COMPETITIVENESS AND PROTECTION: A COMPARATIVE AND PROSPECTIVE STUDY OF THE WEST AFRICAN AND ASIAN RICE SUBSECTOR

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ABSTRACT

COMPETITIVENESS AND PROTECTION: A COMPARATIVE AND PROSPECTIVE STUDY OF THE WEST AFRICAN AND ASIAN RICE SUBSECTOR

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West Africa (WA) consumes more rice than other parts of the continent. Despite significant increases in rice production, WA still procures half of its rice needs through imports, and Asia (particularly Thailand, Vietnam, Pakistan, and India) is the major source of these imports. The 2008 rice crisis provided impetus to expanded rice production in WA, as countries sought to increase rice self-sufficiency rather than relying as heavily as they have had in the past on international trade to meet their food security goals. Recent changes in the Asian rice economy suggest a favorable environment for expansion of West African rice production, as area is shifting out of rice in Asia, productivity growth is slowing and labor costs are increasing.

This study examines the evolving competitiveness of West African value chains vis-à-vis those of major Asian rice exporters, focusing on : (i) estimating the current competitiveness of irrigated rice systems in three major West African producers (Côte d'Ivoire, Senegal and Mali) using a Domestic Resource Cost (DRC) analysis and identifying the major factors that will influence the competitiveness of these systems in the future, and (ii) assessing the forces driving the evolution of rice price policies over the period 1980-2009 by conducting country-specific time-series analyses for selected major rice importing countries in WA (Côte d'Ivoire, Senegal, Mali, and Nigeria) and their major imported rice suppliers in Asia (Vietnam, Thailand, India, and Pakistan) using an ARDL bounds-testing approach.

The results show that large-scale irrigated production was financially profitable in 2011 in Senegal, Mali and Côte d'Ivoire, but only economically profitable the former two. This suggests that net subsidies to the rice sector since the 2008 world food price crisis have been an important contributor to expansion of production, at least in Côte d'Ivoire. Given its relatively high comparative advantage in producing and marketing rice to its capital city, Mali may even be able to position itself as a substantial exporter of rice to regional markets. However, the competitiveness of West African rice value chains will depend on factors both outside the countries' control (such as world prices and exchange rates) and those they can influence (such as efficiency in production, processing and transport). The ability to achieve increases in system-wide efficiency requires adequate investment in agrifood system research and extension.

The results further show that all countries in both WA and Asia are becoming more protective of their rice sectors. The Asian markets are better able to insulate their domestic market against changes in world prices than WA, except in landlocked Mali, which is the poorest among the WA focused countries. Also, production levels positively affect the protection path of the WA countries, except in Mali. This trend towards increasing protection reflects the desire of these countries, which have invested heavily in irrigation infrastructure and research and development for improving seed varieties, to protect those fixed investments, especially if there is pressure by those who control them to protect the rents that accrue to those assets. However, continuing to protect high-cost producers in order to stimulate production will put a great burden on consumers and may jeopardize poor urban consumers' access to affordable rice supplies. Thus, there may be a need to put in place safety nets, broaden the consumption basket of staples, and open the market further, especially in Nigeria, by increasing investments in market infrastructure, including roads.

To my parents, Affissou and Dede-Essi, for their unconditional love, sacrifice and prayers.

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1. INTRODUCTION

Despite significant increases in production, the dependence of West Africa (WA) on imported rice has widened, with nearly half of its rice needs procured from the international market. The 2008 rice crisis provided impetus to expanded rice production in WA, with governments launching major, often expensive, rice initiatives. These recent efforts have aimed not only at increasing rice production but also improving quality and availability of local rice, especially in urban markets, to make local rice competitive with imported rice, thereby stimulating import substitution, national self-sufficiency and food security.

Rice is a versatile crop that can be grown under a range of water regimes. Three major rice-growing environments have been identified in WA, including rainfed upland systems which have aerobic soils for most of the season – situated on plateaus and slopes; rainfed lowland systems with varying degree of water control (inclusive of hydromorphic fringes or mangrove systems), which have anaerobic soils for most of the season – situated mostly in valley bottoms and flood plains; and irrigated systems with relatively good water control, which have anaerobic soils for most of the season – situated mostly in deltas and flood plains (Seck et al. 2013). While rice produced in rainfed systems might not be able to compete with commercially-produced domestic rice in irrigated areas or higher quality rice imported in large cities, it could complete in supplying rural consumers in secondary cities (Adjao 2011). Although improving production in all farming systems, including incremental opportunities for rain-fed rice production, should be considered to achieve the objective of raising overall domestic rice production, greater attention should be given to commercially produced rice if the other objective of reclaiming the important share of the market currently occupied by imports in urban areas is to be met.

Improving irrigated agriculture has always been a priority for most countries around the world, and it has become increasingly important in WA in the context of climate change. Since the 2008 rice crisis, increasing attention has been given to modernizing rice production systems. As WA decision makers carefully rethink their sectoral policy, they may raise the following questions: How do commercial rice value chains differ across WA countries and how to they compare to Asia? What are the main constraints to current competitiveness of WA rice value chains? What are the implications of the previous questions in terms of policy and strategies for improving competitiveness in the short to medium-run?

This study consists of four chapters, including this introduction. The second chapter identifies factors of competitiveness, examines the dynamics of the rice economies in Asia and WA, and derives their implications for improving the competitiveness of the growing WA rice economies. The third chapter further discusses price competitiveness of the rice sector in WA: (1) by benchmarking the performance, in financial terms, of selected WA rice value chains that connect commercial production zones to the capital cities of Senegal, Mali and Côte d'Ivoire compared to value chains of major Asian rice exporters to the selected WA countries (i.e., Thailand, Vietnam and India); and (2) by assessing the future comparative advantage of rice value chains in the selected WA countries using scenarios of comparative advantage under alternative assumptions about the evolution of production costs in Asia based on a Domestic Resource Cost (DRC) analysis. Finally, the fourth chapter focuses on trade policy and explores the forces driving the evolution of rice price policies in WA since 1980 by conducting specific time-series analyses for four major rice economies in WA: Nigeria, Senegal, Côte d'Ivoire, and Mali. These results are compared with similar analyses for four major Asian rice exporters to the selected WA countries (i.e., Vietnam, Thailand, India, and Pakistan).

Chapter 2 develops a conceptual framework for assessing competitiveness of rice value chains in Asia and West Africa and presents assumptions regarding the future direction of the factors of competitiveness. Although competitiveness is affected by both price and non-price factors, non-price competitiveness is intangible and difficult to measure. While there is no single comprehensive index to measure non-price competitiveness because of the variety of contributing factors, there exist several indices to measure price competitiveness, including domestic resource cost ratios (DRC), which are widely used in the literature in WA. Thus, Chapter 3 focuses on measuring price competitiveness building on the assumptions formulated in Chapter 2. Moreover, competitiveness can also be assessed by calculating the extent of government protection, using for instance the nominal protection coefficient (NPC), which compares private revenues to social revenue. Chapter 4 focuses on assessing the evolution of NPC and its determinants for selected countries in Asia and West Africa.

2. THE CHANGING ASIAN RICE ECONOMY AND ITS IMPLICATIONS FOR THE DEVELOPMENT OF COMMERCIAL RICE VALUE CHAINS IN WEST AFRICA

2.1 Introduction

2.1.1 Background and problem statement

Asia accounts for about 90% of the world rice production and consumption and is the home of many of the world's top rice exporters and importers. West Africa (WA) consumes more rice than other parts of the continent. However, about half of WA's rice needs is procured from the international market, with Asia (particularly Thailand, Vietnam, Pakistan, and India) accounting for most of these imports. Improving the comparative advantage of local rice production has been one of the key issues in the West African food policy debate since the early 1980s. The food crisis that occurred in 2008, with the FAO's cereal price index reaching a peak 2.8 times higher than in 2000, provided further impetus to expanded rice production in WA, as countries sought to increase rice self-sufficiency rather than relying on international trade to meet their food security goal. Such efforts will be economically sustainable only if WA production remains cost-competitive with Asian production. However, improving the competitiveness of WA rice production compared to Asia depends not only on conditions in WA but also on how the rice economy in Asia evolves. Several factors are likely to strongly affect the major Asian rice economies in the upcoming years: (i) increased diversification of the diet as a result of changing age structures and rapid economic growth; (ii) changes in production patterns across Asia, as land moves out of rice and into more high-value products; and (iii) evolving costs of production in response to higher energy and water costs, technological change, changing marketing strategies of rice producers, and climate change, although great uncertainty remains over the impact of the latter on the cost of production of rice. Therefore, there is a need to better understand how changes in dynamics of both WA and Asian economies over the coming 5 to 10 years would affect the competitiveness of WA rice systems.

2.1.2 Knowledge gap and purpose of the present study

The purpose of this chapter is to contribute to the literature on comparative analysis of Asian and WA rice value chains, to develop a framework that discusses the factors that contributed to the changing structure of rice value chains since the 1980s and derive implications for the development of the rice subsector in WA. This analysis aims to help shape subsequent inquiry in this dissertation about whether further investment in commercial rice value chains in WA is economically warranted. Understanding how these forces have influenced production incentives of small rice farmers and agribusiness in both WA and Asia in the past will allow better estimation of their likely impacts in the future.

Competitiveness has a broad and changing definition depending of the school of the thought and the level of analysis (Latruffe 2010; UNIDO 2009). In this study, competitiveness is be defined as "the ability to face competition and to be successful when facing competition, (i.e.,) the ability to sell products that meet the requirements (price, quantity, quality) and, at the same time, ensure profits over time that enable the firm to thrive (…) within domestic or international markets" (Latruffe 2010). Thus, an increase in competitiveness or financial profitability occurs when a firm or country is able to lower its costs relative to those incurred by their rivals.

There is a prolific literature that focuses on understanding how rice value chains around the world, including Asia and WA, are organized and perform. Many of these studies have used the concept of value chain to analyze this problematic. Most comparative studies on rice value chains have an intra-regional or continental focus. Recent comparative analysis on Asian rice value chains include the work of Reardon et al. (2014), who conducted an analysis of seven rice value chains supplying major cities in four Asian countries (Bangladesh, China, India, and Vietnam). That study compared four major "commercial zones" near mega cities to three "less developed zones", located in relative hinterland areas. Also, recent research on rice value chains in WA was carried out by AfricaRice and national agricultural research systems (NARS) in collaboration with Michigan State University for various rice production systems in Côte d'Ivoire (RCI), Senegal, Mali, Guinea, and Benin (Diallo et al. 2012). However, few studies have tackled the issue from an inter-regional or continental perspective, focusing especially on Asia-WA comparison. To my knowledge, the comparative study is the one done by the World Bank (2013) that compares rice value chains in Thailand, Senegal and Ghana.

Value chain analysis was popularized by Michael Porter (1990; 1998), who analyzed the competitive position of a firm or nation in global competition in adding value to a product, step-by-step, until it finally reaches the consumer. Since then, the value chain approach has diffused into a wide array of scientific studies and practical development approaches and nowadays constitutes an important concept complementing other development approaches such as enterprise development, sector and industry development, as well as territorial or integrated regional development (UNIDO 2009).

A value chain describes the full range of activities required to bring a product or service through the different phases of production, value addition, and marketing to respond to consumer demand. In this sense, the value chain describes how producers, processors, buyers, sellers, and consumers — separated by time and space — gradually add value to products as they pass from one link in the chain to the next.

As such, value chain analysis focuses on segmenting the different activities that add value in the production and sale of a product or service and thus provides a key framework for understanding the constraints and opportunities within each segment, and mechanisms for increasing productivity, efficiency, competitiveness and value-added along each segment of the chain (World Bank 2007).

The value chain approach has proven useful in providing important information for decision making in sector development and promotion: it focuses on development options and allows for the identification of intervention opportunities. Moreover, the value chain approach is demand-driven; it starts from an understanding of the final demand and works its way back through distribution channels to the different stages of production and transformation. Also, the value chain concept is flexible enough to allow a global perspective in the analysis; thus recognizing that trade, coordination of productive activities and technology transfer are increasingly organized across borders. Furthermore, the value chain approach allows more flexible analysis of chain governance or coordination of business transactions, as it acknowledges that governance is not the duty of a single member of the chain but of collective character drawing from a multiplicity of nodal points of governance, including markets and hierarchies[1].

However, the value chain approach has been often criticized for its lack of focus on human, social and environmental development. Critics have also highlighted that factor markets, especially labor markets, which are critical for stimulating sustained competitiveness as they promote wealth creation and stimulate investments, are not systematically addressed and only appears in an indirect, implicit way in the value chain literature and practice (Reardon and Timmer 2014; Meyer-Stamer and Wältring 2007; UNIDO 2009). Despite these criticisms, the value chain approach is

[1] When the formal rules surrounding markets are weak and informal institutions are not supportive of business transactions, the environment for the market is dysfunctional. Market failure generates suboptimal delivery of critical investments; thus reinforcing the competitiveness gap that keeps producers and the private sector from upgrading so that they might connect with dynamic markets. Thus, in a an environment where market failures are prevalent, hierarchies, in the shape of government institutions that create enabling environment, for instance by securing property rights, or private sector organizations that internalize processes with high transaction costs, are a necessary complement to markets (Williamson 1973; Dorward et al. 2005).

still a very useful tool as it helps identify more clearly interventions that could be carried out by both the public and private sector to support development processes in promising sectors.

2.1.3 Research objectives

The objectives of this chapter are (1) to develop a more comprehensive framework that identifies the factors of competitiveness to assess the performance of the WA and Asia rice value chains building on the value chain approach; (2) to assess changes in the dynamics of WA and Asian rice economies using the framework previously defined, highlighting constraints and potential for changes in the main drivers of competitiveness; (3) synthesize major projections over the coming decade of world rice consumption, production and prices, including for Asia and WA; and (4) discuss the implications of current and future trends in both Asia and WA for West African rice promotion strategies.

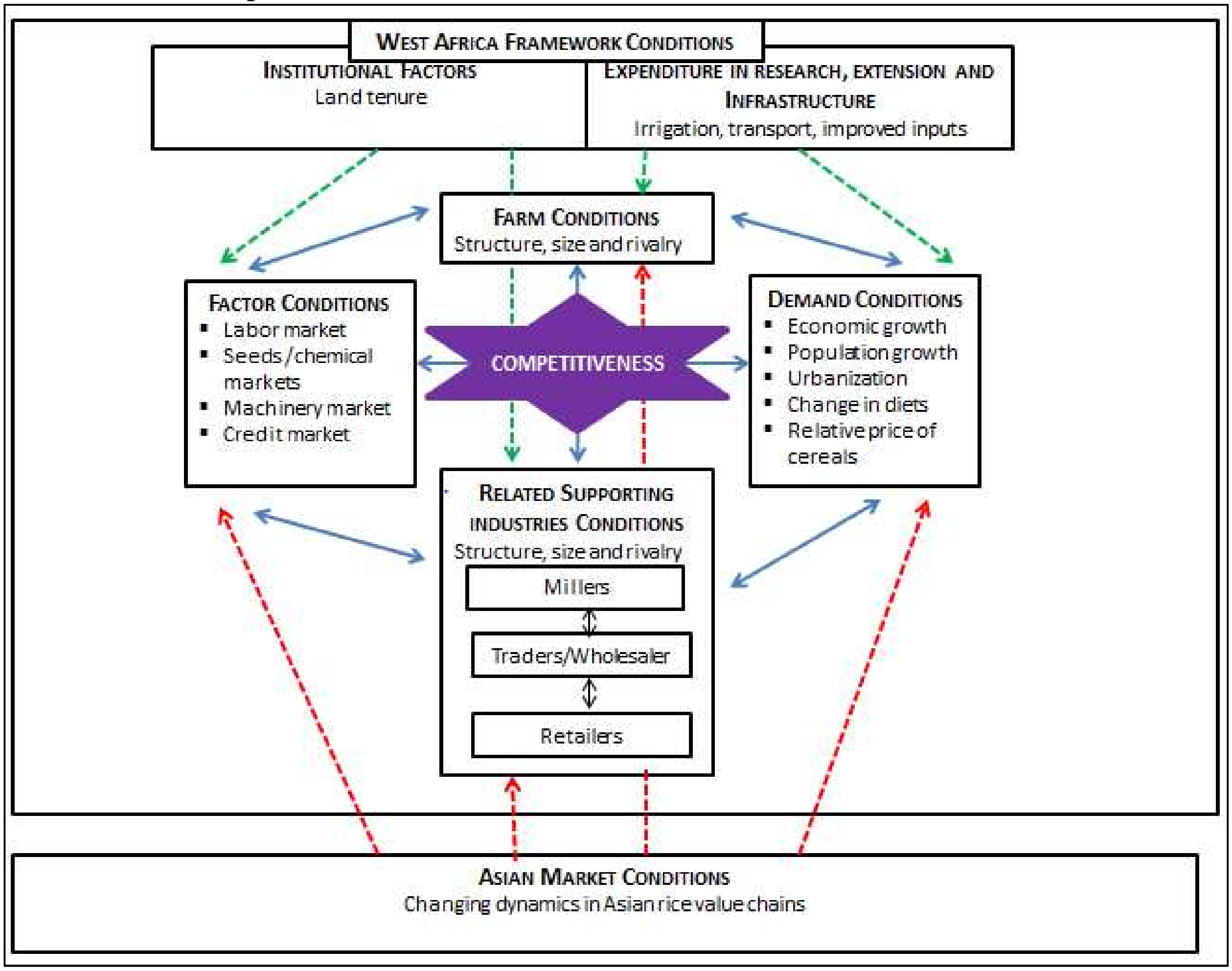
2.1.4 Conceptual framework and methods

Agri-food systems, including rice value chains, have undergone various structural changes since the 1980s. These changes have occurred in waves over developing regions, with waves roughly correlated with levels of income. Previous studies have measured competitiveness as being the outcome of changes in (1) demand conditions; (2) the size of the firm and structure of the industry, (3) relative factor prices; (4) institutional factors or public policies and regulations that influence producers' decisions regarding resource allocation; and (5) expenditure in research, extension and infrastructure that enables the creation of new technologies that may improve firm's productivity and lower their costs (Latruffe 2010). This study builds upon frameworks developed by Porter (1998) that explain the competitive advantage of nations and by Reardon and Timmer

(2014) that describe the rapid changes occurring in the Asian agrifood systems, in order to develop an analytical framework that: (i) identifies the main driving forces of competitiveness of WA and Asian rice systems, and (ii) explains the changing structures of these systems as their economies evolve. The proposed framework uses an incremental approach to the traditional value chain analysis by addressing some of the major limitations of the value chain approach mentioned above. Thus, the proposed framework consists of a descriptive diagnosis of coordination as well as potential opportunities and constraints along each segment of the chain. Similarly to the traditional value chain approach, the proposed framework is demand driven, effectively links urban demand to rural supply, includes a global perspective given the importance of rice imports in WA rice value chains, and allows for a more flexible analysis of coordination of transactions or chain governance. However, in addition to the traditional value chain approach, the proposed framework includes a systematic analysis of specialized factor markets, including labor markets, given their importance in generating wealth and stimulating investments in technology and knowledge, which are critical to improving competitiveness.

The proposed framework (see Figure 2.3) models changes in competitiveness as the outcome of four interlinked factors, including (1) changes in demand conditions; (2) changes in farm conditions; (3) changes in the conditions of related supporting industries; (4) changes in specialized factor markets, including labor and capital markets, resulting from substantial, sustained investments in technology and knowledge (know-how). These interlinked factors are complemented by both national framework conditions, and global framework conditions of international markets, especially Asian markets, which influence the development of local value chains in WA. Each of these factors is linked by transactions (within firms or across markets), and the analysis of the chain governance or coordination of these transactions is central to the model.

Figure 2.1: Proposed framework of four interlinked factors that determine the changing structure and competitiveness of rice value chains in West



By author

2.1.5 Organization

This chapter is organized into five parts, including this introduction. The second part provides an overview of the evolution of the world rice market, highlighting the dominance of Asia and the rising importance of WA. The third part describes the structural changes of the rice value chain of major exporters to WA (i.e., Thailand, Vietnam and India) since the 1980s; contrasts them to selected commercial WA value chains in RCI, Mali and Senegal, highlighting constraints and opportunities for changes in the competitive forces that determine the changing structures of

WA rice value chains. The fourth part synthesizes major projections over the coming decade of world rice consumption, production and prices, highlighting potential changes in these main drivers of competitiveness. Finally, the last part discusses the implications of current and future trends for West African rice promotion strategies.

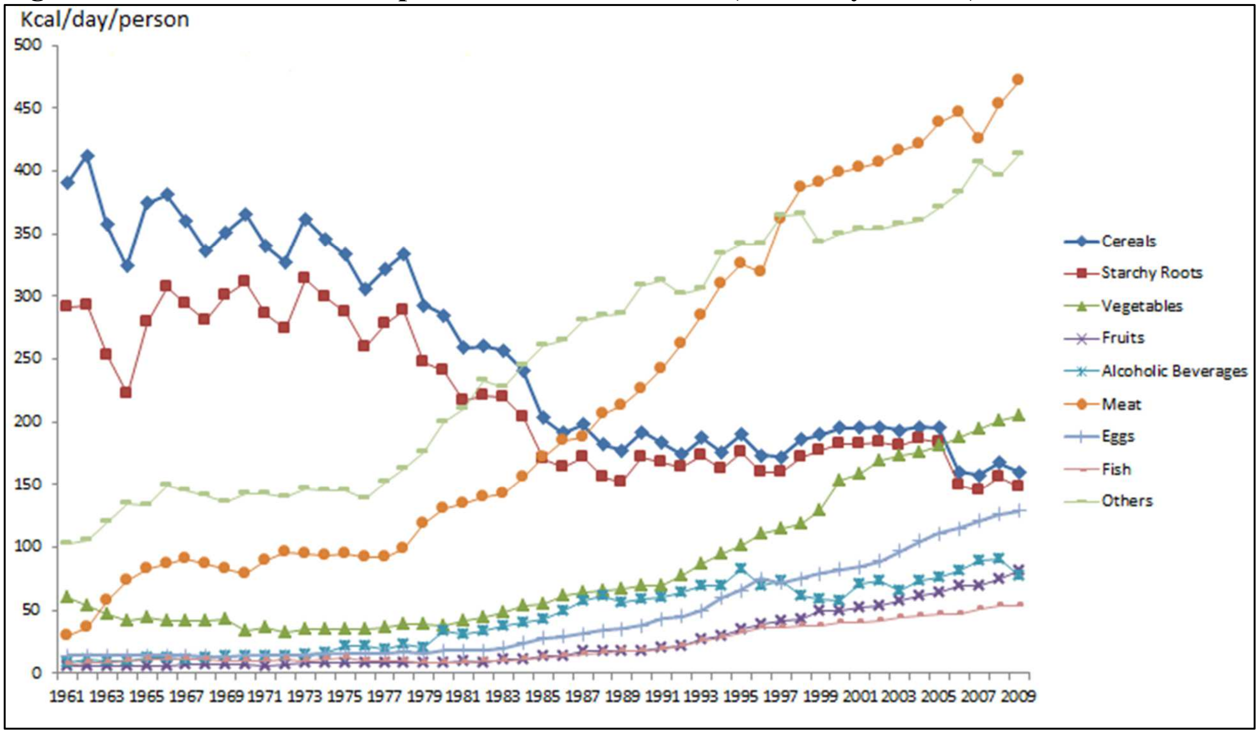
2.2 Global framework conditions: The dominance of Asia and the increasing importance of West Africa in the global rice market

2.2.1 Global rice consumption, production and trade

About 90% of the world's rice is grown and consumed in Asia, with China and India accounting collectively for nearly half of world production and consumption in 2011. World per-capita consumption of rice is about 57 kg per year. Most Asian countries consume, on average, more than 100 kg of rice per capita annually, with Cambodia (292), Lao People's Democratic Republic (289), Bangladesh (218), and Vietnam (217) having among the highest per-capita consumption levels in the world. However, sustained increases in average per-capita incomes and urbanization in Asia has led to diversification of national diets, with rapid growth in demand for many high-value foods, particularly livestock products, fruits, and vegetables, while the growth in demand for food staples, such as rice, has been slowing (Pandey et al. 2010; Hazell 2008). Growing evidence suggests that income elasticities of demand for rice have even become negative for high-income and emerging economies such as Japan, the Republic of Korea, Thailand, Vietnam, China, and India, which accounted for 60% of rice consumption in 2010. For instance, in India, the ratio of rice consumption in the top quintile to that of the bottom quintile dropped from 2.21 in 1983 to 1.07 in 2004 (Pandey et al. 2010) and per capita cereal consumption in China decreased from about 400 kilocalories (kcal) per day to about 150 kcal per day over the period 1961-2009 (see Figure 2.2). However, for most lower-income Asian countries, including Bangladesh, Cambodia, Pakistan, Myanmar, and the Philippines, which altogether accounted for 15% of rice consumption in 2010, rice is still a normal good (Matriz et al. 2010).

Total rice consumption in WA has nearly tripled between 1980 and 2009, driven mainly by population growth, rapid urbanization, and increasing incomes. Today, rice accounts for a third of WA's total cereal availability in calorie terms, and it is the largest source of calories for many coastal countries, except Ghana, Togo, Benin and Nigeria (about 20 kg per year), where consumption of roots, tubers and maize are more important. Most Sahelian countries (with the exception of Mali) consume much less rice (about 30 kg per year) (AFD 2011; Me-Nsope and Staatz 2013).

Figure 2.2: Trends of dinner plate, 1961-2009, China (Kcal/Day/Person)



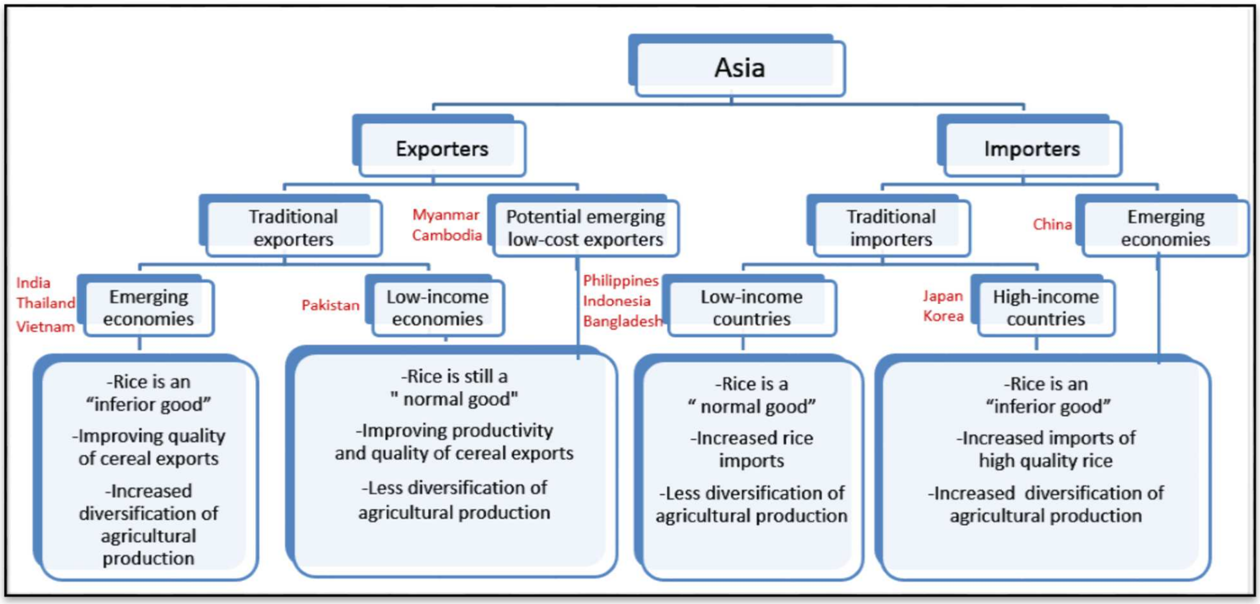
Source: Chen, 2014

Global rice production increased from 409 million metric tons (Mt) of paddy to nearly 700 Mt between 1980 and 2011, with a compound growth rate of 1.8% per year (see Table 2.1). The overall growth in production over those 30 years was primarily the result of yield increases ensuing from the Green Revolution, especially in Asia, which averaged 1.4% per year over the period (see Table 2.2), while there was little growth in area harvested (0.4% per year) (see Table 2.3). However, farmers have been facing increasing shortages of land, water and labor as well as volatile oil and food prices, and studies conducted in East and South Asia rice bowls suggest that annual growth rates of total factor productivity (TFP) in rice production, which increased significantly as a result of the Green Revolution, have been declining, especially in India, the world second largest rice producer (Fuglie 2012). As a result, rates of increase of rice yields have been declining for many years from a compound rate of 2.5% per year over 1962–1979 to 1.4% per year over 1980–2011. Reasons for this declining TFP growth rate include: (1) substantial lessening of investments—notably public-sector investments, (2) displacement of cereals from better lands by more profitable crops, including horticultural crops; (3) diminishing returns to modern varieties when irrigation and fertilizer use are already high; and (4) falling cereal prices relative to input costs, which makes additional intensification less profitable (Pandey et al., 2010; Hazell, 2008; FAO 2002).

Despite significant growth in its rice production, which increased from 3.2 Mt to 12 Mt over the period 1980–2011, WA contributes less than 2% of world rice production. The overall increase in production in WA, however, was primary led by area expansion, although the share of total output growth due to yield improvement has increased from 26% per year over 1980–1990 to 47% per year over 2000–2010 (Seck et al. 2013).

With rapid growth in international agricultural trade, some Asian countries have become important exporters of cereals (including rice) and high-value agricultural products, while others have become more dependent on imports to meet their national food needs (see Figure 2.3). International rice trade has expanded rapidly since 1980, increasing more than 2.5 fold by 2010. However, the global rice market remains thin, with trade representing only 7% of total production. With 90% of the world's rice produced in Asia, most rice tends to be eaten in the country where it is produced and does not enter international markets. In the early 1980s, the top five exporters (Thailand, Vietnam, India, the USA, and Pakistan) had about 70% of the world market; this share rose to nearly 80% in the late 2000s. Asia accounts for about 45% of the world's total imports, with over 90% of these imports being procured through regional trade. For instance, over the period 2005–2010, the Philippines, the world's largest rice importer, purchased most of its rice from Vietnam (84%), Bangladesh from India (84%), and China from Thailand (83%). Exports to WA make up about 20% of the world's rice exports. Nigeria, Côte d'Ivoire and Senegal account for nearly 80% of WA rice imports. In fact, none of the WA countries currently meets fully its rice consumption needs from domestic production. Self-sufficiency levels vary widely across the region, with rates ranging from less than 20% (Niger) to over 90% (Mali).

Figure 2.3: Changing consumption dynamics in major Asian rice economies



Source: By author

Rice continues to be one of the most protected commodities in both developing and developed countries, through high tariff and non-tariff barriers, export restrictions, aid, state trading, and other domestic market interventions. Most industrialized nations heavily subsidize their rice producers, and major exporters such as Thailand, Vietnam, Pakistan, and India have national rice strategies for supporting production and sustaining market prices, although they generally do not heavily subsidize rice exports (Dorosh and Wailes, 2010; Dawe 2002) (see Appendix for more details).

Table 2.1: Evolution of paddy rice production for selected regions

A. Paddy rice production (1000 metric tons)

	1980-1983	1984-1987	1988-1991	1992-1995	1996-1999	2000-2003	2004-2007	2008-2011
WA	3,439	4,112	5,826	6,118	6,903	7,018	8,330	11,306
Africa	8,713	9,836	12,556	14,414	16,394	17,559	20,589	24,965
Asia	372,013	427,142	466,548	490,350	534,267	535,463	575,397	632,821
World	409,632	465,906	509,787	536,480	584,011	589,410	635,155	699,205

B. Growth rate of paddy rice production (%)

	1980-83 to 1984-87	1984-87 to 1988-91	1988-91 to 1992-95	1992-95 to 1996-99	1996-99 to 2000-03	2000-03 to 2004-07	2004-07 to 2008-11	1980-83 to 2008-11	% per year 1980-2011
WA	19.6%	41.7%	5.0%	12.8%	1.7%	18.7%	35.7%	135.2%	4.4%
Africa	12.9%	27.7%	14.8%	13.7%	7.1%	17.3%	21.3%	114.7%	3.7%
Asia	14.8%	9.2%	5.1%	9.0%	0.2%	7.5%	10.0%	55.8%	1.8%
World	13.7%	9.4%	5.2%	8.9%	0.9%	7.8%	10.1%	56.0%	1.8%

Source: FAOSTAT

Table 2.2: Evolution of rice yield for selected regions

A. Average rice yields (metric tons/Ha)

	1980-1983	1984-1987	1988-1991	1992-1995	1996-1999	2000-2003	2004-2007	2008-2011
WA	1.5	1.6	1.7	1.6	1.7	1.6	1.6	2.0
Africa	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5
Asia	2.9	3.3	3.5	3.7	3.9	4.0	4.2	4.4
World	2.9	3.2	3.5	3.6	3.8	3.9	4.1	4.3

B. Growth rate of rice yield (%)

	1980-83 to 1984-87	1984-87 to 1988-91	1988-91 to 1992-95	1992-95 to 1996-99	1996-99 to 2000-03	2000-03 to 2004-07	2004-07 to 2008-11	1980-83 to 2008-11	% per year 1980-2011
WA	9.5%	4.2%	-3.7%	2.9%	-4.6%	2.0%	24.2%	34.6%	1.1%
Africa	7.5%	4.2%	4.4%	4.8%	2.3%	4.7%	5.6%	33.6%	1.1%
Asia	14.3%	6.6%	4.9%	4.9%	1.9%	5.5%	5.7%	43.8%	1.4%
World	13.9%	6.6%	4.9%	5.4%	2.2%	5.3%	5.5%	43.8%	1.4%

Source: FAOSTAT

Table 2.3: Evolution of area of paddy harvested for selected regions

A. Area of paddy harvested (1000 Ha)

	1980-1983	1984-1987	1988-1991	1992-1995	1996-1999	2000-2003	2004-2007	2008-2011
WA	2,353	2,568	3,489	3,820	4,181	4,453	5,173	5,663
Africa	4,816	5,053	6,183	6,809	7,391	7,734	8,661	9,965
Asia	128,092	128,603	131,713	131,973	137,037	134,860	137,349	142,989
World	143,678	143,444	147,254	147,687	152,480	150,535	154,040	160,777

B. Growth rate of area of paddy harvested (%)

	1980-83 to 1984-87	1984-87 to 1988-91	1988-91 to 1992-95	1992-95 to 1996-99	1996-99 to 2000-03	2000-03 to 2004-07	2004-07 to 2008-11	1980-83 to 2008-11	% per year 1980-2011
WA	9.1%	35.9%	9.5%	9.4%	6.5%	16.2%	9.5%	96.1%	3.1%
Africa	4.9%	22.4%	10.1%	8.5%	4.6%	12.0%	15.1%	77.6%	2.5%
Asia	0.4%	2.4%	0.2%	3.8%	-1.6%	1.8%	4.1%	11.2%	0.4%
World	-0.2%	2.7%	0.3%	3.2%	-1.3%	2.3%	4.4%	11.5%	0.4%

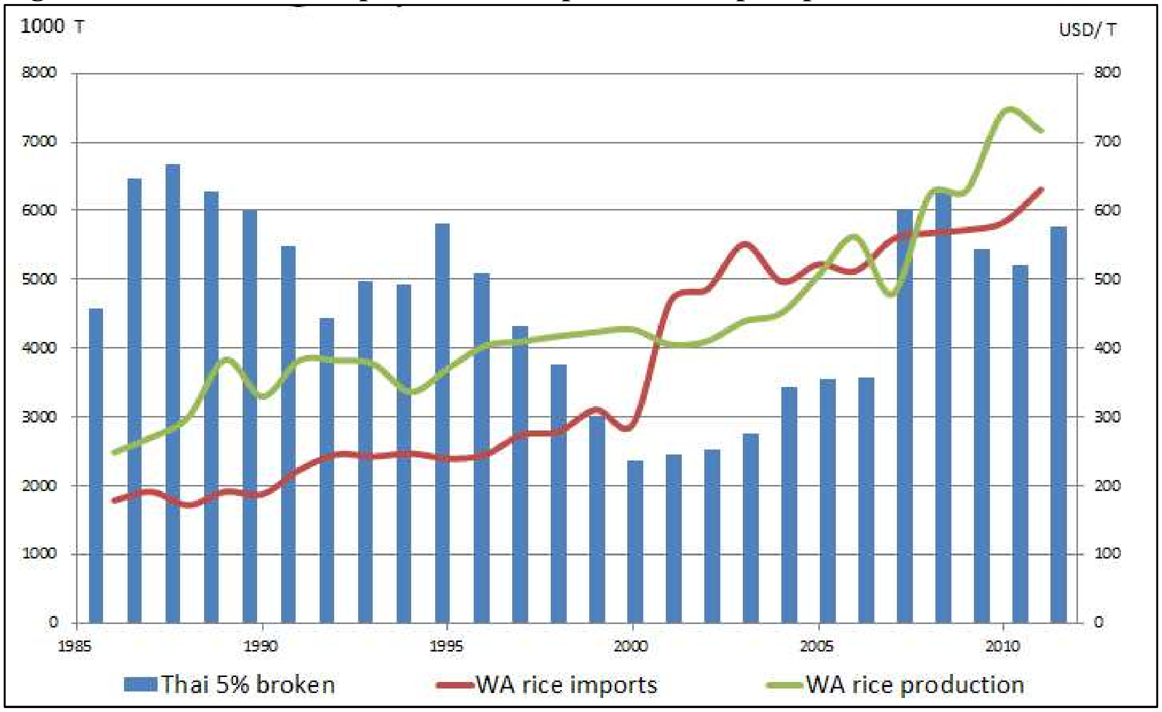
Source: FAOSTAT

2.2.2 The performance of global rice markets

Because of these structural characteristics of the world rice market (i.e., thin and highly segmented), a small change in production and consumption brings a relatively large change in total trade, resulting in a high degree of price volatility. Although international rice prices have fluctuated dramatically in both nominal and real terms since the 1980s, the long-term trend of real prices was downward for many years, with real rice prices of Thai rice 5% broken declining by 0.22% per year over 1985–2007 (USDA 2013). However, the large rice price increases in 2007–2008 reversed this trend and called into question the reliability of the international rice market as a source of supply for importing countries (see Figure 2.4). Even before these world price surges, few countries allowed domestic prices to be driven directly by world prices. After these price surges, even fewer countries were willing to rely as heavily on international rice trade. Many of them, including SSA countries, have adopted very aggressive production strategies with the aim of improving their levels of self-sufficiency.

The above depiction of the world rice market suggests that improving the competitiveness of WA rice production and marketing relative to Asia depends not only on conditions in WA but also on how the rice economy in Asia evolves. The section below provides a more detailed description of the changing structure of commercial rice value chains in Asia and West Africa, highlighting changes in the main drivers of competitiveness using the framework previously defined in Figure 2.1.

