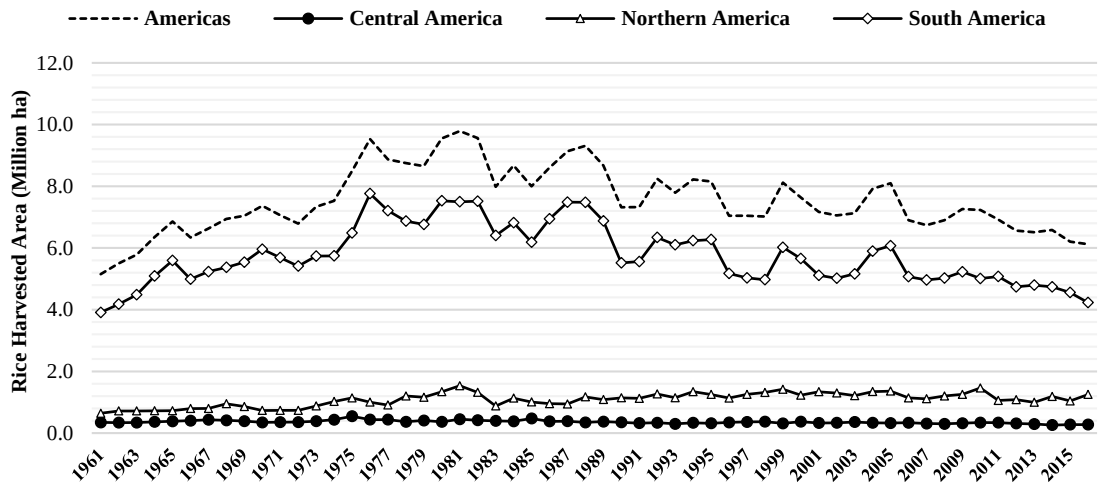
(b) African paddy production



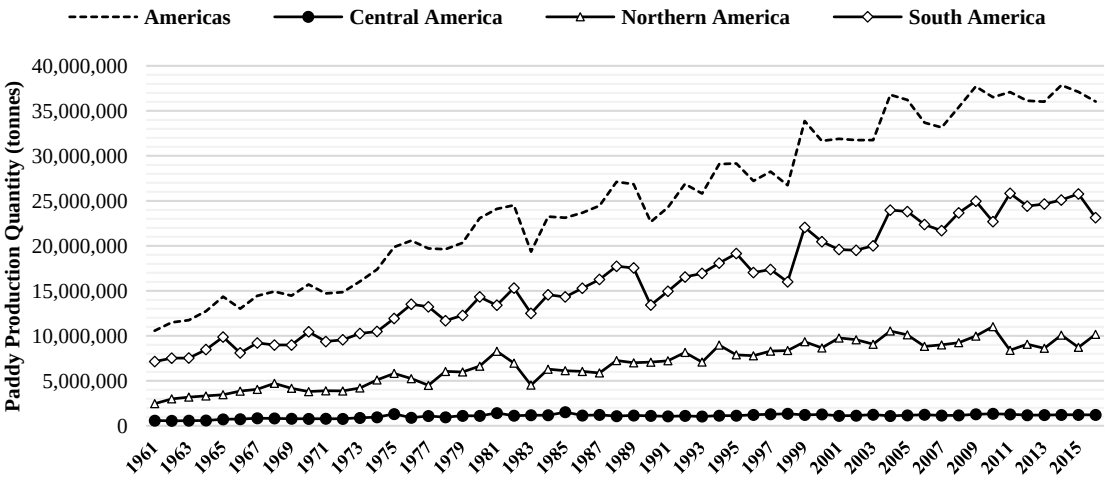
(c) African milled rice production

Figure A.1: African rice production, 1961-2016

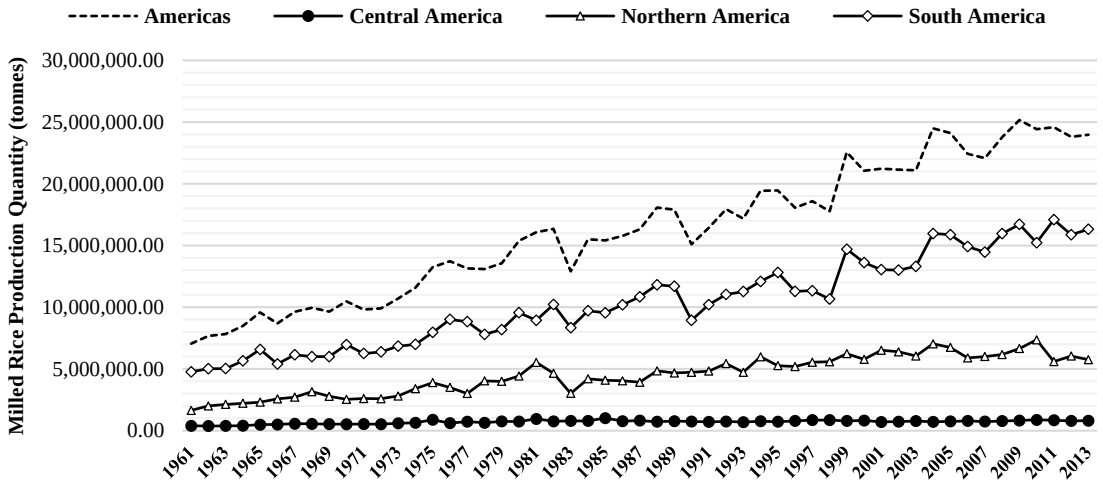
Source: World rice statistics database of IRRI (WRS 2018)