Figure 2.4: Trends in rice production, imports and import prices in West Africa



Notes: Thai 5% broken represents prices (USD/T); WA rice imports and production represents quantities (1000 T)
Source: By author using data from FAOSTAT, USDA, and IMF

2.3 Structural analysis of commercial rice value chains in Asia and West Africa

As mentioned above, improving irrigated agriculture has always been a priority for most countries around the world, and it has become increasingly important in WA in the context of climate change. Since the 2008 rice crisis, many WA countries set the objective of reclaiming the important share of their market currently occupied by imports in urban areas, and have thus given increasing attention to modernizing rice production systems.

The discussion below reviews the changing structure of rice value chains in Asia and WA, focusing on comparing irrigated rice production systems of Thailand, Vietnam, and India, which are the main suppliers of imported rice to West Africa, to dynamic irrigated rice systems in West Africa that are the mainstays of rice supply to capital cities in RCI, Mali and Senegal. The WA production zones and their affiliated main markets include: (1) the Great Lakes region (GL) to

Abidjan in RCI, (2) the Office du Niger (ON) to Bamako in Mali, (3) the Senegal River Valley (SRV) to Dakar in Senegal (see Figure 2.5).

Figure 2.5: Rice production in selected West African countries

Source: SWAC/OECD, 2011

2.3.1 Farm conditions: strategy, structure and rivalry

Asia. Overall, farmland holding is still quite fragmented in the Asian focus countries, especially in India, despite new evidence suggesting moderate increases in concentration, especially in more developed rice production zones in Vietnam (Reardon et al. 2014). There is a disproportion between the number of smallholder farmers (less than 1 ha) and their share in landholding. For instance, in Uttar Pradesh (UP) / India and Vietnam, medium/large farms constitute less than one quarter of the farm population but control over two thirds of farm land (CITE). One of the main reasons for land concentration, and in some cases increased average farm size, is the rapid development of a dynamic land market, except India, as a result of migration and the rise of commercialized small farms. In Red River Delta (RRD) / Vietnam, for instance, about 25% of the farmland is rented (a 10% increase from five years ago) compared to less than 5% in India (Reardon et al. 2014).

Moreover, the Green Revolution has enabled Asia to successfully transform rice farming thanks to rapid increases in rice productivity driven by capital-led farm technology intensification. As a result, rice farms have increasingly commercialized, using more irrigation; and shifted from non-purchased to purchased input use (from human to machine power and use of herbicides, from manure to chemical fertilizer and pesticides, and from own seeds to purchased, high-yield varieties). Significant investments in human capital in how to use these technologies were also crucial to this success. This structural change has allowed the shift from subsistence farms using non-traded inputs and producing little surplus, into semi commercialized farms, buying some traded inputs and producing greater surplus, and into rural nonfarm employment in addition to farming (Reardon et al. 2014). Overall, the share of marketed paddy surplus is very high, although usually correlated with farm size, averaging 90% in Eastern UP/India but only 37% in RRD. Over time, the transformation at the farm level has spread not only upstream into farm inputs in segments but also downstream in the wholesale, milling and retail segments.

West Africa. Most rice in WA is produced by small-scale farmers (less than 1 ha) despite increasing concentration in farmland holding, due in part to the modernization of rice value chains (similarly to Asia) and the development of dynamic, but often illegal land markets resulting from weak land tenure regulations (unlike Asia), especially in irrigated zones.

West Africa (WA) has been trying to replicate the Asian Green Revolution through various policy reforms using similar technologies, but with mixed results (Seck et al. 2010). The investments in technology and human capital in WA were not as significant and prolonged over time as in Asia, and thus failed to create the development of rural integrated factor markets and generate rural nonfarm employment in addition to farming (Reardon et al. 2014). Although the creation of rural nonfarm employment tends to increase the opportunity cost of agricultural labor and thus increase rural wage, it is essential for sustainable competitiveness as it generates additional nonfarm income that can be invested in improving productivity at the farm level.

2.3.2 Demand conditions

Asia. Rice is the major staple food of Asia. However, liberalization, growing prosperity, rapid urbanization, and lifestyle changes that accompany urbanization and that increase the opportunity cost of women's time, have led to the diversification of diet, via Bennett's law, with decreasing consumption of cereals and increased consumption of non-grains (meat, fish, dairy, fruits and vegetables), processed food and prepared food bought away from home. This transformation is also happening in rural areas, although at a slower pace, given that rural households have typically lower income than urban households. As a result, the share of rice in the diet in the focus Asian countries (Thailand, Vietnam and India) has been declining, and the income elasticity for rice is now negative in these countries (Reardon and Timmer 2014).

West Africa. Similarly to Asia, rapid changes in the social and economic environment in WA during the last 30 years have resulted in substantial shifts in food consumption patterns. As mentioned above, rice has become a major component of West African diets. It is considered a convenience food in WA, as it has longer shelf life and requires less time and energy to cook than most of the other staples such as beans, bananas, cassava and coarse grains. It is the largest single source of calories for many countries, including Côte d'Ivoire, Mali and Senegal, which consume over 60 kg per capita. The growing demand for rice has been driven by population growth, income growth, urbanization and the preference of increasingly time-poor urban consumers, including women who increasingly participate in the labor market, for a staple that is quick, affordable and convenient to prepare. Moreover, the increasing trend of rice consumption is likely to continue in the short to medium-run as income and urbanization are expected to rise further in the region. Although trends in rice consumption have been mainly driven by urbanization and the resulting changes in diet, rice consumption is also growing in rural areas.

2.3.3 Related supporting industries

The transformation of the related supporting industries refers to that taking place in the post farm-gate segments of the supply chain, including wholesale/brokerage/logistics, processing and retail following the liberalization/globalization that shifted investments from the public to the private sector. Urbanization is a major driver of that change in Asia, as the majority of supply chains connect rural to urban areas, and many of the post farm-gate activities are located in towns and cities.

2.3.3.1 Wholesale/brokerage/logistics

Asia. The wholesale/brokerage/logistics transformation in Asia has been mainly driven by (1) urbanization, (2) extension and improvement of transport infrastructure, including rural roads and railways, leading to lower transaction costs for access to mills and wholesale markets in urban areas, and (3) increased ownership of trucks and warehouses by wholesalers and the development of hire transport services. This transformation has spurred shortening intermediation of the supply chain by reducing the role of middlemen (both village traders involved in paddy procurement from farm to mills in towns and urban traders/semi-wholesalers involved in rice distribution from mills to retail markets in cities)[2] while expanding procurement of paddy beyond local production zone (i.e., geographic lengthening of the value chain)[3] (Reardon et al. 2014; Reardon and Timmer 2014).

West Africa. Most rice produced outside irrigated perimeters is retained for household use, with very small quantities effectively marketed. In the commercially irrigated zones under study, about one third of harvested rice is retained for family consumption and replanting, and the remainder is actively marketed or used for input credit repayments (including water charges) (USAID 2009; World Bank 2013).

Rice paddy is marketed through various channels, but overall, the rice value chain in WA remains quite long, with middlemen (collectors or village traders, semi-wholesalers, and sorters) still playing an important role in the chain, mainly due to the lack of transport infrastructure, coupled with the lack of competition in the trucking and hire transport services, leading to overall high transaction costs for access to mills and wholesale markets in urban areas.

The persistence of high transport costs in WA is in part explained by strong market regulation of the trucking sector through freight bureaus and shippers' councils, resulting in few large, modern trucking companies and fewer new trucks, which ultimately reduces competition (Hollinger and Staatz 2015).

[2] However, smaller farmers still tend to sell to the village trader while larger farms tend to access mills directly or the government and urban wholesale markets, which usually pay better prices than village traders.

[3] In more developed rice areas in Asia, similar to those under study, most paddy is sold to larger mills, and paddy is sourced beyond the local production zone as larger mills are increasingly competing to attract higher volumes in order to operate close to capacity. However, in the less developed rice areas, most of the paddy is sold to small mills, although transactions with medium and larger mills are decreasing but still high (Reardon et al. 2014).

2.3.3.2 Milling

Asia. Although some large mills are owned by the government[4], especially in Vietnam and India, the private sector dominates the milling sector (including small mills), but the number and share of small mills has been declining over the past decade. The main drivers of this change include: (1) massive investments by larger mills in expanding and upgrading milling equipment (e.g., color sorters and polishers), which are very expensive, (2) more rigorous implementation of food safety and hygiene regulations to meet the quality requirements of increasingly exigent urban consumers[5]; and (3) massive enabling investments by the government in rural electrification, rural roads and railways (Reardon et al. 2014).

While there is very little contract-farming between mills and farmers, evidence suggests increased vertical coordination between large mills and large wholesalers, with large mills establishing contractual or semi-contractual relationships with large wholesalers (including regular but informal relations) (Reardon et al. 2014).

West Africa. Similarly to Asia, the WA milling segment is also dominated by the private sector, but unlike Asia, the number of small mills has been increasing, due mainly to significant investment by small and medium scale millers to upgrading milling equipment.

The emergence of small-scale Engelberg-type mills, often mobile, facilitating access to remote areas and permitting on-farm husking at lower cost, led to the development of a custom milling sector. The small scale of these hullers allowed them to be privately owned and operated by a number of small entrepreneurs, creating income and employment. Moreover, the rapid spread

[4] Most parastatal mills in both Asia and Africa were privatized following the structural adjustment in the late 1980s or 1990s.

[5] Larger mills have shifted (at least partially) from marketing loose rice to bagged and packaged rice, displaying mill information but no brand (Reardon et al., 2014).

of small mills led to increased competition in the milling industry, as small mills competed not only with larger mills but also among themselves for paddy (Adjao 2011).

However, rice milled by the small mills presents high levels of impurity and brokens, limiting its penetration in the bigger cities, including capital cities, and its ability to compete with imports on a quality basis. Significant investments by small- and medium-scale local investors in improved mini-rice mills of greater capacity than the Engelberg type in the irrigated rice production zones have helped improve the overall quality of local rice and capture a part of the increasing market for good-quality local rice as a substitute for imported rice (Wopereis et al. 2013). Moreover, some branding efforts have been carried out in the region to help promote high quality local rice, which can fetch up to a 20% price premium in some markets. Despite these higher margins, this remains a very small niche as many processors are still reluctant to increase investments in higher quality mills because of their inability to capture an adequate supply of paddy, especially when they face high transaction costs mainly due to high transportation and energy costs (USDA 2013).

Following the 2008 food price crisis, WA governments have committed to increasing investments in transport and energy infrastructure (e.g., the highway linking Yamoussoukro and Abidjan in Côte d'Ivoire was expanded in 2013; the rehabilitation of a hydroelectric dam in the same zone is expected to start in February 2015)[6]. Also, there have been increasing discussions of developing contract farming between farmers and millers to help secure appropriate quantities of paddy for medium and large mills capable of producing higher quality rice, which often perform below capacity (i.e., about 60% in Mali). These projects have been possible thanks to increased foreign direct investments (FDI).

[6] See the Ministry of Energy of Côte d'Ivoire for more details (http://www.energie.gouv.ci/).

2.3.3.3 Retail markets

Asia. The retail segment of the rice value chains in the Asian study countries is dominated by small rice stalls/shops selling loose rice packed in poly bags, albeit some small shops now sell some mill-branded rice. However, modern retailers, including supermarkets, are emerging quickly. The penetration rate of supermarkets is more important in more developed value chains (50% in Beijing vs 7% in Delhi). Supermarket chains source directly from large wholesalers, with some even from large mills (e.g., in China), and sell both loose and branded rice. It is expected that supermarket penetration in the countries under study will continue to increase given that supermarkets can usually sell rice more cheaply than traditional shops, controlling for quality, due in part to their ability to source high volume (Reardon et al. 2014).

West Africa. The retail segment of the rice value chains in the WA study countries is also dominated by traditional retail outlets (open markets, small shops) selling loose rice. In more affluent countries, selected modern outlets (supermarkets/ hypermarkets) have started to sell some mill-branded rice (e.g. Rival brand in Senegal) to cater to the quality requirement of rising urban middle class. However, the latter segment remains a niche market, mainly due to limited availability of high quality rice in important urban markets on a regular basis and lack of product recognition, with many urban consumers still unaware that quality local rice even exists (Demont and Rizzotto 2012).

2.3.4 Factor conditions: Development of integrated factor markets, especially the rise of the rural non-farm labor market

The main rural factor markets include: (1) land rental and purchase/sale markets; (2) water market; (3) seeds and chemical markets, including fertilizer; (4) farm equipment markets; (5) credit markets; and (6) labor markets in the farm sector and the non-farm sector, including activities in the related supporting industries to the farm such as processing, wholesale, and transport.

2.3.4.1 Land market

Asia. There have been important reforms in land tenure laws in most of Asia over the past two decades. Both Thailand and Vietnam have implemented transparent land administration systems by providing land registration and land–use-right certifications that can be sold, leased or mortgaged at a fairly low cost. These measures contributed to strengthening tenure security and have been successful in enhancing investment, land productivity and rental activities (Holden et al. 2013; World Bank 2013). These reforms have also significantly contributed to increased land consolidation, promoted the expansion of small commercialized farms, and increased rural-urban migration with the rising price of farm land. In India, however, the beneficiaries of the land redistribution reform were given usufruct rights, but not the right to lease or sublease. This excessive regulation of land transactions created inefficiency in land use and increased inequity in operational land distribution (Holden et al. 2013).

West Africa. Land tenure in many West African countries, including those under study, is characterized by the coexistence of customary law and statutory law, inspired by Western judicial concepts of state and private property. However, in practice, the distinction between these tenure systems is considerably blurred. In fact, land-tenure and water rights are often the source of conflict in rural areas in WA. While farm land ownership in rainfed production zones is communal and based on customary rules, in irrigated production zones it is vested with the state, which delegates land management and responsibilities to local authorities or parastatal entities. However, the implementation of state policies is limited, and customary law still continues to be the main way to access land, mainly due to the lack of financial resources and institutional capacity of government agencies, lack of legal awareness, and often lack of the perceived legitimacy of official rules and institutions. Also, formal law tends to benefit large investors and state actors and marginalize small farmers and the rural population, as official farming licenses and land use right registration are often expensive and cumbersome to obtain (e.g., Mali[7]) (Adjao 2011).

Moreover, rising interest for higher value land (e.g., that with greater irrigation potential or proximity to markets), has increased foreign direct investments (FDI) and private investments by agribusiness firms, thereby adding pressure on land and insecurity for small farmers. In fact, in WA, both foreign governments and private companies and individuals have intensified investment activities in agricultural land. For instance, Mali allocated over 130,000 ha to FDI in 2009[8] (GTZ 2009), and RCI entered a partnership[9] with a grouping of multinational and national companies involved in the rice trade for the development of large rice farms on 600,000-800,000 ha (GRAIN 2013; CTA 2013). While the debate on increased "land grabs" mainly focused on large-scale land acquisitions by international actors (Cotula et al. 2009), for many small farmers in WA, increased land acquisitions by local actors, including entrepreneurs and politicians, is equally important (Kaag et al. 2011).

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[7] In the region of the Office du Niger (ON) in Mali, land ownership is vested in the state, which delegates land management and responsibilities to a parastatal body that allocates land use right to farmers following a two-tier model (i.e., two years of probation, followed by permanent, transmissible use rights). The inability of small-scale farmers to pay the water fee often results in the loss of land use rights. Farming licenses provide greater tenure security, as they have indeterminate duration, they are transferable to heirs, and their withdrawal entails payment of compensation. Land titles can be held only by national farmers. Foreign operators are entitled to leases only.

[8] Mali allocated a total area of 130,105 ha to FDI in 2009, 100,000 ha of which have been granted to Malibya-Agriculture; 14,100 ha to Markala Sugar Project; 11,288 ha to UEMOA; 2,605 ha to Agro Energy Développement; and 2,112 ha to Mali Biocarburant.

[9] Under this partnership, Côte d'Ivoire promises to reform its land laws to facilitate private investment in agriculture in exchange for financial assistance and promises from eight foreign companies and their local partners to invest nearly US$ 800 million in the development of massive rice farms. These companies include Olam (Singapore) - US$ 50 million, Louis Dreyfus (France)/SDTM (Côte d'Ivoire/Lebanon) - US$ 60 million, Cevital (Algeria) - US$150 million, Groupe Mimram (France) - US$ 230 million, Groupe CIC (Switzerland) - US$ 30 million, Export Trading Group (Singapore) - US$ 38 million, Novel Group (Switzerland) - US$ 95 million, and Sud Industries SA - US$ 150 million.

This context has led to the emergence of a dynamic land market, often illegal, in rural areas. For instance, in the region of Office du Niger (ON) in Mali, where annual leases range from 125,000 to 150,000 CFAF per ha (i.e., US $ 270 to 325) including fees for water, illicit sale prices per ha for rice-growing land ranged from 200,000 to 500,000 CFAF/ha (i.e., US $430 to $1080/ha) in 2008 (GTZ 2009).

2.3.4.2 Irrigation and water market

Asia. With more than 70% of the world's 277 million hectares of irrigated land, Asia represents the bulk of irrigation in the world. Most of the irrigation infrastructure was built in the 1960s and 1970s during the Green Revolution that allowed Asian agriculture to flourish. Today, 73% of the water consumed globally for agriculture is used in Asia. Rice represents about 45% of all irrigated crop areas in Asia, and 60% of the rice is irrigated (FAO 2000, FAO 2014). The cost to farmers of water in most Asian countries, including Thailand, Vietnam and India, has traditionally been very low, as irrigation is a good often provided by the government. However, many of the large-scale, state-funded irrigation systems that powered the Green Revolution and helped Asian countries to become self-sufficient in food production have fallen into disrepair since the 1990s for a variety of reasons, including poor maintenance by governments. This has led to important damage to the environment, including water pollution and reduction of biodiversity as well as reduction in agricultural productivity. The failure to develop adequate operation and maintenance mechanisms to ensure the sustainability of the irrigation schemes has led to irrigation management transfer or increased participation of users in the management of the schemes through the development or improvement of water users associations (WUAs) (FAO 2000, FAO 2014).

In most cases, the irrigation infrastructure was designed primarily to secure rice cultivation in the main cropping season. However, increasing intensification of rice farming has progressively led some countries to design new irrigation schemes for year-round irrigation (e.g. Thailand and Vietnam, which have three rice crops a year). While most wet-season rice irrigation is fully gravity irrigation (cascades from plot to plot), dry-season cropping may require pumping in places. As an alternative to these old irrigation systems, farmers have been allowed to tap directly into groundwater themselves to irrigate more frequently (i.e., atomistic irrigation via tube-wells, such as in India, or construction of local dykes using pumping machines, such as in Vietnam and Thailand). While farmers do not have to pay a water source fee for the use of the canal, they have to pay a fee for pumping of water to the field, but this measure is poorly regulated. As a result of the unregulated use of groundwater, the total area of irrigated land in Asia has been expanding, although surface irrigation has been shrinking (Reardon et al. 2013; World Bank 2013).

West Africa. Despite a large amount of available farmland, agricultural potential in WA, especially in the Sahel, is limited by low and irregular rainfall patterns. The total rice area harvested in WA in 2009 is estimated at over 6 million ha, with irrigated rice accounting only for 12% of total rice areas, and over 60% of irrigated rice area is located in Mali (335,269 ha) and Senegal (94,185 ha) (Wopereis et al. 2013). To develop their vast irrigable land potential and thereby reduce the unfavorable effects of the irregular rainfall pattern, many WA countries established government-managed irrigation schemes in the 1970s, with financial support mainly provided by donors. Prior to the structural adjustment programs enacted in the 1980s, irrigated agriculture, including rice production, was strongly supported by the state. Farmers received subsidies on inputs, price support for their products and various other services from a parastatal, including water management (e.g., SAED in Senegal, the Office du Niger in Mali, and SODERIZ in RCI).

Although some rice farms, organized in farmers' groups, located in government-managed irrigation schemes supplement water from the canal with pumps, it is not a common practice (Ouattara 2011).

Following state disengagement from irrigated agriculture in the 1980s and the 1990s, water distribution and maintenance was mainly carried out by famers' organizations upon payment of a fee, which rice farmers are required to pay in order to keep their land use rights (e.g., up to 15% of production costs in Mali). Unfortunately, most of these structures, which are often weak and disorganized, failed to carry out their duties properly (i.e., maintaining irrigation and drainage canals), often leading to important drainage issues and yield loss.

The policy of water control adopted after the 2008 food price crisis in the focus countries as a component of the broader rice initiatives introduced important structural improvements to the water distribution systems, including regular cleaning of canals and the rehabilitation all sites previously developed under total water control. For instance, in Senegal, improvements in infrastructure have focused on rice production in the Delta region (northeast of Saint Louis, extending to Richard Toll/Ross Bethio) and consisted of upgrading canals and pumping/water-distribution infrastructure in collaboration with the *Millennium Challenge Corporation* (MCC), whose $540 million grant has been underway since 2010. Final design studies are completed and works in the Delta were expected to begin in January 2013. In RCI, the government has committed to rehabilitate the dam-based schemes throughout the country, starting with the Great Lakes region. In addition, new irrigation infrastructures will be constructed in production zones that can be equipped with minimal costs, such as lowlands. While rehabilitation of full water control systems can cost up to US$ 3,000 per ha, the development of water control in the lowlands, including construction of dykelets with a level curve, sloping dykes, and diversion works with an irrigation network cost three times less. Design studies are still being conducted (GRAIN 2013; Adjao 2011).

2.3.4.3 Seeds and chemical market

Asia. In Asia, the basic paddy intensification technology using improved seeds, chemicals and irrigation has become the prevalent system even among smallholder farmers, cultivating 1 ha of land or less. However, there is significant variation in the supply and commercialization of certified seeds, with low diffusion of hybrid seeds in Eastern Uttar Pradesh in India (22%) compared to 49% in Vietnam. The private sector is by far the main retail provider of inputs to farmers. Although government direct input sales are declining, the government has provided subsidies for fertilizer.

The supply of fertilizers is met both by domestic production and imports in Asia; however the quantity demanded exceeds the quantity supplied at prevailing prices. For instance, in South Asia, consumption represents about 1.5 times the amount produced (Mujeri et al. 2012). While nearly all farmers, regardless of their size, in India, Vietnam, and Thailand use fertilizer, there is an apparent overuse of this input, especially in RRD/Vietnam, with about 500 kg/ha of urea plus DAP used on average vs 200 kg/ha recommended. This is due in part to: (i) the cheapness of fertilizer given the widespread subsidization of fertilizers from the government; (ii) availability of credit from fertilizer suppliers to farmers to maximize its use; and (iii) the lack of extension advice on how to efficiently use fertilizers. Pesticide use is also widespread, with average rates of 100% of farmers in RRD/Vietnam and 67% in Eastern UP/India. This is mainly due to the easy access to pesticides through the numerous private small shops in rural areas in Asia. However, there is more variation in the use of herbicides, with lower use rates in India (i.e., 11% of farms), as herbicides are often a substitute for farm labor, which is quite abundant despite farm wages increasing due to rural nonfarm employment (e.g., machinery rental and repair) (Reardon et al. 2014).

West Africa. Since the 1990s, WA and its development partners have undertaken a number of actions to improve farmers' access to improved inputs, ranging from input subsidies to attempts to strengthen private-sector input production and marketing systems. Despite those efforts, the average level of use of improved inputs is very low in WA. For instance, less than 7 kg of fertilizer per ha of arable land compared to over 12 kg/ha in East Africa, 43 kg/ha in Southern Africa and 130 kg/ha in South Asia (Hollinger and Staatz 2015; Stamoulis and Lipper 2012). Although several countries in the region have phosphate deposits, and five countries (Burkina Faso, Cote d'Ivoire, Mali, Nigeria and Senegal) have fertilizer blending plants, none of them has substantial production of nitrogen-based fertilizers. Thus, most of the fertilizer used in WA is imported, with imports controlled by a few firms[10] (Hollinger and Staatz 2015).

Although the supply of agricultural inputs (seeds, fertilizer, and pesticides) has been liberalized since the mid-1980s, the structure of input demand and supply are heavily influenced by the degree of donor projects and WA governments' involvement in the rice sub-sector and in subsidy programs, which led to a crowding out of the private sector. Moreover, important structural problems in input markets, including the lack of access to input credit, lengthy regulatory procedures for certification[11], and the lack of complementary technical information (or extension

[10] The fertilizer industry tends to be oligopolistic at the import level while it is much more competitive at the wholesale and retail levels.

[11] WA has adopted a more stringent set of rules for regulating the seed market compared to Asia but lacks the administrative capacity to make the system work. WA follows European-style legislation, which requires seeds to be registered in the country where they are to be sold, which involves doing trials to establish performance, etc. India, however, follows the US model, where no registration is required, but where seed sellers can be sued if the seeds do not perform as advertised. As a result of the more liberal rules governing the seed market in India, there has been very large private-sector investment in the seed market there, compared to practically none in WA. For example, the

service) to ensure best use of fertilizer (Hollinger and Staatz 2015) further decrease the availability and use of these inputs. However, the level of use of fertilizer in irrigated areas is much higher (e.g., about 300 kg/ha in RCI and Senegal and up to 400 kg/ha in Mali) and comparable to levels in Asia (e.g., 400kg/ha and up to 500kg/ha in Thailand), mainly due to higher rate of economic returns to these inputs in irrigated agricultural production (Diallo 2011).

Moreover, many West African countries adopted nation-wide fertilizer subsidy programs, often in conjunction with subsidies on seeds in response to the 2008 spike in world food prices. In fact, these recent government subsidy programs have made the input situation more complex. While the subsidy has substantially increased fertilizer volumes and reduced uncertainty concerning quantities to order and letters of credit, it has increased costs due to government inefficiencies in the administration of the subsidy program such as late orders and late supplier payments (AFRE 2011). Also, these programs were generally untargeted and often involved the state rather than the private sector in input procurement, leading to furthering crowding out of commercial sales.

2.3.4.4 Farm equipment market

Asia. Rapid small farm mechanization led the development of a growing farm equipment rental market, especially for tractors and harvesters. For instance, nearly all farmers in RRD/Vietnam use farm equipment compared 86% in Eastern UP/India. While equipment rental is widespread, ownership is still marginal (i.e., less than 10%) and positively correlated with farm size. As machines substitute for labor, the uptake of machine services appears to be correlated with

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value of the seed market (all crops) in India is worth about US $ 2 billion/year compared with about $10 million/year in Nigeria.(Ian Barker, personal communication with John Staatz).

the rise of the rural wage rate, mainly due to rising nonfarm employment and migration (Reardon et al. 2014). Rental of farm machines has further developed recently with the spread of outsourced-service of teams of labor with large harvesting machines in China, allowing economies of scale on the machine side to small farmers, analogous to post-harvest services that are increasing in size (Reardon and Timmer 2014).

Although sun drying is still widespread among smallholder farmers in Asia, grain drying in the wet season when sun drying is not possible has led to the development and growing adoption of improved mechanical dryers, both small and larger scale, that burn oil or other fuels to produce heat for drying (Champs et al. 1996).

West Africa. There is increasing evidence that progress attained in agricultural mechanization in WA over the past three decades has stalled and has even started to recede. Tractor hire services have declined, and much of the imported agricultural machinery has been abandoned as the technology was of inappropriate design, not well-suited to local field conditions, and expensive to maintain. Moreover, in some areas where animal traction was initially promoted, rice farming has reverted back to hand hoeing due to the decimation of livestock herds by outbreaks of diseases and recurring droughts (Mrema et al. 2008).

Although the overall mechanization level remains low, rice farming in more developed irrigated production zones is semi-mechanized, with land preparation and threshing activities often mechanized while transplanting and harvesting remain highly labor-intensive. However, several constraints remain, especially with respect to shortages in quality machinery, labor during land preparation and harvesting activities, and storage facilities. Most of the tillers and harvesters currently available are old and have low capacity, resulting in important delays and losses. Also, facilities for drying are limited, and rice paddy is often dried on the roads and any open ground available, which reduces quality and further increases losses. This situation is aggravated by declining availability of labor during transplanting and harvesting due to increased migration (Wopereis et al. 2013).

2.3.4.5 Credit markets

Asia. Rice value chain finance is provided: (1) through and among the value chain actors; (2) from financial institutions to value chain actors; or (3) some combination of the two (USAID 2009). In Asia, credit from commercial banks is limited, especially to smallholder farmers. In the 1980s, tied output-credit markets, where paddy traders and mills provided input credit to farms to lock them in to secure paddy supplies, was the norm in Asian rice value chains. However, with the modernization of rice systems, an improved road network, increased access to cell phones, and augmented farmers' revenues from nonfarm income, this practice has been largely abandoned. Reardon et al. (2014) reported that the share of paddy producers receiving advances from traders is very low, with 5% in Eastern UP/India and 10% in RRD/Vietnam. Unlike input credits, marketing credit provided from clients to mills and from milled rice traders to small retailers is more common, although still minor (e.g., 23% of millers receiving this credit in Madhya Pradesh). The government also provides fertilizer subsidies as well as mechanization subsidies to small mills through low interest rates to farmers and electricity subsidies to reduce water pumping costs, especially in India (Reardon et al. 2014).

West Africa. Following the liberalization of the cereal sector in the 1980s, which was characterized by government disengagement from marketing and financing activities, the private sector, in particular farmers' organizations, has been responsible for acquiring and distributing input credit. In Senegal for instance, a seasonal reference price is agreed upon by a committee of stakeholders and determines the quantity of paddy rice that must be delivered by a farmer to the farmers' organization to repay the loan (World Bank 2013). However, farmers' organizations in WA are often weak and disorganized. Despite the lack of formal financial structures that are particularly interested in the rice subsector, there are still some financial institutions and systems that provide credit to rural populations throughout WA. Commercial banks offer very few agricultural loans (less than 5% of total loan portfolio) and mostly target large cash-crop production (e.g., cocoa, coffee, palm oil and rubber tree in RCI, cotton in Mali and sugar cane in Senegal). In the case of rice, financial intermediation is mainly carried out by microfinance institutions (MFIs). The interest rates for input credit, including fertilizer, are around 12%[12]. However, MFIs lack the long-term resources allowing them to finance medium- to long-term loans, due to structure of their resources, consisting mainly of beneficiaries' short-term savings, the bank's refinancing, donors' resources, and their own funds. Thus, the ability of the MFIs to provide the enormous financing needs for the modernization of the rice sector is very problematic (Adjao 2011; Djato 2001; Ouattara 2011).

Most sales between farmers and traders/millers are arms-length transactions. Although transactions could be repeated, credit or technical assistance is usually not provided. However, following the 2008 crisis, several investment agreements between the focus WA countries and foreign investors (public-private partnerships) have been promoting contract farming and tied output-credit markets where millers/wholesalers advance payments and technical assistance to farmers to "lock them in." For instance, in Senegal, USAID has helped develop a contracting model for use between rice processing companies, banks and producers. Farmers contract loans

[12] Credit is provided by MFIs at an annualized rate of 7-8% compared to commercial banks at a rate of 12%, although by the time all the costs of obtaining credit from the MFIs have been included, the true cost is nearer 12% (Djato 2001) .

from the bank and repay with rice. Banks can transfer the rice to industrial companies that will, in turn, have enough stock to mill and supply the market. Once the industrial companies sell the rice, they pay the banks in cash. This type of agreement allows millers to work without disbursing their own funding and the bank to secure its loan. Processors maintain possession of the rice, but do not take ownership (USDA 2013). Tied output-credit market models are also being tested in RCI[13].

2.3.4.6 Labor markets

Asia. Rural wages in historically densely settled rural areas in Asia are rising as a result of a declining rural labor force. For instance, rural wages have increased by 35% in India over the period 2005-2012 while they increased by over 90% in China over the period 2003-2007. The main drivers include slowing population growth (i.e., falling fertility rates), increased migration out of rural areas, and expansion of manufacturing and urban jobs in general, which further draw labor out of agriculture (Wiggins and Keats 2014).

Rural nonfarm employment (RNFE) has significantly grown in Asia, and it is now of greater importance to rural Asians than migration employment and farm wage labor. For instance, RNFE in manufactures and services, especially in construction, commerce/transport of food products and inputs, and personal services like repairs and tailoring, alone accounts for 40% of total rural employment and incomes, with migration income accounting for an additional 11%. RNFE is positively correlated with density of rural roads and tends to develop in proximity to cities and towns (Reardon and Timmer 2014).

[13]Author's personal communication with rice producers in Yamoussoukro, January 2013 reveals that this model is currently being tested in the District of Yamoussoukro/RCI between rice producers and Novel Group, a major rice importer.

Moreover, RNFE tends to promote the development of small commercialized farms. Profits from RNFE and migration remittances play a critical role in financing investments in rural services, notably in supply chain services, and funding farm investments, allowing smallholder farmers to purchase machines (especially in areas with credit constraints) and to continue farming as part-time farmers. While RNFE and migration remittances allow farmers to replace home labor on farm with hired labor and the ownership of machines, using farm machines in turn also frees labor for both migration to cities and local RNFE, driving upward non-farm wages (Reardon and Timmer 2014).

West Africa. Despite strong economic growth over the past two decades, the output structure of sub-Saharan African (SSA) economies has changed only moderately, with some increase in the service sector, especially in the low-middle income countries, and little, if no change in the output share of industry or manufacturing. For instance, the manufacturing output of East Asian low-middle income countries by 2010 accounted for about twice the corresponding output of SSA. Moreover, the population has been getting younger and the labor force has been growing rapidly. This lack of demographic transition poses challenges for the employment transition similar to the Asian experience discussed above and is even more worrisome as this trend is expected to continue in the next decade (Fox et al. 2013).

About 15% of Africa's labor force works in non-farm enterprises. However, the networks of small businesses that have developed in Asia, allowing flexible production specialization, are less common in Africa. Moreover, these enterprises tend to be small informal businesses providing a wide range of goods and services, mainly linked to agriculture and are often located on a farm (unlike in Asia, where they are mainly located off-farm). Rural enterprises operate in a context of rural isolation, low population density, and high farming risks, which limit productivity and growth due to high transaction costs. A large share of rural enterprises does not operate continuously over a year, and most of them cease operations because of low profits, a lack of finance, or the effects of idiosyncratic shocks (Nagler and Naude 2014; Meyer-Stamer and Wältring 2007).

2.3.5 National framework conditions

Asia. Over time, Asian governments have heavily invested in infrastructure, notably rural roads, communications systems, electrification, and irrigation, which have been critical to the transformation and improved competitiveness of rice value chains. Moreover, the trade liberalization of the rice sub-sector, which enabled global price signals to be transmitted to domestic markets, has been essential to spur investment and productivity growth on the farm and throughout the entire value chain. Although subsidized credit for machinery purchase and improved inputs (i.e., seeds and fertilizer) has declined, except in India, governments still subsidize production in the form of producer price supports. The private sector is playing an increasing role in providing extension services via input retailers and financing to farmers, mostly by processors and some wholesalers (Reardon et al. 2013).

West Africa. Rice production in WA was stagnant in the 1990s as a result of the implementation of structural adjustment reforms, which led to the total withdrawal of parastatals specially created to invest in irrigation, provide input and extension services, and manage markets by supporting both producer and consumer prices, In the 2000s, however, there was a renewed effort to rejuvenate local rice production by modernizing rice farming in order reduce food bills and improve food security. The 2008 food price hikes provided further impetus to expanded rice production.

This renewed momentum led to the development of very ambitious national strategies for the development of rice production, aiming at achieving self-sufficiency and eventually exports in the subregion by promoting profitable production of affordable quality local rice while generating job creation through added value in seed production, transportation and marketing, and machinery repairs. These initiatives stove to improve: (i) access to high quality inputs by subsidizing their costs, including the provision of credit and the development of a formal seed sector; (ii) irrigated rice production by rehabilitating all previously developed irrigation sites and developing new irrigation systems in major cultivable area, especially lowlands; and (iii) support for processing and marketing of locally produced rice, which were neglected in the past. However, these national programs may be difficult to accomplish considering all the necessary groundwork, i.e., the need to reorganize and build capacity of the extension services, create seed packaging centers and rehabilitate land. Most of them have already encountered significant delays in their execution due to due lack of funding and were subsequently revised (see Appendix for more details).

2.3.6 Future challenges of Asian rice value chains

The description of the changing structure of rice value chains in Asia painted above reveals that: (1) the part of rice in the diet of most Asian consumers has been declining mainly as a result of falling income elasticity of rice demand over time driven by increases in both incomes and rural-to-urban migration as well as changes in consumers' preferences; (2) rice value chains have lengthened geographically by sourcing paddy outside their traditional production zones, but shortened intermediationally with a reduced role of village traders or brokers; (3) there has been increased concentration of farms as well as notable consolidation in the mill and wholesale segment (i.e., increased horizontal linkages or coordination) that helped reduce transaction costs, create economies of scale and increased efficiency; (4) there has been a rapid development of markets for seed, water, land, fertilizers, machine services, and pesticides/herbicides, accompanied by rapid commercialization, driven mainly by the private sector (i.e., the great majority of input shops, mills, wholesalers, retailers, the farmers) ; (6) there are strong vertical linkages or coordination amongst the network of these businesses throughout the value chain further strengthened by the provision of infrastructure (i.e., transport and communication); (7) the government has provided key investments in research and development of improved seeds, roads, power grids, and liberalization of FDI in retailing and processing, that facilitated and encouraged the emergence and growth of these markets, except in India where, in some instances government interventions crowded out the private sector.

However, some challenges lie ahead. Although the Green Revolution (GR) led to rapid growth in cereal yields, saving large areas of forest, wetlands, and other fragile lands from conversion to cropping, productivity in the "rice granary" areas across Asia has leveled off. Despite continuing improvements in crop varieties (e.g., the recent release of hybrid rice), annual production growth rates are slowing, with the compound rate of 2.5% per year over 1962-1979 falling to 1.4% per year over the period 1980-2011 for Asia as a whole. Evidence from India's major irrigated-rice growing states and East Asia's rice bowls indicates that Total Factor Productivity (TFP) has been declining, meaning that farmers now have to use higher levels of inputs to obtain the same yields as before (Hazell 2008).

Moreover, the GR introduced new environmental concerns, especially related to the overuse and poor management of irrigation water, fertilizers, and pesticides, leading to degradation of soils and build-up of toxins. Questions have been raised about the sustainability of intensively farmed systems, which lead to off-site externalities, including water pollution, silting of rivers and waterways and loss of biodiversity (Hazell 2008; Pandey et al. 2010). Many Asian countries have taken steps in resolving these issues (i.e., adoption of improved soil nutrient, water, and integrated pest management) at high social costs, and much more efforts remains (Hazell 2008; Pandey et al. 2010).

Rapid urbanization, industrialization and development of infrastructure in many Asian countries have further limited the scope for bringing new good agricultural land into cereal production. New sources of irrigation water are also limited, while nonagricultural uses of water for urban, industrial, and environmental purposes are growing rapidly. Increasing rice production is constrained not only by worsening land and water scarcities but also rising energy and fertilizer prices. Continued strong growth in the production of high-value foods and biofuels is also adding to the competition with cereals for land and water. Climate change will exacerbate the problem by adversely affecting yields and increasing evapotranspiration.