(a) American rice harvested area



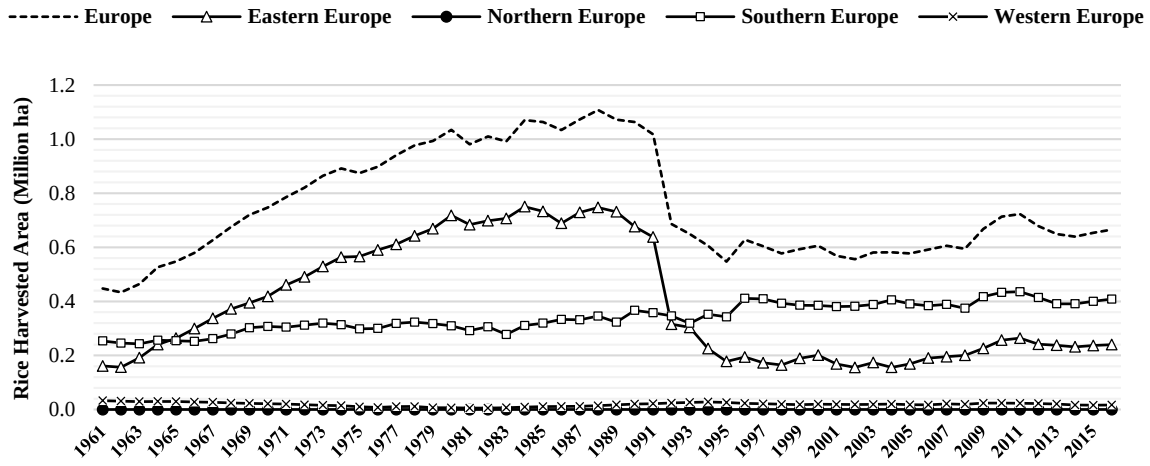
(b) American paddy production



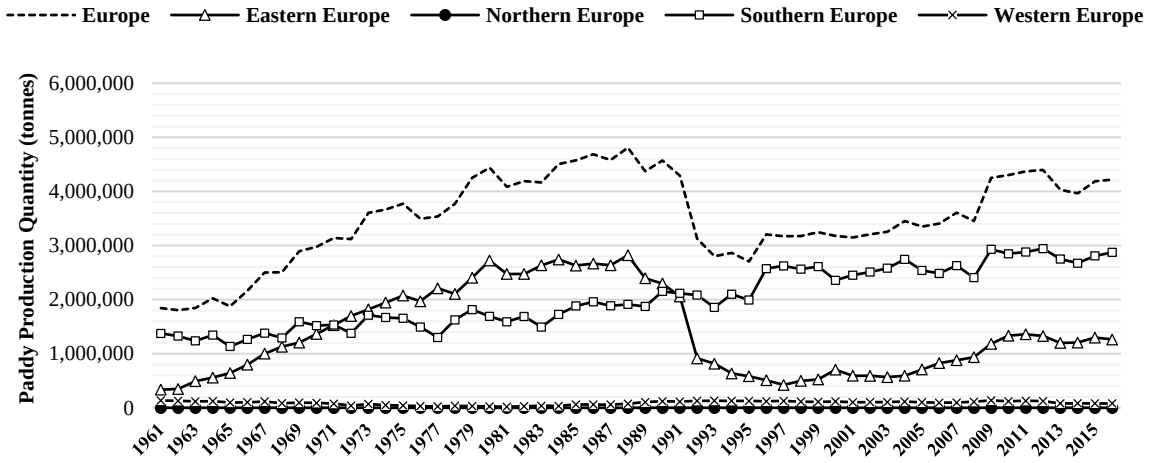
(c) American milled rice production

Figure A.2: American rice production, 1961-2016

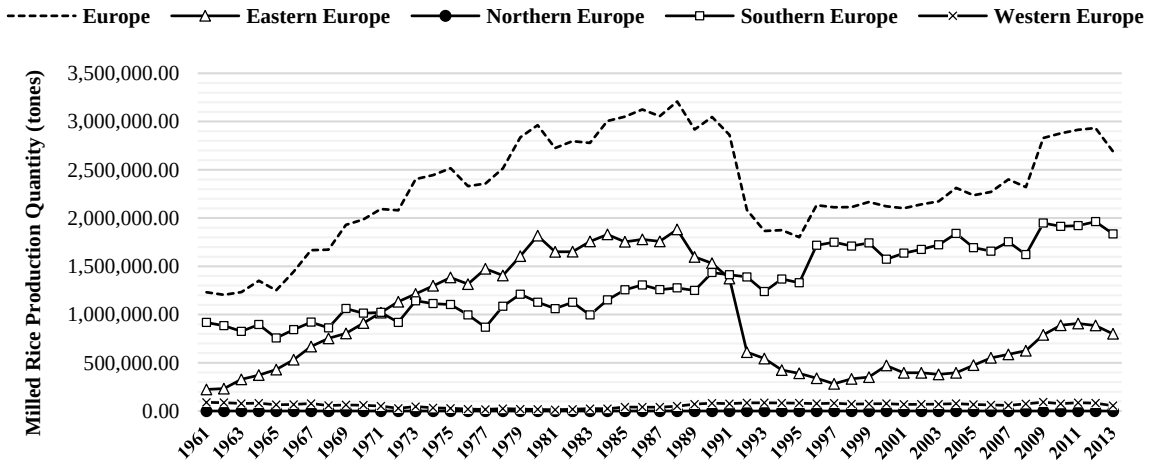
Source: World rice statistics database of IRRI (WRS 2018)