Given this context, future increases in rice production in Asia will have to come almost entirely from higher yields, with limited if any increase in the total amount of irrigation water used. If world energy prices rise in the future, it will also mean higher fertilizer and mechanization costs for farmers, placing a greater premium on the types of management practices that aim to achieve environmental sustainability while increasing yields through more efficient use of these inputs. For instance, water-pricing methods will need to send stronger signals about the real value of water. Additional agricultural research will be the key to meeting these goals.

2.3.7 Main constraints to rice value chain competitiveness in West Africa

Although there has been notable improvement in WA rice value chains since the 1980s, many constraints still challenge their competitiveness. These challenges are discussed in more detail below.

2.3.7.1 Mistrust among value chains actors

In WA, the private sector and rural communities are highly vulnerable to signals sent by the governments and donors. Following the 2008 food price hikes, many WA governments reacted by launching rice self-sufficiency programs similar to those in place before the liberalization of cereal markets. These programs have mostly been distortionary through subsidies that artificially lowered production costs, crowd out private investments, foster continued reliance on unstainable structures, including donors, and devalue self-investment in upgrading. Moreover, government corruption, bribery and lack of transparency in policies and processes affecting businesses further contribute to mistrust (USAID 2009).

2.3.7.2 Poor horizontal and vertical coordination

Overall, there is a high level of competition among actors in the selected WA rice systems with weak coordination and low concentration. Since actors at all segments of the chain have multiple choices of buyers, there is a poor incentive structure for entering binding contracts. Coordination takes place mainly through the price mechanism, , but the strength of coordination and cooperation among and between actors of rice value chains is fragmented due to poor infrastructure and distrust among stakeholders, especially traders and input suppliers (USAID 2009).

The rice programs adopted in WA following the 2008 price hikes resulted in a substantial increase in production at the cost of highly subsidized inputs. While the important increase in production has made private vertical coordination possible and attractive between large millers and large wholesalers/ importers due mainly to a decline in prices, especially in Mali, the provision of input subsidies, however, resulted in decreased market power of private input suppliers and deterred producers from entering into contracts with traders with the aim of gaining access to fertilizer credit (Oden 2011).

2.3.7.3 Land and water tenure

Reforming land tenure to encourage investments in irrigation is essential to improving domestic competitiveness. Unlike their Asian counterparts, especially Thailand and Vietnam, land administration systems in WA are still opaque (i.e., duality of tenure system between formal and customary law), expensive and cumbersome. While acquisitions of agricultural land by both local and foreign investors have been growing, the legal pluralism (i.e., customary vs. formal laws) that currently plagues land tenure systems in WA is an important source of risk and constitutes a major challenge for investors, as it could worsen their relationship with local communities, which are potential agricultural labor suppliers. If not addressed, this could negatively affect trust and cooperation among the actors upstream the value chain, resulting in higher land costs and ultimately higher total production costs.

Moreover, farmers' water costs are higher in WA than Asia given that, unlike their Asian counterparts, WA rice farmers are often required to pay substantial water fees for the use of the canal in order to keep their land use rights (e.g., up to 15% of production costs in Mali).

2.3.7.4 Input supply

In addition to limited access to adequate water control, the lack of availability of and access to improved inputs, notably fertilizer and seeds, has been a major constraint to improving yield, and thus, competitiveness of WA rice value chains. While subsidies help address the short-run problem of high input costs, they do not address the underlying structural reasons for high input costs in WA. As WA governments move forward on their subsidy programs, there will be a need to ensure that adequate competition remains in the sector. Moreover, a critical issue in lowering both fertilizer and seed costs will be to develop effective regional markets for these inputs, which would offer enough scale to attract major investors, such as private seed companies. Right now, it is not profitable for a large firm to try to meet regulatory requirements in 15 different ECOWAS countries given the small size of the markets in many of them. ECOWAS has regional regulations in place that aim at creating such a regional market (for example, the granting of marketing authorization for seeds that have been tested in any one of the ECOWAS countries following ECOWAS protocols), but to date, these rules are not being implemented at the national level (Hollinger and Staatz 2015).

2.3.7.5 Extension services

Extension services for rice production outside of public irrigation schemes are practically non-existent. Public irrigation schemes in Senegal, Mali and RCI have government-mandated institutions to provide extension services to farmers, which contributed to higher yields in these areas. This extension system crowded out information provision from the private sector such as input suppliers (USAID 2009). However, today government extension services have limited staff capacity and funding, and little incentive to improve outreach. Donor-funded, project-based extension systems are the main vehicle for extension and have limited reach. As a result, investment in research often fails to translate into increased yields (USAID 2009).

2.3.7.6 Financing

The lack of access to long- and medium-term loans further constrains producers' level of input use, especially agricultural equipment. In their new rice development strategies, WA countries have conveyed their desire to help producers gain access to loans from MFI at relatively low interest rates for the purchase of agricultural inputs and equipment. However, continued credit subsidies to farmers could impede the momentum of mobilizing local savings, which constitute an important part of MFI's credit supplies. Moreover, the rice development strategies further advocate for the mobilization of supplier credits through the development of agribusinesses and its association with well-organized farmers as part of the new financing agricultural policies. The creation of a tailored system of warrantage (tradable warehouse receipt system of storage) has also either been discussed or implemented. This system would allow producers to obtain input credit by placing their production in a secure warehouse from which it can be recovered when loan repayment is made or at a time when prices are better.

2.3.7.7 Farm equipment rental services

Since 2008, improving mechanization in commercial rice production systems has also become a policy priority for governments in WA, whose main concern pertains to the ability of local farmers to compete with those in Asia who have mechanized not only the land preparation tasks but also many harvesting and post-harvest operations. Developing machine rental markets similar to those in Asia can play an important role in the growth of rural nonfarm employment, which is critical in expanding financing capability, as profits from farming and income from nonfarm rural employment (including from migration) can help fund necessary investment in technology at the farm and the off-farm (distribution and processing) components of the rice value chain. Although there exist significant opportunities to exchange mechanical power for human or animal power throughout the production cycle and after the harvest, most countries in WA have not entered the rapid demographic transition with falling birth rates and growing jobs off the farms (especially in manufacturing) that draw labor from rural to urban areas, as experienced by many Asian countries. Thus, caution must be taken to develop appropriate mechanization efforts given that rural wage growth in WA is likely to be much slower in the next 10 years than Asian rice-producing countries.

2.3.7.8 Processing services

There are additional opportunities for generating rural non-farm employment in the off-farm segments of the value chains depending on the milling technology promoted. The small scale of the mills in WA allowed them to be privately owned and operated by a number of small entrepreneurs, creating income and employment. Moreover, smaller mills have been able to outcompete larger mills due in part to the lack of transport infrastructure, notably rural roads, that allowed mobile small mills to expand rapidly in remote rural areas. However, increased liberalization of FDI following the 2008 rice crisis is encouraging massive investments, mostly by foreign firm but also some domestic firms, in large-scale milling facilities. Unless significant investments by the government in rural electrification and rural roads are undertaken, larger mills may still have difficulties competing with smaller mills. As long as small mills continue their investments in upgrading milling equipment, they will be able to improve the quality of milled rice, and thus capture some of the price premium discussed above. The lack of financing may be a limiting factor in this expansion. Moreover, improving contracting systems between mills and farmers will be key in securing adequate raw material and improve overall efficiency in milling.

2.3.7.9 Transport infrastructure

Improving transport infrastructure is key in linking urban demand with rural supply, especially in counties such as RCI and Senegal where proximity of major cities to ports put local production from the hinterland at a competitive disadvantage. Despite important investments made in recent years to improve road quality on major transport corridors, WA still faces the highest transport costs in the world. The main reasons for this are problems related to road governance and the structure of the trucking industry. Unless reforms in these critical areas are implemented, the potential benefits of large road infrastructure investments will be limited.

2.4 Review of major rice outlook studies: Perspectives about the determinants of competitiveness

Three major organizations have developed outlook reports on probable trends over the coming decade in world rice markets, which are mainly driven by the major Asian rice economies: the USDA (Westcott and Trostle 2013) – covering the period 2011-2022; the University of Arkansas (Wailes and Chavez 2011) – covering 2010-2021; and the OECD/FAO (2013) – covering 2013-2022. These projections were developed assuming that no major domestic or external shocks would affect global agricultural markets in the next decade (e.g., normal weather with, in general, continuation of current trends in crop yields). The projections also assume: (i) an overall increase in economic growth in developing countries at around 3.8-4.2% per year, with strongest growth expected in Asia and Africa; (ii) population growth at around 1% per year, with the fastest growth occurring in Africa, while rates decline in the major Asian rice exporting countries; (iii) subdued inflation in most part of the world, at around 2%, with higher rates in the range of 4-8% for high-growth emerging countries; (iv) continued depreciation of the U.S. dollar, which will further decrease rice import prices (quoted in US dollars) to countries whose currencies are not linked to the US dollar; (v) further increases in crude oil prices, which are expected to increase faster than the general inflation rate; and (vi) continuation of domestic agricultural and trade policies, including long-term economic and trade reforms in many developing countries.

Based on these assumptions, the three studies all projects global rice consumption to grow at an average rate of 1% annually, with higher rates in Africa and in the Middle East. For instance, Wailes and Chavez (2011) estimate total rice consumption in Africa to rise particularly fast (about 3% per year over the next decade) while the opposite is expected in China (0.3% per year). Moreover, all three studies project global rice production to increase by about 1% annually, mainly as a result of improvements in yields, although new investments in the sector in Africa are expected significantly contribute to area expansion. Most of the expected growth in production is likely to come from India and Asian Least Developing Countries, including Cambodia and Myanmar, but also African countries, especially Nigeria, Mali, Sierra Leone and Ghana. However, China, currently the world's largest producer, is projected to significantly cut output in response to declining per capita domestic consumption and strong competition for land. As a result, Wailes and Chavez (2011) expect Asia's share of world production to decline slightly from 89.9% to 89.3% over 2010-2021 while Africa's share will increase from 3.4% to 4.2% over the same period.

Moreover, world prices, on average, are projected to remain on a high plateau compared to the previous decade in both nominal and real terms, although they are likely to be lower than the 2007/08 levels. In fact, the OECD/FAO projections foresee the world rice/coarse-grain price ratio falling from 2.5 in recent years to 1.9 by 2022 and the rice/wheat price ratio falling from 1.8 to 1.7 (OECD/FAO, 2013), suggesting some shift in consumption away from rice toward coarse grain and wheat-based products, such as noodles, especially among lower income consumers in WA for whom rice is a normal or even a necessary good. The three studies also expect international trade in rice to continue to grow within a range of 2.0-2.5% per year, likely fueled by increased import demand by countries in West Africa, especially Nigeria and Côte d'Ivoire, and in the Middle East, especially Iran and Iraq, as well as traditional rice-deficit Southeast Asian countries, such as the Philippines and Bangladesh. However new trade patterns are expected to emerge. While China and India are projected to remain the largest rice economies, still accounting for nearly half of global rice production and consumption in the next decade, China will significantly reduce its rice exports while India's exports will increase. Although Thailand, Vietnam, India, Pakistan, and the U.S are projected to remain the top five rice exporters, accounting for over fourth-fifths of global net trade, Vietnam may surpass Thailand as the leading exporter by 2020 depending on whether Thailand will pursue its high producer price policies, which have eroded its competitive edge in recent years. Myanmar and Cambodia are also expected to increase exports by about 10% per year to 2020.

Understanding the perspectives of consumption, production, and price both in Asia and WA are crucial for understanding how the future competitiveness of WA rice value chain may evolve over the medium- and long-run, given the changes in rice-systems dynamics of both Asia and WA. The review of the perspectives of the world rice market and trends resulting structural changes in rice value chains in Asia and West Africa discussed above are summarized in Figure 2.6, in coherence with the proposed framework of Figure 2.1. More specifically, (1) farm conditions are measured by total rice output (i.e., area and yield); (2) related supporting industries are measured by milling efficiency and inland transport costs; (3) demand conditions are measured by total rice consumption; (4) factor conditions are measured by the cost of land, water, fertilizer, labor and capital; and (5) the international market conditions are measured by world rice price, exchange rate of the dollar relative to the local currency, and freight costs. In Figure 2.7, the positive and negative signs indicate the direction of relationship between each factor and competitiveness, and the up and down arrows indicates an increase or decrease in the future trend of each factor.

Figure 2.6: Perspectives of the determinants of competitiveness of rice value chains in Asia and West Africa and their expected impact on future competitiveness

	Asia		West Africa	
	Current	Trend	Current	Trend
Consumption	+ + (green)	↑ (green)	+ (green)	↑ ↑ (green)
Production				
Output	+ + (green)	↑ (green)	+ (green)	↑ ↑ (green)
Area	+ + (green)	↓ (red)	+ (green)	↑ ↑ (green)
Yield	+ + (green)	↑ ↑ (green)	+ (green)	↑ (green)
Input costs				
Labor	− − (red)	↑ (red)	− (red)	↑ ↑ (red)
Land	− − (red)	↑ (red)	− (red)	↑ ↑ (red)
Water	− (red)	↑ (red)	− − (red)	↓ (green)
Fertilizer	− (red)	↑ (red)	− − (red)	↑ ↑ (red)
Capital	− (red)	↓ (green)	− − (red)	↓ (green)
Milling efficiency	+ + (green)	↑ (green)	+ (green)	↑ (green)
Inland transport cost	− (red)	↓ (green)	− − (red)	↑ (red)
Trade				
World rice price		↓ (green)	+ + (green)	↓ (red)
Dollar exchange rate	+ (green)	↓ (green)	+ (green)	↓ (red)
Ocean freight cost	− (red)	↑ ↑ (red)	+ (green)	↑ ↑ (green)

Green: Positive effect on competitiveness
Red: Negative effect on competitiveness

Note: the positive and negative signs indicate the direction of relationship between each factor and competitiveness; the up and down arrows indicates an increase or decrease in the future trend of each factor; and the number of signs indicates the relative magnitude of each factor.

2.5 Conclusion and implications of the changing Asian rice economies for the future comparative advantage of West African rice sector

In this evolving world rice economy, increased maritime freight rates between Asia and West Africa and the reduction of exports from countries like China suggest a favorable environment for expansion of West African rice production. Yet, declining real prices for rice as per capita consumption in major Asian countries decreases due to rising incomes, probable expansion of output from new potential low-cost producers such as Cambodia and Myanmar, possible weakening of the US dollar (and hence lower costs for dollar-denominated rice imports) and continued volatility due to the thinness and segmentation of world rice markets also suggest that West African countries will need to pay careful attention to production, processing and marketing costs as well as risk management tools if they are to capture an increasing share of their home markets. Furthermore, higher fuel costs will likely also spur higher input costs (including costs of pumping water) and restrain regional trade in bulky products like rice within the subregion. The future competitiveness of West African rice value chains will therefore depend critically on three factors: (i) continuing to improve productivity and hence drive down per-unit farm-level production costs, (ii) reducing per-unit costs in the off-farm parts of the value chain (both upstream—for inputs—and downstream—for processing and marketing), and (iii) improving product quality and more effective exploitation of the various quality niches that exist in West African rice markets.

2.5.1 Increasing farm-level productivity

The scope for productivity increases varies significantly across West Africa's three major rice-growing ecologies (irrigated, lowland, and upland). From an economic standpoint, increasing productivity, in terms of total factor productivity, is measured in terms of the value of additional output obtained from an incremental expenditure of inputs. It thus is not equivalent to partial physical measures of productivity, such as yield per ha, which may be high in full water-control systems but are sometimes purchased at the cost of very high levels of expensive input use. In addition, bringing additional areas under gravitational full water-control in West Africa can cost up to $6,000-8,000/ha (Diallo et al. 2012) while more basic water control in the lowlands can cost about six times less. Thus, while irrigated land is a high-value productive asset, especially in a context of climate change, assessments of ways of increasing farm-level productivity need to cover the full range of production systems. In particular, lowlands in WA often tend to have low social opportunity costs because few African staple crops are able to withstand the flooding conditions prevailing in this ecology, giving rice a comparative advantage in compared to other crops (Lançon and Erenstein 2002). Estimates of available rainfed lowland areas range from 113 million ha to 238 million ha (Seck et al. 2010). However, irregular rainfall patterns have historically discouraged rice farming in lowlands because the amount of moisture available to the rice plant is often insufficient to ensure acceptable yields, so some investments in better water control are likely necessary to exploit these areas.

As West African governments undertake water-control works, they must assess the potential impact on water availability for other users and take into account the full environmental and social impacts of these interventions, especially in lowlands where rice production is primarily a women's activity. If not carefully planned, construction of water control infrastructure can lead to increased gender-based conflict, as men have often taken the land back from women following infrastructure improvements. Also, pastoralists sometimes lose out when lowland areas that were traditionally used as dry-season grazing areas are converted into rice production areas (Dimithe 1997).

Moreover, West Africa has potential for further increasing yields through diffusion and adaptation of rice technologies to local conditions. While returns to agricultural research and development (R&D) incurred during the GR in Asia continued to give high returns through the 1990s, they have started to decline as yields have become stagnant (Pandey et al. 2010). In West Africa, returns on investments on rice research were found to exceed 20% annually (Seck et al. 2010). However, the effective demand of several technologies developed in the late 2000s, including improved seed varieties such as Nerica, has been limited, due in part to the lack of operational seed multiplication systems that permit dissemination at scale of improved technologies to farmers (Seck et al. 2010). Thus, there is still a potential to raise production and extract high returns to R&D given those opportunities are not fully exhausted yet.

Moreover, improving secure and exchangeable rights to water and land is essential to stimulating rapid agricultural growth and productivity in WA, as they allow land to be used as collateral for loans, improving farmers' access to capital. A reliable land registry would allow national and/or local governments to use land taxes as a source for efficient financing of critical public services. Tradable rights to water and land also facilitate the access to these resources by those most able to use them efficiently, thereby spurring economic growth. The need for designing land and water tenure rules that better protect the current rights of local populations is even more critical, as competition for land and land-related resources such as water is likely to grow as demand for water and land increase with increased commodity price volatility, growing human and environmental pressures, worries about food security and desire to modernize agriculture. However, poor governance and the lack of transparency of checks and balances in contract negotiations can create a breeding ground for corruption and increased land tenure insecurity, especially for resource poor small-scale farmers.

2.5.2 Decreasing per-unit costs throughout the value chain

Achieving price-competitiveness is dependent on each link in the value chain and requires high yields, large volumes, low input costs, fewer losses, and high levels of efficiency throughout. Thus, efforts to expand rice production in the region need to pay particular attention to holding down per-unit costs throughout the value chain. At the farm level, improving input availability in a manner that will generate savings to the economy as a whole (e.g. via more productive seeds and better water control) and not simply through transfers of resources to farmers (e.g., via subsidies) will be critical for the sustainability of these efforts. There is scope for further gains in system-wide productivity through improvements in post-harvest operations, which are critical not only to the final cost to consumers of West African rice but also equally important for increasing the value of rice through improving quality (see below). In particular, improved systems for paddy aggregation and assured delivery to processors, and improvements in wholesaling, packaging and marketing of the milled rice are all areas needing attention. These fall under two broad rubrics: improved contractual linkages between smallholders and processors and improvement in the wholesaling function, two areas that have received relatively little attention in CAADP programs aimed at spurring agricultural production in West Africa (Hollinger and Staatz 2015).

2.5.3 Improving Product Quality and Market Segmentation

Local rice still has to overcome a quality image problem in most West African markets. Recent evaluations of the rice value chain in West Africa (e.g., USAID 2009) argue that lack of consistent quality in milled rice is a major constraint to West African producers capturing a larger share of the market currently supplied by imports. To accommodate these diverse production systems and consumer preferences, processing of rice also takes various forms across the region, involving both parboiling and milling. Historically, experience with large-scale industrial mills has generally been poor as they have often had problems in attracting enough paddy to operate close to capacity. Milling is largely small-scale, using Engelberg-type dehullers that are frequently up to 30 years old and require relatively low investment cost. While they have the advantage of being located close to the farmer, reducing assembly costs for paddy and allowing the farmers to recover the husks easily for livestock feed, they often produce variable quality milled rice (USAID 2009). Producing more consistent quality would allow capturing a larger portion of the growing middle-class demand for rice as well as to separate different qualities of rice and sell them to various segments of the West African market (e.g., 100% brokens to Senegal and long-grain to Ghana). Efforts to improve quality through the introduction of medium- and large-scale mills and improvements to small-scale milling systems (e.g. use of de-stoning machines for paddy prior to milling and increased use of mills with rubber rollers) have, however, frequently run into problems of millers being unable to attract adequate volume of paddy in competition with small mills and poor post-harvest drying of paddy that leads to inconsistent milled product. These problems highlight the need mentioned above for further work on improving contracting systems between farmers and millers (perhaps mediated through farmer organizations and private wholesalers) to create stronger incentives for farmers to respond to the need for improved quality of milled rice.

However, it is vital that future promotion strategies of rice in West Africa recognize that approximately three-quarters of the West African population still lives below the poverty line of US $2/day (AfDB 2011) and thus is willing to make some trade-off between the cost of their rice and some degree of product quality. While larger mills produce a more homogenous product than do the small local mills, the small mills have to date exhibited a lower unit cost of processing than the large facilities. There is a danger that in the quest to improve the quality of domestically produced rice, policies will subsidize industrial mills (e.g. via tax exemptions for imported equipment), thereby favoring a shift to the higher-cost processing and denying low-income consumers access to cheaper rice.

Moreover, the role of public sector policies and investments in this intricate system is key, as an improved policy environment is conducive to fostering investments in productivity-enhancing technologies and institutional innovations by private-sector actors (including farmers), which ultimately enhances quality and improves risk management throughout the rice value chain. However, the public sector should focus its investments in areas with the highest returns for long-term, broad-based growth, and in which the private sector has limited ability or incentives to invest. Such investments include (1) agricultural research, extension and development and related human capital development; (2) infrastructure, especially, rural roads, market infrastructure, irrigation and a reliable supply of electricity; (3) strengthening the capacity of value chains actors so that they are able to effectively use the technology issued from investments in agricultural research by reforming agricultural education systems; (4) supporting collective action and institutional innovations for managing risks and reducing transaction costs, including working with the private sector to improve grade and standard of rice quality; and (5) supporting adequate policy design and implementation, notably in land tenure. These critical public-sector investments should be complemented by additional private investments (Hollinger and Staatz 2015).

3. COMPETITIVE ADVANTAGE AND COMPARATIVE ADVANTAGE OF COMMERCIAL RICE VALUE CHAINS IN WEST AFRICA: THE CASE OF CÔTE D'IVOIRE, MALI AND SENEGAL

3.1 Introduction

3.1.1 Background and Problem Statement

With increased urbanization and rapidly growing demand for convenience food and easy-to-cook cereals, rice has become the most rapidly increasing dietary staple in West Africa (WA). However, rice consumption has increased faster than production in the subregion since the 1980s, and imports, especially in cities, are increasingly filling the deficit in production. Today, rice is a major tradable cereal in WA, with great importance in terms of food security, income generation, and trade balance; thus, improving the comparative advantage of local rice value chains, and thereby stimulating import substitution, has been one of the key issues in the West African food policy debate since the early 1980s.

Given its importance as an urban staple, and the ability to grow it under irrigation, which helps stabilize its production, several West African countries affirmed the political will for substituting rice imports by domestic production in order to meet their consumption needs. Although the wave of reforms induced by Structural Adjustment Programs throughout the 1980s and 1990s resulted in a sharp reduction of public resources available for supporting the development of the rice subsector, opening the Western African rice market to world suppliers, the 2007/08 rice crisis changed the underlying economic conditions (Lançon 2008). Moreover, with many studies documenting a decline in rice productivity in Asia (IRRI 2008), increasing investment in domestic rice production could become an attractive option for West African import-dependent countries. Thus, in the new global environment characterized by higher input, energy and commodity prices, it is crucial that West African decision makers carefully reassess the competitiveness of commercial rice value chains, both from a financial and economic perspective, as more investments are made. Such efforts will be economically sustainable only if West African rice value chains remain cost-competitive with Asian rice imports. Improving the comparative advantage or economic profitability of WA rice value chains compared to Asia, however, depends not only on conditions in WA but also on how the rice economy, including policy, in Asia evolves.

This chapter compares the competitiveness of rice produced in the West African systems with imports of Asian rice from both a financial and economic perspective by building on secondary data with the aim to provide additional empirical analysis to assess whether further investments in commercial rice value chains in WA are warranted, and if so, of which kinds. The financial analysis uses standard budgeting techniques to compute the cost of production and net value added using prevailing market prices, including any taxes and subsidies received by value-chain actors. The economic analysis uses a domestic resource cost approach to assess the comparative advantage of these rice production systems, netting out the value of any transfers and accounting for the effects of distorted exchange rates. While the financial analysis examines the profitability of rice production and marketing to private actors under existing market conditions, the economic analysis measures profitability to the economy as a whole. Understanding the distribution of the total financial value and costs among actors within the value chain as well as the economic performance of the rice value chain from society's point of view will provide insight into how incentives to various stakeholders could be adjusted so that they would be consistent with a more efficient overall allocation of resources.

3.1.2 Key Research Gap and Purpose of this Study

Many studies have assessed the comparative advantage of the rice subsector in West Africa (Pearson et al 1981; Barry 1994; Lançon and Erenstein 2002; Seck et al. 2010; Diallo et al. 2012; Diagne et al. 2013). The domestic resource cost (DRC) ratio has been the most intensively used measure of comparative advantage of rice ecologies in West Africa over the past three decades (AfricaRice 2008). Previous studies on comparative advantage in West Africa have compared (i) rice production with other commodities, (ii) different rice production systems within a country, and/or (iii) similar rice production systems across countries. Many of these studies focused on assessing the profitability of locally produced rice at the farm-level, in both financial and economic terms. The most recent studies, however, attempted to examine profitability of the entire rice value chain, highlighting the importance of taking the end market into account (Diallo 2012; Diagne et al. 2013).

The purpose of this chapter is to assess the comparative advantage of rice value chains for the major production system across several countries in West Africa. While previous efforts mainly investigated the prospects for improving rice production in the region, the focus of this study is to assess the capacity of selected West African countries to respond over time to key drivers and structural changes in Asian and West African major rice economies identified in Chapter 2. The chapter does this by conducting a domestic resource cost (DRC) analysis and developing scenarios of future comparative advantage using projected output prices and input costs for both West Africa and major Asian exporters obtained from major outlook studies. The analysis focuses on dynamic irrigated rice systems in West Africa that are the mainstays of rice supply to capital cities, including (1) the Great Lakes region (GL) to Abidjan, RCI, (2) the Office du Niger (ON) to Bamako, Mali, and (3) the Senegal River Valley (SRV) to Dakar, Senegal.

3.1.3 Research Objectives

The main objectives of this chapter are to: (i) compute estimates of cost and price structure along the different segments of the rice value chain to assess the competitiveness of the selected WA value chains with imports from Vietnam, Thailand, and India; (ii) carry out a more up-to-date economic analysis using domestic resource cost (DRC) analysis to assess the comparative advantage of the selected West African rice value chains compared to Thai rice imports; (iii) identify and examine constraints to the comparative advantage of locally grown rice; (iv) develop scenarios of future comparative advantage of the rice subsector in West Africa based on projections obtained from major outlook studies; and (v) derive policy implications about how to improve the comparative advantage of rice for the selected countries and for West Africa as a whole in the next 5 to 10 years.

3.1.4 Conceptual Framework

An economy has comparative advantage in the production of a tradable commodity if its production in the country involves a lower opportunity cost, in terms of foregone production of other goods and services, than in other countries. The comparative advantage of that economy could reside in the fact that: (i) it uses fewer traded inputs per unit of output; (ii) it uses fewer domestic resources per unit of output; and/or (iii) its domestic resources have lower opportunity costs (Tsakok 1990). Thus, comparative advantage is largely determined by factor endowments (i.e., resources in labor, land and capital) and by demand conditions. However, there has been little use of fully specified models of supply, demand and trade to assess the comparative advantage of rice production in West Africa due primarily to the lack of availability of adequate data. Given the data constraints, there was a preference towards computing unit-free numerical indicators based on observed input-output coefficients and imputed shadow prices. The domestic resource cost (DRC) ratio has been the most intensively used measure of comparative advantage over the past three decades in West Africa (AfricaRice 2008).

The domestic resource cost compares the opportunity costs of domestic production to the value added that it generates. It is derived from the optimization of social profitability of economic activities and represent a normalization of the net social profits (NSP) calculated as:

$$NSP = (P_{ei} * Q_i - \Sigma^{T}_{t=1} P_{et} * Q_t) *SER - \Sigma^{N}_{n=1} P_{en} * Q_{n}, \text{ with}$$

$$DRC = \frac{\Sigma^{N}_{n=1} P_{en} * Q_n}{(P_{ei} * Q_i - \Sigma^{T}_{t=1} P_{et} * Q_t) *SER},$$

where:

P_{ei} : economic price of output i

Q_i : quantity of output i

P_{et} : economic price of tradable input t used to produce output i

Q_t : quantity of tradable input t used to produce output i

P_{en} : economic price of nontradable input t used to produce output i

Q_n : quantity of nontradable input t used to produce output i

SER : shadow exchange rate.

The numerator represents the sum of the costs of using land, labor and capital; i.e., the total cost of domestic resources considered as nontraded inputs. The denominator represents the value added in border prices; i.e., the net foreign exchange earned or saved by producing the good domestically. The DRC value may be positive or negative. A positive value below unity indicates efficiency and comparative advantage – the economy saves foreign exchange from local production; a value equal to unity indicates that the economy neither gains nor saves foreign exchange through domestic production; and a value greater than unity indicates inefficiency and lack of international comparative advantage – the economy is incurring costs in excess of what it gains or saves from the production in terms of foreign exchange. A negative DRC value indicates that the foreign exchange cost of production from tradable inputs is greater than the foreign exchange value of the product. Finally, when a series of DRC values are positive but below unity, the least value indicates the most economically efficient system in the production of the product.

The DRC has been the preferred measure for assessing comparative advantage of various agricultural sectors in WA, including rice, due mainly to its simplicity and ease with which the result may be interpreted. Moreover, the DRC presents the advantage of evaluating comparative advantage without using data from other countries than the one considered[14] (Latruffe 2010). However, its major limitations include: 1) the tendency for some "domestic" costs to involve imported components, which are not always easy to disaggregate; 2) the partial equilibrium framework on which it is based and which focuses only on a single market without addressing the linkages among markets (i.e., the indicator ignores substitution and cross-price effects); and 3) possible undervaluation or overvaluation of imported resources due to undervalued or overvalued exchange rates; thus, assumptions about real exchange rate are critical, as competitiveness may be artificially created by devaluing the domestic currency, which results in the decrease of the economic valuation of exports and increase in those of imports (Latruffe 2010).

The above limitations can be partially addressed through sensitivity analysis and by computing alternative cost measures of comparative advantage that do distinguish between

[14] Since the supply and demand conditions in the Asian countries largely determine the world price of rice, this study is implicitly making the comparison with the Asian countries.

tradable and nontradable components of domestic costs. Masters and Winter-Nelson (1995) argue that the difficulty of correctly classifying locally produced inputs as tradable and nontrable introduce an inherent bias against activities that rely heavily on domestic factors (i.e., land and labor). Thus, they propose the simpler social cost-benefit (SCB) ratio as a superior measure of social profitability. The DRC and the SCB use the same data and provide the same criterion for determining whether or not an activity is socially profitable. However, unlike the DRC, the SCB, as well as the NSP, is not affected by the classification of costs as tradable or nontradable, and is calculated as the ratio of total costs to total benefits[15].

Thus, this study computes the SCB ratios to see how they compare to DRC ratios. Various sensitivity and scenario analyses are also conducted to assess the implications of the changing dynamics of the Asian rice economies for the future comparative advantage of WA under alternative assumptions about the evolution of production costs, yields, exchange rates, world prices, wage rates and transport costs. The assumptions were derived from (i) comparative analysis on the evolution of the rice subsector and rice policy for selected countries in Asia and West Africa, and (ii) an appraisal of earlier efforts to project rice consumption, production and prices both in Asia and WA (see Chapter 2). The set of DRC ratios derived from the various scenarios allow us to make predictions about the future comparative advantage of rice production in WA and to indicate whether there is a good case for further exploring efficiency aspects of expanding rice production in the subregion given the changing dynamics in both Asia and WA.

[15] Although the SCB ratio does not make a distinction between tradables and non-tradables, the real exchange rate is implicitly used in the valuation process of tradables.

3.1.5 Estimation procedure: determining financial and economic prices

Since competitiveness is a relative concept, this chapter assesses the performance of WA rice value chains relative to their Asian counterparts, both in financial and economic terms. This chapter is making the comparison with Thailand, using the Thai export price as a measure of world prices. While competitive advantage is measured with market (i.e., observed) prices, comparative advantage should be measured with equilibrium (i.e., unobserved) prices as it is based on the assumption that economic prices net out transfers due to taxes, subsidies, non-equilibrium exchange rates and market power.

First, an analysis of the cost and price structure along the different segments of selected value chains in WA (i.e., RCI, Mali, and Senegal) and in Asia (i.e., Thailand, Vietnam, and India) is conducted to assess individual costs of production and net value added of local WA rice with imports for the year 2011, using prevailing market prices. Then, a DRC analysis is conducted to assess the comparative advantage of commercial rice production systems in selected West African countries relative to Thailand, which is one of the major rice exporters to the region. The base scenario is established for the year 2011. All the calculations were conducted on a hectare basis and in CFAF, the local common currency in the West African countries under study. With farm budget data and relevant macroeconomic data, DRC ratios were estimated by: (1) classifying and decomposing input items into their tradable, non-tradable and transfer payments (tax or subsidy) components; (2) estimating social (or shadow prices) of the output and all the inputs; (3) constructing commodity and system budget tables; (4) and computing the corresponding DRC ratios.

There is a substantial literature on shadow pricing, and two kinds of numeraires have been widely used: the first one, the “world price” numeraire, adjusts the prices of nontraded goods to be equivalent to border prices, while the second one, the "domestic price" numeraire, adjusts the prices of traded goods to be equivalent to domestic prices (Belli et al 1997; Gittinger 1982). This paper will compute shadow prices using the "domestic price" numeraire. More specifically:

- traded goods, which include production output (i.e., milled rice) and inputs (i.e., seeds, fertilizers, pesticides, herbicides, transport, and farm equipment) are valued at their economic parity prices. The import parity price is the economic price of the imported good at the point of delivery obtained by adding to its FOB[16] price all freight and insurance charges between the world market and the point of reference, accounting for the adjustment of the currency. Conversely, the export parity price, which is the economic price of exports at a specific point, is obtained by deducting freight and issuance charges from the CIF[17] price, accounting for the adjustment of the currency;
- tradable but nontraded goods, which are goods that are not traded because of government regulation (e.g., rice under an export ban), are valued at their domestic market price; and
- non traded goods are goods that by their very nature tend to be cheaper to produce domestically than to import but for which the export price is lower than the domestic cost of production. Such goods include labor, capital and land, farm tools, construction, services, utilities, credit and irrigation water and are valued at their

[16] Free on Board or FOB is a term of sale to indicate that the price quoted by a seller includes all charges up to placing the goods on board a ship at the port of departure specified by the buyer.
[17] Cost, Insurance, Freight or CIF is a term of sale to indicate that the price quoted by a seller includes insurance and all other charges up to the named port of destination.

opportunity costs or the benefit forgone by using a scare resource for one purpose instead of its best alternative use (Gittinger 1982) (see further discussion below).

In order to see the changes in the comparative advantage of the selected rice production systems under different scenarios of transformation and changing dynamics in the rice value chains in both Asia and WA, sensitivity analyses are conducted, by both varying individual and a combined group of factors, notably the world rice price, shadow exchange rate, price of imported fertilizers, social cost of labor, irrigation charge, the market rent for land and transport costs. Although scenarios are not predictions, they are important tools to explore the economic consequences of alternative assumptions. The scenarios are developed using projection data obtained from major outlook efforts and trends discussed previously in Chapter 2.

3.2 Financial analysis

3.2.1 Data

The data used for this analysis were compiled based on recent rice value chains studies conducted by the Asian Development Bank and the Regional-Research and Development Technical Assistance (R-RDTA) (Chen et al. 2013) for several Asian countries, including India, and Vietnam; the Asian Development Bank and its Institute (ADBI) (Reardon et al. 2014) in Vietnam; the World Bank (2013) in Thailand and Senegal; USAID/Mali (Stryker and Coulibaly 2011) in Mali, and AfricaRice and its national partners (NARS) in collaboration with Michigan State University (MSU) (Diagne et al. 2013; Diallo et al. 2012; Dieng et al. 2011; Ouattara 2011) for several countries in WA, including Côte d'Ivoire, Mali, and Senegal. The year 2011 is taken as the base year of this study. The data, especially per unit costs figures and average producer and consumer prices for WA, were subsequently updated using data obtained from national Market

Information Systems (MIS) and Famine Early Warning Systems (FEWSNET). The cost data are mostly representative of those facing small- to medium-scale paddy producers and processors. Up-to-date world prices and exchange rates were obtained from international statistical databases, including the World Bank and FAOSTAT. However, it is important to note that rice is not a homogeneous product and quality differences are not always accurately reflected in the data, making some of the cross-country comparisons subject to error. Therefore, cost numbers have to be interpreted with caution.

3.2.2 Assumptions

Performance indicators, in financial terms, are important as they are instrumental in determining whether the various actors along the value chain continue or cease their activities. The actors will remain active if they are able to cover their costs and generate profits (i.e., financial profitability is positive). While the following analysis basically assume all actors desire to maximize their profits by making the best possible use of the resources available to them, it is important to note that their objectives are usually more complex and may include non-monetary and social concerns such as meeting their food security needs.

To measure the average performance of the commercial rice value chains in the selected countries and assess eventual competitiveness with imports, information was gathered on best estimates of the cost and price structure along the different segments of the value chain Since the most profitable enterprise may not necessarily be the least costly, several performance indicators measuring costs of production and net value added are used to evaluate the financial profitability along each segment of the value chain. The findings are compared with similar estimates computed for their main Asian rice suppliers.

3.2.3 Results and discussion

The results of the analysis confirm that rice production and marketing is financially profitable in WA, as expected (Table 3.1). While average yields in irrigated rice production systems in WA are comparable to those in Asia (except India, where average yields are below 4 tons per ha), there exist important disparities in production and marketing costs. Beside labor, which is the largest single component of production costs and accounts for over one third of the total, fertilizers and chemical substances are the second largest expense and represent about one quarter of the costs, except in Vietnam (where they represent one quarter and one half respectively). Land and water costs are also quite high in Mali (about one quarter of the costs) as well as in Senegal and India (about one fifth of the costs).