(a) European rice harvested area



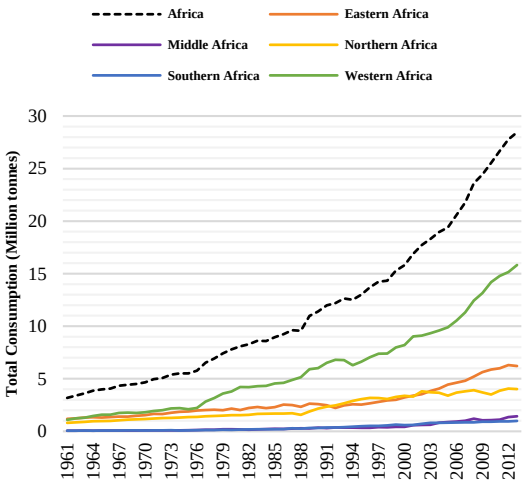
(b) European paddy production



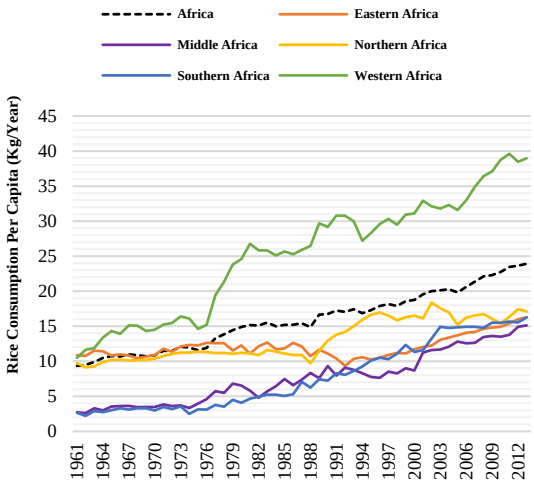
(c) European milled rice production

Figure A.3: European rice production, 1961-2016

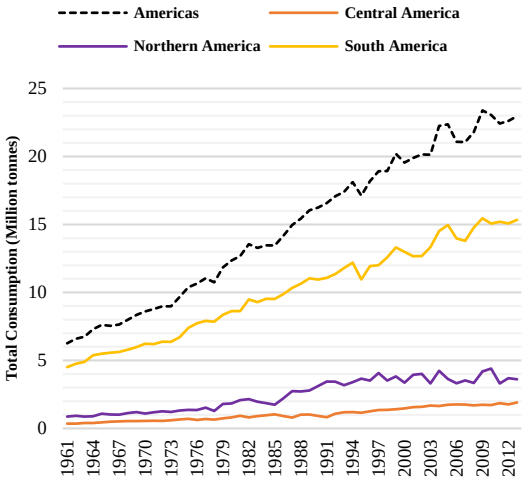
Source: World rice statistics database of IRRI (WRS 2018)



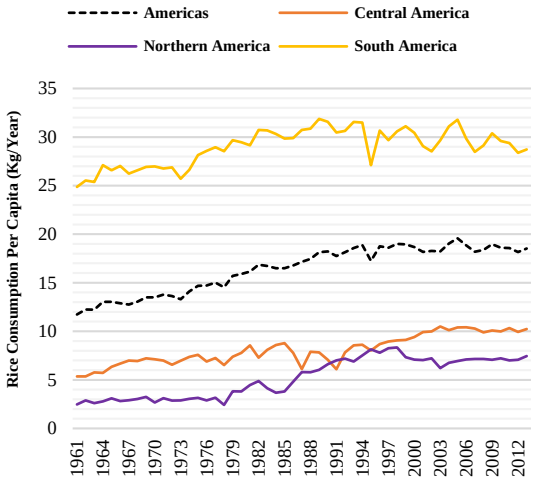
(a) African total milled rice consumption



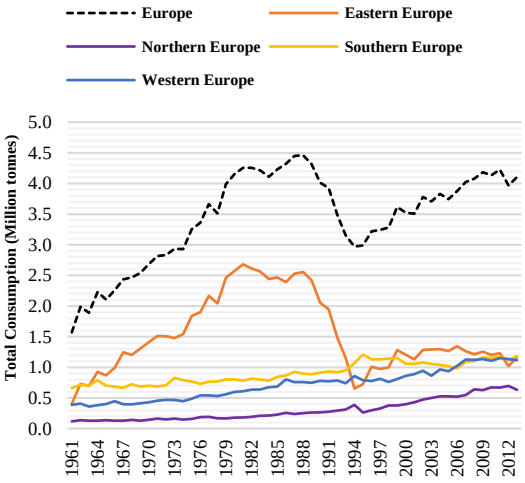
(b) African rice consumption per capita



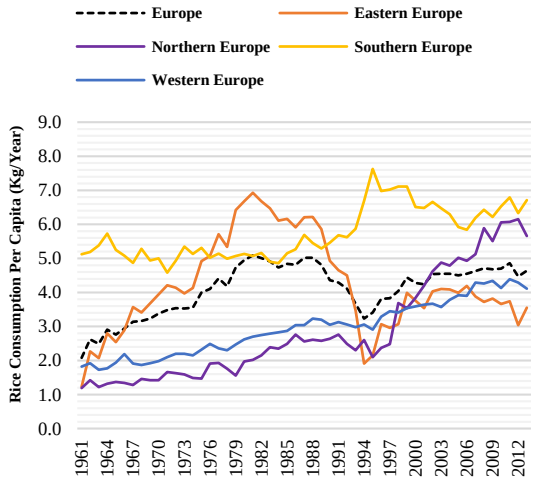
(c) American total milled rice consumption



(d) American rice consumption per capita



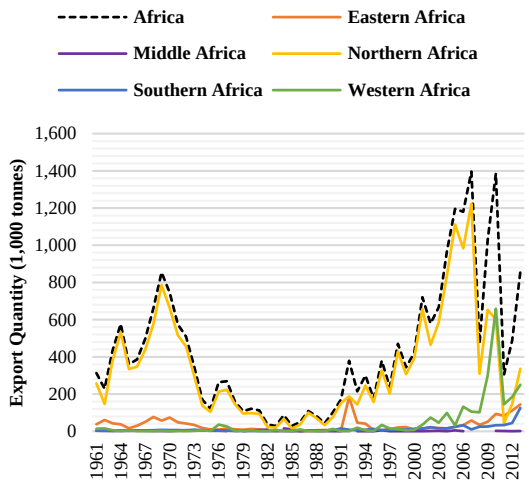
(e) European total milled rice consumption



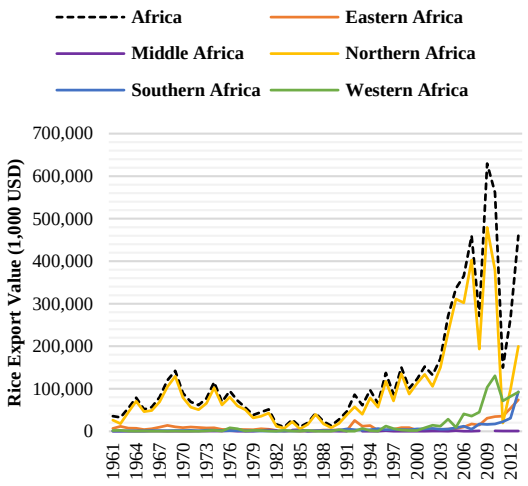
(f) European rice consumption per capita