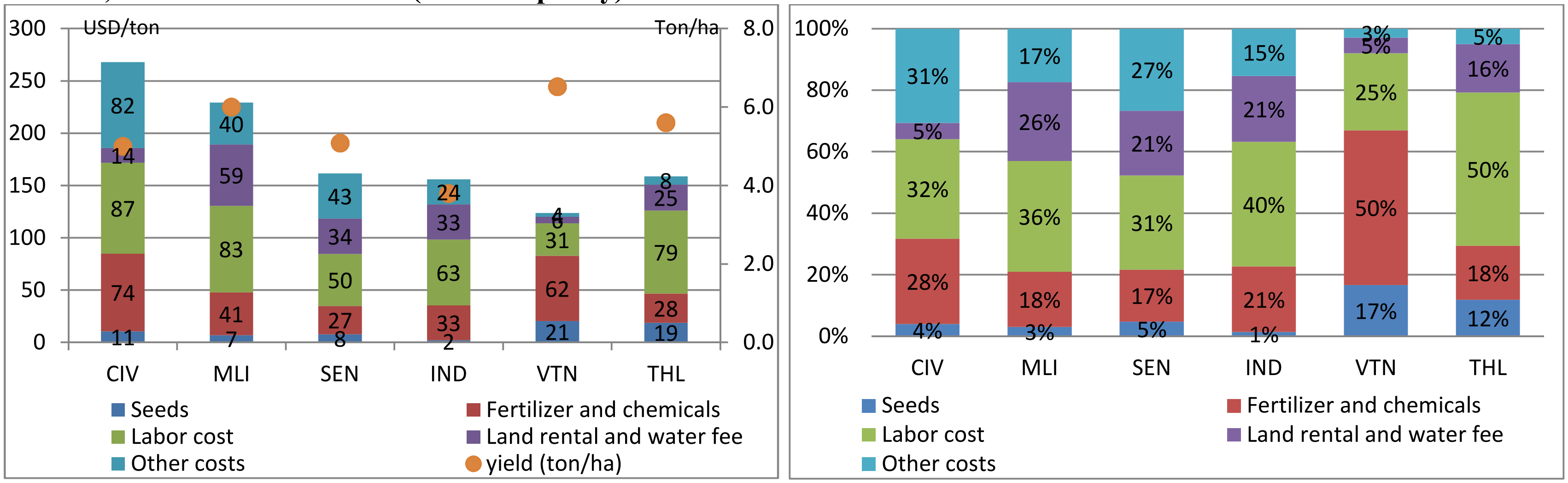
Moreover, Figure 3.1 and Table 3.1 reveal that among the West African countries, average rice production costs per unit of output, in financial terms, are lower in Senegal, which produces rice with higher levels of broken grains, than in RCI and Mali. These costs are comparable to those of the common rice grade widely exported by the selected Asian countries (i.e., 25% broken long grain white rice variety). The slight difference in costs per ton reflects slightly lower yields and higher mechanization costs in Senegal, mainly due to limited equipment availability. The World Bank (2013) reports that manual clearing and rotavation with a hand tractor may cost US$ 180 per ha in Senegal compared to hiring a tractor and plow for US$ 35 per ha in Thailand.

Production costs are highest in RCI (i.e., 66% higher than Senegal) followed by Mali (37% higher than Senegal). In addition to high mechanization costs, owing in part to degraded equipment and important equipment repair and maintenance costs, these higher costs are also driven by high costs and limited availability of chemicals, notably fertilizers.

Higher production costs in Mali, however, are mainly the result of high land and water costs. While irrigation water is mostly subsidized by the government, the rental rates for land are relatively high. In RCI and Senegal, land rental rates are lower, but the water use fee associated with an irrigated plot is quite significant in Senegal (about US$ 130 per ha). In Mali however, both the land rental (US$ 195) and water use (US$ 140) fees are high.

Moreover, in the off-farm segments of the local WA rice value chains, transport costs as share of overall costs were modest, mainly because the total distance in domestic WA chains are relatively short compared to the total distances covered by imports originating from Asia. However, transport costs per ton per kilometer in West Africa are among the highest in the world, and are 40-100% higher than South Asia, which are among the lowest in the world (World Bank 2009). In addition, milling costs are also lower in WA, mainly due to the fact that the analysis does not adjust for quality of milled rice, which is higher in Asia, where more expensive and efficient milling equipment is used. In sum, these various trends translate into a high profit share going to marketing in Senegal relative to RCI and Mali (see Figure 3.1).

Figure 3.1: Level and distribution of production costs in financial terms for irrigated rice in RCI, Mali and Senegal benchmarked to India, Vietnam and Thailand (USD/ton paddy)



Note: Other costs include machine rental, equipment maintenance and depreciation, interest on capital, gas and fuel, sacks; depreciation of irrigated infrastructure is excluded

Source: Compiled by author with data from (Chen et al. 2013; Reardon et al. 2014; World Bank 2013; Stryker and Coulibaly 2011; Diallo et al. 2012; Dieng et al. 2011; Ouattara 2011)

Table 3.1: Distribution of revenues, costs and value-added in the rice value chains for selected countries (USD/ton)

Per unit revenues, costs and value-added (USD/ton)

	CIV			MLI			SEN			IND			VTN			THL		
	Revenue	Cost	Value-added	Revenue	Cost	Value-added	Revenue	Cost	Value-added	Revenue	Cost	Value-added	Revenue	Cost	Value-added	Revenue	Cost	Value-added
Farmer	642	446	195	575	370	205	348	261	87	286	147	139	300	190	110	376	256	120
Collector				35	20	16				17	5	12	45	27	19	105	93	12
Miller	62	61	1	45	35	10				28	16	12	58	43	15			
Marketing	88	22	66	59	40	19	257	86	171	104	66	38	110	73	37	65	50	16
Total	792	529	263	715	465	250	605	347	258	435	234	201	514	334	180	547	399	148

Distribution of revenues, costs and value-added (% of wholesale or FOB price)

	CIV			MLI			SEN			IND			VTN			THL		
	Revenue	Cost	Value-added	Revenue	Cost	Value-added	Revenue	Cost	Value-added	Revenue	Cost	Value-added	Revenue	Cost	Value-added	Revenue	Cost	Value-added
Farmer	81.0%	56.4%	24.7%	80.4%	51.7%	28.7%	57.5%	43.1%	14.4%	65.8%	33.9%	31.9%	58.4%	37.0%	21.4%	68.9%	46.9%	22.0%
Collector				5.0%	2.8%	2.2%				3.9%	1.1%	2.8%	8.8%	5.2%	3.6%	19.2%	17.0%	2.1%
Miller	7.9%	7.7%	0.2%	6.3%	5.0%	1.4%				6.5%	3.8%	2.8%	11.3%	8.4%	2.9%			
Marketing	11.1%	2.8%	8.3%	8.3%	5.6%	2.7%	42.5%	14.2%	28.3%	23.8%	15.0%	8.8%	21.4%	14.3%	7.1%	12.0%	9.1%	2.9%
Total (% of price wholesale or FOB)	100.0%	66.8%	33.2%	100.0%	65.1%	34.9%	100.0%	57.3%	42.7%	100.0%	53.7%	46.3%	100.0%	65.0%	35.0%	100.0%	73.0%	27.0%

Notes:

1. The value of paddy prices and costs were divided by the appropriate milling rate to convert them into rice equivalent measures
2. The figure in parenthesis show the share of marketing price (i.e., wholesale price for WA and FOB price for Asia)

Source: Compiled by author with data from (Chen et al. 2013; Reardon et al. 2014; World Bank 2013; Stryker and Coulibaly 2011; Diallo et al. 2012; Dieng et al. 2011; Ouattara 2011)

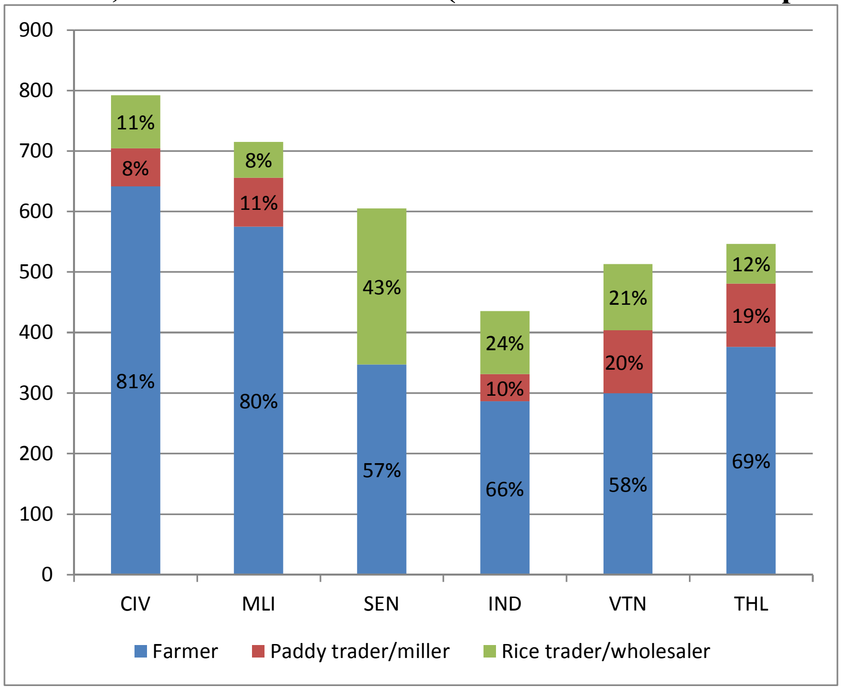
Figure 3.2 presents a comparison of the price structure along the retail (or export) value chains in the selected countries, highlighting the principal activities in the chain that capture the highest share of the final retail price. Knowing the structure of the value chain can help determine whether farmers' share of total profits generated by the value chain is higher in a particular country, product, or quality of product than in another country.

The price structure in WA contrasts strongly with the structure in Asia. Overall, the performance of downstream segments of Asian rice value chains (i.e., traders, millers, and wholesalers) has become nearly as important as the farm segment, with about 40% of the total value added of the rice value chain (reflected in the final retail price) deriving from the downstream segments and the remaining 60% from the farm segment. However, in WA the share of the off-farm components in the final retail price is only half of those estimated for Asia, except Senegal. Rice farmers in RCI and Mali capture about 80% of the final retail price in the rice value chain while farmers in Senegal capture much less (i.e., less than 60%). The share of rice farmers in Senegal, however, is more comparable to farmers in Vietnam, who capture roughly two thirds of the final export price of common rice.

In Senegal[18], wholesalers tend to capture a higher share of the price (i.e., 43%) compared to wholesalers in the other countries, as a result of procuring paddy directly from farmers. While the share of wholesale in the final price in RCI and Mali is comparable to that in Thailand, and represent about half of that in India, the shares of milling in the final price in RCI and Mali are comparable to that in India (about 10%), which is half of the that in Thailand. In Vietnam, however, the share of wholesale in the final export price are comparable to those from milling (about 20%).

[18] Rice paddy is marketed through various channels (see Chapter 2). For all countries, except Senegal, it is assumed that individual farmers or producer associations sell paddy to millers, who sell the milled rice to wholesalers/retailers. In Senegal, however, wholesalers acquire paddy directly from farmers and use custom mills services for a fee.

Figure 3.2: Price structures of the rice value chain in RCI, Mali and Senegal benchmarked to India, Vietnam and Thailand (% of wholesale or FOB price)



Note: In the Delta region in Senegal, paddy is processed either by the farmer or the wholesaler. In the above scenario, paddy is processed by the wholesaler who pays for custom milling and transportation fees from farm to wholesale markets.
Source: Compiled by author with data from (Chen et al. 2013; Reardon et al. 2014; World Bank 2013; Stryker and Coulibaly 2011; Diallo et al. 2012; Dieng et al. 2011; Ouattara 2011)

Figure 3.3 presents a comparison of the entire value chain of selected WA and Asian rice economies. Estimates of the CIF price of imported rice from the selected Asian countries at the wholesale level in the selected WA countries, adding freight and port charges to FOB price at the port of the exporting country and including domestic transportation and marketing costs, are lower than the average wholesale price of domestically produced rice, except for imports from Vietnam and Thailand to Mali and to Senegal. Thus, under zero tariffs, rice produced in RCI cannot compete with imports on price, in financial terms, even without adjusting for quality. Given the current protection[19] level in WAEMU countries, including domestic transport and marketing costs, the

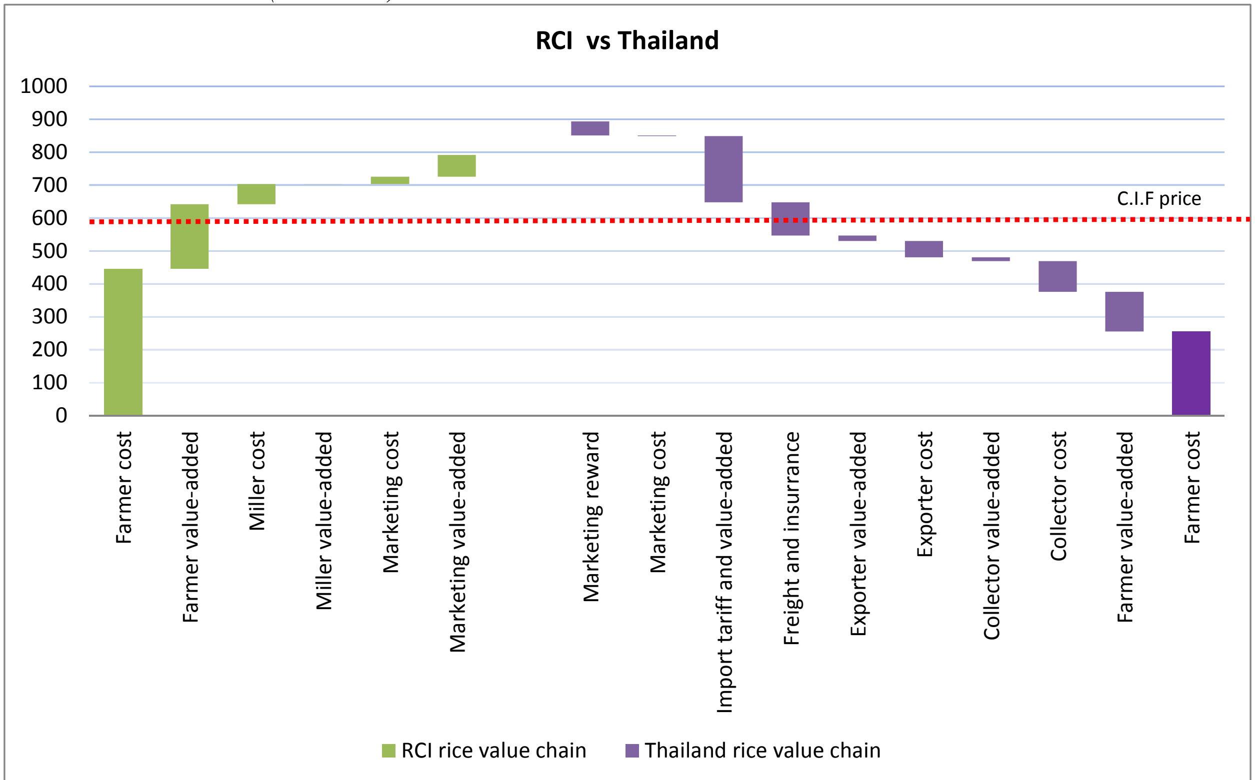
[19] All three WA focus countries have applied the common 10% external tariff (TEC) of the UEMOA, in addition to other duties and VAT at 18%. Thus, the current overall taxation level of rice is about 30% of the customs value.

final import parity price at wholesale rises above the average wholesale price, allowing local rice produced in RCI to compete with Asian imports, in financial terms. However, decreasing average protection levels from 30% to about 20% of the CIF price in RCI could result in the final import parity price at wholesale being equivalent to the level of the average wholesale price of local rice, as shown in Table 3.2.

Based on price alone, Mali and Senegal could compete with imports from Vietnam and Thailand even without a tariff, when domestic transport and marketing costs are included. These price differentials make sense considering that domestic rice in Senegal is usually of lower quality than imported rice and that Mali benefits from additional “natural protection” as a result of its landlocked geographic nature.

Figure 3.3: Comparison of selected irrigated rice value chains in WA benchmarked to selected irrigated rice value chains in Asia

A. RCI value chains (USD/ton)



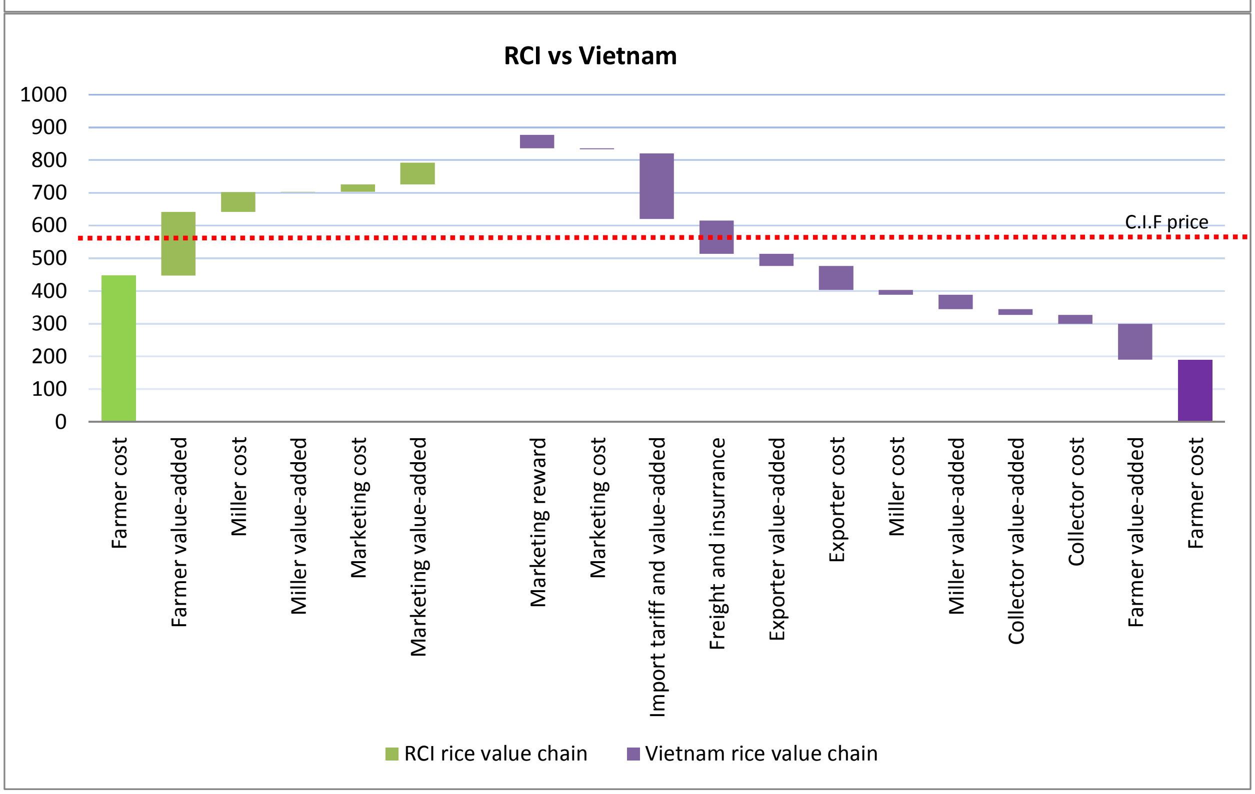
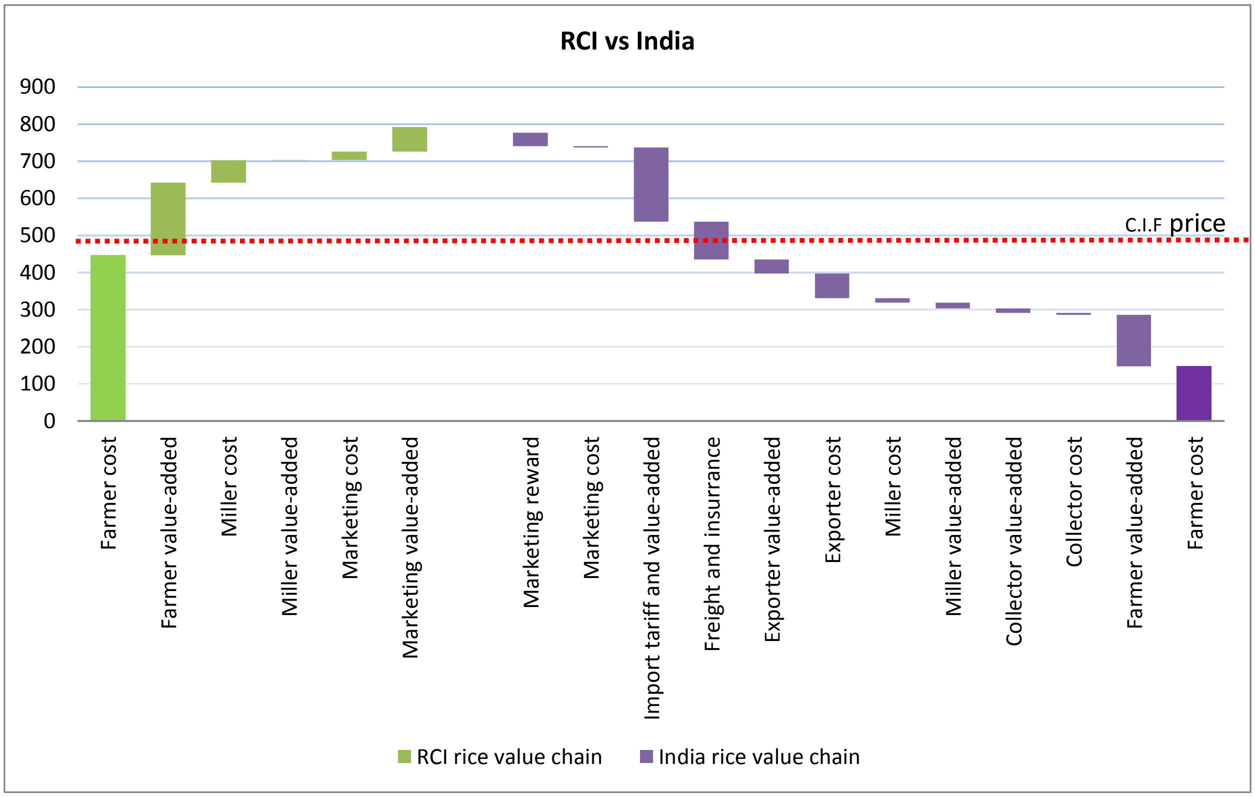


Figure 3.3. (cont'd)



B. Mali value chains (USD/ton)

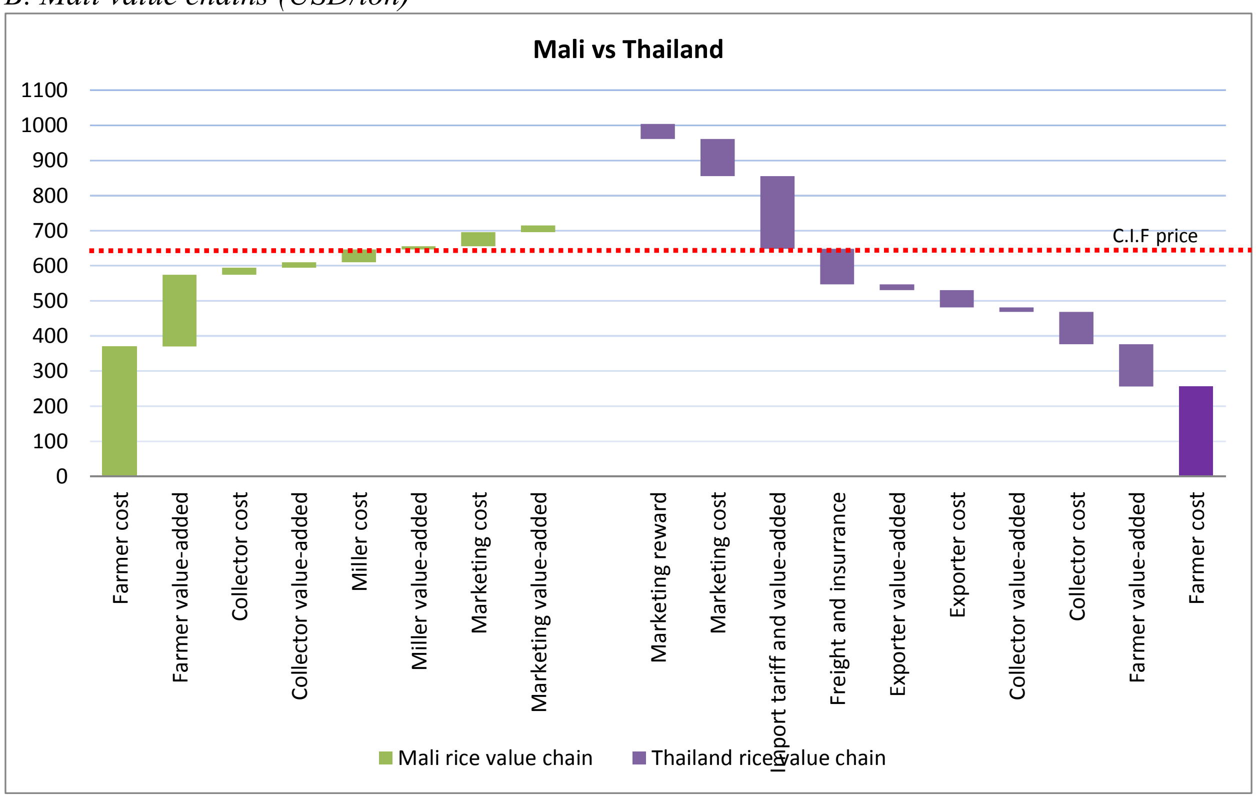
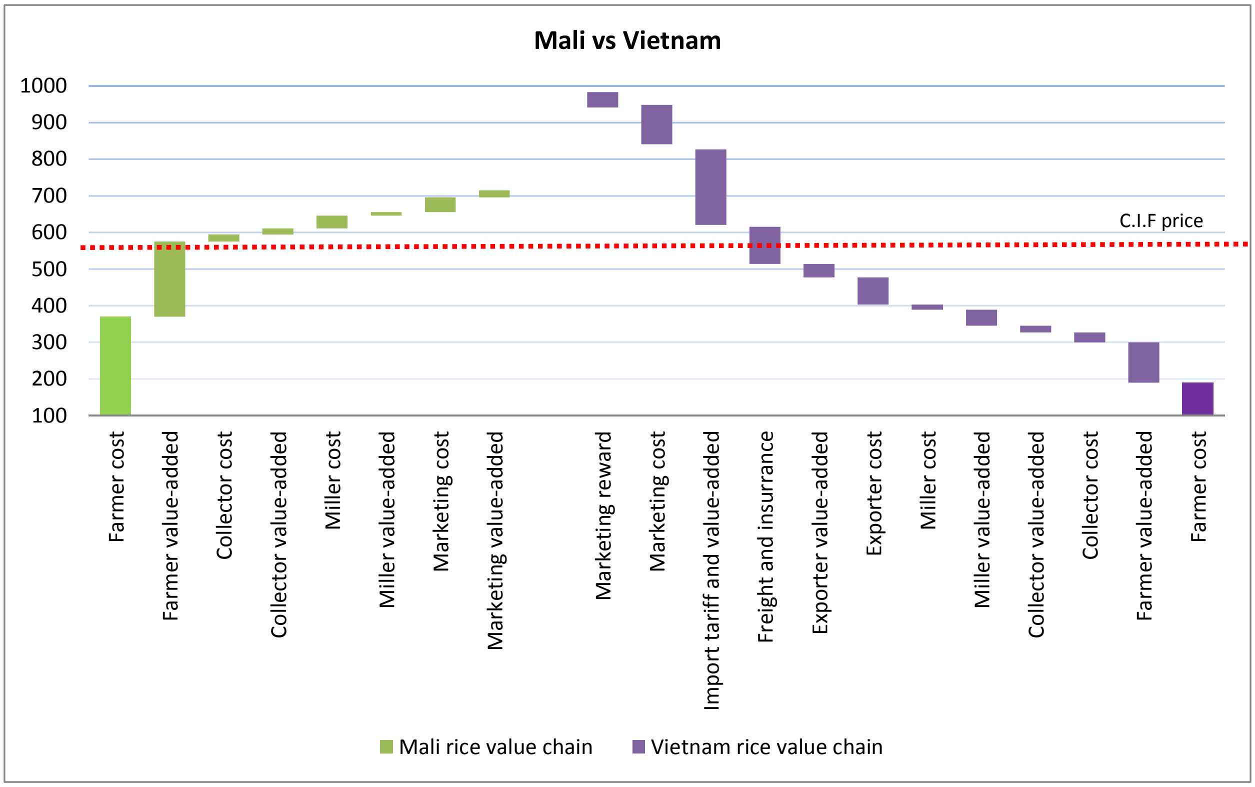


Figure 3.3. (cont'd)



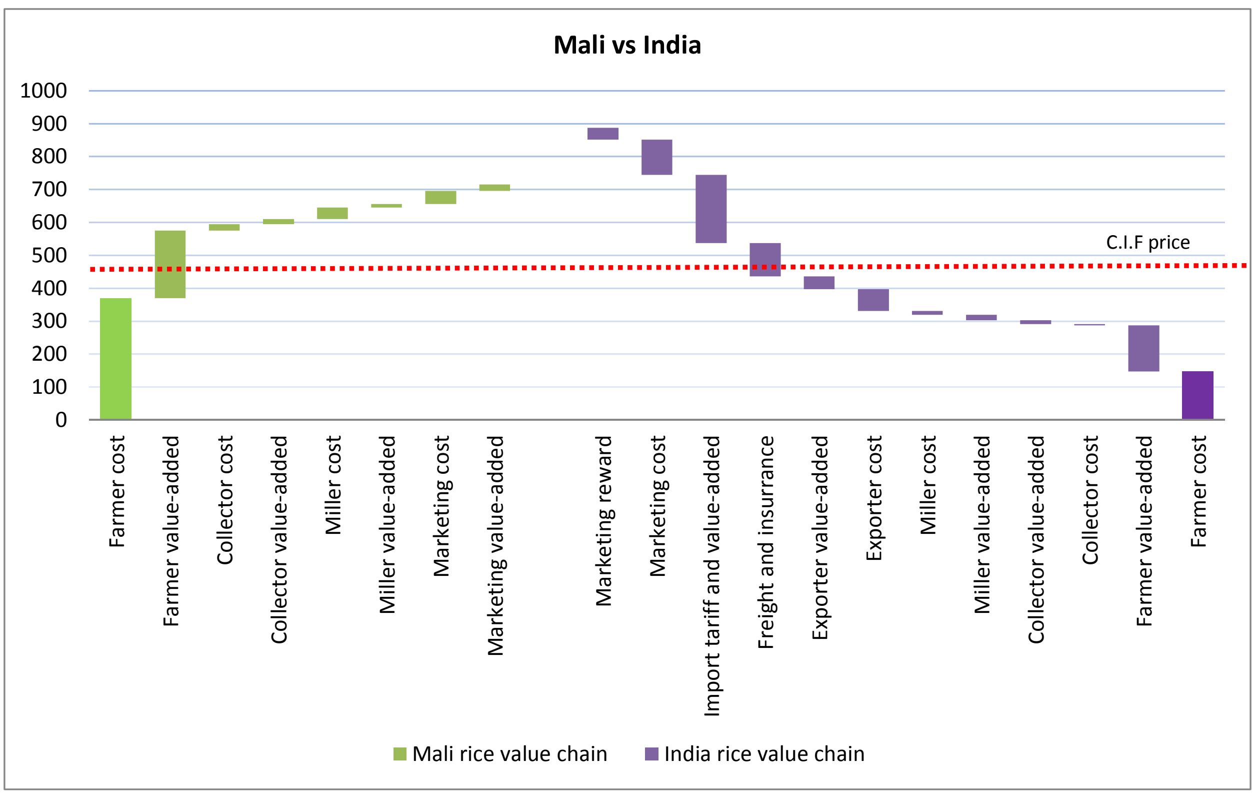
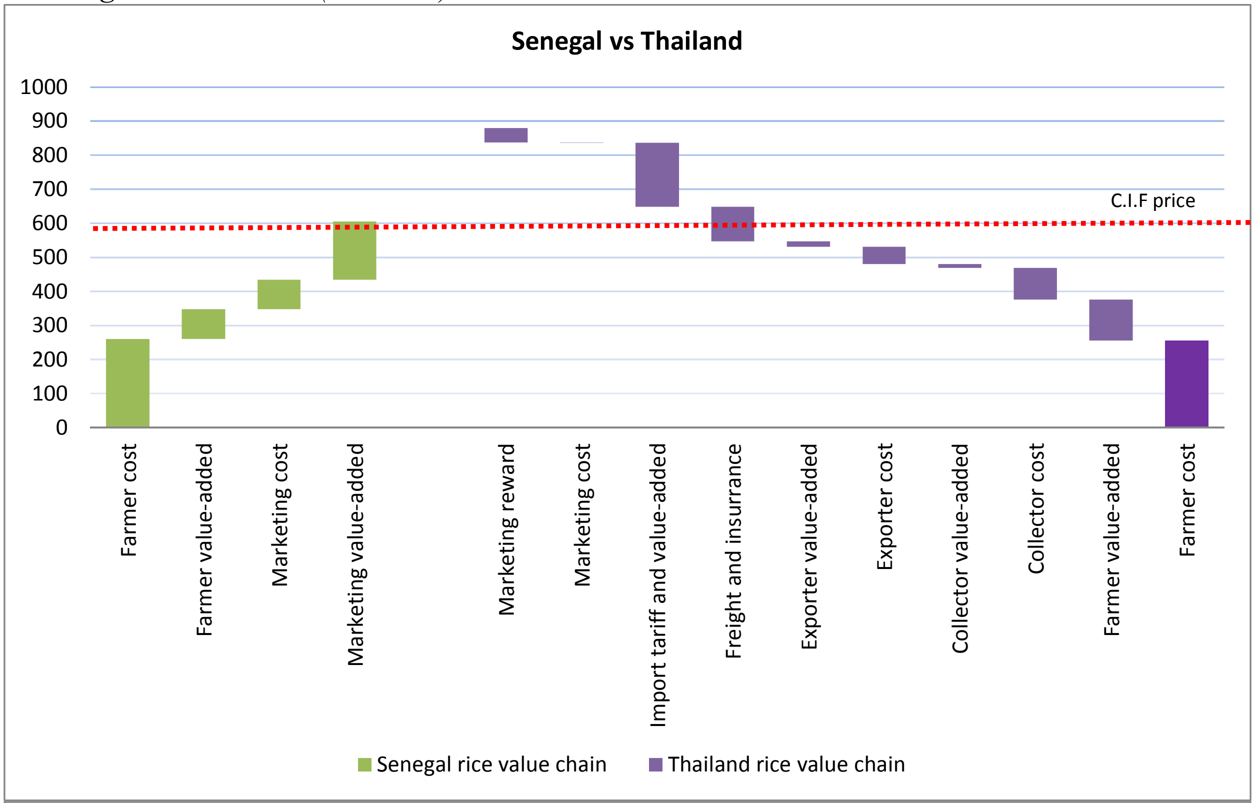
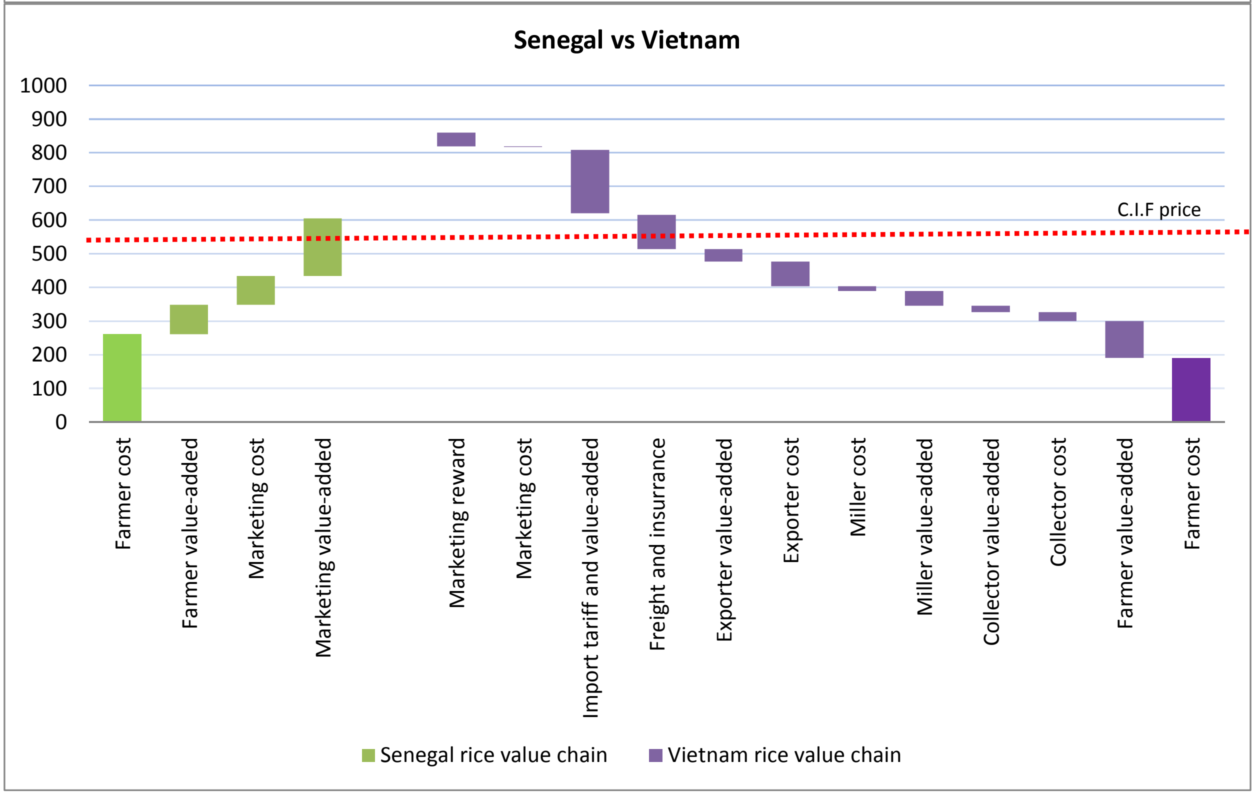
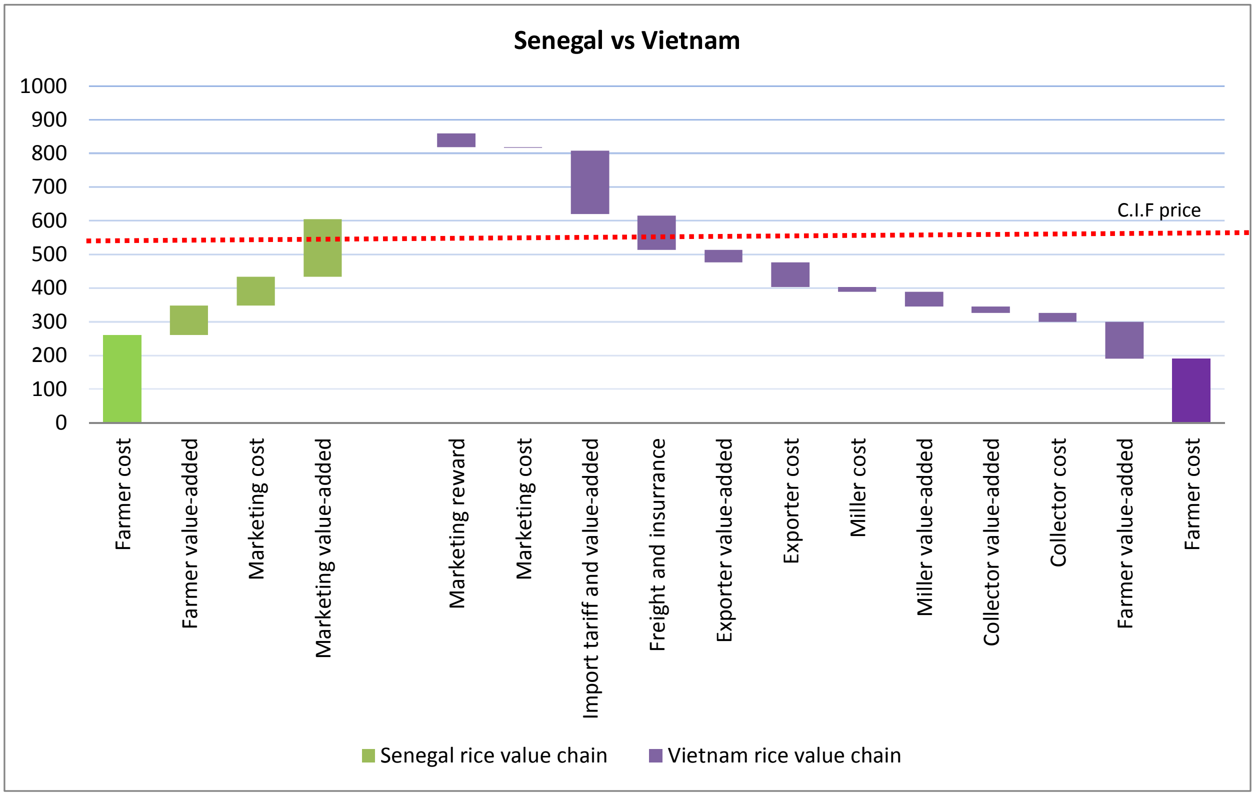


Figure 3.3. (cont'd)

C. Senegal value chains (USD/ton)







Source: Compiled by author with data from (Chen et al. 2013; Reardon et al. 2014; World Bank 2013; Stryker and Coulibaly 2011; Diallo et al. 2012; Dieng et al. 2011; Ouattara 2011)

Table 3.2: Protection level in selected WA rice value chains (USD/ton)

	RCI			MALI			SENEGAL		
	RCI - INDIA	RCI - VIETNAM	RCI - THAILAND	MALI - INDIA	MALI - VIETNAM	MALI - THAILAND	SENEGAL- INDIA	SENEGAL- VIETNAM	SENEGAL- THAILAND
Domestic wholesale price	792	792	792	715	715	715	605	605	605
Import parity price with zero tariff (CIF), including transport and marketing costs	622	665	688	687	769	792	580	663	686
Import parity price with current import tariff (FOB), including transport and marketing costs	811	868	897	896	1004	1034	760	868	898
Current protection level	31%	31%	31%	31%	31%	31%	31%	31%	31%
Break-even protection level	27%	19%	15%	4%	-7%	-10%	4%	-9%	-12%

Source: Compiled by author with data from (Chen et al. 2013; Reardon et al. 2014; World Bank 2013; Stryker and Coulibaly 2011; Diallo et al. 2012; Dieng et al. 2011; Ouattara 2011)

3.3 Economic analysis

3.3.1 Data

The analysis is conducted for selected countries in WA (Senegal, Côte d'Ivoire, and Mali). These countries were selected based on (a) their growing rice demand (and imports), (b) their potential comparative advantage and hence scope for import substitution, (c) the importance of rice production in their national investment plans, (d) the likelihood of rapidly expanding rice production in the next 5-10 years, and (e) the availability of adequate data to conduct the proposed analysis.