Figure A.4: Milled rice consumption of Africa, America and Europe, 1961-2013

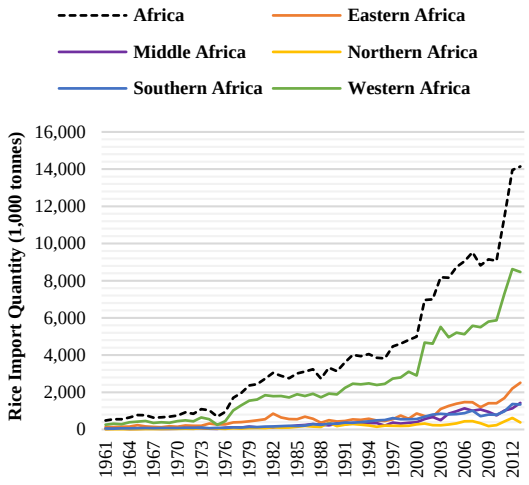
Source: World rice statistics database of IRRI (WRS 2018)



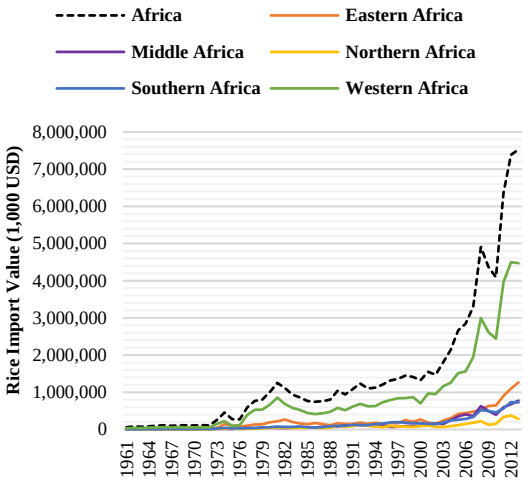
(a) African Rice Export Quantity



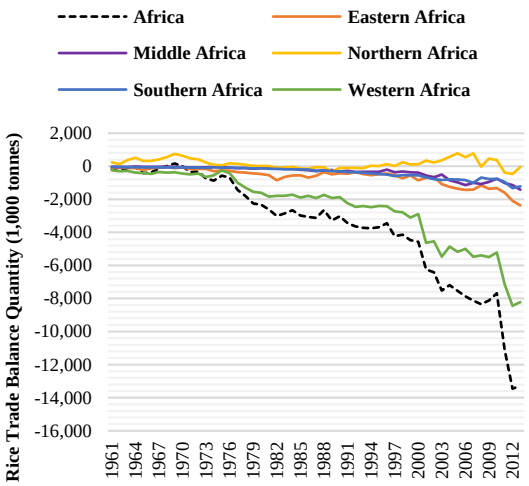
(b) African Rice Export Value



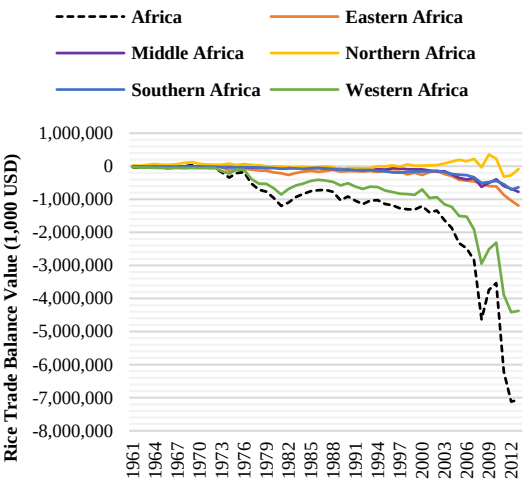
(c) African Rice Import Quantity



(d) African Rice Import Value



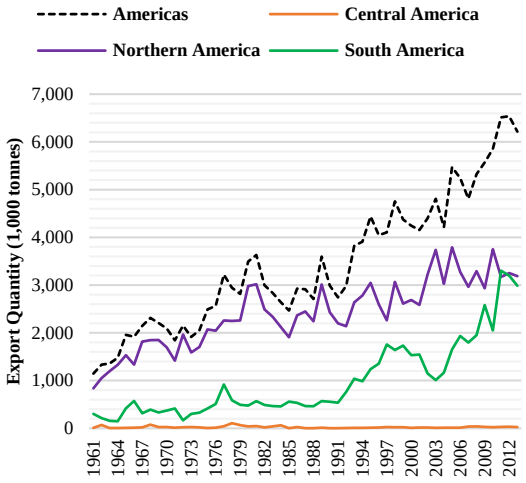
(e) African Rice Trade Balance Quantity



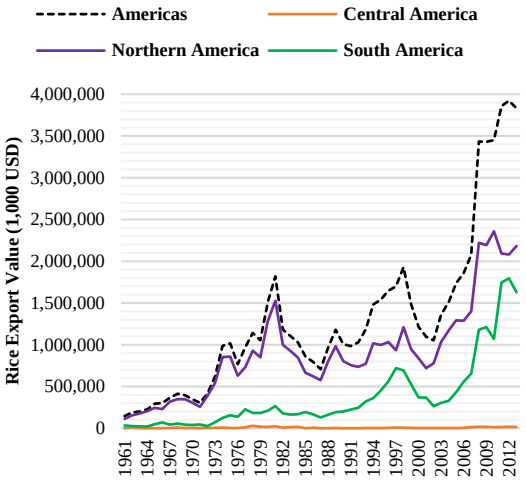
(f) African Rice Trade Balance Value

Figure A.5: African rice export, import, trade balance, 1961-2013

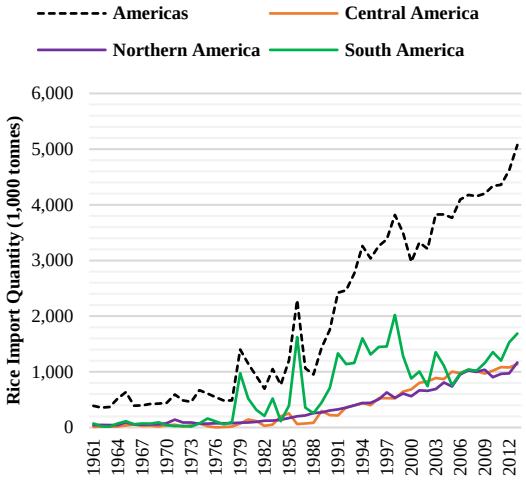
Source: World rice statistics database of IRRI (WRS 2018)



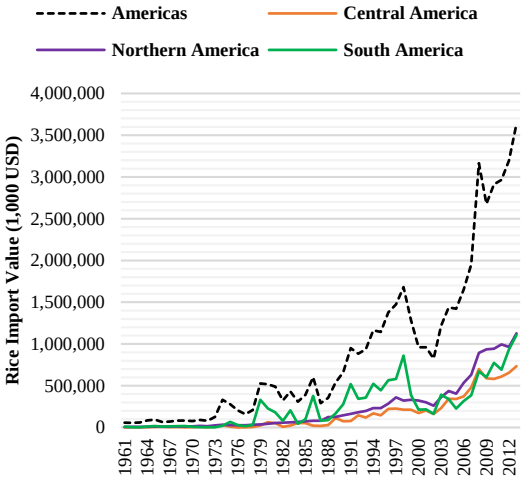
(a) American Rice Export Quantity



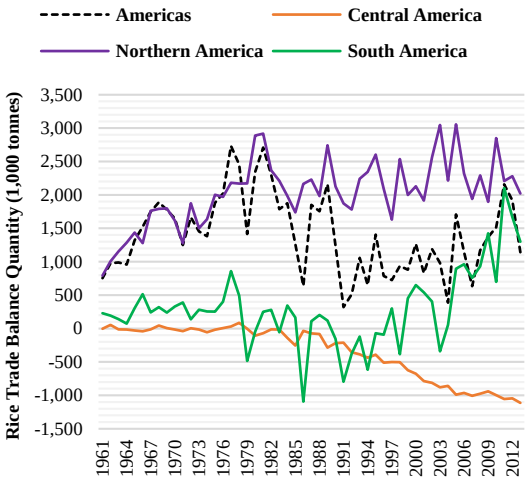
(b) American Rice Export Value



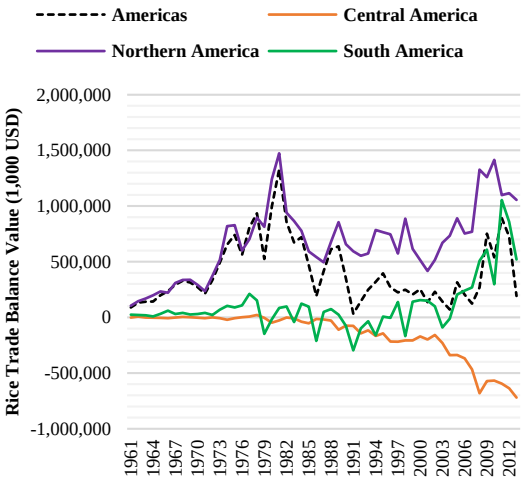
(c) American Rice Import Quantity



(d) American Rice Import Value



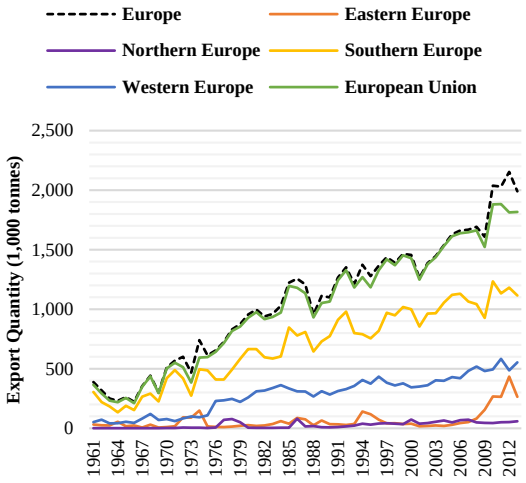
(e) American Trade Balance Quantity



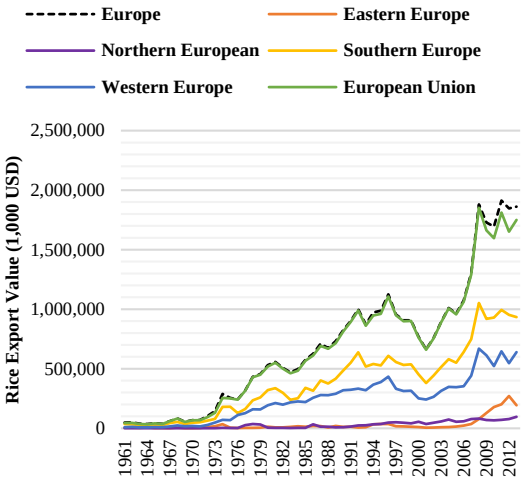
(f) American Trade Balance Value

Figure A.6: American rice export, import, trade balance, 1961-2013

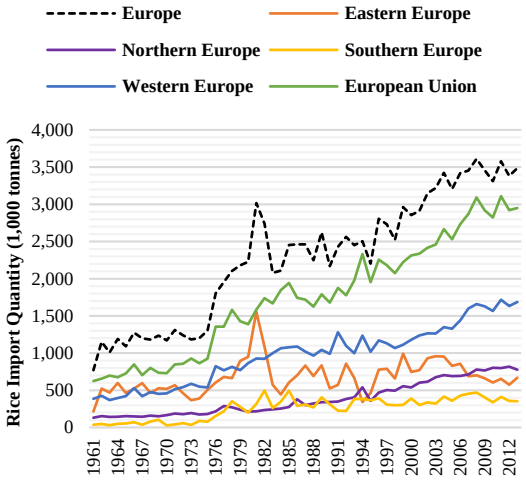
Source: World Rice Statistics Database of IRRI (WRS 2018)