The analysis built on and updated secondary data extracted from previously completed comparative advantage and value chain analyses, notably those conducted by USAID (Stryker and Coulibaly 2011) for Mali and by AfricaRice and its national partners (NARS) in collaboration with Michigan State University (MSU) for RCI and Senegal (Diallo et al. 2012; Ouattara 2011; Dieng et al. 2011). The crop budgets used in those studies were developed in year 2009. Unfortunately, no recent detailed crop budgets for the selected value chains were available. Since up-to-date data on quantity of inputs used for the production of a hectare of rice were not available, this study assumed that no changes in quantities of inputs have occurred since 2009 and only adjusted the per unit cost figures of these inputs. Domestic output and input prices were collected from the NARS, the national Market Information Systems (MIS), and the Famine Early Warning Systems (FEWSNET). The processing and marketing data were also collected from the NARS. World market output and input prices were obtained from USDA/ERS and the World Bank Commodity Price Data (The Pink Sheet). Inflation rates were obtained from the Economic Community of West African States (ECOWAS), which were used to update transport rates[20]. Finally, freight rates, port

[20] Transport rates in West Africa are usually collected from traders; thus, these rates are likely to include nontariff barriers and bribes.

charges, and customs and import duties data were collected from various country reports presented at a workshop on price transmission and parity prices held in Bamako in 2009, notably for Mali, Senegal, Cote d'Ivoire and Burkina Faso (Diallo et al., 2009). The projected data on output prices and input costs for both West Africa and major Asian exporters used in the sensitivity analysis were obtained from major outlook studies discussed in Chapter 2 (i.e., OECD/FAO, USDA and the University of Arkansas). This information was also complemented with information collected from various stakeholders involved in the selected rice economies.

3.3.2 Main assumptions

3.3.2.1 Output prices

The year 2011 is taken as the base year of the study. Thus, the analysis is based on prices, subsidies, and tax policies that prevailed during that year, unless noted otherwise.

The prices of paddy and milled rice used in this study are the average producer price in the production zones under study (i.e., 175 CFAF/kg for RCI, 162 CFAF/kg for Mali and 92 CFAF/kg for Senegal) and average wholesale price in the capital city (i.e., 360 CFAF/kg in Abidjan for RCI, 325 CFAF/kg in Bamako for Mali and 275 CFAF/kg in Dakar for Senegal) reported by the national Market Information Systems (MIS) and the Famine Early Warning Systems (FEWSNET).

This study assumes that rice is imported to the main markets in the capital cities through the port of Abidjan for RCI and through the port of Dakar for Senegal and Mali. An important share of rice imports to West Africa originate from Thailand, the world's largest rice exporter, which produces different qualities of rice, ranging from 5 to 100% broken grains. The bulk of the rice imported by Mali and RCI is 25% broken rice, which is equivalent to the rice cultivated in the irrigated perimeters under study, while Senegal mostly imports 100% broken rice, which is comparable in quality to Thai A1 super. Thus, this study used the average 2011 FOB price for the 25% broken rice and Thai A1 rice of $505/MT and $488/MT, respectively, as reported by the World Bank Commodity Price Data (The Pink Sheet). Since imported rice into West Africa is considered an import substitute, given that rice imports are used to bridge the gap between production and local demand, the shadow price is estimated by the import parity price as defined above.

3.3.2.2 Exchange rate

In the early 1990s, there was empirical evidence showing that the CFAF currency, which is pegged to the Euro, was overvalued. The overvalued currency was believed to be the root of some of the poor economic performance of the countries in the CFAF zone; and thus, a devaluation of 50% of the currency was adopted and implemented in 1994 by all the countries of this monetary community. Although further evidence suggested that following the devaluation of the CFAF, the overvaluation trend was steadily increasing, reaching about 25% in the late 2000s (Etta-Nkwelle et al 2010), recent findings suggest that the currency remains slightly overvalued in Mali but is no longer overvalued in RCI and Senegal (Gnansounou and Verdier-Chouchane 2012). In light of the recent evidence, this study assumes that the CFAF is overvalued by 3% in Mali only.

The official exchange rate used to convert the reference price for rice (CIF) in CFAF franc is 409 CFAF to U.S. $ 1, i.e., the average rate from January to December 2011 (OANDA 2014). Assuming that the CFAF is not overvalued in RCI and Senegal but overvalued by 3% in Mali, the real exchange rate is estimated at 518 CFAF to U.S. $ 1 in Mali.

3.3.2.3 Cost of traded intermediate inputs

The most important input subsidy is that of fertilizer and improved seeds (up to 50% in Senegal). In the financial analysis, all traded production inputs are valued at their market price. Ideally, intermediate inputs such as fertilizer, seed, and transportation should be disaggregated into cost components until all cost items are traced back to tradable inputs, domestic factors and transfer payments (Gittinger 1982). However, this process is not used in this study because all necessary data were not available. Thus, the full costs of seed and fertilizer are classified as tradable input costs and are valued at their import parity price as described above.

3.3.2.4 Cost of labor

Irrigated rice production in rehabilitated perimeters is considered to be a commercial operation, and the rural labor market is relatively competitive during the period between land preparation and harvest, and therefore uses an average wage rate as the shadow value of agricultural labor. Thus, this study assumes that all labor is hired and is remunerated at the rural market wage rate, using data provided by the NARS.

3.3.2.5 Cost of land

The value of land is accounted for in both the financial and economic analysis. Conventionally, land has been assigned a zero economic cost in most DRC analyses conducted in West Africa. In this study, land is valued at its opportunity cost. Given the commercial nature of the rice operation in irrigated perimeters and growing concerns about land deterioration, the proxy of the opportunity cost of using land is estimated by the actual payment that a farmer makes for using land (or the rental price per hectare), which ranges from about 90,000 CFAF/ha in Mali where land rental markets are more developed to 15,000 CFAF/ha in Senegal, assuming no illicit land rental or sale.

3.3.2.6 Cost of capital

Capital costs involve working capital as well as both the depreciation and the cost of capital that is tied up in physical investment and thus are not available to earn the going rate of return in the capital market. Fixed depreciation on all tools and other equipment with a useful life spread over more than one crop cycle has been estimated applying a capital recovery factor, which depends on the service life of that investment and the rate of interest, to the cost of the initial investment.[21]

The most important capital cost in the analysis is that associated with total water control irrigation infrastructure[22], which varies from 3.5 million CFAF/ha in Senegal up to 4.5 million CFAF/ha in Mali. Much of this investment in irrigation infrastructure is paid for by the government and is thus considered to be a sunk cost in the financial analysis. However, this investment cost in irrigation is included in the economic analysis.

A major factor determining the economic profitability of irrigation systems of rice production is the real rate of interest at which the cost of irrigation is calculated. The cost of capital is valued at the going rate in the private sector for bank lending adjusted for inflation (ranging from 8% to 10%). This rate is assumed to be devoid of any distortion and therefore represents the social cost of capital.

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[21] Annual capital cost per hectare = purchase price of implement * per hectare share of use * capital recovery factor (CRF). The CRF is given by $(1+i)^n/((1+i)^n -1)$, where i is the real interest rate and n is the service life of the investment. The real interest rate $i = ((1+r)/(1+\pi))-1$, where r is the nominal in interest rate and π is inflation. For a full description of this methodology, see Monke and Pearson (1989).

[22] The other capital expenditures are for agricultural and processing equipment and for working capital, but these are much less important.

3.3.3 Results and discussion of base scenario

The analysis conducted below estimates the economic as well as financial profitability of the rice value chain. The main results of the analysis using the base assumptions described above are presented in Table 3.3. Details are provided in the appendix.

The rice value chain is most profitable in financial terms in RCI (119 000 CFAF/t), followed by Mali (114 000 CFAF/t) and Senegal (102 000 CFAF/t). Although both financial and economic profit are positive for Mali and Senegal in 2011, suggesting that commercial rice production and marketing is profitable for the entire value chain as well as for society as a whole in each of these countries for that year, economic profit is negative for RCI. Thus, the rice value chain is least profitable in economic terms in RCI (-1 000 CFAF/t) and most socially profitable in Mali (98 000 CFAF/t), followed by Senegal (48 000 CFAF/t). The positive difference between the financial and economic profit in all countries results from current policies that are subsidizing production and marketing of rice, making it look more profitable to private actors than it is for society as a whole. In other words, there are net transfers from the rest of society to the actors in the rice value chain.

However, the results of the economic analysis above need to be taken with caution, given that estimations were made without accounting for the relative importance of total area of rice produced in a particular system, nor the relative size of these production schemes. While the above indicators of social profitability show whether a production system is profitable to society, they do not explicitly inform on how they make use of domestic resources relative to an alternative system. The computation of DRC ratios explicitly addresses this issue.

Results of the DRC computations are consistent with the results of the absolute measure of economic profitability analysis above. The DRC ratio of RCI is equal to one (1.00) while it inferior to one for Mali (0.68) and Senegal (0.78). This shows that, from the national point of view, it is desirable to produce and market rice and further develop commercial rice value chains in Mali and Senegal because the social net value added is greater than the social cost of its domestic production factors while RCI neither gained nor saved foreign exchange through domestic production. In fact, agronomic research suggests that Sahelian regions are typically better suited to rice production because of greater insolation and fewer diseases than in more humid zones (Wopereis 2013). Moreover, the magnitude of the DRC ratios suggests that commercial rice value chains are relatively more competitive in Mali, which has the lowest DRC ratio at the time of investigation. As expected, the values of the SCB ratios differ from those of the DRC ratios, except for RCI, implying that some misclassification of costs of locally produced inputs as tradable and nontrable may have occurred in the DRC analysis. Nonetheless, the SCB computations are also consistent with the DRC ratios results, with SCB ratios inferior to one for Mali (0.74) and Senegal (0.83) and equal to one for RCI (1.00), corroborating that rice value chains are competitive in Mali and Senegal but “break even” in RCI, with Mali being the most efficient of the three systems and RCI the least efficient.

Table 3.3: Selected Financial and Economic Performance Indicators

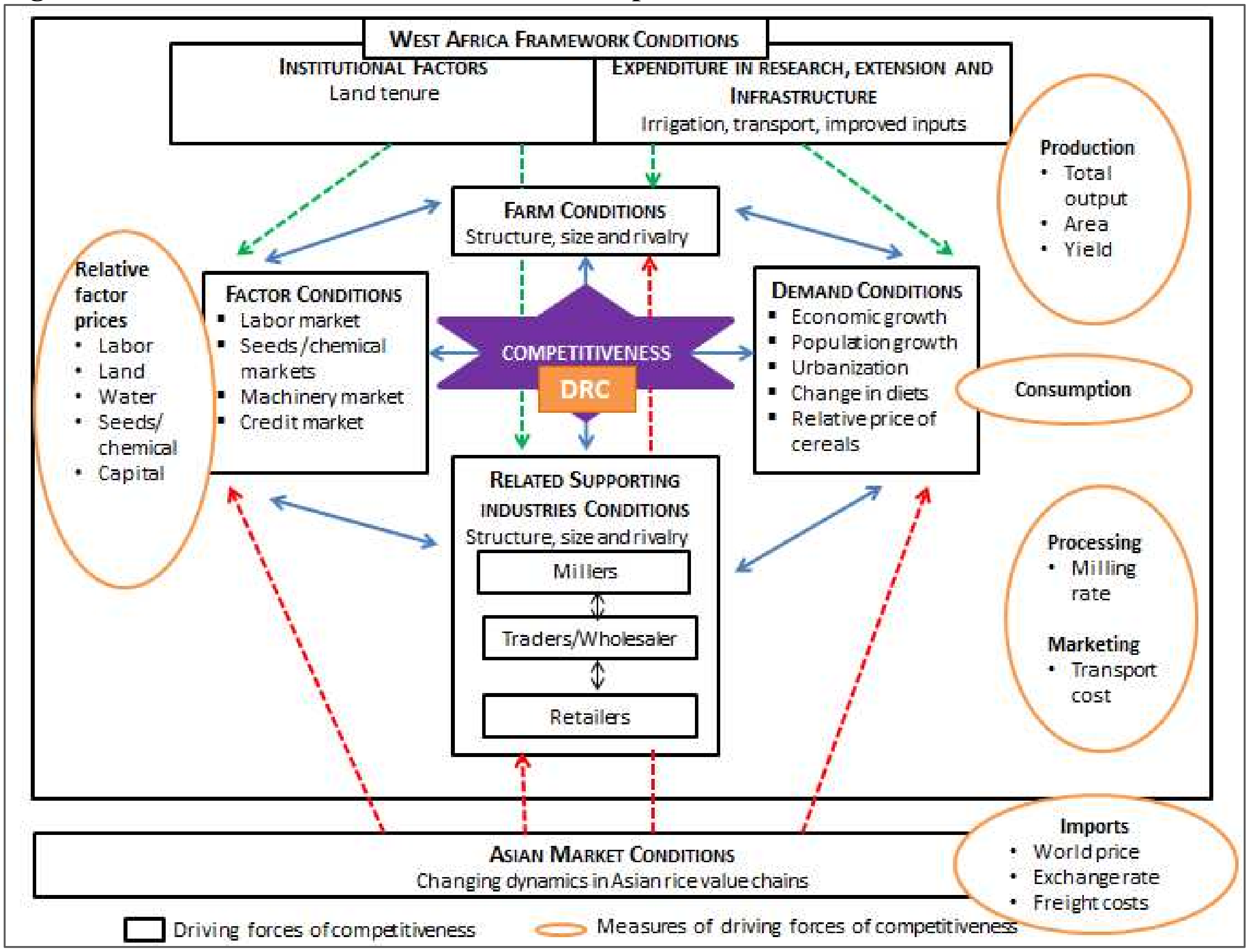
Indicators	Production systems								
	RCI			MLI			SEN		
	Financial	Economic	Divergence	Financial	Economic	Divergence	Financial	Economic	Divergence
TECHNOLOGY									
Yield (MT paddy per ha)	5	5	0	6	6	0	5	5	0
Milling rate (%)	60%	60%	0	62%	62%	0	62%	62%	0
Fertilizer and seed costs (1000 CFAF/MT)	111	105	6	119	140	-21	52	98	-45
Irrigation costs (1000 CFAF/MT)	0	282	-282	67	344	-277	64	276	-212
Transport costs (1000 CFAF/MT)	43	27	16	82	49	34	22	12	9
TOTAL COST LOCAL RICE (1000 CFAF/MT)									
Value-added									
Farmer	203	287	-85	168	247	-79	134	205	-71
Trader				9	7	2			
Miller	28	26	1	16	16	0			
Wholesaler	10	6	4	18	12	6	39	36	3
Total Value-added	241	320	-80	211	282	-70	173	241	-68
TOTAL VALUE OF LOCAL RICE (1000 CFAF/MT)									
Retail price local rice	360	320	40	325	380	-55	275	289	-14
PROFITABILITY OF LOCAL RICE (1000 CFAF/MT)									
Net returns	119	-1	120	114	98	15	102	48	54
COMPARATIVE ADVANTAGE									
DRC		1.00			0.68			0.78	
SCB		1.00			0.74			0.83	

3.3.4 Comparative advantage under alternative scenarios

This chapter analyzes the capacity of WA to respond to key structural changes in rice systems and demand in Asia and WA. It does so by developing scenarios of future comparative advantage of WA using projections obtained from major outlook studies discussed previously in Chapter 2 (see Figure 3.4).

The scenario analysis assesses: (i) the impact of single policy variables on the economic competitiveness or comparative advantage of the rice subsector in the selected WA countries, assuming that there are no interactions between changes in the Thai and West African economies (i.e., partial equilibrium) in order to determine the relative magnitude of the expected changes of each factor on comparative advantage; (ii) the impact of single policy variables on the comparative advantage of the WA rice value chains resulting from changes in both the Thai and WA economies, assuming changes in the Thai economy are reflected in the world price of rice; and (iii) the impact of multiple policy variables on the comparative advantage of the WA rice value chains resulting from changes in both the Thai and WA economies.

Figure 3.4: The determinants of economic competitiveness and their measures



Source: By the author

3.3.5 Impact of individual determining factor on comparative advantage, assuming no interaction between changes in world prices and factors affecting WA economies

The results of sensitivity analysis showing the impact of the individual factors, assuming no interaction between the factors affecting the Thai and WA economies, are summarized in Table 3.4. The analysis looks at the impact of reductions in world prices, shadow exchange rate, yields and milling rates, as well as increases in fertilizer, labor, land, irrigation, transportation, and capital costs over the medium run (i.e., period 2011-2016) and long run (i.e., 2011-2021).

3.3.5.1 Change in the world price

World prices of rice, on average, are projected to remain on a high plateau, although below 2007/08 levels (Wailes and Chavez 2011). Thus, a 12% decrease over the next 10 years in the world price yields a DRC of 1.24 in RCI, 0.78 in Mali, and 0.93 in Senegal, resulting in a deterioration of comparative advantage.

3.3.5.2 Change in the shadow exchange rate

The foreign exchange rate is an important factor affecting prices in global rice trade because international rice prices are quoted in US dollars. The U.S. dollar is projected to continue to depreciate through 2011-2021 (Wailes and Chavez 2011). However, as the prevailing market exchange rate in all three focus countries is already approaching the shadow exchange rate (SER) (Gnansounou and Verdier-Chouchane 2012), it is unrealistic to simulate a scenario with a substantial change in the shadow rate of exchange[23]. Thus, assuming a 10% depreciation of the dollar relative to the CFAF and continued fixed parity of the CFAF and the Euro over the next 10 years yields a DRC of 1.18 in RCI, 0.76 in Mali, and 0.89 in Senegal, indicating a deterioration of comparative advantage.

3.3.5.3 Change in yield

Technological change is one of the major driving forces in altering a country's comparative advantage. Wailes and Chavez (2011) project Africa's total rice output to grow by 2.86% per year,

[23]Although the stated policy of ECOWAS is to move to a common (presumably unlinked) WA currency that will harmonize the CFA currency, common among the eight Francophone members, and the individual currencies of the other members, by 2020, this study assumes that parity is maintained with the Euro even in the long-run scenario given historical delays and uncertainty in implementation (commencement date shifted from 2003 to 2005, then 2010 and to 2014).
http://dailytrust.com.ng/daily/editorial/30623-another-postponement-of-ecowas-common-currency

driven by 1.09% annual growth in area and 1.75% annual improvement in yields. The expected productivity improvement in Africa is supported by availability of increased research funding from institutions and NGOs, more focused efforts by the AfricaRice Center and the International Rice Research Institute (IRRI), and a possible expanded distribution and adoption of improved rice varieties like the recently developed New Rice for Africa (NERICA) cultivars. More specifically, yields are expected to increase steadily and significantly in Mali (i.e., 22% over 2011-2021) and Senegal (5% over 2011-2021) while in RCI, they are expected to first decrease in the medium-run before increasing again in the long-run (i.e., - 6% over 2011-2016 and 3% over 2011-2021) (Wailes and Chavez 2011). Under these assumptions, comparative advantage is expected to improve in the long run in all WA countries, including RCI, with DRC ratios of 0.96 in RCI, 0.55 in Mali and 0.74 in Senegal.

3.3.5.4 Change in milling rates

Well-performing processing technologies are essential to improve the comparative advantage of the rice value chain, as the paddy-to-milled rice conversion rate determines the unit cost of milled rice; the higher the conversion rate is, the lower the unit cost of milled rice will be. The conversion rate of paddy to rice varies depending on the milling equipment. It averages about 60% for small mobile Engelberg-type hullers, 63% on average for the compact plastic roller units, 65% for mini rice mills, and 67 to 68% for larger industrial units (Diarra 2000). Assuming that average rates increase from 60% to 65% in RCI and from 62% to 67% in both Mali and Senegal by 2021, DRCs would decrease to 0.89 for RCI, 0.62 for Mali and 0.70 for Senegal.

3.3.5.5 Change in fertilizer and fuel prices

Crude oil prices are transmitted to agricultural commodity prices mainly through fertilizer and fuel costs, and the world oil price is expected to increase from an observed price of USD 78 per barrel in 2010 to USD 107 per barrel by 2020 or about an average of 2% per year (OECD/FAO 2013). This analysis is conducted assuming that fertilizer and other chemicals as well as transport costs (both maritime transport from Thailand to WA as well as inland transport within WA) increase proportionally to these projected oil prices. The results suggest an overall reduction in comparative advantage of the rice value chains for all countries when chemical costs increase 20% in the next ten years (DRC of 1.06 for RCI, 0.70 for Mali, and 0.80 for Senegal). When inland transport costs increase 20% over the same period, there is a slight decrease in comparative advantage for RCI and Mali (DRC of 1.02 and 0.69, respectively) but no change for Senegal (DRC of 0.78). However, there is a notable improvement in comparative advantage for all countries when similar assumptions are made for maritime freight costs (DRC of 0.95 for RCI, 0.65 for Mali, and 0.74 for Senegal). Moreover, higher energy prices would increase production costs in Asia and hence world prices, further contributing to improving comparative advantage of WA rice value chains.

3.3.5.6 Change in the social cost of labor

As discussed earlier, fewer young people want to work in the agricultural sector, and the share of the WA urban population of 41.6% in 2010 is projected to increase to 48.3% by 2020. More specifically, this share is expected to increase from 50.6% to 57.5% in RCI, 36% to 40.7% in Mali, and 42.2% to 43.7% in Senegal, over the same period (UN-DESA 2014). Moreover, the clear commitment of WA governments to improve mechanization is expected to increase the share of skilled workers in rural areas, and thus drive up the rural cost of labor. Assuming a 50% rise in the rural wage rate by 2021 yields a DRC of 1.17 in RCI, 0.78 in Mali and 0.86 in Senegal.

3.3.5.7 Change in the market rent for land

Significant rice area expansion is expected in Mali over the period 2011-2021 (19%), while there will noticeable contractions in RCI (-32%) and relative stagnation in Senegal (2%) (Wailes and Chavez 2011). Moreover, West Africa's population is rapidly urbanising, with urban populations growing 4.5% annually, against 1.8% in rural areas over the period 1980- 2010. This trend is expected to continue between 2011 and 2050, with urban population growth projected at 3.7% per annum compared to only 0.5% in rural areas (Hollinger and Staatz 2015). Continued population growth and urbanization will put considerable pressure on total agricultural land and will, therefore, affect the value of agricultural land. Irrigated land rental prices in Mali, where a dynamic land rental market already exists, are much higher than RCI and Senegal (i.e., 3 to 6 times as high, respectively). Thus, the rental market is expected to significantly increase for irrigated land in RCI and Senegal, where less area will open up for rice cultivation and where a formal rental market is not yet well developed. Assuming that land rental costs will at least double over the next ten years in RCI and Senegal and only increase 20% in Mali yields a DRC of 1.06 in RCI, 0.70 in Mali and 0.80 in Senegal.

3.3.5.8 Change in irrigation costs

Given West African countries' priorities to develop irrigation systems in major cultivable areas, especially lowlands, water must be used and priced more efficiency; and thus, irrigation infrastructure costs must be reduced. As mentioned above, the development of water control infrastructure in the lowlands costs about six times less per ha than full water control. Assuming that the costs of irrigation are at least halved by 2021 as a result of adopting new technologies yields a DRC of 0.77 in RCI, 0.56 in Mali and 0.62 Senegal.

3.3.5.9 Change in financing costs

Low investment and lack of access to credit facilities are among the major limiting factors in smallholder rice production. Although still high, interest rates have been declining in much of Africa (2.5% over the period 2006-2011) (Rosenberg et al. 2013). These trends are expected to continue, especially in a context where contract farming and "tied output-credit markets" – situations where millers/wholesalers advance payments and technical assistance to farmers to "lock them in"— is expected to reemerge (see Chapter 2). Assuming a 10% decline in interest rates over the next ten years in all countries yields improves their comparative advantage (DRC of 0.95 for RCI, 0.65 for Mali, and 0.74 for Senegal).

The relative magnitude of the expected changes of each factors on competitiveness are summarized in Figure 3.5. Rising wage rates, land costs, and inland transport costs are expected to contribute to reducing the comparative advantage of WA rice value chains but much less than declining world prices of rice, increasing chemical costs, and continued depreciation of the dollar relative to the CFA franc. However, improving yields and milling efficiency, along with decreasing irrigation costs have the most potential to improve comparative advantage; rising ocean freight costs and declining interest rates also contribute to increasing comparative advantage, but to a lesser extent.

Table 3.4: Impact of single policy variables on the comparative advantage of the rice value chain in WA countries

		% change		DRC		SCB	
			RCI				
	Scenario	% change		DRC (1.00)*		SCB (1.00)*	
		MR	LR	MR	LR	MR	LR
1	World rice price	-5%	-12%	1.09	1.24	1.09	1.14
2	Dollar exchange rate	-5%	-10%	1.09	1.18	1.05	1.11
3	Ocean freight costs	10%	20%	0.97	0.95	0.98	0.97
4	Inland transport costs	10%	20%	1.01	1.02	1.01	1.01
5	Yield	-6%	3%	1.11	0.96	1.06	0.97
6	Chemical costs	10%	20%	1.03	1.06	1.02	1.03
7	Milling rate	5%	8%	0.93	0.89	0.95	0.69
8	Irrigation costs	-20%	-50%	0.91	0.77	0.94	0.85
9	Capital costs	-5%	-10%	0.97	0.95	0.98	0.97
10	Land costs	50%	100%	1.03	1.06	1.02	1.04
11	Labor costs	20%	50%	1.07	1.17	1.04	1.1
			MALI				
	Scenario	% change		DRC (0.68)*		SCB (0.74)*	
		MR	LR	MR	LR	MR	LR
1	World rice price	-5%	-12%	0.72	0.78	0.78	0.83
2	Dollar exchange rate	-5%	-10%	0.72	0.76	0.77	0.81
3	Ocean freight costs	10%	20%	0.67	0.65	0.73	0.72
4	Inland transport costs	10%	20%	0.68	0.69	0.75	0.75
5	Yield	11%	22%	0.61	0.55	0.68	0.62
6	Chemical costs	10%	20%	0.69	0.70	0.75	0.76
7	Milling rate	5%	8%	0.64	0.62	0.71	0.69
8	Irrigation costs	-20%	-50%	0.63	0.56	0.70	0.64
9	Capital costs	-5%	-10%	0.67	0.65	0.73	0.72
10	Land costs	10%	20%	0.69	0.70	0.75	0.75
11	Labor costs	20%	50%	0.72	0.78	0.77	0.82
			SENEGAL				
	Scenario	% change		DRC (0.78)*		SCB (0.83)*	
		MR	LR	MR	LR	MR	LR
1	World rice price	-5%	-12%	0.83	0.93	0.88	0.95
2	Dollar exchange rate	-5%	-10%	0.83	0.89	0.88	0.92
3	Ocean freight costs	10%	20%	0.76	0.74	0.82	0.81
4	Inland transport costs	10%	20%	0.78	0.78	0.84	0.84
5	Yield	3%	5%	0.75	0.74	0.81	0.80
6	Chemical costs	10%	20%	0.79	0.80	0.84	0.85
7	Milling rate	5%	8%	0.73	0.70	0.80	0.77
8	Irrigation costs	-20%	-50%	0.72	0.62	0.79	0.72
9	Capital costs	-5%	-10%	0.76	0.74	0.82	0.80
10	Land costs	50%	100%	0.79	0.80	0.84	0.85
11	Labor costs	20%	50%	0.81	0.86	0.86	0.90

Notes: * Base scenario, MR = medium-run; LR = long-run

Figure 3.5: Impacts of likely trends in various factors on the comparative advantage of WA rice value chains

		Trend	RCI	MALI	SENEGAL
Productivity	Yield	↑	+	+ +	+
	Milling rate	↑	+ +	+ +	+ +
Non-domestic factors	World rice price	↓	− −	− −	− −
	Dollar exchange rate	↓	− −	− −	− −
	Ocean freight costs	↑	+	+	+
	Inland transport costs	↑	−	−	−
	Chemical costs	↑	−	−	−
Domestic factors	Irrigation costs	↓	+ +	+ +	+ +
	Interest rate	↓	+	+	+
	Land costs	↑	−	−	−
	Labor costs	↑	− −	− −	− −

Note: the positive and negative signs indicate the direction of relationship between each factor and comparative advantage, and the up and down arrows indicates an increase or decrease in the future trend of each factor.

3.3.6 Impact of individual determining factors on comparative advantage, assuming interaction between the Thai and WA economies

This section assesses the impact of individual policy variables on the comparative advantage of the commercial rice value chain for the selected WA countries in the short-run and long-run, assuming that future comparative advantage is affected by changes occurring in both the Thai and WA rice economies. Changes occurring in Thailand are assumed to be reflected through impacts on world prices. The baseline situation in these scenarios—decline in world price and decline in US dollar—are drawn as the likely world market conditions as indicated from the analysis in Chapter 2. The following scenarios are considered in the sensitivity analysis:

1) Decreased world rice prices and exchange rates ;
2) in addition to scenario 1, increased ocean freight costs;

3) in addition to scenario 1, increased inland transportation costs;
4) in addition to scenario 1, increased yields
5) in addition to scenario 1, increased chemical costs
6) addition to scenario 1, increased milling rates;
7) in addition to scenario 1; reduced irrigation costs;
8) in addition to scenario 1; reduced financing costs;
9) in addition to scenario 1; increased land rental costs; and
10) in addition to scenario 1; increased labor costs.

The results, summarized in Table 3.5, indicate that the comparative advantage of all three WA countries is expected to worsen in all 10 scenarios. However, the comparative advantage of producing and marketing rice remains strongest in Mali (i.e., smallest DRC and SCB ratios, and all inferior to one) in all 10 scenarios while RCI lacks comparative advantage in all 10 scenarios. Senegal is only able to compete with Thai imports in the long run under scenario 6 and 7 (i.e., milling rates are increased 8% and irrigation costs halved, respectively).

RCI would be able to compete with imports in the long run if, for instance, land costs decreased by at least 7 times (versus 2 times as projected), ocean freight costs increased by about 2.5 times (versus 20%), labor costs decreased by 100% (versus 50% increase), yield or increased milling rates increased by 26% (versus 3% or 8%, respectively), or irrigation costs decreased by 70% (versus 50%). In the case of Senegal, land costs should decrease by about 3.5 times, ocean freight costs increase 27%, labor costs decrease 31%, or yields increase 6% for the country to remain competitive with Thai imports. However, Mali would lose its competitive edge if ocean freight costs decreased by 68%, labor costs increased by 52%, yield or milling rates decreased by about 10%, or irrigation costs increased by 42%.

Table 3.5: Impact of single policy variables on the comparative advantage of the rice value chain in WA countries resulting from changes in both the Thai and WA economies

	RCI								
	Scenario	BE**		% change		DRC (1.00)*		SCB (1.00)*	
		MR	LR	MR	LR	MR	LR	MR	LR
1	World rice price Dollar exchange rate			-5% -5%	-12% -10%	1.18	1.49	1.11	1.26
2	Ocean freight costs	60%	145%	10%	20%	1.21	1.54	1.12	1.27
3	Inland transport costs	--	--	10%	20%	1.32	1.45	1.18	1.22
4	Yield	11%	26%	-6%	3%	1.22	1.62	1.13	1.3
5	Chemical costs	-58%	-122%	10%	20%	1.09	1.29	1.05	1.16
6	Milling rate	11%	26%	5%	8%	1.07	1.14	1.04	1.07
7	Irrigation costs	-33%	-70%	-20%	-50%	1.26	1.74	1.15	1.39
8	Capital costs	-28%	-62%	-5%	-10%	1.15	1.40	1.09	1.21
9	Land costs	-290%	-614%	50%	100%	1.22	1.57	1.13	1.30
10	Labor costs	-47%	-100%	20%	50%	1.26	1.74	1.15	1.39
	MALI								
	Scenario	BE**		% change		DRC (0.68)*		SCB (0.74)*	
		MR	LR	MR	LR	MR	LR	MR	LR
1	World rice price Dollar exchange rate			-5% -5%	-12% -10%	0.76	0.87	0.81	0.90
2	Ocean freight costs	-128%	-68%	10%	20%	0.74	0.84	0.80	0.87
3	Inland transport costs	166%	96%	10%	20%	0.76	0.89	0.81	0.91
4	Yield	-21%	-11%	11%	22%	0.68	0.70	0.74	0.76
5	Chemical costs	187%	87%	10%	20%	0.77	0.90	0.82	0.92
6	Milling rate	-20%	-10%	5%	8%	0.71	0.79	0.77	0.84
7	Irrigation costs	90%	42%	-20%	-50%	0.70	0.71	0.77	0.78
8	Capital costs	70%	33%	-5%	-10%	0.74	0.83	0.79	0.87
9	Land costs	269%	126%	10%	20%	0.77	0.89	0.82	0.92
10	Labor costs	11%	52%	20%	50%	0.80	0.99	0.84	1.00
	SENEGAL								
	Scenario	BE**		% change		DRC (0.78)*		SCB (0.83)*	
		MR	LR	MR	LR	MR	LR	MR	LR
1	World rice price Dollar exchange rate			-5% -5%	-12% -10%	0.89	1.07	0.92	1.05
2	Ocean freight costs	-44%	27%	10%	20%	0.87	1.02	0.91	1.01
3	Inland transport costs	147%	--	10%	20%	0.90	1.08	0.93	1.06
4	Yield	-9%	6%	3%	5%	0.86	1.01	0.90	1.01
5	Chemical costs	71%	-38%	10%	20%	0.91	1.11	0.93	1.07
6	Milling rate	-8%	5%	5%	8%	0.84	0.96	0.88	0.97
7	Irrigation costs	30%	-17%	-20%	-50%	0.82	0.86	0.87	0.90
8	Capital costs	23%	-13%	-5%	-10%	0.87	1.02	0.91	1.06
9	Land costs	427%	-234%	50%	100%	0.90	1.10	0.93	1.07
10	Labor costs	56%	-31%	20%	50%	0.93	1.19	0.95	1.13

Notes: *base scenario; **break-even analysis for DRC, -- = more than 1000%, MR = medium-run; LR = long-run
The assumptions in scenario 1 are added to the assumptions in the other scenarios.