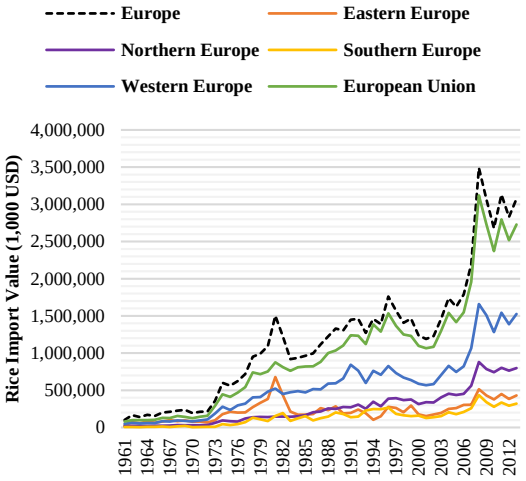
(a) European Rice Export Quantity



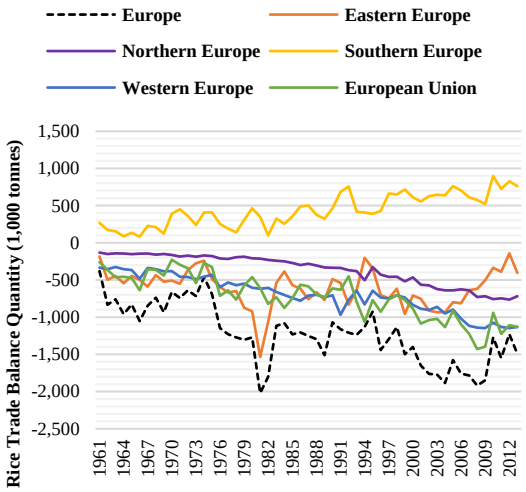
(b) European Rice Export Value



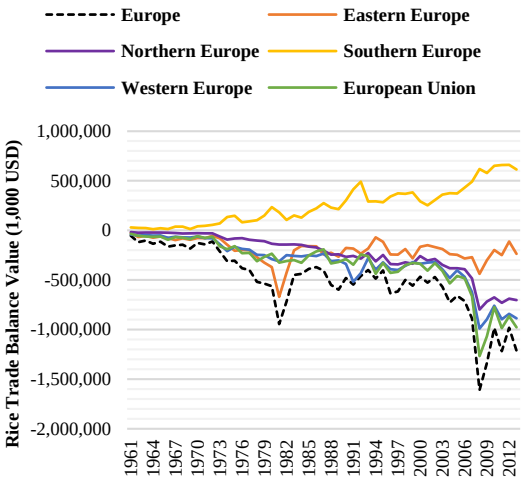
(c) European Rice Import Quantity



(d) European Rice Import Value



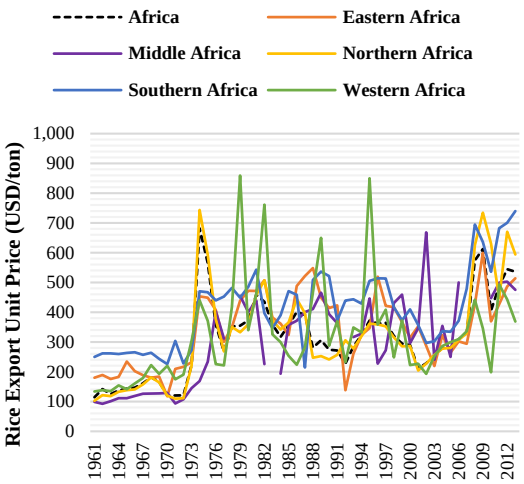
(e) European Trade Balance Quantity



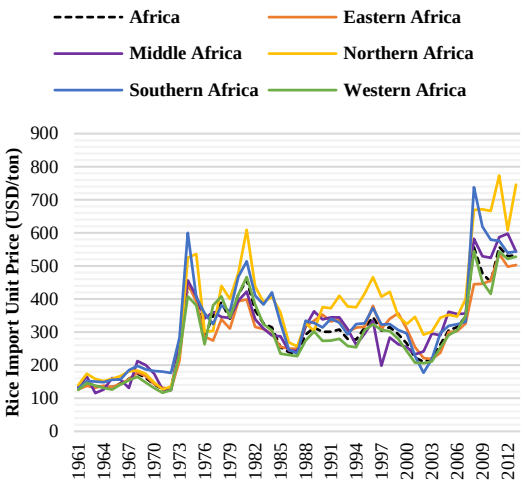
(f) European Trade Balance Value

Figure A.7: European rice export, import, trade balance, 1961-2013

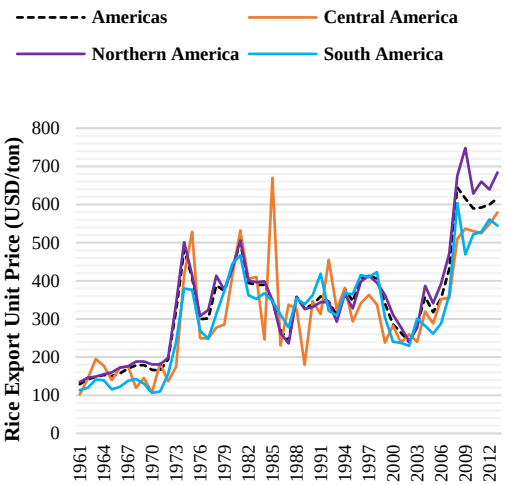
Source: World rice statistics database of IRRI (WRS 2018)



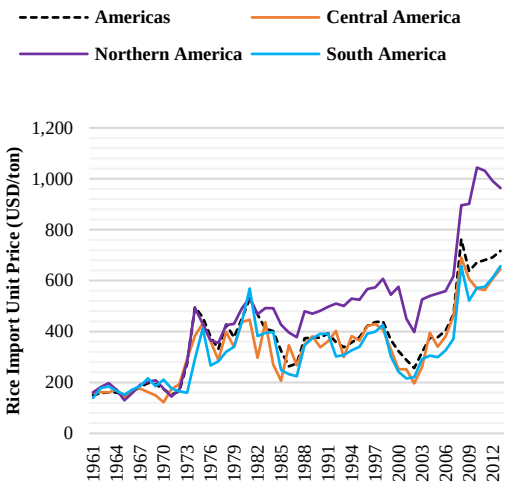
(a) African rice export unit price



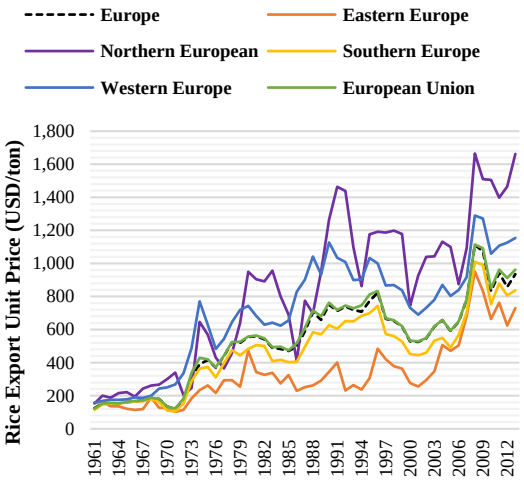
(b) African rice import unit price



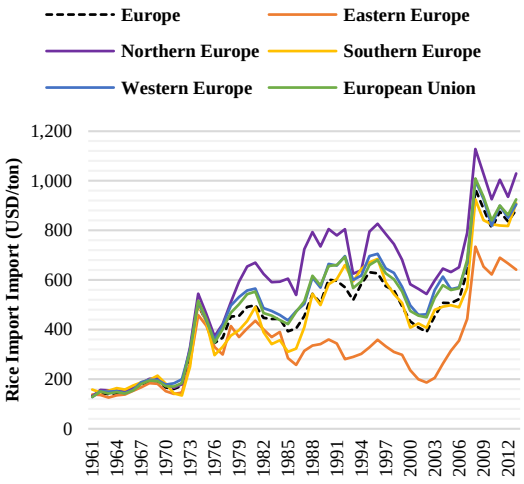
(c) American rice export unit price



(d) American rice import unit price



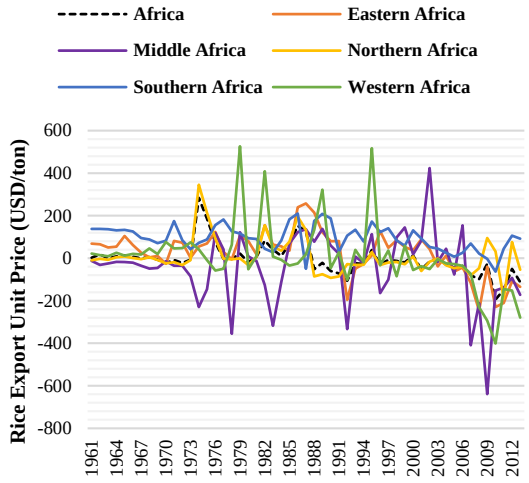
(e) European rice export unit price



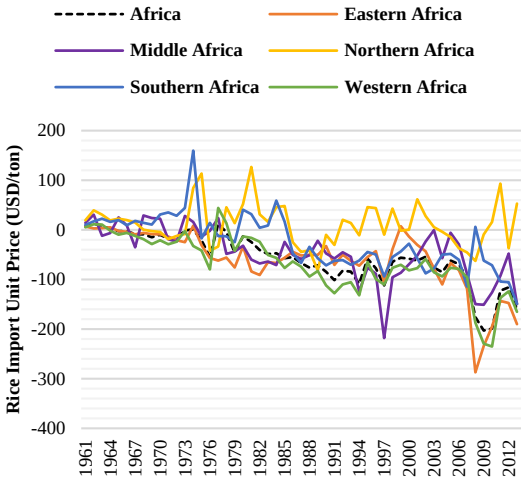
(f) European rice import unit price

Figure A.8: Average unit price of rice in Africa, America and Europe, 1961-2013

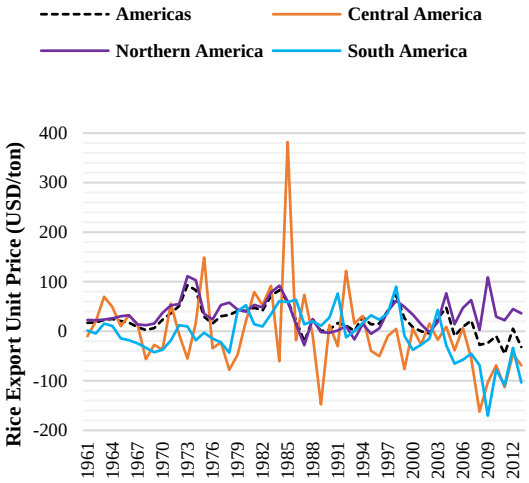
Source: World rice statistics database of IRRI (WRS 2018)



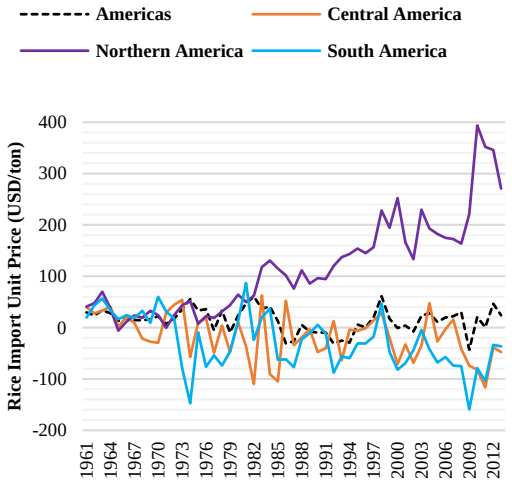
(a) African export unit price/world average



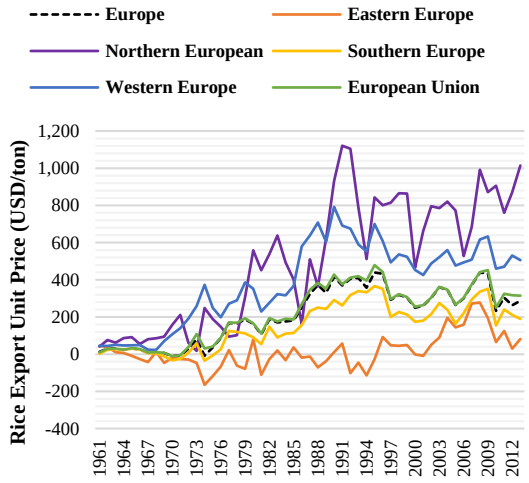
(b) African import unit price/world average