3.3.7 Impact of multiple determining factors on comparative advantage

In the previous section, sensitivity analyses were performed to assess how DRC coefficients react to a change in a single factor of comparative advantage. Although changing a single factor may sometime help improve the comparative advantage of rice, it is not always the case, as suggested by the results of RCI. A more realistic picture can be obtained from the combined effects of the assumptions discussed above (Table 3.6). This section assesses the joint impact of several policy variables on the comparative advantage of the commercial rice value chain for the selected West African in both the short-run and long-run, assuming that future comparative advantage is affected by changes occurring in both the Asian and WA rice economies, under the following scenarios:

1) Decreased world rice prices and exchange rates ;
2) in addition to scenario 1, increased ocean freight costs;
3) in addition to scenario 2, increased inland transportation costs;
4) in addition to scenario 3, increased yields
5) in addition to scenario 4, increased chemical costs
6) addition to scenario 5, increased milling rates;
7) in addition to scenario 6; reduced irrigation costs;
8) in addition to scenario 7; reduced financing costs;
9) in addition to scenario 8; increased land rental costs; and
10) in addition to scenario 9; increased labor costs.

When several policy variables are implemented simultaneously, the rice value chain in RCI is expected to lose comparative advantage vis-à-vis imported Thai rice in the long run, except in scenario 7, 8, and 9. While the gain in comparative advantage obtained from increased yield and milling rate, and decreased irrigation and financing costs are sufficient to compensate the loss in comparative advantage resulting from the combined effect of reduced world rice prices and exchange rate, and increased fertilizer, transport costs, and land costs, it is not enough to compensate additional increase in labor costs.

Moreover, Senegal loses its competitive edge in the first three scenarios, suggesting that the benefits obtained from decreased ocean freight costs (20%) are not sufficient to compensate the losses resulting from declining world prices and exchange rates (12% and 10%, respectively) and increasing inland transport costs (20%) for in the long run. However, an increase in yield (5%) restores that competitive edge.

The comparative advantage of producing and marketing rice remains strongest in Mali (i.e., smallest DRC and SCB ratios, and all inferior to one). Mali remains competitive in all ten scenarios, although its comparative advantage is also considerably reduced in the first scenario over the long-run. In all three countries, the strongest impact is realized under the eighth scenario as a result of improved yields and milling efficiency as well as reduced financing and irrigation infrastructure costs.

Table 3.6: Joint impact of multiple policy variables on the comparative advantage of the rice value chain in WA countries resulting from changes in both the Thai and WA economies

			RCI				
	Scenario	% change		DRC (1.00)*		SCB (1.00)*	
		MR	LR	MR	LR	MR	LR
1	World rice price	-5%	-12%	1.18	1.19	1.11	1.26
	Dollar exchange rate	-5%	-10%				
2	Ocean freight costs	10%	20%	1.15	1.40	1.09	1.21
3	Inland transport costs	10%	20%	1.16	1.43	1.09	1.23
4	Yield	-6%	3%	1.29	1.36	1.16	1.19
5	Chemical costs	10%	20%	1.34	1.47	1.18	1.23
6	Milling rate	5%	8%	1.22	1.26	1.13	1.14
7	Irrigation costs	-20%	-50%	1.11	0.97	1.06	0.98
8	Capital costs	-5%	-10%	1.08	0.93	1.04	0.96
9	Land costs	50%	100%	1.11	0.99	1.06	1.00
10	Labor costs	20%	50%	1.19	1.20	1.11	1.11
			MALI				
	Scenario	% change		DRC (0.68)*		SCB (0.74)*	
		MR	LR	MR	LR	MR	LR
1	World rice price	-5%	-12%	0.76	0.87	0.81	0.90
	Dollar exchange rate	-5%	-10%				
2	Ocean freight costs	10%	20%	0.74	0.84	0.80	0.81
3	Inland transport costs	10%	20%	0.75	0.85	0.80	0.89
4	Yield	11%	22%	0.67	0.69	0.73	0.75
5	Chemical costs	10%	20%	0.68	0.70	0.74	0.77
6	Milling rate	5%	8%	0.64	0.64	0.71	0.71
7	Irrigation costs	-20%	-50%	0.59	0.53	0.67	0.63
8	Capital costs	-5%	-10%	0.58	0.51	0.66	0.61
9	Land costs	10%	20%	0.59	0.53	0.67	0.62
10	Labor costs	20%	50%	0.63	0.62	0.70	0.70
			SENEGAL				
	Scenario	% change		DRC (0.78)*		SCB (0.83)*	
		MR	LR	MR	LR	MR	LR
1	World rice price	-5%	-12%	0.89	1.07	0.92	1.05
	Dollar exchange rate	-5%	-10%				
2	Ocean freight costs	10%	20%	0.87	1.02	0.91	1.01
3	Inland transport costs	10%	20%	0.87	1.03	0.91	1.02
4	Yield	3%	5%	0.84	0.97	0.89	0.98
5	Chemical costs	10%	20%	0.86	1.00	0.90	1.00
6	Milling rate	5%	8%	0.80	0.90	0.86	0.93
7	Irrigation costs	-20%	-50%	0.74	0.72	0.81	0.81
8	Capital costs	-5%	-10%	0.72	0.69	0.80	0.78
9	Land costs	50%	100%	0.73	0.72	0.80	0.80
10	Labor costs	20%	50%	0.77	0.81	0.83	0.87

Notes: * Base scenario, MR = medium-run; LR = long-run
Each scenario's assumptions, as going down the list, are added to the assumptions in the previous scenario.

3.4 Conclusion and policy implications

The rice sector in West Africa, which is important for the economy in terms of food security, income generation, and trade balance, is facing stronger competition, with increased liberalization and important transformation of the Asian rice value chains. In the wake of the price spikes of 2008, West African countries are seeking to improve their competitiveness in supplying rice to their major urban centers in order to reduce imports from Asia. The comparative advantage of the rice value chains in WA and their sensitivity to change are, therefore, a particular concern for decision makers. The purpose of this chapter is to assess the ability of selected West African countries (RCI, Mali and Senegal) to transform their domestic rice sectors and to respond to key structural changes in rice systems and demand in Asia and WA. It does so by conducting a domestic resource cost (DRC) analysis and developing scenarios of future comparative advantage of WA using projection data obtained from major outlook efforts.

The results indicate commercial rice value chains are profitable, in financial terms, in all three focus countries; however, the use of domestic resources in producing and marketing rice from major irrigated systems to the capital city is efficient in economic terms in Mali and Senegal, but only "breakeven" in RCI. Moreover, the magnitude of computed DRC ratios (0.68, 0.78, and 1.00 for Mali, Senegal and RCI, respectively) suggests that commercial rice value chains are relatively more competitive in Mali (i.e., lowest DRC ratio) at the time of investigation. Although the corresponding SCB ratios differ slightly from the DRC estimates, suggesting possible misclassification of costs of domestic resources as tradable and mon-tradable in the DRC analysis, they corroborate that Mali and Senegal currently have a relatively comparative advantage while RCI does not (0.74, 0.83, and 1.00 for Mali, Senegal and RCI, respectively). The fact that Mali has the strongest the comparative advantage of producing and marketing rice in the capital city is aligned with expectations as Mali benefits from additional "natural protection" due to its landlocked position whereas coastal countries such as RCI and Senegal whose major cities' proximity to ports put local production from the hinterland at a competitive disadvantage.

In terms of dynamics, Mali is likely to retain its comparative advantage in the rice sector in the next ten years in all scenarios based on projections from major outlook efforts. Senegal loses its competitive edge in the long run as increases in ocean freight costs (20%) are being overshadowed by declining world prices and exchange rates (12% and 10%, respectively) and increasing inland transport costs (20%), but raising yields at least 5% restores that competitive edge. In the long run, RCI gains comparative advantage when irrigation costs are decreased by 50% and capital costs reduced by 10% in spite of substantial increases in land costs (100%). However, that competitive edge does not withstand additional increases in labor costs (50%) Moreover, for all three countries, the strongest impact is realized as a result of a mix of improved yield and milling efficiency and reduced financing and irrigation infrastructure costs. However, rising, land costs, and inland transport costs are expected to contribute to reducing the comparative advantage of WA rice value chains much less than declining world prices of rice, continued depreciation of the dollar relative to the CFA franc, and increasing wage rates and chemical costs.

The results of this study contrast with previous studies conducted by AfricaRice (Diagne et al. 2013) and their national partners, which found that RCI has a comparative advantage in producing and marketing irrigated rice in the year 2011. The differences in findings largely stem from the fact that in the economic analysis AfricaRice's analysis only accounted for a proportional depreciation costs of a commonly held pumping machine used to provide additional water to a one hectare rice farm and assumed depreciation costs of full-control irrigation infrastructure, which are more than 10 times higher, to be sunk costs. Although some rice farms in RCI organized in farmers' groups supplement water from the canal with pumping machines, it is not a common practice (see Chapter 2). When making similar assumptions, results of this study concur with those of AfricaRice (Diagne et al. 2013) (i.e., DRC ratio of 0.57). However, both studies found commercial rice value chains to be most competitive in Mali and least competitive in RCI.

Despite the numerous constraints that still characterize the rice value chains in these West African countries, this study suggests that the prospects for replacing Asian rice imports with locally produced rice in capital cities are encouraging, especially for Mali and Senegal. Given its relatively high comparative advantage in producing and marketing rice in the capital city, Mali may even position itself as a potential credible exporter of rice to regional markets as suggested by previous studies (Adjao 2011). However, current surplus levels are low, and it is necessary that Mali, and the other countries as well, generate enough rice surpluses.

Increasing rice volumes could be achieved if efforts in lowering the cost of irrigation are undertaken to increase the areas cultivated under water control. In addition to increased acreage, new strategies must be envisaged to improve research and extension and continue the extension of good agricultural practices in order to increase yield levels. Also, improving the availability and use of fertilizers, given higher rate of economic returns to these inputs in irrigated agricultural production, is crucial. Although RCI, Mali, and Senegal have fertilizer blending plants, none of them has substantial production of nitrogen-based fertilizers. Thus, efforts to reduce lengthy regulatory procedures for certification and improve complement technical information (or extension service) to ensure best use of fertilizer must be emphasized to further increase volumes of marketable rice surplus.

Furthermore, there is a need to develop and implement mechanisms for financing investments. The amendments to the land policy in the Office du Niger , following the 2007/08 rice crisis, that grant land titles to private investors is a first step to help facilitate the mobilization of these financial resources, which is a prerequisite for the promotion of commercial rice production (Adjao 2011). Finally, urgent measures need to be put in place to break up the transport oligopolies and eliminate non-tariff barriers, which contribute to further increase the already high marketing costs. Again, information/awareness programs that inform the various actors involved in the marketing segment of the rice value chain could help fight against these practices. Providing additional incentives to customs officers and other agents, through pay raises for example, may also contribute to reduce corruption on the transportation corridors.

Despite being of lower quality, on average, than Asian imports, local rice in these three WA countries is competitive in the capital city, indicating that average urban consumers do not currently think that the quality is important enough to pay a price premium to improve it. However, increasing the marketable volume of milled rice without addressing the quality issue may no longer be sufficient in the long-run if West African rice value chains are to claim a bigger share of the booming West African rice market. Regardless of the grade of rice they prefer, the rising urban middle class in WA in labor-limited households is more likely to demand rice that is clean and free of debris, as income continues to rise and the urban population continues to grow in the subregion. The current poor quality of local rice in WA could represent an important challenge for marketing rice in major urban markets in the future, given current trends. In countries such as Mali, where there is a traditional preference for local rice, efforts to capture part of that premium are underway, with the emergence of retailers/sorters, who hand-sort lots of Malian rice that they sell to consumers in the high-end market segment, fetching up to 20% premium. Thus, it is crucial to develop and implement strategies that could help improve processing technologies that reduce the level of impurities and harmonize the amount of brokens in each grade of rice, in a cost effective manner, raising the question of whether small or large mills should be promoted.

4. THE DETERMINANTS OF THE EVOLUTION OF RICE PRICE POLICY OVER THREE DECADES IN ASIA AND WEST AFRICA: AN ARDL BOUND TESTING APPROACH

4.1 Introduction and problem statement

Historically, one of the major objectives of domestic rice policies in West Africa has been to provide affordable rice to satisfy the demand of urban consumers and prevent social unrest. As rice is becoming a structural component of West Africans' diet and is gaining increasing political and economic importance, there has been considerable political interest in increasing production of local rice. As discussed in Chapter 3, competitiveness, in an economic sense, assesses the degree of efficiency in a system. As Monke and Pearson (1989) point out, efficient systems can earn excess profits without any help from the government, but transfers (including subsidies) can allow inefficient systems to survive. The extent of transfers, and hence government protection (or market failure not corrected by efficient policy), can be assessed by computing, for instance, the nominal protection coefficient (NPC), which compares private revenues to social revenues (Monke and Pearson 1989).

Rice policies, especially trade and price policies, have been key determinants of the expansion of rice imports in West Africa over the past three decades. However, designing rice policies has proven difficult given the endeavor to balance multiple objectives, including the protection of the interests of small farmers, poor consumers and other players in the industry (such as millers, retailers and traders) while maintaining economic stability, all within the constraints of limited national budgets.

There is no single policy with which to manage the domestic rice markets. To date a wide variety of policy instruments have been used to increase productivity, influence rice prices directly and stabilize prices. Those include both trade policies (i.e., tariffs and quotas) and sector-specific interventions (i.e., commodity programs, marketing supports, subsidies and tax exemption, investment assistance). While in the past, many West African countries were able to afford price interventions to protect domestic rice consumers, such policies may no longer be financially possible given the new high world price environment that resulted from the 2008 rice price spike and the increase in the number of rice consumers in these countries and their levels of per capita consumption. Furthermore, the increased instability of the world rice market since the 2008 rice crisis has led many West African countries to pursue rice self-sufficiency objectives rather than relying on international trade to meet their food security goal, as they believe that the price increase offers an opportunity to expand production without high tariffs or subsidies (Campbell et al. 2009). With imports still accounting for 48% of total West African rice consumption over the period 2006-10 (Hollinger and Staatz 2015), it may not be financially possible for West African countries to isolate themselves from the world market over the long-run, and a major issue facing many West African countries is how to ensure additional supply at minimum costs.

Governments have traditionally played an important role within the rice industry, especially in terms of price policy; i.e., interventions in input and output markets through subsidies, taxes and trade policies that influence prices of imports and exports (FAO 2010). Price policies are key aspects of trade and economic policy in most African countries, including West Africa (Anderson and Masters 2009). The price of rice is a key variable for farmers, consumers, and governments given its important influence on resource allocation. Understanding the dynamics of price policy formulation is crucial to better formulate and evaluate appropriate rice policies. Both sector-specific and macro-economic policies jointly and separately affect the domestic relative price of a tradable good such as rice. An important question concerns the extent to which government policies have contributed to the observed movement in the domestic price of rice. This is especially relevant in West Africa because (i) the share of rice production in national investment plans of West Africa economies has been significantly increasing over the past few years and (ii) West Africa is the region of the world where domestic and macroeconomic (including exchange rate) policies have been the most heavily interventionist and slowest to reform (Anderson and Masters 2009).

4.2 Key research gap

Previous studies that examined the determinants of price policy in Africa (Anderson and Masters 2009) focused on the broader agricultural sector. The bulk of the literature that specifically addressed the dynamics of rice price policy formulation largely focused on Asia and identified several factors that may cause domestic rice prices to diverge from world prices, and thus change the nominal protection rate of rice over time (Kajisa and Akiyama, 2005; Dawe, 2001; David and Huang, 1996; Timmer, 1993; Lindert, 1991; Miller, 1991). Those factors include both sector-specific and macro-economic policies relating to (i) price instability in the world rice market, (ii) import dependence, (iii) comparative advantage of the rice value chain, (iv) trade position of a country with respect to rice, and (v) level of economic development (Pandey et al. 2010; Anderson and Masters 2009; David and Huang 1996; Thiele 1990). However, there is limited evidence from regression analysis of the determinants of the paths along which rice polices have moved in Africa (Pandey et al. 2010; Thiele 1990). These few studies have usually used Ordinary Least Square (OLS) regressions, included countries from other parts of the world, relied on aggregated cross-country time series analyses and reported their findings based on trade status (i.e., net importing versus net exporting countries) regardless of the geographic location.

While such analyses enabled one to detect the factors that have influenced the sample countries, they did so on average rather than in particular, thus neither permitting to evaluate rice pricing policies of individual countries nor West Africa as a region. To formulate country-specific policies, the generalized ideas provided by cross-country analyses should also be examined by country-specific time series analyses and should take into account the fact that the market for rice in West Africa is not homogeneous but rather consists of individual country markets that differ greatly in terms of their size, importance of rice in food consumption, and consumer preferences. Moreover, OLS regressions may lead to spurious regression in a time series analysis if non-stationary in the series under investigation is not taken into consideration.

4.3 Research Objectives

The objective of this chapter is to explore the forces driving the evolution of rice price policies over the past three decades by conducting country-specific time-series analyses for selected major rice importing countries in West Africa, compare those findings to the major Asia rice exporters, and provide implications of the findings for possible future directions of price policies affecting rice production incentives in West Africa. The period covered in this study is 1980-2009.

This chapter builds on previous studies (Pandey et al., 2010; David and Huang, 1996; Thiele, 1990) and focuses specifically on major West African net importers (Nigeria, Senegal, Côte d'Ivoire, and Mali) and Asian net exporters of rice to these West African countries (Thailand, Vietnam, Pakistan, and India) with extended newly available time-series data. The selected countries show some diversity in stages of economic, political and social development, including their resource endowments and trade specialization, thus providing an interesting sample for a comparative study. Thus, much can be learned from examining and comparing of these different countries in order to formulate sound rice price policy for West Africa as a whole for the next 5 to 10 years. The need for a regional policy, as opposed to just individual country rice polices, arises because of the aim of creating a customs union under ECOWAS, with a common external tariff, in the context of regional economic integration.

The rest of this chapter is organized as follows: following the presentation of the analytical framework, the next part discusses potential determinants of change, formulates hypotheses, and specifies an econometric model to test those hypotheses, using country-specific time-series analysis. The regression results are then presented and discussed. Finally, major findings and policy implications are drawn in the conclusion.

4.4 Conceptual framework

4.4.1 Method of measurement of rice price protection

The deviation between domestic and world prices related to the type of trade and sector-specific interventions discussed above can be assessed by means of various indicators, including Nominal and Effective Protection Coefficients, Producer Support Estimates, and Nominal Assistance Coefficients (Maetz et al. 2011; OECD 2009; Anderson and Masters 2009).

The Nominal Protection Coefficient (NPC) is the simplest coefficient used to assess the level of protection resulting from market “distortions” or transfers. It measures the ratio between the domestic price actually received by farmers and the economic parity price of a commodity, both taken at the farm-gate level. Although useful, the NPC does not recognize the protection or implicit tax impact that transfers (e.g. subsidies) in the input markets may have on the production of a commodity nor does it account for the implications of these transfers for value added (i.e., the difference between the value of output and the value of the intermediate inputs).

The Effective Protection Coefficient (EPC) overcomes the limitations of the NPC by measuring the degree of protection as the ratio between the value added in the presence of market distortions (i.e. the net income actually received by farmers) and the value added in the absence of such transfers (i.e. when inputs and outputs are valued at their economic parity prices). The Producer Support Estimate (PSE) (previously referred to as the Producer Subsidy Equivalent), adopted by the OECD to measure agricultural support, is an even more comprehensive measure of support. The PSE is an aggregate measure of support to farmers, including taxes or subsidies on the final product, taxes and subsidies on inputs as well as any other form of direct support to producers. Finally, the Nominal Assistance Coefficient (NAC), defined as the ratio between the value of gross farm receipts (including support) and gross farm receipts valued at border prices (measured at farm gate), is analogous to the NPC except that the numerator encompasses all forms of assistance and not just that provided through market price support.

Despite the fact that there are more complete protection measures, such as the EPC, PSE or NAC discussed above, and that input subsidies have played such an important role in the recent rice initiatives in West Africa, the NPC is used in this chapter to measure the impact of government policies on the price of rice. Computing the other estimates requires additional data on the various intermediate input shares of output, which are not available for most selected countries for every year in the long time series that is the focus of this study. Moreover, the main purpose of this analysis is to identify factors underlying the policies that affect domestic relative to international prices of rice. Thus, in this chapter, NPC is defined as the ratio of the domestic price at farm gate (PD) to the world price (PW) at the border, converted at the official exchange rate. PD corresponds to the financial marginal cost of rice production, including taxes and subsidies. PW represents the opportunity cost of producing rice domestically as described in David and Huang (1996) and Kajisa and Akiyama (2005). Import prices include cost, insurance and ocean freight (c.i.f. prices) to the local (importing) port whereas export prices are free on board (f.o.b. prices) at the local (exporting) port. However, it is important to highlight an important limitation in the data. Border equivalent prices, or world prices, serving as yardsticks and to indicate the extent to which domestic prices have been distorted by government intervention, are not adjusted for domestic transport, marketing and processing costs as there was not sufficient information to do so. Thus, this major limitation, which led to an overestimation of the real extent of price distortion from government intervention, calls for caution in interpreting the results reported in the study.

4.4.2 Data and Model

4.4.2.1 Data

This study uses secondary annual data collected from major international databases, notably FAOSTAT and the World Development Indicators (WDI) of the World Bank, for selected West African net importers (Nigeria, Senegal, Côte d'Ivoire, and Mali) and Asian net exporters of rice (Thailand, Vietnam, Pakistan, and India) from 1980 to 2009[24].

[24] Except for Vietnam, for which data are available only for the period 1985-2009.

4.4.2.2 Model

By definition, the Nominal Protection Coefficient (NPC) is affected by three key variables: domestic price, world price, and exchange rate used to convert the world price into local currency terms. To estimate the NPC, the extent of pass-through from the world price back to the farm-gate needs to be first estimated. A simple price-transmission model that illustrates the relationship between the real domestic price (PD) and the real border price in local currency (PW) of rice in year t is described in Kajisa and Akiyama (2005):

$$PD_t = \alpha \, PW_t^{\beta} , \qquad (1)$$

where α reflects tax or protection measures determined independently of the level of the world price, as well as marketing and transportation costs[25], and β captures the elasticity of price transmission (reflecting protection measures that are a function of the world price), which is expected to be positive. Although unusual, β could be negative if the world and domestic prices move in opposite directions. When β is one, the full percentage change of PW is transmitted to the domestic price. When β is zero, PD is equal to α irrespective of the level of PW, implying a constant domestic price.[26] This constant domestic price could imply a shift over time from tax to subsidy relative to the world price, or vice versa, depending on how the world price evolves. To analyze NPC, equation (1) is modified as:

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[25] Due to the lack of data availability, marketing and transport costs from the border to the farm gate are not included in PW.

[26] Moreover, Colman (1995) has noted that the concept of an elasticity of price transmission itself needs to be treated carefully. In particular, equating perfect price transmission with an elasticity of one only makes sense if all duties and transport costs are proportional to price (which is unlikely to be the case). In the case of an import, we would expect the domestic price to be higher than the world price before transport costs are paid, so perfect price transmission would imply an elasticity of less than one. In the case of an export, perfect price transmission would correspond to an elasticity greater than one.
http://www.oecd.org/agriculture/agricultural-policies/40443640.pdf

$$\ln NPC_t = \ln \frac{PD_t}{PW_t} = = \alpha' + (\beta - 1) \ln PW_t \quad (2)$$

where $\alpha' = \ln \alpha$. The coefficient α' may change over time due to the effects of some variables. Let us assume a linear relationship between the coefficients and these variables as follows:

$$\alpha' = \alpha_0 + \Sigma_i \alpha_i \ln X_{it} \quad (3)$$

where X_{it} is a vector of determinants of protection policies including factors pertaining to the level of economic development of a country, the comparative advantage of rice production, and the relative share of agriculture in the national economy. Combining equations (2) and (3), and adding a statistical error term, the following equation can be estimated:

$$\ln NPC_t = \alpha_0 + \Sigma_i \alpha_i \ln X_{it} + (\beta - 1) \ln PW_t + e_t \quad (4)$$

4.4.2.3 The determinants of rice price policy and hypotheses

Previous cross-country studies on rice price protection consider (i) the level of economic development, (ii) the competitive advantage of the rice subsector, and (iii) the trade position of a country with respect to rice to be major explanatory variables for rice price protection (Pandey et al., 2010; Anderson and Masters, 2009; David and Huang, 1996; Thiele 1990).

4.4.2.3.1 Economic development

The structure of the economy is considered to have critical impacts on the level of agricultural protection. Previous studies (Lindert, 1991; Timmer, 1988; Anderson and Hayami, 1986) argue that the rice sector tends to be taxed in low-income countries, where proportions of the total labor force and gross domestic product in agriculture is high. In contrast, this sectoris more likely to be subsidized in high-income countries with smaller and more cohesive agricultural populations, where the burden of subsidizing a small share of the workforce falls on the nonfarm majority. In fact, subsidizing farmers when they represent the majority of the work force will be a heavy burden on the nonfarm minority in low-income countries similar to those under analysis. The capacity and effectiveness of farmers in lobbying for stronger protection vary according to the level of economic development. In lower income countries, electorates in the growing urban centers, interested in low food and raw material prices, have usually a stronger economic and political voice than rural populations. Moreover, a higher share of rice in the diet puts more pressure on government to hold down domestic prices to protect consumers, especially in urban areas.

In this analysis, these politico-economic factors are represented by three factors: (1) per capita gross domestic income (GDP), which measures the level of economic development and is expected to be positively related to protection levels; (2) the relative size of the agricultural sector as measured by the share of agriculture in GDP (AGSHGDP), which reflects the influence of powerful agricultural interest groups and is expected to be positively correlated with protection levels; and (3) the share of rice calories in total calorie consumption (RICESH), which indicates the importance of rice in the diet and the scope for consumers to substitute from rice to other foods, which is negatively correlated with protection levels.

4.4.2.3.2 Comparative advantage

Increased comparative advantage of domestic rice production is related to the lower opportunity cost of labor, land or technological change such as the adoption of modern varieties, use of fertilizer and expansion of irrigation. In most West African countries, land resources are relatively abundant but irrigation developments remain low, as is the adoption of high-yielding and fertilizer-responsive modern varieties. Given limited data availability, the comparative advantage of the rice sector in this study is measured by two factors reflecting (1) the natural comparative advantage represented by share of total arable land area under rice (LANDSH), and (2) the technological progress represented by rice yield per hectare (YLD) (Kajisa and Akiyama, 2005; David and Huang, 1996). Increased comparative advantage is expected to reduce the level of protection.

4.4.2.3.3 Trade position

Finally, previous studies also suggest that the trade position of a country is an important determinant of the nominal protection rate. For low-income net-importing countries, including WA[27], reducing import-dependence by increasing domestic food production has been among the major means to achieve food security objectives. Pursuing these objectives has led policy makers to offer cheap rice to politically influential urban consumers while concurrently raising the share of domestic production by purchasing local rice at high prices or by helping reduce production costs[28] in order to create production incentives.

[27] West African countries are net rice importers. Although there are some exports, they are usually informal and there is no reliable information on the regional rice trade in the sub-region.
[28] The effect of input subsidies on production are not captured in this analysis since the NPC only focuses on the output price.

The ability of governments to protect domestic rice producers thus depends on the expenditures needed to guarantee low consumer prices. These costs increase with increased domestic rice production and consumption. It can be argued that net importing countries that do not protect their (high-cost) domestic producers are more concerned about providing cheap calories to consumers, and thus end up importing more. Moreover, trade taxes such as import tariffs and levies, are often imposed on imported rice, generating revenues for the importing country and thus conferring positive protection to domestic producers. For net exporting countries, however, rice is an important source of revenue for the government. Positive protection of an exportable commodity in a developing country, except in the short run, is unlikely as it would require budgetary outlay and would contribute to subsidizing importing countries. Thus, one would expect decreasing protection levels (or increasing taxation) as export shares rise.

In this study, the trade position is measured by the trade share (TRDSH). For net rice importers, this is estimated by import share, defined as rice imports divided by the sum of rice imports and rice production. For net rice exporters, TRDSH is estimated by the export share, defined as the ratio between exported and produced rice quantities. Protection levels are expected to be positively related to import shares but negatively related to export shares.

Moreover, rice trade policies include not only tariff barriers but also non-tariff (quotas) barriers. The non-tariff barriers were essentially removed with the dissolution of state marketing companies following trade liberalization and accession to the World Trade Organization (WTO). Prior to trade liberalization, many poor developing-country exporters in South and Southeast Asia restricted and controlled exports for the sake of food security. Exports of common rice from India were banned until 1994. Exports were not permitted in Vietnam until 1987, but export quotas were in place until 2001. Similarly, Thailand had an export quota until 1986 and Pakistan until 1988

(IFPRI 2002). Export bans, however, reappeared for many exporters during the 2008 crisis, including India and Vietnam. Poor developing countries in West Africa also had quantitative restrictions on the maximum quantities of imported rice allowed on domestic markets. Senegal had quotas in place until the rice parastatal was dismantled in 1996 (UNDP, 2005). Similarly, Mali and Côte d'Ivoire liberalized rice imports in 1994 and 1995, respectively. Nigeria had a ban on rice imports until 1995[29]. Thus, a dummy variable, which takes the value one in and after the year of liberalization[30], has been included in the analysis to account for the quantitative trade restrictions. We expect protection levels and the removal of quantitative restrictions to be a positively related. The foregoing considerations are summarized in Table 4.1 below.

Table 4.1: The determinants of Nominal Protection Coefficient and their expected signs

Variable	Unit	Definition	Source	Expected sign
PW	USD/t	Border price of rice (i.e., either import or export price)	FAOSTAT	Negative (both import and export prices)
GDP	USD	Per capita gross domestic income	WDI	Positive
RICESH	%	Share of rice calories in total calorie consumption	FAOSTAT	Negative
AGSHGDP	%	Share of agriculture in GDP	WDI	Positive
LANDSH	%	Share of rice area in total arable land area	FAOSTAT	Negative
YLD	t/ha	Yield per hectare	FAOSTAT	Negative
TRDSH	%	Trade position (i.e., either import or export shares)	FAOSTAT	Positive (for importer); negative (for exporter)
DUMYTRD		Quantitative trade restrictions	IFPRI/UNDP	=1 if no restrictions; =0 otherwise

[29] Although Nigeria allowed imports of parboiled rice, it maintained bans on polished white rice. However, in Nigeria consumers prefer parboiled rice whether imported or local. Nigeria is the main market in West Africa for parboiled rice, while other countries have a preference for regular milled white rice (USAID, 2009).

[30] For India and Vietnam, the dummy variable also takes the value zero in 2008 to reflect the reinstatement of the export ban during that year.

The variables are specified in logarithms to reduce data variability. Structural breaks can occur in time series for many reasons, including economic crises, as well as changes in regime or policy; thus, dummy variables are constructed to account for structural differences between sub-periods. Structural breaks were identified using the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of recursive residuals of square (CUSUMSQ) test as suggested by Pesaran and Pesaran (1997). Unlike the alternative Chow test that requires break points to be specified, these tests can be used without the requirement of a priori knowledge of the exact date of the structural breaks.

4.5 Estimation approach

Time series introduce dynamics in analysis, and thus, one would expect co-integration or long-run relationships between the series. Given that time-series data are used for the analysis, the OLS method may not be suitable for the analysis due to its restrictive assumptions[31]. In time series analysis, one needs to worry about whether errors are serially correlated, in which case OLS estimates are no longer efficient, although still unbiased and consistent. As a result, the usual test statistics may be wrong (Gujarati 2003).

The first step in time series analysis is to investigate the stationary properties of the variables by conducting various unit root tests. If all the series are stationary or I(0), the standard OLS approach can be used. If all the series are integrated of same order (e.g., I(1)), we can conduct co-integration analysis using conventional methods such as the Johansen approach to co-integration. However, if there is a mix of I(0) and I(1), the conventional approach to co-integration

[31] The Gauss-Markov theorem states that in a linear regression model in which the errors have expectation zero, are uncorrelated, and have equal variances, the best linear unbiased estimator (BLUE) of the coefficients is given by the ordinary least squares (OLS) estimator, with "best" referring to the linear estimator giving the lowest variance of the estimate, as compared to other unbiased, linear estimators.

no longer holds, and we use the bounds-testing approach to co-integration with the Autoregressive Distributed Lag (ARDL) framework developed by Pesaran et al. (2001) to investigate the existence of a long-run equilibrium relationship between the variables. However, the latter approach does not hold if there is a mix of any variable of integration order greater than one.

ARDL models include lagged values of both dependent and explanatory variables. The ARDL approach to co-integration gained popularity in recent years, as it addresses the major shortcomings of the Johansen approach: (i) it is more flexible and does not impose the restriction of having all variables to be integrated of the same order; (ii) it has superior properties in a small sample; and (iii) it is used for both testing long-run relationships and estimating long-run parameters (Pesaran et al. 2001; Pesaran and Shin 1995). The ARDL approach to co-integration can be estimated as a single unrestricted error correction model (ECM)[32] as specified in equation (5):

$$\begin{aligned}\Delta NPC_t &= \alpha_0 + \phi DUMYTRD + \pi_1 NPC_{t-1} + \pi_2 PW_{t-1} + \pi_3 GDP_{t-1} + \pi_4 AGSHGDP_{t-1} + \pi_5 RICESH_{t-1} \\ &+ \pi_6 LANDSH_{t-1} + \pi_7 YLD_{t-1} + \pi_8 TRDSH_{t-1} + \sum_{j=1}^{k}\alpha_{1j}\Delta NPC_{t-j} + \sum_{j=0}^{k}\alpha_{2j}\Delta PW_{t-j} + \sum_{j=0}^{k}\alpha_{3j}\Delta GDP_{t-j} \\ &+ \sum_{j=0}^{k}\alpha_{4j}\Delta AGSHGDP_{t-j} + \sum_{j=0}^{k}\alpha_{5j}\Delta RICESH_{t-j} + \sum_{j=0}^{k}\alpha_{6j}\Delta LANDSH_{t-j} + \sum_{j=0}^{k}\alpha_{7j}\Delta YLD_{t-j} + \sum_{j=0}^{k}\alpha_{8j}\Delta TRDSH_{t-j} + e_t\end{aligned} \quad (5)$$

The residual e_t is assumed to be normally distributed and white noise. The ARDL model is conditional upon assuming unity slope of the lagged value of the dependent variable (π1). The bound test for detecting co-integration or the presence of a long-run relationship consists of an F-test. It tests the null hypothesis of no co-integration, by restricting the coefficients of the lagged level variables from equation (5) to zero (Ho: $\pi_1 = \pi_2 = \pi_3 = \pi_4 = \pi_5 = \pi_6 = \pi_7 = 0$), against the alternative

[32] It is important to note however that ECM models are appropriate for stationary time series, while ARDL models are only appropriate for non-stationary time series, characterized by cointegration (Keele and Deboeuf, 2005).

that the coefficients of the lagged level variables are not jointly equal to zero. The exact critical values for the F-test are not available for an arbitrary mix of I(0) and I(1) variables. The F-statistic, which is non-standard, is compared with the upper bound I(1) values and the lower bound I(0) values of the tables provided by Narayan (2004).

If the value of F-statistic is greater than the upper bound value, we reject the null hypothesis of no co-integration, suggesting evidence of a long-run relationship among the variables regardless of the order of integration. If the value of the F-statistic is lower than the lower bound value, we fail to reject the null hypothesis. However, if the F-statistic lies between the upper and the lower bounds, the test is inconclusive.

Once the existence of a long-run relationship has been established, we can estimate the short-run and associated long-run coefficients. The long-run relationship is regarded as a steady equilibrium, whereas the short-run relationship is evaluated by the magnitude of the deviation from the equilibrium. The long-run equilibrium is reached when the error correction mechanism equals 0, i.e., $\pi_1 NPC_{t-1} + \pi_2 PW_{t-1} + \pi_3 GDP_{t-1} + \pi_4 AGSHGDP_{t-1} + \pi_5 LANDSH_{t-1} + \pi_6 YLD_{t-1} + \pi_7 TRDSH_{t-1} = 0$. A key issue in estimating this type of model is the identification of the correct number of lags to be included, given that both under- and over-parameterization can create problems of misspecification and of unnecessary reduction in the degrees of freedom. The relevant number of lags j are chosen through the minimization of the Akaike information criterion, supplemented by the Schwartz criterion, which tends to favor a relative parsimonious parameterization (Pesaran and Shin, 1998). Thus, given the lag structure, the long-run relationship implied by this model is:

$$NPC_t = \alpha + \delta DUMYTRD + + \sum_{j=1}^{k} \omega_{1j} NPC_{t-j} + \sum_{j=0}^{k} \phi_{1j} PW_{t-j} + \sum_{j=0}^{k} \varphi_{1j} GDP_{t-j} + \sum_{j=0}^{k} \theta_{1j} AGSHGDP_{t-j} + \sum_{j=0}^{k} \vartheta_{1j} LANDSH_{t-j} + \sum_{j=0}^{k} \gamma_{1j} YLD_{t-j} + \sum_{j=0}^{k} \eta_{1j} TRDSH_{t-j} + e_{1t} \qquad (6)$$

Next, we conduct several diagnostic tests to ensure that there is no problem related to serial correlation, functional-form misspecification, non-normality and heteroscedasticity. The existence of co-integration does not necessarily imply that the estimated coefficients are stable. If the coefficients are unstable, the short-run and long-run coefficients will be unreliable. In the presence of structural breaks, the diagnostic tests are likely to suggest that the estimated model suffers from the non-normality problem. In order to test for long-run parameter stability for the detection of structural breaks or/and outliers over the sample period, which results from non-recurring exogenous shocks, we apply the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of recursive residuals of square (CUSUMSQ) test as suggested by Pesaran and Pesaran (1997).

Finally, we derive the long-run coefficients by reparametrization of the OLS estimates obtained from equation 5 by dividing them by the coefficient of the error correction mechanism (π1). We recover the standard error and confidence level of the long-term coefficients using the Bewley transformation regression in equation 7 below by first obtaining an estimate of ΔNPC_t, estimating equation 5, and by then taking the predicted value of ΔNPC_t to estimate the equation 7 such that :

$$\begin{aligned}\Delta NPC_t &= \alpha + \phi DUMYTRD + \delta_1 NPC_t - \sum_{j=1}^{k}\delta_{2j}\Delta NPC_{t-j} + \delta_3 PW_t - \sum_{j=0}^{k}\delta_{4j}\Delta PW_{t-j} + \delta_5 GDP_t - \sum_{j=0}^{k}\delta_{6j}\Delta GDP_{t-j}\\ &+ \delta_7 AGSHGDP_t - \sum_{j=0}^{k}\delta_{8j}\Delta AGSHGDP_{t-j} + \delta_9 RICESH_t - \sum_{j=0}^{k}\delta_{10j}\Delta RICESH_{t-j} + \delta_{11} LANDSH_t - \sum_{j=0}^{k}\delta_{12j}\Delta LANDSH_{t-j}\\ &+ \delta_{13} YLD_t - \sum_{j=0}^{k}\delta_{14j}\Delta YLD_{t-j} + \delta_{15} TRDSH_{t-1} - \sum_{j=0}^{k}\delta_{16j}\Delta TRDSH_{t-j} + e_t\end{aligned} \quad (7)$$

4.6 Empirical results

4.6.1 Unit Root test

The results of the unit root tests are presented in Table 4.2.We used the Augmented Dickey-Fuller (ADF), and Philllips-Perron (PP) unit root test to determine the order of integration of each series. Since the ADF test is low power in a small sample (Cheung and Lai, 1995), the PP is also applied to check the robustness of the results. The ADF test is based on Schwarz Information Criteria (SIC).