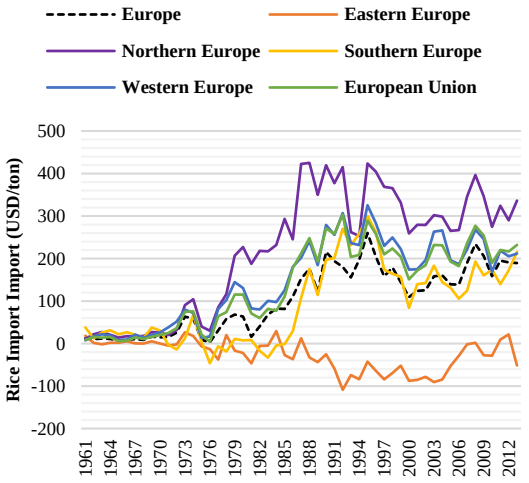
(c) American export unit price/world average



(d) American import unit price/world average



(e) European export unit price/world average



(e) European import unit price/world average

Figure A.9: Average unit price of rice compared to world average, 1961-2013

Source: World rice statistics database of IRRI (WRS 2018)

ACKNOWLEDGMENTS

A PhD research and dissertation were the long and complicated tasks. These works, therefore, would have not been accomplished without the help and encouragement of many people.

First of all, I would like to offer the flowers of gratitude to my beloved parents (*Kea Bunsith* and *Khon Vivann*) for their love, incessant encouragements, affections, supports, patience, and encouragements. Moreover, I am also indebted to my lovely sister (*Kea Sokvoleak*), brother (*Kea Sokmunnyvathana*) and all of my family members and relatives for their loves, kindness, and supports.

The deepest thanks and appreciations should be offered to *Professor Li Hua*, my supervisor, for her inspiration, guidance, and gracious supports throughout my academic life as an 'International Student' in China, since my M.Sc. (2013-2017) until my PhD (2017-2020). I am very appreciating and glad to work with / under the optimistic supervision of *Professor Li Hua*, and her encouragement, motivation, patience, enthusiasm, kinds, flexible and freedom.

I would also thankful to the Government of the People's Republic of China (PRC), the Royal Government of the Kingdom of Cambodia (RGC), the Chinese Scholarship Council (CSC), the Northwest A&F University (NWAFU) and the Royal Consulate-General for their kind permission, administrative and financial supports, during my 7-years academic journey in China.

It is my excessive pleasure to acknowledge my PhD research's supports and financial assistances, sponsored by the National Social Science Foundation of China (NSSFC) and the Northwest A&F University, under the project of "*Study on the mechanism of farmer's green production guided by geographical indications* (18XJY007)".

I also deeply acknowledge and the special thanks are due to all of my academic professors during my 7-years in China, especially, *Professor Kong Rong*, *Professor Yao Shunbo*, *Professor Zheng Shaofeng*, *Professor Yan Xiaohun*, *Professor Lu Qian*, *Professor Huo Xuexi*, *Professor Zhao Kai*, *Professor Zhao Minjuan*, *Professor Xue Jianhong*, *Professor Gu Rong*, *Professor Guo Yajun*, for spending their valuable time to evaluate my course works and offering their insightful comments.

My sincere thanks go to my dear collaborators (*Saleh Shahriar*, *Nazir Muhammad Abdullahi* and *Touch Tharo*) and my research team. I will never forget the amusing moments we shared for researches as well as for our life in China. More than the research collaborators and research team, we are *brothers*.

My thanks also go to the teachers of the *College of International Education* (CIE) at the Northwest A&F University (NWAFU), especially, to all of my Chinese language teachers, such as *Yu Ying Laoshi*, *Wang Yuhuan Laoshi*, *Zhang Jie Laoshi*, *Su Leixin Laoshi*, *Zeng Zhu Laoshi*, *Wang Min Laoshi*, *Shao Guiwen Laoshi*, *Pang Xueqin Laoshi* and *Cao Yushu Laoshi*, for their suggestions, encouragements, helps, and providing me knowledge as well as experiences during my hardest time (first year) in China, as well as for my entire long-journey in China.

In addition, several editors as well as the anonymous reviewers from various journals read my manuscripts meticulously, and subsequently provided their constructive comments that benefits for further improvement of the quality of my papers. In this regard, I must record my heart-felt gratitude to some prolific authors, editors and professors, especially, *Dr. Ali M. Kutan*, *Dr. Louise Manning*, and *Dr. Eleanor Wright*, for their kind supports and comments.

At last, I would like to express my thanks to all of my international friends and Chinese friends for being an important part of my life. I would never forget the memorable time we had sharing together.

KEA SOKVIBOL

College of Economics and Management

Northwest A&F University

Yangling, Shaanxi, China

May 11, 2020

ABOUT AUTHOR

Biography

Sokvibol Kea is a PhD Researcher in agricultural economics and management, at the College of Economics and Management, Northwest A&F University, Yangling, Shaanxi, China. He has been a recipient of the Chinese Government Scholarship (CSC) to carry out his research works for the period 2013–2017 and 2017–2020. His main research fields lie in several key areas, include, rice economy, international trade, FDI, agricultural economics, gravity modelling, food security, food safety, productivity and efficiency analysis, SFA, BRI, RCA, and competitiveness. His works appeared in leading academic journals, such as *Emerging Markets Finance and Trade*; *British Food Journal; Economies MDPI; Global Journal of Human-Social Science: Economics.* He can be reached at ✉ ***keasokvibol@gmail.com***.

Academic Achievements

Book

1. *KEA S. Cambodian rice production technical efficiency and its determinant [M]. Deutschland, Germany: LAP Lambert Academic Publishing, 2017.*

SCI & SSCI

2. *KEA S, LI H, SHAHRIAR S, et al. Relative export competitiveness of the Cambodian rice sector [J]. British Food Journal, 2020, 1-22.*
3. *KEA S, LI H, SHAHRIAR S, et al. Factors influencing Cambodian rice exports: An application of the dynamic panel gravity model [J]. Emerging Markets Finance and Trade, 2019, 55(15): 1-22.*

International Articles

4. *KEA S, LI H, PICH L. Technical efficiency and its determinants of rice production in Cambodia [J]. Economies, 2016, 4(4): 22.*
5. *KEA S, LI H, PICH L. Technical efficiency analysis of Cambodian household's rice production [J]. Global Journal of Human Social Science: E (Economics), 2016, 16(3): 33-44.*