The results of the ADF and PP test are consistent for almost all variables in each country, showing a mix of I(0) and I(1) variables, indicating that the hypothesis that each variable has unit root fails to be rejected at 1%, 5% or 10% significance levels. However, there is a dissonance between the two tests for $YLD_{Nigeria}$ and $YLD_{Pakistan}$. The PP test suggests those variables are I(1) at 1% significance level while the ADF test suggests that they are integrated of higher order. We rely on the PP test and assume that both these variables can be characterized as I(1) processes. Moreover, both the ADF and PP test suggest that $GDP_{Thailand}$ is I(2); thus, we may expect some irregularity in the results.

Table 4.2: Results of unit root test

WEST AFRICA					ASIA				
RCI					INDIA				
Variable	ADF(0)	ADF(1)	PP(0)	PP(1)	Variable	ADF(0)	ADF(1)	PP(0)	PP(1)
NPC	-3.877***	-6.043***	-3.469***	-6.541***	NPC	-2.422	-5.967***	-3.759***	-8.487***
PW	-1.676	-5.763***	-0.193	-8.183***	PW	2.291	-5.531***	-1.760	-7.181***
GDP	-3.052	-3.031**	-2.651*	-2.677**	GDP	-0.431	-2.569*	3.502	-4.169***
AGSHGDP	-2.081	-3.642**	-1.770	-4.166***	AGSHGDP	-1.285	-2.996**	0.133	-7.249***
RICESH	-2.056	-4.638***	-2.182	-5.580***	RICESH	-1.176	-5.68***	-1.816	-7.705 ***
LANDSH	-1.830	-3.917***	-1.221	-6.628***	LANDSH	-2.223	-5.770***	-2.288	-8.486***
YLD	-1.876	-3.064**	-1.197	-9.250***	YLD	-2.64	-4.165***	-1.364	-12.835***
TRDSH	-1.617	-4.344***	-1.681	-9.846***	TRDSH	-3.123	-4.579***	-1.639	-6.944
MALI					PAKISTAN				
Variable	ADF(0)	ADF(1)	PP(0)	PP(1)	Variable	ADF(0)	ADF(1)	PP(0)	PP(1)
NPC	-2.487	-5.810***	-4.787***	-11.860***	NPC	-2.863**	-5.414***	-3.050**	-7.416***
PW	-2.675	-5.250***	-4.350***	-10.372***	PW	-0.845	-2.681*	1.113	-6.703***
GDP	-2.799	-5.127***	0.39	-6.522***	GDP	-2.148	-2.898**	-1.026	-3.502***
AGSHGDP	-1.833	-4.112***	-1.864	-6.085***	AGSHGDP	-2.375	-4.832***	-1.475	-5.230***
RICESH	-1.343	-5.926***	-1.316	-6.477***	RICESH	-2.172	-5.022 ***	-2.312	-6.811***
LANDSH	-3.339*	-6.431***	-3.625***	-7.298***	LANDSH	-3.808**	-5.966***	-1.956	-5.412***
YLD	-2.900	-3.617***	-1.776	-11.637***	YLD	-1.879	-2.486	-0.089	-7.677***
TRDSH	-2.281	-6.597***	-3.100**	-8.452* **	TRDSH	-6.195***	-6.854***	-3.492***	-8.440***
NIGERIA					THAILAND				
Variable	ADF(0)	ADF(1)	PP(0)	PP(1)	Variable	ADF(0)	ADF(1)	PP(0)	PP(1)
NPC	-2.907**	- 4.233***	-3.167**	-7.602***	NPC	-3.973***	-6.235***	-4.577***	-10.789***
PW	-2.896	-3.576***	-0.08	-4.572***	PW	-2.63	-3.891***	-0.068	-5.027***
GDP	-1.169	-2.999**	-1.047	4.355***	GDP	-1.573	-2.603	-1.371	-2.506
AGSHGDP	-4.602***	-6.098***	-3.603***	-5.190***	AGSHGDP	-0.808	-4.595***	-2.415	-6.220*
RICESH	-2.595*	-2.729**	-3.395**	-7.161***	RICESH	-1.414	-5.814***	-1.825	-6.348***
LANDSH	-0.089	-4.570***	-1.779	-9.248***	LANDSH	-2.272	-4.834***	-0.207	-7.033***
YLD	-0.606	-2.464	-1.636	-7.068***	YLD	-1.624	-2.957**	-0.816	-7.699***
TRDSH	-1.798	-3.112**	-1.638	-6.384***	TRDSH	-4.937***	-7.785***	-3.881***	-11.375***
SENEGAL					VIETNAM				
Variable	ADF(0)	ADF(1)	PP(0)	PP(1)	Variable	ADF(0)	ADF(1)	PP(0)	PP(1)
NPC	-2.196	-4.198***	-2.068	-4.899***	NPC	-2.726*	-2.001	-2.842*	-4.471***
PW	-3.265*	-5.944***	-0.867	-5.854***	PW	-4.147***	-3.222**	-6.702***	-4.164***
GDP	-0.849	-3.529***	-0.656	-5.751***	GDP	-4.833	-4.009***	-1.149	-3.551***
AGSHGDP	-2.934	-4.575***	-1.505	-8.239***	AGSHGDP	-2.868	-3.713***	-0.632	-3.935***
RICESH	-2.058	-4.611 ***	-2.794*	-7.837 ***	RICESH	-2.095	-4.707 ***	-1.529	-5.506***
LANDSH	-0.332	-3.960***	-2.013	-4.358***	LANDSH	-2.183	-3.363**	-1.667	-4.838***
YLD	-3.873	-4.033***	-3.968***	-7.903***	YLD	-2.072	-4.553***	-0.557	-5.914***
TRDSH	-1.805	-3.773***	-2.860*	-6.171***	TRDSH	-2.385	-5.857***	-2.215	-7.206***

Note: ***, **, and * refer to 1%, 5%, and 10% of significance respectively

4.6.2 Co-integration test

Since the set of variables for each country contains both I(0) and I(1), we proceed to examine the relationship between NPC and the explanatory variables of interest using an ARDL bounds testing approach, testing the existence of a co-integration relationship. As mentioned before, an important issue in applying the bounds test approach to co-integration is the selection of the optimal lag length. We initially set the maximum lag length at 3 years given the sample size of this study. The AIC, supplemented by the SIC, are then used to choose the best ARDL models.

Moreover, the ARDL approach assumes that the size of the co-integrating space is unity (i.e., at most one co-integration relationship). Thus, it is important to ascertain whether the explanatory variables of interest are in fact long-run forcing. If $-1<\pi 1<0$ and we fail to reject Ho: $\pi 1=0$ in equation (6), then the assumption of a unique co-integration relationship among the variables holds.

The calculated F-statistics for co-integration and the diagnostic tests are presented in Table 4.3. The CUSUM and CUSUMSQ tests suggest the presence of exogenous shocks for Nigeria (1998, 1999), Senegal (1996) and Vietnam (2008) only. Since the CUMSUM approach is known to have poor power (Hansen, 1992), further specification testing was conducted. Thus, pulse dummy variables, which take values equal to zero for all observations except the year in which the pulse intervention occurs (i.e., the observation goes beyond the 5% critical bounds), have been constructed. However, expanding the co-integration regression with the suggested pulse dummy variables did not significantly improve the regression results; and thus, they were not included in the analysis.

The results further show that the F-statistic is higher than the upper critical bound at the 1% level of significance for Mali, Senegal and Vietnam, 5% for Côte d'Ivoire, and 10% for

Nigeria and Pakistan, suggesting the existence of co-integration among the variables in the model. However, the F-statistic is below the lower bound at 10% for India, suggesting that no long-run relationship can be inferred from the model. Although F-statistic is higher than the critical bound at 1% in the case of Thailand, the co-integrating space assumption of unity is violated, suggesting the ARDL model is not the appropriate framework. These results are coherent with the unit-root test, which suggested that the set of variables for Thailand contained a mix of I(0), I(1) and I(2) variables. Therefore, long-run multipliers are not computed for India and no further analysis is conducted for Thailand. Serial correlation[33], normality and heteroscedasticity tests in the residuals are also conducted.

[33] Serial correlation will not affect the unbiasedness or consistency of OLS estimators, but it does affect their efficiency. With positive serial correlation, the OLS estimates of the standard errors will be smaller than the true standard errors. This will lead to the conclusion that the parameter estimates are more precise than they really are. There will be a tendency to reject the null hypothesis when it should not be rejected.

Table 4.3: Results of the ARDL co-integration test

<table>
<tr><th></th><th>Determinants</th><th>Optimal lag length</th><th>k</th><th>π1</th><th>t-stat</th><th>F-stat</th><th>DW_{alt}-stat</th><th>W-stat</th><th>Het-stat</th><th>CUSUM</th></tr>
<tr><td>RCI</td><td>F(NPC|PW, LANDSH, TRDSH)</td><td>2, 1, 1, 1</td><td>3</td><td>-0.611</td><td>-3.44</td><td>4.98</td><td>0.030</td><td>0.984</td><td>0.490</td><td>--</td></tr>
<tr><td>MALI</td><td>F(NPC|PW, GDP)</td><td>1, 1, 3</td><td>2</td><td>-0.969</td><td>-4.80</td><td>8.23</td><td>0.167</td><td>0.955</td><td>1.530</td><td></td></tr>
<tr><td>NIGERIA</td><td>F(NPC|PW, RICESH, LANDSH, YLD)</td><td>1, 1, 1, 1</td><td>3</td><td>-0.865</td><td>-4.15</td><td>3.87</td><td>1.335</td><td>0.952</td><td>1.330</td><td>1998, 1999</td></tr>
<tr><td>SENEGAL</td><td>F(NPC|PW, AGSHGDP, LANDSH)</td><td>2, 1, 1, 1</td><td>3</td><td>-0.827</td><td>-5.05</td><td>6.54</td><td>0.154</td><td>0.956</td><td>0.000</td><td>1996</td></tr>
<tr><td>INDIA</td><td>F(NPC|PW, AGSHGDP)</td><td>1, 1, 1</td><td>2</td><td>-0.475</td><td>-2.49</td><td>3.68</td><td>0.057</td><td>0.947</td><td>0.240</td><td>--</td></tr>
<tr><td>PAKISTAN</td><td>F(NPC|PW, GDP, YLD)</td><td>1, 2, 1, 1</td><td>3</td><td>-0.429</td><td>-1.93</td><td>4.13</td><td>0.516</td><td>0.971</td><td>1.660</td><td>--</td></tr>
<tr><td>THAILAND</td><td>F(NPC|PW, GDP, AGSHGDP, YLD)</td><td>1, 1, 1, 1, 1</td><td>4</td><td>-1.377</td><td>-5.25</td><td>9.03</td><td>0.124</td><td>0.975</td><td>0.680</td><td>--</td></tr>
<tr><td>VIETNAM</td><td>F(NPC|PW, GDP, AGSHGDP, YLD)</td><td>1, 1, 2, 3, 1</td><td>4</td><td>-0.761</td><td>-2.36</td><td>6.35</td><td>0.187</td><td>0.937</td><td>1.670</td><td>2008</td></tr>
</table>

Notes:

The sample period is 1980-2009, except for Vietnam 1985-2009.

DWalt-stat denotes the (nR^2) Durbin Watson's alternative test statistic for serial correlation

W-stat denotes the Shapiro-Wild W test statistic for normally distributed residuals

Het-stat denotes (nR^2) the Breusch-Pagan-Godfrey test statistic for heteroscedasticity.

t-stat denotes the t-statistic for the null hypothesis H0: π1=0

F-stat denotes the F-statistic for the joint null hypothesis π1 = π2 = π3 = π4 = π5 = π6 = π7 = 0.

k denotes the number of explanatory variables

For k=2 ; the 10%, 5%, 1% critical values for the F-test are, respectively, equal to 317, 3.79, and 5.15 when I(0); 4.14, 4.85, and 6.36 when I(1)

For k=3 ; the 10%, 5%, 1% critical values for the F-test are, respectively, equal to 2.72, 3.23, and 4.29 when I(0); 3.77, 4.35, and 5.61 when I(1)

For k=4 ; the 10%, 5%, 1% critical values for the F-test are, respectively, equal to 2.45, 2.86, and 3.74 when I(0); 3.52, 4.01, and 5.06 when I(1)

Critical values are provided in Pesaran et al. (2001) Table CI(iii)

4.7 Regression results

The results of the ARDL model are presented in Table 4.4, and the long-run coefficients deriving from the ARDL model are computed in Table 4.5 (see more detailed result in Appendix Table 6). Overall, the regression results are very good, especially for the Asian countries, with over 90% of the time series variation in nominal protection rates being explained by the explanatory variables. Although the goodness of fit of the model is also very good for Mali (adjusted R-squared of 91%), it is slightly lower for RCI and Senegal (adjusted R-squared above 75%) but much lower for Nigeria (adjusted R-squared of 47%). The error correction coefficient or coefficient of the lagged value of the protection indicator (L.NPC) indicates the speed of the equilibrium restoring adjustment in the dynamic model and shows how quickly/slowly variables return to equilibrium. The results suggest that the adjustment takes place very quickly for Mali, with deviation from the long-term NPC path being corrected by over 95 % over the following year. The adjustment for Nigeria and Senegal are also rapid (about 85%), followed by Vietnam (over 75%) and RCI (over 60%). The adjustment for Pakistan is fairly slow (about 40%). Moreover, for all of the WA countries, except Senegal, as well as Vietnam and Pakistan, there is a statistically significant positive trend in NPCs over time, showing that the countries are becoming more protective of their rice sectors. The magnitude of dummy variable coefficient indicates that protection levels are much higher in the WA countries than the Asian countries (up to 3.5 times higher), and are higher in more affluent WA coastal countries (RCI and Nigeria) than poorer WA landlocked country (Mali). In contrast, the trend is the opposite for Senegal, which is becoming less protective, ceteris paribus. The following discussion is based on time series analysis specific to each country and uses the results of the long-term response unless indicated otherwise.

Table 4.4: Estimated short-run coefficients - Unrestricted ARDL model

	WEST AFRICA				ASIA			
D.NPC	RCI	MALI	NIGERIA	SENEGAL	INDIA	PAKISTAN	THAILAND	VIETNAM
Cons	2.272**	-6.785***	-17.726*	10.156***	-0.458	-20.700***	-6.136***	10.941
L.NPC	-0.611***	-0.969***	-0.865***	-0.827***	-0.475**	-0.429*	-1.377***	-0.761**
L.PW	-0.103	-0.711***	-0.315**	0.01	-0.381***	-0.739***	-1.095***	-0.511
L.GDP		1.703***				1.938***	3.218***	1.828***
L.AGSHGDP				1.417**	-1.593***		2.132***	2.940*
L.RICESH			-0.702					
L.LANDSH	0.746**		1.349**	2.036***				
L.YLD			2.864**			1.483**	-1.088**	-1.871
L.TRDSH	0.960**							
LD.NPC	0.309**			0.400***				
D.PW	-0.713***	-0.702***	-0.386	-0.573***	-0.855***	-1.172***	-0.747***	-0.789***
LD.PW						0.077		
D.GDP		-1.13				2.745**	1.126	1.972***
LD.GDP		-1.004						-0.504***
L2D.GDP		-1.490*						
D1.AGSHGDP				0.565	1.679**		0.938***	1.680*
LD.AGSHGDP								-2.158**
L2D.AGSHGDP								-0.68
D.RICESH			-1.916**					
D.LANDSH	0.694***		0.744*	-0.189				
D.YLD			1.791**			0.990**	0.384	1.67
D.TRDH	0.706**							
DUMYTRD	0.433***	0.452***	0.878*	-0.843***	0.078	0.117	-0.027	0.224**
No obs	28	27	29	28	28	28	29	22
F(16, 10)	11.54	35.58	3.55	10.13	42.27	33.43	12.59	156.67
Prob > F	0	0	0.0095	0	0	0	0	0
R-squared	0.8523	0.9405	0.6633	0.8351	0.9235	0.9435	0.875	0.9961
Adj R-squared	0.7785	0.9141	0.4763	0.7527	0.9017	0.9153	0.8055	0.9897
Root MSE	0.13679	0.14166	0.3351	0.12821	0.13489	0.08025	0.10018	0.09748

Notes:

1. PW = border price of rice; GDP = per capita gross domestic income; RICESH = share of rice calories in total calorie consumption; AGSHGDP = Share of agriculture in GDP; LANDSH = share of rice area in total arable land area; YLD = yield per hectare; TRDSH = trade position
2. L. = lag operator; D. = difference operator
3. For Thailand, the co-integrating space assumption of unity is violated, suggesting the ARDL model is not the appropriate framework. The results for Thailand are displayed (grey area) for illustrative purpose only.

Table 4.5: Estimated long-run coefficients

	WEST AFRICA				ASIA			
NPC	RCI	MALI	NIGERIA	SENEGAL	INDIA	PAKISTAN	THAILAND	VIETNAM
Cons	3.717***	-7.005***	-20.490**	12.281***	-0.965***	-48.213***	-4.457**	14.382
L.PW	-0.169	-0.734***	-0.364**	0.012	-0.802***	-1.721***	-0.796***	-0.672***
L.GDP		1.758***				4.514***	2.338***	2.403***
L.AGSHGDP				1.713***	-3.352***		1.549***	3.865***
L.RICESH			-0.812					
L.LANDSH	1.220***		1.559***	2.462***				
L.YLD			3.311***			3.453***	-0.790*	-2.459
L.TRDSH	1.570***							
DUMYTRD	0.708***	0.467***	1.014*	-1.019***	0.165	0.272***	-0.019	0.294*

Notes:
1. PW = border price of rice; GDP = per capita gross domestic income; RICESH = share of rice calories in total calorie consumption; AGSHGDP = Share of agriculture in GDP; LANDSH = share of rice area in total arable land area; YLD = yield per hectare; TRDSH = trade position
2. L. = lag operator; D. = difference operator
3. Both India and Thailand failed to pass the ARDL bound test, suggesting that no long-run relationship can be inferred from the model. The results for India and Thailand are displayed (grey area) for illustrative purposes only.

RCI. The path of RCI's NPC is determined by the share of rice area in total arable land area, import share and world rice prices, although the latter is not statistically significant. All the estimated coefficients are consistent with a priori expectations, except the share of rice area in total area. The positive significance of the trade position in determining the path of protection suggests that the Ivorian government is more concerned about protecting local producers against the rising imports than providing cheap calories to consumers and generating revenues from imports. The unexpected positive correlation between increased rice areas and protection levels further supports the claim of increased protection in RCI and could be explained by the fact that poor importing countries such as RCI, which have invested heavily in irrigation infrastructure, want to want to protect that fixed investment.

Mali. Protection levels in Mali are determined by world rice prices and per capita gross domestic income. All the estimated coefficients are statistically significant and consistent with a priori expectations. Protection levels decline by 73% as world rice prices increase by 10%, suggesting that a poor country such as Mali is willing to give up import tax revenues when world prices increase in order to protect consumers. Although changes in the world price is statistically significant for both Mali and its richer neighbor Nigeria, Mali appears to be better able to insulate their domestic market from these changes as suggested by the higher estimate of its coefficient. Moreover, Mali is the only WA country whose NPC path significantly depends on growth of income rather than growth of production. The strong positive relationship between income growth and protection implies that the Malian government is more inclined to subsidize domestic rice prices relative to world prices as the economy grows. This could reflect the growing importance of rice consumption in Mali, where the demand for rice is more income-elastic than in the other WA coastal countries, (e.g., 1.2 in Mali vs 0.7 in RCI and 0.9 in Senegal in rural areas (Hollinger and Staatz 2015)), and hence the growing concerns about consumer rice prices over time. However, continued protection of rice producers may be financially unsustainable in a poor WA country such as Mali, as it would put a huge burden on the consumers.

Nigeria. The path of Nigeria's NPC is determined by world rice prices, the share of rice area in total arable land area, rice yields, and the share of rice calories in total calorie consumption, although the latter is not statistically significant. All the estimated coefficients are consistent with a priori expectations, except the share of rice area in total area and rice yields. The positive relationship between increased comparative advantage and protection levels could be explained by the fact that Nigeria, similarly to RCI, has heavily invested in irrigation infrastructure in addition to research and development of improved seed technology, and may want to protect those fixed investments. Moreover, protection levels in Nigeria decline by 36% as world rice prices increase by 10%. Although Nigeria is richer and has greater scope for domestic substitution of cereals with roots and tubers than Mali, the smaller magnitude of the world price coefficient in

Nigeria compared to Mali suggests that Nigeria is more willing to transmit increases in world prices to consumers. Nigeria is also less willing to give up import tax revenues when world prices increase to protect consumers.

Senegal. Protection levels in Senegal are determined by the share of agriculture in GDP, the share of rice area in total arable land area, and world rice prices, although the latter is not statistically significant. All the significant estimated coefficients are consistent with a priori expectations, except the share of rice area, suggesting again that Senegal, similarly to the other WA countries, has heavily invested in irrigation infrastructure and want to protect that investment. Also, the share of agriculture in the economy positively contributes to the NPC path of Senegal, which historically has had strong and organized producer associations the Senegal River Valley.

Pakistan. Protection levels in Pakistan are determined by world rice prices, per capita gross domestic product, and rice yields. All the estimated coefficients are statistically significant and consistent with a priori expectations, except for rice yields. Protection levels decline by 172% when world rice prices increase by 10%, suggesting that in period of rising world prices, the rice sector is heavily taxed in Pakistan as the result of the government's desire to generate revenues and keep domestic prices low to consumers. However, the large coefficient on world prices also suggests that the government substantially increases the protection of the sector when world prices fall.

Moreover, GDP is positively correlated with NPC, suggesting that government is more willing to subsidize rice producers as the economy grows. However, the unexpected positive correlation between rice yields and protection rates may suggest that, similarly to the WA countries, Pakistan wants to protect its important investments in irrigation infrastructure and research and development of improved technologies.

Vietnam. The path of Vietnam's NPC is determined by world rice prices, GDP, the share of agriculture in GDP, and export shares, although the latter is not statistically significant. All the statistically significant estimated coefficients are consistent with a priori expectations. Similarly to Pakistan, the negative correlation between world rice prices and protection level reflects the desire of the Vietnamese government to generate revenues (e.g. via export taxes) and keep domestic prices low to consumers during periods of high prices (i.e., NPC declines by 67% when world prices increase by 10%). Also, the positive correlation between GDP and protection rates suggests that as the Vietnamese government is more willing to subsidize rice producers as the economy grows. Moreover, with the liberalization of the 1990s, the economy has become more open and hence protection levels have fallen, particularly since the country joined the WTO in 2006. However, the unexpected positive relationship between the share of agriculture in GDP and protection levels could be explained by the fact that Vietnam is still considered a developing country, and although declining, the share of agriculture in GDP is still large, with the share of agriculture accounting for about 35% of GDP in the early 1990s compared to 20% by the late 2000s; the share of the industry and services have grown from about 27% to 35% and from 38% to 45%, respectively over the same period.[34]

4.8 Conclusion and policy implications for West Africa

This chapter explores the forces driving the evolution of rice price policies over the period 1980-2009 by conducting country-specific time-series analyses for selected major rice importing countries in West Africa and their major imported rice suppliers in Asia using an ARDL bounds testing approach. The results show that the variables are co-integrated, meaning that there is a

[34] These data were obtained from World Bank's Development Economics Database (http://data.worldbank.org/).

stable long-run relationship between protection levels and its determinants for all countries, except India and Thailand.

The results of the econometric analysis confirms previous findings on the importance of economic development and resource endowments in explaining the pattern of agricultural protection in the selected Asian countries (David and Huang. It also reveals the importance of price stabilization as a policy objective and the relation between cost-reducing policies (technology generation and input price subsidy) and the rice price policy. The removal of quantitative trade restrictions is significantly positively correlated to protection levels, except in Senegal, highlighting the fact that the rice sector remains strongly protected in both Asia and West African despite liberalization efforts. In fact, for all of the WA countries, except Senegal, as well as Vietnam and Pakistan, there is a statistically significant positive trend in NPCs over time, showing that the countries are becoming more protective of their rice sectors. Moreover, input subsidies in the rice sector have also increased since 2008. These subsidies, whose impact is not captured in the NPCs, further increased the degree of protection of the sector.

Keeping in mind that neither world prices nor domestic prices in this analysis include domestic transport costs, the results suggest that world and domestic rice markets are rather well integrated. The magnitude of protection levels relative to world rice prices further implies that, on average, the Asian markets are better able to insulate their domestic market to changes in world prices than WA, except Mali, which has the second highest elasticity of price transmission among the focus countries.

Moreover, the analysis suggests that production levels (i.e., share of rice area and/or rice yields) positively affect the NPC path of the WA countries, except in Mali. Although it is expected that area rather than yield would be a better predictor of protection for West African countries given the high degree of extensification of WA rice systems, the direction of the relationship of these factors goes against expectations. The unexpected positive relationship between the measures of comparative advantage (i.e., increased rice area and yields) could reflect the fact that these countries, which have invested heavily in irrigation infrastructure and research and development for improving seed varieties, want to protect those fixed investments, especially if there is pressure by those who control them to protect the rents that accrue to those assets. This is especially true for countries with higher purchasing power, such as Côte d'Ivoire, Senegal and Nigeria. In Mali, however, where the demand for rice is strongly income-elastic, the NPC path significantly depends on growth income. The positive relationship between income growth and protection could be reflecting the growing importance of income-driven; rice consumption, and hence the growing concerns about consumer rice prices over time.

Although protection is common in rice-producing developed countries, continuing to protect high cost producers to stimulate production will put a great burden on consumers and may jeopardize poor urban consumers' access to affordable rice supplies; thus, there may be a need to put in place safety nets. Alternatively, opening the market further, especially in poorer landlocked countries such as Mali where the elasticity of price transmission is the highest among the net importing West African countries, could be another option to help smooth prices and meet food security objectives, assuming increased dependability of the world rice market. Further investments in market infrastructure, including roads, will be key in achieving this objective. Another option could consist in undertaking efforts to broaden the consumption basket of staples in various countries (e.g., promoting more easy-to-prepare processed forms of other staples so that consumers have more options when rice prices increase).

Given that some variables may be significant in one country but not necessarily in another, country-specific analysis, rather that aggregated cross-country analyses which have been extensively carried out in the literature, may provide more relevant insights to guide both country and regional rice policy in WA, especially in the current context of regional economic integration. The discussion of the results highlights the fact that each of the WA countries, which are all members of ECOWAS, may have diverging interests depending on their geographic location or level of economic development, for instance. Thus, the design of the trade policy needs to pay particular attention to the structure of incentives facing the member states as well as the actors within them (e.g., consumers and producers) in order to implement common approaches. To date, the progress of WA's efforts to develop a more integrated regional market for agricultural products has been slower than anticipated[35] , reflecting these potentially diverging interests. Nonetheless, a consensus on issues regarding uniform protection levels, including the structure of a common external tariff (CET) and the safeguards mechanisms[36] designed to accompany its implementation, has been reached after much debate. The proposed set of safeguard measures aimed at dealing with: (1) price volatility emanating from international markets; (2) transitional problems that particular industries in individual countries might face as a result of adopting the CET, (3) import surges and (4) the aim of ECOWAP to provide differentiated protection to various value chains (Hollinger and Staatz 2015).

[35] ECOWAS members signed the agreement to create a CET in 1996, with plans for it to be fully implemented by 2004. It began to go into force in 2015.

[36] The safeguards mechanisms include: (1) the Degressive Protection Tax (DPT), aimed at providing additional industry-specific protection (at a decreasing rate over time) to countries as they adapted to lower tariff rates under the CET; (2) the Safeguard Tax on Imports (STI), aimed at dealing with import surges; (3) the Compensatory Levy (ECL) aimed at counteracting the competitive advantages that imports gain due to agricultural subsidies in the exporting countries; and (4) the Inverse Safeguard Tax (ISF), aimed at providing a uniform mechanism by which import duties would drop in cases of soaring international prices or precipitous drops of the level of imports to help stabilize trade volumes (ECOWAS, 2012).

Although the CET is to be applied regionally, the safeguard measures are to be triggered by conditions facing individual countries, which could create different levels of protection among member states and thereby induce a lack of coherence between national and regional policies, leading to additional implementation challenges. Thus, additional regional safeguard measures beyond those currently adopted by the formal ECOWAS trade agenda could also been considered in order to help deal with price volatility emanating from international markets. These measures could provide countries with more alternatives (e.g., technologies and safety nets) for addressing price volatility rather than solely relying on rice trade policy. Some of these measures, as suggested by Hollinger and Staatz (2015), could include:

1. Promoting regional private storage, by facilitating funding for storage facilities; providing support for storage, marketing credit and collective marketing by farmer organizations; and encouraging warehouse receipt systems (warrantage) through contracting with private sector warehouse operators in cross-border production areas. This will help reduce the pressure on farmers to sell immediately after harvest, which accentuates seasonal price variation.
2. Promoting the establishment of a regional commodity exchange for food products, which would create a transparent venue for price formation over the medium- to long-term. Well-functioning cash markets, however, are precondition for the regional futures market to succeed.
3. Creating a regional food security reserve by allocating of a certain percentage of each member country's national reserve into the regional food reserve with the aim to provide targeted food aid to vulnerable segments of the population. How such actions are implemented, however, is critical, as badly managed reserve stocks can be highly

disruptive of the market and crowd out private stockholding, leading to little or no net gain in inventories in the marketing system.

4. Strengthening social safety net systems to help mitigate the adverse effects of price volatility and other exogenous shocks on vulnerable populations. Such safety nets have to be carefully targeted, however, because it is not financially feasible to protect all of the politically vocal urban consumer groups from higher prices given the large number of net food buyers in most ECOWAS countries.

Finally, most WA countries, including those under study, have emphasized input subsidies as an important part of their rice policies, especially since 2008. Providing extreme high-cost protection as more investments are allocated toward the research and development of improved technology is financially unstainable and undesirable from an economic standpoint. Thus, to escape from this trap and improve comparative advantage in WA, policy makers need to find better ways to promote technological progress when designing polices aiming at protecting local rice producers. Unfortunately, these factors are not captured in the model developed in this study. Therefore, future research could expand the current model by including additional exogenous variables that account for technology and policy contributing to lowering the unit cost of production such as the ratio of area planted to modern varieties and the level of nominal protection on fertilizer.

APPENDICES

Appendix 1: The Evolution of agricultural and trade policies in Asia and West Africa since the 1980s

To date, rice continues to be one of the most protected commodities in both developing and developed countries, through high tariff and non-tariff barriers, export restrictions and aid, state trading, subsidized loans, and payments to encourage fallow areas and other domestic market interventions. Despite some liberalization of the agricultural sector, both developed and developing rice-producing countries have maintained high levels of rice protection. Most Western nations heavily subsidize their rice producers and in doing so depress world rice prices. Following structural adjustment, trade liberalization and accession to the WTO, high-income Asian net rice exporters such as Japan and South Korea have lifted some non-tariff barriers such as absolute quotas but have maintained high tariff rates, with the goal of protecting rice farmers and millers from entry of cheaper rice and safekeeping their rice farming tradition. These countries are characterized by important production support policy, including high tariff rates, limited quotas on imports and high producer price supports, as well as declining per capita consumption, increasing yields and large surpluses resulting in artificially high producer and consumer prices. For instance, the producer price in Japan is ten times higher than that of other japonica rice produced in countries such as China. Export subsidies and shipping rice as food aid are increasingly used as means to dispose of the surpluses, and imports mainly consist of expensive and relatively high quality rice.

The main objective of rice policy in developing Asian rice producing countries consists of achieving food security mainly through national self-sufficiency while protecting the domestic rice sector. In particular, Asian countries with rice surpluses such as Thailand, Vietnam, and India have traditionally taxed rice farming and exports through quotas or ad valorem taxes in order to generate government revenue and hold down domestic prices of rice to protect vocally powerful urban consumers. However, since the mid-1980s, these countries have started to move away from taxing to supporting rice production as rice surpluses increase (Rakotoarisoa 2006). Although major exporters such as Vietnam, Pakistan and India have national rice strategies for supporting production and sustaining market prices, they generally do not heavily subsidize rice exports. However, since 2002, Thai prices have been set at above-market levels, resulting in a build-up of government stocks that are disposed of via subsidies. This has played a key role in sustaining Thai exports and in keeping the top exporter spot. Price supports for rice producers have been important in the major industrialized countries or regions, including the European Union, Japan, and the United States. In recent years, many Asian countries have revamped their efforts to achieve rice self-sufficiency and stabilize domestic prices through stronger policy interventions. Many large rice-growing countries have increased the minimum support price for farmers and introduced many-short policies measures to subsidize inputs such as fertilizer, seed, electricity and fuel to expand domestic rice production. A few major rice-exporting countries adopted some measures to buffer the domestic rice market from sharp price fluctuations, such as imposing an export ban for a short period and setting minimum export prices to ensure an available rice supply in the domestic market (India and Vietnam). In contrast, in periods of high world rice prices, such as 2008, major rice-importing countries lifted or reduced tariffs on imported rice and also provided a price subsidy on rice to make it affordable to poorer consumers (Tobias et al. 2012). The net effect of these offsetting actions resulted in having less of an impact on world prices than either the importing or exporting country intended (Anderson, 2012).

The liberalization of agricultural markets accompanied by increased exposure to regional and global markets strongly influenced rice policy in West Africa over the past 30 years. Prior to the wave of structural adjustment programs in the 1980s and 1990s, governments in West Africa tended to heavily intervene in agricultural markets. While the agricultural sector as a whole was generally taxed in West Africa that taxation was heavily concentrated on export crops, while import-substituting crops such as rice were often subsidized. The general policy orientation was to maintain cheap food for urban consumers, using border price interventions to stabilize price fluctuations in domestic markets. The elimination of many of the marketing boards and the liberalization of agricultural trade were central features of structural adjustment programs in the region. Following the onset of structural adjustment programs in the mid-1980s, the general use of trade policy interventions was reduced and was less oriented toward counteracting international price swings (Anderson and Masters 2009). Moreover, the wave of reforms induced by Structural Adjustment Programs throughout the 1980s and 1990s resulted in a sharp reduction of public resources available for supporting the development of the rice value chain; thus, opening the Western African rice market to world suppliers was a very attractive option for West African governments until the mid-2000s, given the continuous trend of low international rice prices during that period (Lançon and Erenstein, 2002).

Although following the implementation of the structural adjustment programs in the 1990s, West African governments refrained from directly intervening in the production and marketing of rice, the surge in food prices starting in 2007/08 prompted a rethinking of their rice policies. The large rice price increases and trade restrictions in 2007/08 called into question the reliability of the international rice market as a source of supply for importing countries. Furthermore, the increased instability of the world rice market since the 2008 rice crisis has led many West African countries to pursue rice self-sufficiency objectives rather than relying on international trade to meet their food security goal, as they believed that the price increase offered an opportunity to expand production without high tariffs or subsidies (Campbell et al., 2009). Nonetheless, with imports still accounting for a significant share of total consumption, it may not be possible for West African countries to isolate themselves from the world market over the long-run, and a major issue facing many West African countries is how to ensure this additional supply at minimum costs.

Even before the recent world price surges, few countries allowed domestic prices to be determined directly off of world prices (i.e., domestic markets were not consistently integrated with international markets). After these price surges, even fewer countries are willing to rely as heavily as they have in the past on the international rice trade. In fact, many of them, including West African countries, have adopted very aggressive strategies with the aim of improving their levels of self-sufficiency. In addition to these short-term reactive measures, several countries adopted policies aiming at stimulating domestic rice production in the medium to long-term. The policies often include the provision of subsidies on inputs such as seed and fertilizer, farm machinery and post-harvest equipment (e.g. in Nigeria, Senegal, and Togo), the establishment of a minimum producer price (in Nigeria) and the expansion of areas under irrigation by speeding up the rehabilitation of existing irrigation schemes (e.g., in Mali).

However, because they faced a food price dilemma, several governments in West Africa also adopted policy interventions to mitigate increases in consumer rice prices in the short-term that worked in opposite direction of their rice self-sufficiency objectives. Probably due to the ease of its implementation, the most widespread intervention consisted of the temporary reduction or suspension of customs duties and taxes on imported rice, resulting in significant loss of fiscal revenues. Some countries used price control mechanisms to contain the increase in consumer prices (e.g., Benin, Burkina Faso, and Senegal) while others have attempted to ban grain exports (e.g., Burkina Faso, Guinea, Liberia, Mali and Niger). Other food policy measures implemented include subsidies on retail prices (Benin, Burkina Faso and Senegal) and the release of food security stocks (Nigeria).

Even though most West African countries reverted back to more protection of their rice sector after the 2008 crisis, the lack of harmonization of tariff policies across countries in West Africa did not allow a reduction in import volume. For instance, Ghana charges a 12.5 percent value-added tax in addition to the 20 percent import duties while Côte d'Ivoire only imposes a 10 percent import duty, thus favoring imports in the later country combined with informal trade between the two countries (USAID 2009). This situation works against ECOWAS's desire to build an integrated regional market for agricultural and to obtain membership in the WTO, which will enable it to negotiate on the behalf of its member states. The most debated policy instrument to achieve this goal is the Common External Tariff (CET). The CET was adopted in October 2014, 17 years after the member states initially agreed to establish it, with implementation set for 2015. It features a newly created fifth tariff band set at 35% (compared to 20% under WAEMU structure) primarily for meat products, horticulture, cocoa and vegetable oils (ECOWAS press release); the rate for rice was maintained at 10%--a relatively low level of protection.. The argument for more protection of domestic rice is rooted in the infant industry theory, which stipulates that smaller countries need to protect their emerging industries (Edwards, 1993) in order to develop. Increasing tariff's levels is gaining in popularity in West Africa, especially among small-scale producers' organizations who argue that the success of major rice producers and exporters was due to a large extent to the protectionist policy implemented by their governments. However, it is uncertain that governments will move in this direction, given the growing numbers of the politically vocal urban poor who current rely on cheap rice imports. Reaching agreement in the CET was a long and controversial process, as some member states such as Nigeria wanted a higher level for the fifth band (50%) and the inclusion of a broader array of products, notably rice.

Appendix 2: Evolution of Government Strategy in Côte d'Ivoire, Mali, and Senegal[37]

Governments in WA, especially Sahelian countries such as Mali and Senegal that are characterized by irregular rainfall and generally poor soils, have historically given priority to developing irrigated agriculture, including rice farming, in the fertile river valleys and deltas to ensure food security for their populations. Countries in more humid zones, such as RCI, have also invested in irrigation infrastructure, notably in the lowlands. For years after independence in the 1960s, the countries under study pursued a very aggressive interventionist rice policy through various parastatals, (e.g., SODERIZ[38] and CIDV[39] in RCI, ON[40] in Mali, and SAED[41] in Senegal), which were specially created to invest in irrigation, provide inputs and extension services, and manage the market by supporting both producer and consumer prices, and imposing quotas and high tariffs on imported rice. As a result, overall rice production substantially increased in the region. RCI even achieved complete self-sufficiency and exports by the mid-1970s, with local rice prices exceeding border prices (up to more than 50 percent) for a few years in the mid-1980s when world prices were very low.

While production grew rapidly during the 1980s with the implementation of ad hoc programs and development projects, the 1990s were a period of stagnation where rice development programs have been hampered by macro-economic and agricultural policies reforms (i.e., total withdrawal of the State, which was previously directly involved in rice sub-sector and rice imports) leading to an overall decrease domestic production and increase of imports. Moreover, the impact

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[37] This section greatly draws from Anderson and Masters (2012); National rice development strategies; and set of rice value chains studies carried out by AfricaRice and national agricultural research systems (NARS) in collaboration with Michigan State University for various rice production systems in Côte d'Ivoire (RCI), Senegal, Mali, Guinea, and Benin (Diallo et al. 2012).
[38] Société pour le développement du riz
[39] Compagnie Ivoirienne pour le Développement des Cultures Vivrières
[40] Office du Niger
[41] Société national d'aménagement et d'exploitation des terres du delta du fleuve Sénégal et des vallées du fleuve Sénégal et de la Falémé.

of the 1994 CFAF devaluation on reducing import demand was mitigated due to increased consumers' preference for imported rice, especially in coastal countries such as RCI and Senegal, where consumers responded to the price increases in imported rice resulting from the devaluation by reducing the consumption of other food items (e.g., meat and wheat products) while they maintained or relatively less reduced their level of imported rice consumption (Diagana et al. 1999). Thus, traditional cereals and other staples didn't benefit from the price increase in imported rice as much as expected, with the exception of Mali where domestic rice the production and consumption increased mainly due to Malians' preference for domestic rice over imported rice (Diagana et al. 1999).

As a result, in the 2000s there was a renewed effort to rejuvenate local rice production in order reduce food bills and improve food security. This interest brought about a series of reforms aiming to modernize rice farming, often accompanied with the establishment of a structure, whose main mandate was to coordinate and monitor the implementation of numerous rice-related projects throughout the country. The impact of these liberalization efforts was mitigated and difficult to assess, especially in RCI, which faced a military coup d'état in 1999 that turned into a decade-long full-scale civil war by 2002. The war disrupted the efforts of the government to develop the rice sector, as it influenced the specifics of agricultural policy through the north-south division of the country. Because most rice is produced in the north, local rice was no longer delivered to the urban areas of the south, resulting in increased imports to feed growing demand in the urban areas of the south. "Voluntary administered prices" for rice in urban areas were established, but these appear to have helped traders more than farmers, raising wholesale-to-retail margins (OECD 2006; Abbott 2007).

The 2008 price hikes resulted in severe food shortages and provided further impetus to expanded rice production in RCI in order to increase rice self-sufficiency rather than rely on international trade. This renewed momentum led to the development of very ambitious national strategies for the development of rice production (i.e., SNDR in RCI, Initiative Riz in Mali, and GOANA and PNAR in Senegal[42]). In brief, these national rice strategies often consisted of a 10-year plan and usually comprised three stages: (i) an emergency rice program component in the short-run, (ii) achievement of self-sufficient objectives in the medium-run, and (iii) buildup of a safety or buffer stock for potential exports in the subregion in the long-run.

Overall, the short-term emergency measures mainly consisted of measures aiming at lowering consumer prices through temporary exoneration of the value added-tax (VAT) and import tariffs on imported rice, setting of ceiling or administered consumer prices, and export restrictions. The aim of the medium- and long-run components is to achieve self-sufficiency and eventually exports in the subregion by promoting profitable production of quality rice by local farmers, leading to low and stable prices to consumers while generating job creation through added value in seed production, transportation and marketing, and machinery repairs. The medium- and long-run measures tend to focus on improving: (i) access to high quality inputs by subsidizing their costs, including the provision of credit and the development of a formal seed sector; (ii) irrigated rice production by rehabilitating all previously developed irrigation sites and developing new irrigation systems in major cultivable area, especially lowlands; and (iii) support for processing and marketing of locally produced rice, which were neglected in the past.

[42] SNDR stands for Stratégie Nationale de Développement de la filière Riz, (National Development Strategy for the Rice Sector); GOANA stands for Grande Offensive Agricole pour la Nourriture et l'Abondance (Grand Offensive for Food Abundance); PNAR stands for Programme National d' Autosuffisance du Riz National Program for Rice Self-sufficiency). For instance, the total costs of the agricultural development strategy in Senegal (GOANA) are estimated to vary from US$ 800 million to US$ 1.8 billion, but the budget for rice alone appears to be US$ 390 million, more than the government budget for investment in agriculture for the four years prior to GOANA. Achieving the ambitious targets would require 1.5 million tons of paddy production

Table A.1: Production and Marketing Budgets – RCI

Cote d'Ivoire: Forest Zone - Irrigated Perimeter

	Amount	Per unit costs		Total costs			
		Financial	Economic	Financial	Economic	Tradable	Non tradable
FARMER							
Operating costs (CFAF/ha)							
Agricultuaral inputs							
Seeds (kg/ha)	40	600	573	24000	22918	22918	
Urea (kg/ha))	100	270	255	27000	25460	25460	
NPK (kg/ha)	200	300	284	60000	56815	56815	
DAP (kg/ha)							
Organic fertilizer (kg/ha) - including manure							
Herbicide 1 (l/ha) -- Roundup	2.0	6000	5615	12000	11229	11229	
Herbicide 2 (l/ha)	0.8	45000	42174	36000	33739	33739	
Herbicide 3 (l/ha)	4.0	3500	3500	14000	14000	14000	
Insecticide (/ha)	0.4	20000	18715	8000	7486	7486	
Nemacide (kg/ha) -- Furadan	4	3000	2805	12000	11219	11219	
Labor and equipment rental							
tillage		8000	8000	8000	8000		8000
puddling		8000	8000	8000	8000		8000
nursery preparation		8000	8000	8000	8000		8000
irrigation and cleaning canal		7200	7200	7200	7200		7200
transplanting		40000	40000	40000	40000		40000
weeding		10000	10000	10000	10000		10000
fertilization and chemical application		2000	2000	2000	2000		2000
surveillance		64000	64000	64000	64000		64000
harvesting		30000	30000	30000	30000		30000
threshing		20000	20000	20000	20000		20000
drying							
Other costs							
Sacs (80kg)	63	300	300	18750	18750		18750
Fuel (l/ha)	48	615	402	29520	19306	19306	
Oil (engine) (l/ha)	12	1000	850	12000	10197	10197	
Capital							
interest on working capital - informal (30%) -- 6	13%	29281	29281	29281	29281	29281	
Total operating costs				**479751**	**457600**	**241650**	**215950**
Fixed costs (CFAF/ha)							
Land rental		32000	32000	32000	32000		32000
Water charges		0	0	0	0		0
Maintenance of irrigation infrastructure		0	0	0	0		0
small equipement depreciation		7515	7515	7515	7515		7515
agricultural equipement depreciation		89,499	84,545	89499	84545	84545	
Irrigation infrastructure depreciation	4300000		281621	0	281621		281621
Total fixed costs				**129013**	**405681**	**84545**	**321135**
Total cost (CFAF/ha)				**608764**	**863280**	**326195**	**537085**
Total cost (CFAF/kg paddy)				**122**	**173**	**65**	**107**

Table A.1 (cont'd.)

	Amount	Per unit costs		Total costs			
		Financial	Economic	Financial	Economic	Tradable	Non tradable
TRADER							
Transport							
Maintenance/labor							
Purchase of paddy							
Working capital (20% borrowed)							
Total distribution cost (without paddy purchase) (CFAF/ha)							
Total distribution cost (without paddy purchase) (CFAF/kg paddy)							
MILLER							
Transport	1	12500	7888	12500	7888	7888	
Equipement depreciation		9824	10,560	9824	10560	10560	
Building depreciation		6000	6000	6000	6000		6000
Purchase of paddy	5000	175		875000			
Labor		30000	30000	30000	30000		30000
Electricity		24000	24000	24000	24000		24000
Intrest		786	786	786	786		786
Milling costs (flat rate) (CFAF/ha)	60%						
Total milling cost (without paddy purchase)				**83109**	**79235**	**18449**	**60786**
Total milling cost (without paddy) (CFAF/kg rice)				**28**	26	6	20
MARKETING							
Transport	1	30000	18932	30000	18932	18932	
Maintenance/labor							
Stockage							
Milling costs (flat rate) (CFAF/ha)	60%						
Transformation (repackaging)							
Purchase of milled rice	3000.0	320		960000			
Working capital (20% borrowed, except Senegal 100%)							
Total distribution cost (without paddy purchase)				**30000**	**18932**	**18932**	**0**
Total distribution cost (without paddy) (CFAF/kg rice)				**10**	**6**	**6**	**0**
				Cote d'Ivoire: Forest Zone - Irrigated Perimeter			
TOTAL COST LOCAL RICE (FCFA/kg rice)							
Farmer				203	288	109	179
Trader				0	0	0	0
Miller				28	26	6	20
Marketing				10	6	6	0
Total				241	320	121	199
TOTAL VALUE OF LOCAL RICE (FCFAF/Kg)							
Retail price local rice				360	290		
PROFITABILITY OF LOCAL RICE (FCFAF/kg)							
Net margin				119	-31		
COMPARATIVE ADVANTAGE							
DRC	1.18						
SCB	1.11						

Notes:

Infation rate per year up to 2012	1.033	(see transp cost spreadsheet)
Trans. cost, econ. paved road, 30-ton truck, per ton-km in	31.2	
Trans. cost, econ. paved road, 30-ton truck, per ton-km in	37.9	

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Rapport du Senegal suite a l'atelier sur la transmission des prix et les prix de parites tenu a Bamako en Juillet 2009

Table A.2: Production and Marketing Budgets – Mali

Mali: Office du Niger - Irrigated Perimeter

	Amount	Per unit costs		Total costs			
		Financial	Economic	Financial	Economic	Tradable	Non tradable
FARMER							
Operating costs (CFAF/ha)							
Agricultuaral inputs							
Seeds (kg/ha)	25	750	722	18750	18053	18053	
Urea (kg/ha))	250	250	284	62500	71034	71034	
NPK (kg/ha)							
DAP (kg/ha)	150	250	342	37500	51252	51252	
Organic fertilizer (kg/ha) - including manure							
Herbicide 1 (l/ha) -- Roundup	2.0	6000	5603	12000	11206	11206	
Herbicide 2 (l/ha)							
Herbicide 3 (l/ha)							
Insecticide (/ha)							
Nemacide (kg/ha) -- Furadan							
Labor and equipment rental							
tillage		5000	5000	5000	5000		5000
puddling		5000	5000	5000	5000		5000
nursery preparation		5000	5000	5000	5000		5000
irrigation and cleaning canal		7500	7500	7500	7500		7500
transplanting		25000	25000	25000	25000		25000
weeding		50000	50000	50000	50000		50000
fertilization and chemical application				0	0		0
surveillance		15000	15000	15000	15000		15000
harvesting		30000	30000	30000	30000		30000
threshing		82875	82875	82875	82875		82875
drying							
Other costs							
Sacs (80kg)	75	200	200	15000	15000		15000
Fuel (l/ha)		650	409				
Oil (engine) (l/ha)							
Capital							
interest on working capital - informal (30%) -	12%	22268	22268	22268	22268	22268	
Total operating costs				**393393**	**414188**	**173813**	**240375**
Fixed costs (CFAF/ha)							
Land rental		92738	92738	92738	92738		92738
Water charges		67000	67000	67000	67000		67000
Maintenance of irrigation infrastructure							
small equipement depreciation		7448	7448	7448	7448		7448
agricultural equipement depreciation		64,429	60,863	64429	60863	60863	
Irrigation infrastructure depreciation	4560000		276572	0	276572		276572
Total fixed costs				**231615**	**504621**	**60863**	**443758**
Total cost (CFAF/ha)				**625008**	**918810**	**234676**	**684133**
Total cost (CFAF/kg paddy)				**104**	**153**	**39**	**114**

Table A.2 (cont'd.)

	Amount	Per unit costs		Total costs			
		Financial	Economic	Financial	Economic	Tradable	Non tradable
TRADER							
Transport	1	36000	21301	36000	21301	21301	
Maintenance/labor	2	3000	3000	6000	6000		6000
Purchase of paddy	6000	162		972000			
Working capital (20% borrowed)	12%	12168	12168	12168	12168		12168
Total distribution cost (without paddy purchase) (CFAF/ha)				**54168**	**39469**	**21301**	**18168**
Total distribution cost (without paddy purchase) (CFAF/kg paddy)				**9**	**7**	**4**	**3**
MILLER							
Transport							
Equipement depreciation							
Building depreciation							
Purchase of paddy	6000	172		1032000			
Labor							
Electricity							
Intrest							
Milling costs (flat rate) (CFAF/ha)	62%	37200	37200	37200	37200		37200
Total milling cost (without paddy purchase)				**37200**	**37200**		**37200**
Total milling cost (without paddy) (CFAF/kg rice)				**16**	16		16
WHOLESALER/RETAILER							
Transport	1	46500	27514	46500	27514	27514	
Maintenance/labor	2.0	3720	3720.0	7440.0	3720		3720
Stockage							
Milling costs (flat rate) (CFAF/ha)	62%						
Transformation (repackaging)							
Purchase of milled rice	3720.0	298		1108560			
Working capital (20% borrowed, except Seneg	0.1	13950	13950	13950	13950		13950
Total distribution cost (without paddy purchase)				**67890**	**45184**	**27514**	**17670**
Total distribution cost (without paddy) (CFAF/kg rice)				**18**	**12**	**7**	**5**

Mali: Office du Niger - Irrigated Perimeter

TOTAL COST LOCAL RICE (FCFA/kg rice)							
Farmer				168	247	63	184
Trader				9	7	4	3
Miller				16	16	0	16
Wholesaler				18	12	7	5
Total				211	282	74	208
TOTAL VALUE OF LOCAL RICE (FCFAF/Kg)							
Retail price local rice				325	349		
PROFITABILITY OF LOCAL RICE (FCFAF/kg)							
Net margin				114	67		
COMPARATIVE ADVANTAGE							
DRC	0.76						
SCB	0.81						

Notes:

Infation rate per year up to 2012	1.022
Trans. cost, econ. paved road, 30-ton truck, per ton-km in	31.2
Trans. cost, econ. paved road, 30-ton truck, per ton-km in	35.5

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Rapport du Senegal suite a l'atelier sur la transmission des prix et les prix de parites tenu a Bamako en Juillet 2009

Table A.3: Production and Marketing Budgets – Senegal

Senegal: Senegal River Delta: Irrigated Perimeter

	Amount	Per unit costs		Total costs			
		Financial	Economic	Financial	Economic	Tradable	Non tradable
FARMER							
Operating costs (CFAF/ha)							
Agricultuaral inputs							
Seeds (kg/ha)	71	250	474	17750	33666	33666	
Urea (kg/ha))	188	120	224	22560	42070	42070	
NPK (kg/ha)							
DAP (kg/ha)	81	150	276	12150	22368	22368	
Organic fertilizer (kg/ha) - including manure							
Herbicide 1 (l/ha) -- Roundup	0.6	7000	6594	4200	3956	3956	
Herbicide 2 (l/ha)							
Herbicide 3 (l/ha)	7.5	3200	2956	24000	22173	22173	
Insecticide (/ha)							
Nemacide (kg/ha) -- Furadan							
Labor and equipment rental							
tillage	7	1000	1000	7000	7000		7000
puddling							
nursery preparation	10	1000	1000	9500	9500		9500
irrigation and cleaning canal	6	1000	1000	5500	5500		5500
transplanting	10	1000	1000	9500	9500		9500
weeding	28	1000	1000	28000	28000		28000
fertilization and chemical application							
surveillance							
harvesting	55	1000	1000	55000	55000		55000
threshing							
drying							
Other costs							
Sacs (80kg)	64	250	250	16351	15897		15897
Fuel (l/ha)	75	615	542	46125	26013	26013	
Oil (engine) (l/ha)	18	1000	885	18000	10621	10621	
Capital							
interest on working capital - informal (30%) -	12%	19336	19336	19336	19336	19336	
Total operating costs				**294972**	**310601**	**180204**	**130397**
Fixed costs (CFAF/ha)							
Land rental		15000	15000	15000	15000		15000
Water charges		59000	59000	59000	59000		59000
Maintenance of irrigation infrastructure		4500	4500	4500	4500		4500
small equipement depreciation		4648	4648	4648	4648		4648
agricultural equipement depreciation		43,910	42,160	43910	42160	42160	
Irrigation infrastructure depreciation	3500000		212281	0	212281		212281
Total fixed costs				**127058**	**337589**	**42160**	**295429**
Total cost (CFAF/ha)				**422030**	**648191**	**222365**	**425826**
Total cost (CFAF/kg paddy)				**83**	**127**	**44**	**84**

Table A.3 (cont'd.)

	Amount	Per unit costs		Total costs			
		Financial	Economic	Financial	Economic	Tradable	Non tradable
TRADER							
Transport							
Maintenance/labor							
Purchase of paddy							
Working capital (20% borrowed)							
Total distribution cost (without paddy purchase) (CFAF/ha)							
Total distribution cost (without paddy purchase) (CFAF/kg paddy)							
MILLER							
Transport							
Equipement depreciation							
Building depreciation							
Purchase of paddy							
Labor							
Electricity							
Intrest							
Milling costs (flat rate) (CFAF/ha)	62%						
Total milling cost (without paddy purchase)							
Total milling cost (without paddy) (CFAF/kg rice)							
WHOLESALER/RETAILER							
Transport	1	21518	12185	21518	12185	12185	
Maintenance/labor	1	8953	8953	8953.1	8953		8953
Stockage	1	814	814	813.9	814		814
Milling costs (flat rate) (CFAF/ha)	62%	38153	38153	38153	38153		38153
Transformation (repackaging)		18924	18924	18924	18924		18924
Purchase of milled rice	5087.0	98		498526			
Working capital (20% borrowed, except Seneg	0.1	35213	35213.2	35213.2	35213		35213
Total distribution cost (without paddy purchase)				**123574**	**114242**	12185	102056
Total distribution cost (without paddy) (CFAF/kg rice)				**39**	36	4	32
				Senegal: Senegal River Delta: Irrigated Perimeter			
TOTAL COST LOCAL RICE (FCFA/kg rice)							
Farmer				134	206	71	135
Trader				0	0	0	0
Miller				0	0	0	0
Wholesaler				39	36	4	32
Total				173	242	74	167
TOTAL VALUE OF LOCAL RICE (FCFAF/Kg)							
Retail price local rice				275	262		
PROFITABILITY OF LOCAL RICE (FCFAF/kg)							
Net margin				102	20		
COMPARATIVE ADVANTAGE							
DRC	0.89						
SCB	0.92						

Notes:

Infation rate per year up to 2012	1.014
Trans. cost, econ. paved road, 30-ton truck, per ton-km in	31.2
Trans. cost, econ. paved road, 30-ton truck, per ton-km in	34.0

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Rapport du Senegal suite a l'atelier sur la transmission des prix et les prix de parites tenu a Bamako en Juillet 2009

Table A.4: Economic Prices

Year =	2011												
Official exchange rate (cfaf/$) =	409												
RCI - (Thai 25% broken, FOB Bangkok)													
Item	%	Rice	Seed	NPK	Urea	DAP	Herbicide 1	Herbicide 2	Herbicide 3	Insecticide	Nemacide	Fuel	Oil (engine)
FOB price milled rice ($/mt)		409	629	400	387		10	71	6	32	5	1	1
Ocean freight and assurance ($/mt)	28%	113	174	110	107		3	20	2	9	1	0	0
CIF price ($/mt)		522	803	510	493		12	91	7	41	6	1	2
Real exchange rate (cfaf/$)	100%	409	409	409	409		409	409	409	409	409	409	409
CIF price (CFA/kg) - Abidjan		213	328	209	202		5050	37036	3030	16835	2559	314	614
Port charges	4%	16	25	16	15		0	3	0	1	0	0	0
Transit cost	4%	9	13	8	8		202	1481	121	673	102	13	25
Customs and import duties, Abidjan (% of CIF)-- excluded													
Transport Port to point of sale	0.038	1	1	1	1		1	1	1	1	1	1	1
Wholesale marketing margin (5%)	5%	12	18	12	11		263	1926	158	876	133	16	32
Retail marketing margin (5%)	5%	13	19	12	12		276	2022	166	919	140	17	34
MALI - (Thai 25% broken, FOB Bangkok)													
Item	%	Rice	Seed	NPK	Urea	DAP	Herbicide 1	Herbicide 2	Herbicide 3	Insecticide	Nemacide	Fuel	Oil (engine)
FOB price milled rice ($/mt)		409	629		387	0	10					1	
Ocean freight and assurance (cfaf/mt)	28%	113	174		107	0	3					0	
CIF price ($/mt)	$/mt	522	803		493	0	12					1	
Real exchange rate (cfaf/$)	103%	421	421		421	421	421					421	
CIF price (CFA/kg) - Abidjan		220	338		208	0	5202					323	
Port charges	4%	16	25		15	0	0					0	
Transit cost	4%	9	14		8	0	208					13	
Customs and import duties, Abidjan (% of CIF)-- excluded													
Transport Port to point of sale	0.036	48	48		48	48	48					48	
Wholesale marketing margin (5%)	5%	15	21		14	2	273					19	
Retail marketing margin (5%)	5%	15	22		15	2	287					20	
SENEGAL - (Thai A1S, FOB Bangkok)													
Item	%	Rice	Seed	NPK	Urea	DAP	Herbicide 1	Herbicide 2	Herbicide 3	Insecticide	Nemacide	Fuel	Oil (engine)
FOB price milled rice ($/mt)		371	570	400	387	0	10		6			1	1
Ocean freight and assurance (cfaf/mt)	28%	102	157	110	107	0	3		2			0	0
CIF price ($/mt)	$/mt	473	727	510	493	0	12		7			1	2
Real exchange rate (cfaf/$)	100%	409	409	409	409	409	409		409			409	409
CIF price (CFA/kg) - Abidjan		193	298	209	202	0	5050		3030			314	614
Port charges	4%	15	23	16	15	0	0		0			0	0
Transit cost	4%	8	12	8	8	0	202		121			13	25
Customs and import duties, Abidjan (% of CIF)-- excluded													
Transport Port to point of sale	0.034	1	1	1	1	1	1		1			1	1
Wholesale marketing margin (5%)	5%	11	17	12	11	0	263		158			16	32
Retail marketing margin (5%)	5%	11	17	12	12	0	276		165			17	34

Table A.5: Depreciation Costs

Note: Derivation of capital recovery costs (CFAF/ha), using fixed depreciation of all tools and equipement with a useful life spread over more than one crop cycle

1) Capital recovery factor or CRF = (((1+i)^n*i)/((1+i)^n-1) where i = real interest on savings; n = number of cycles in the implement's useful life.

2) Cost per cycle = value new*CRF*share of total use

3) i = ((1+r)/(1+f))-1 where i = real interest rate; r = nominal interest rate; f = inflation rate

RCI								
Implement	Unit/ ha	Unit cost	Total cost /ha	Useful life cycles / ha	Share of use/ ha	CRF - Economic	CR cost/ha - Economic	CR cost/cycle - Economic
Ag. Equipment								
Cultivator	1	3,000,000	3,000,000	4	11%	34%	112,065	56,032
Thresher	1	3,500,000	3,500,000	4	5%	34%	53,485	26,743
Sprayer	1	40,000	40,000	4	100%	34%	13,448	6,724
Total ag. equipment			6,540,000					89,499
Irrigation infrastructure								
Irrigation infrastructure	1	4,300,000	4,300,000	40	100%	13%	563,242	281,621
Small equipment								
Hoe	2	2,500	5,000	1	100%	113%	5,650	2,825
Sickle	4	1,000	4,000	1	100%	113%	4,520	2,260
Machete	1	2,500	2,500	1	100%	113%	2,825	1,413
Lime	1	1,000	1,000	1	100%	113%	1,130	565
Bucket	1	800	800	1	100%	113%	904	452
Total small equipment			7,800					7,515

Table A.5 (cont'd.)

MALI								
Implement	Unit/ ha	Unit cost	Total cost /ha	Useful life cycles / ha	Share of use/ ha	CRF - Economic	CR cost/ha - Economic	CR cost/cycle - Economic
Ag. Equipment								
Spray	1	40,000	40,000	4	100%	33%	13,169	6,585
Cart	1	120,000	120,000	15	45%	15%	7,929	3,964
Pair of oxen (2)	1	250,000	250,000	25	45%	13%	14,344	7,172
Tractor	1	12,275,000	12,275,000	15	5%	15%	90,113	45,057
Donkey	1	50,000	50,000	15	45%	15%	3,304	1,652
Total ag. equipment			12,735,000					64,429
Irrigation infrastructure								
Irrigation infrastructure	1	4,560,000	4,560,000	40	100%	12%	553,145	276,572
Small equipment								
Hoe	2	2,500	5,000	1	100%	112%	5,600	2,800
Sickle	4	1,000	4,000	1	100%	112%	4,480	2,240
Machete	1	2,500	2,500	1	100%	112%	2,800	1,400
Lime	1	1,000	1,000	1	100%	112%	1,120	560
Bucket	1	800	800	1	100%	112%	896	448
Total small equipment			13,300					7,448

Table A.5 (cont'd.)

Implement	Unit/ ha	Unit cost	Total cost /ha	Useful life cycles / ha	Share of use/ ha	CRF - Economic	CR cost/ha - Economic	CR cost/cycle - Economic
Ag. Equipment								
Thresher	1	3,500,000	3,500,000	4	5%	33%	52,378	26,189
Sprayer	1	40,000	40,000	4	100%	33%	13,169	6,585
Cart	1	120,000	120,000	15	45%	15%	7,929	3,964
Pair of oxen (2)	1	250,000	250,000	25	45%	13%	14,344	7,172
Total ag. equipment			3,910,000					43,910
Irrigation infrastructure								
Irrigation infrastructure	1	3,500,000	3,500,000	40	100%	12%	424,563	212,281
Small equipment								
Seeder	1	4,000	4,000	1	100%	112%	4,480	2,240
Machete	1	2,500	2,500	1	100%	112%	2,800	1,400
Lime	1	1,000	1,000	1	100%	112%	1,120	560
Bucket	1	800	800	1	100%	112%	896	448
Total small equipment			8,300					4,648

	Inflation rate	Interest rate	Real interest rate
RCI	3.8%	13%	9%
MALI	3.2%	12%	8%
SENEGAL	1.6%	12%	10%

Table A.6: Estimated short-run and long-run coefficients

CIV					
ARDL			Long-term response		
D.NPC	Coef.	P>t	L.NPC	Coef.	P>t
Cons	-11.139	0.097	Cons	12.800	0.111
L.NPC	-0.870	0.004			
L.PW	0.153	0.294	L.PW	-0.176	0.338
L.GDP	0.624	0.224	L.GDP	-0.717	0.257
L.AGSHGDP	-0.367	0.557	L.AGSHGDP	0.422	0.640
L.LANDSH	-1.119	0.033	L.LANDSH	1.286	0.038
L.YLD	0.305	0.519	L.YLD	-0.351	0.596
L.TRDSH	-1.961	0.006	L.TRDSH	2.254	0.007
LD.NPC	0.433	0.009	DUMYTRD	0.637	0.036
D.PW	0.641	0.004	DUMY1998		
D.GDP	-0.061	0.964	DUMY2000		
LD.GDP			DUMY2003		
D.AGSHGDP	-0.868	0.124			
LD.AGSHGDP					
L2D.AGSHGDP					
D.LANDSH	-1.293	0.012			
LD.LANDSH					
D.YLD	-0.899	0.095			
LD.YLD	-0.903	0.096			
D.TRDSH	-1.415	0.003			
LD.TRDSH					
DUMYTRD	-0.554	0.031			
DUMY1998					
DUMY2000					
DUMY2003					

Number of obs	27
F(16, 10)	9.90
Prob > F	0.000
R-squared	0.941
Adj R-squared	0.846
Root MSE	0.113

Table A.6 (cont'd.)

MLI					
ARDL			Long-term response		
D.NPC	Coef.	P>t	L.NPC	Coef.	P>t
Cons	11.641	0.016	Cons	-11.781	0.016
L.NPC	-0.988	0.009			
L.PW	0.841	0.023	L.PW	-0.851	0.023
L.GDP	-3.688	0.024	L.GDP	3.732	0.024
L.AGSHGDP	-1.725	0.098	L.AGSHGDP	1.745	0.099
L.LANDSH	-0.650	0.083	L.LANDSH	0.658	0.084
L.YLD	0.419	0.496	L.YLD	-0.424	0.502
L.TRDSH	-0.092	0.354	L.TRDSH	0.093	0.358
LD.NPC			DUMYTRD	0.730	0.028
D.PW	0.944	0.000	DUMY1998		
D.GDP	-0.461	0.661	DUMY2000		
LD.GDP	1.527	0.187	DUMY2003		
D.AGSHGDP	-1.249	0.088			
LD.AGSHGDP					
L2D.AGSHGDP					
D.LANDSH	-0.036	0.853			
LD.LANDSH	0.355	0.097			
D.YLD	0.004	0.990			
LD.YLD					
D.TRDSH	-0.138	0.117			
LD.TRDSH					
DUMYTRD	-0.722	0.028			
DUMY1998					
DUMY2000					
DUMY2003					

Number of obs	28
F(16, 10)	24.02
Prob > F	0.000
R-squared	0.972
Adj R-squared	0.932
Root MSE	0.139

Table A.6 (cont'd.)

NGA					
ARDL			Long-term response		
D.NPC	Coef.	P>t	L.NPC	Coef.	P>t
Cons	28.817	0.043	Cons	-33.688	0.050
L.NPC	-0.855	0.011			
L.PW	1.221	0.001	L.PW	-1.427	0.001
L.GDP	-4.025	0.003	L.GDP	4.705	0.004
L.AGSHGDP	-1.714	0.139	L.AGSHGDP	2.003	0.162
L.LANDSH	-2.689	0.030	L.LANDSH	3.143	0.035
L.YLD	-1.936	0.273	L.YLD	2.263	0.319
L.TRDSH	1.128	0.002	L.TRDSH	-1.318	0.002
LD.NPC			DUMYTRD	2.565	0.002
D.PW	0.821	0.005	DUMY1998	0.695	0.069
D.GDP	-4.007	0.010	DUMY2000	0.800	0.150
LD.GDP			DUMY2003	0.204	0.689
D.AGSHGDP	-3.042	0.004			
LD.AGSHGDP					
L2D.AGSHGDP					
D.LANDSH	-1.317	0.059			
LD.LANDSH					
D.YLD	-0.804	0.240			
LD.YLD					
D.TRDSH	0.630	0.034			
LD.TRDSH					
DUMYTRD	-2.194	0.002			
DUMY1998	-0.595	0.059			
DUMY2000	-0.684	0.128			
DUMY2003	-0.175	0.589			

Number of obs	28
F(16, 10)	6.59
Prob > F	0.002
R-squared	0.918
Adj R-squared	0.779
Root MSE	0.220

Table A.6 (cont'd.)

SEN					
ARDL			Long-term response		
D.NPC	Coef.	P>t	L.NPC	Coef.	P>t
Cons	-0.077	0.989	Cons	0.208	2.675
L.NPC	-0.370	0.084			
L.PW	0.041	0.840	L.PW	-0.110	2.272
L.GDP	-1.550	0.048	L.GDP	4.191	0.130
L.AGSHGDP	-2.230	0.004	L.AGSHGDP	6.030	0.011
L.LANDSH	-2.078	0.004	L.LANDSH	5.620	0.011
L.YLD	-0.363	0.378	L.YLD	0.980	1.022
L.TRDSH	-4.703	0.078	L.TRDSH	12.720	0.211
LD.NPC			DUMYTRD	-2.333	0.005
D.PW	0.989	0.000	DUMY1998		
D.GDP	1.522	0.410	DUMY2000		
LD.GDP			DUMY2003		
D.AGSHGDP	-2.106	0.013			
LD.AGSHGDP					
L2D.AGSHGDP					
D.LANDSH	0.214	0.829			
LD.LANDSH					
D.YLD	-0.434	0.256			
LD.YLD					
D.TRDSH	-3.183	0.087			
LD.TRDSH					
DUMYTRD	0.862	0.002			
DUMY1998					
DUMY2000					
DUMY2003					

Number of obs	29
F(16, 10)	5.68
Prob > F	0.001
R-squared	0.850
Adj R-squared	0.700
Root MSE	0.139

Table A.6 (cont'd.)

IND					
ARDL			Long-term response		
D.NPC	Coef.	P>t	L.NPC	Coef.	P>t
Cons	-3.859	0.514	Cons	5.011	0.667
L.NPC	-0.770	0.020			
L.PW	0.658	0.041	L.PW	-0.854	0.053
L.GDP	-0.618	0.710	L.GDP	0.802	0.922
L.AGSHGDP	1.013	0.542	L.AGSHGDP	-1.315	0.704
L.LANDSH	-1.659	0.055	L.LANDSH	2.154	0.071
L.YLD	0.530	0.510	L.YLD	-0.688	0.662
L.TRDSH	0.028	0.815	L.TRDSH	-0.036	1.058
LD.NPC			DUMYTRD	0.406	0.323
D.PW	0.784	0.000	DUMY1998		
D.GDP	-1.739	0.465	DUMY2000		
LD.GDP			DUMY2003		
D.AGSHGDP	-0.737	0.642			
LD.AGSHGDP	-1.359	0.352			
L2D.AGSHGDP					
D.LANDSH	-0.861	0.256			
LD.LANDSH					
D.YLD	0.625	0.429			
LD.YLD					
D.TRDSH	0.078	0.489			
LD.TRDSH					
DUMYTRD	-0.313	0.249			
DUMY1998					
DUMY2000					
DUMY2003					

Number of obs	28
F(16, 10)	16.02
Prob > F	0.000
R-squared	0.952
Adj R-squared	0.893
Root MSE	0.141

Table A.6 (cont'd.)

PAK					
ARDL			Long-term response		
D.NPC	Coef.	P>t	L.NPC	Coef.	P>t
Cons	19.473	0.064	Cons	-26.363	0.087
L.NPC	-0.739	0.023	L.NPC		
L.PW	0.769	0.018	L.PW	-1.041	0.024
L.GDP	0.093	0.947	L.GDP	-0.126	1.282
L.AGSHGDP	2.750	0.083	L.AGSHGDP	-3.723	0.112
L.LANDSH	0.296	0.162	L.LANDSH	-0.401	0.219
L.YLD	-2.410	0.039	L.YLD	3.263	0.053
L.TRDSH	-0.028	0.920	L.TRDSH	0.037	1.245
LD.NPC			DUMYTRD	0.313	0.102
D.PW	1.163	0.000	DUMY1998		
D.GDP	-0.474	0.805	DUMY2000		
LD.GDP			DUMY2003		
D.AGSHGDP	-0.416	0.492			
LD.AGSHGDP	-2.353	0.071			
L2D.AGSHGDP	-1.366	0.110			
D.LANDSH	0.015	0.931			
LD.LANDSH					
D.YLD	-1.327	0.050			
LD.YLD					
D.TRDSH	-0.198	0.255			
LD.TRDSH	-0.134	0.346			
DUMYTRD	-0.231	0.075			
DUMY1998					
DUMY2000					
DUMY2003					

Number of obs	27
F(16, 10)	17.78
Prob > F	0.000
R-squared	0.971
Adj R-squared	0.917
Root MSE	0.079

Table A.6 (cont'd.)

THA					
ARDL			Long-term response		
D.NPC	Coef.	P>t	L.NPC	Coef.	P>t
Cons	4.431	0.497	Cons	-3.219	0.361
L.NPC	-1.377	0.001	L.NPC		
L.PW	1.087	0.003	L.PW	-0.789	0.002
L.GDP	-3.178	0.002	L.GDP	2.309	0.001
L.AGSHGDP	-2.106	0.000	L.AGSHGDP	1.530	0.000
L.LANDSH	-0.154	0.872	L.LANDSH	0.112	0.633
L.YLD	1.234	0.300	L.YLD	-0.897	0.218
L.TRDSH	-0.167	0.691	L.TRDSH	0.121	0.502
LD.NPC			DUMYTRD	-0.026	0.572
D.PW	0.798	0.002	DUMY1998		
D.GDP	-1.229	0.162	DUMY2000		
LD.GDP			DUMY2003		
D.AGSHGDP	-0.919	0.027			
LD.AGSHGDP					
L2D.AGSHGDP					
D.LANDSH	-0.555	0.435			
LD.LANDSH					
D.YLD	-0.302	0.773			
LD.YLD					
D.TRDSH	-0.159	0.604			
LD.TRDSH					
DUMYTRD	0.036	0.787			
DUMY1998					
DUMY2000					
DUMY2003					

Number of obs	29
F(16, 10)	7.80
Prob > F	0.000
R-squared	0.886
Adj R-squared	0.773
Root MSE	0.109

Table A.6 (cont'd.)

VNM					
ARDL			Long-term response		
D.NPC	Coef.	P>t	L.NPC	Coef.	P>t
Cons	-27.814	0.056	Cons	29.985	0.060
L.NPC	-0.928	0.017			
L.PW	0.444	0.129	L.PW	-0.478	0.139
L.GDP	-2.023	0.005	L.GDP	2.181	0.005
L.AGSHGDP	-1.331	0.230	L.AGSHGDP	1.435	0.248
L.LANDSH	0.412	0.707	L.LANDSH	-0.444	0.762
L.YLD	4.435	0.031	L.YLD	-4.781	0.033
L.TRDSH	0.680	0.055	L.TRDSH	-0.733	0.059
LD.NPC			DUMYTRD	0.092	0.754
D.PW	0.592	0.010	DUMY1998		
D.GDP	-1.934	0.000	DUMY2000		
LD.GDP	0.781	0.004	DUMY2003		
D.AGSHGDP	-0.204	0.804			
LD.AGSHGDP					
L2D.AGSHGDP					
D.LANDSH	1.265	0.247			
LD.LANDSH	1.269	0.207			
D.YLD	2.962	0.174			
LD.YLD					
D.TRDSH	0.499	0.072			
LD.TRDSH					
DUMYTRD	-0.085	0.699			
DUMY1998					
DUMY2000					
DUMY2003					

Number of obs	23
F(16, 10)	127.76
Prob > F	0.000
R-squared	0.997
Adj R-squared	0.989
Root MSE	0.103

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