博士論文

An analysis of impediments to
trade between local rice markets
in the Philippines
（フィリピンにおける
国内各地方
コメ市場間交易の障壁要因
に関する分析）

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Acknowledgements

An analysis of impediments to trade between local rice markets in the Philippines

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Abstract

In most developing nations such as the Philippines, there is a large degree of heterogeneity in each geographic market's ability to produce food staples. Also, a lack of rice for consumption has often been at the root cause of political instability. The sharp contrast in the supply of rice available for consumption across geographic markets within the nation speaks of the importance in ensuring that rice is redistributed efficiently from regions where it is produced in surplus, to regions where it is in deficit. This dissertation aims to answer two questions, which have a tremendous bearing on food security. First, are rice markets in the Philippines well arbitraged across space, ceteris paribus (that is, given the existing state of transportation and logistics facilities)? Second, what factors prevent rice from being traded between surplus regions and deficit regions?

The existing literature is unable to provide a conclusive answer to both questions. For example, while findings have been made, which suggest that Philippine rice markets are well arbitraged across space, Figure a1 below indicates significant price gaps across provinces which do not get arbitraged away across time. In the figure, each line plots the evolution of the wholesale price of regular milled rice across time in each of the different

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provinces in the Philippines. Compared to the observable shipping cost
of less than 1 peso / kilogram, there seem to be opportunities for traders
to make profits via arbitrage.

Figure a1. Evolution of rice prices over time
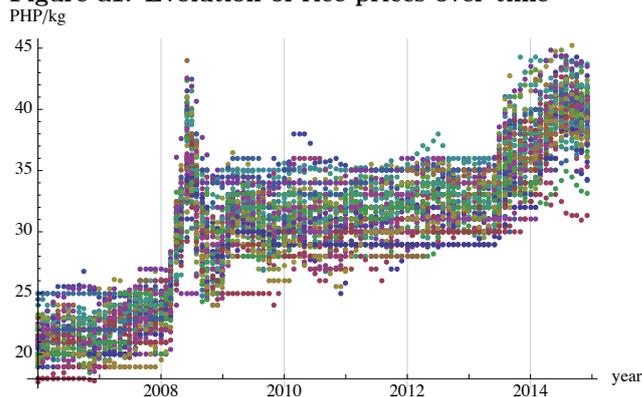
On the other hand, in an influential and highly cited paper, [Allen, T.
(2014). Information frictions in trade. Econometrica, 82(6), 2041-2083.]
argues that Philippine rice markets are not well arbitraged across space
and large information frictions are responsible for preventing trade from
taking place between surplus and deficit markets. As evidence to support
his claim that information frictions are tremendous in the Philippines,
Allen (2014) points to the fact that about 50% of importing provinces
export rice to destinations from which they import (that is, they engage
in "two-way trade"). According to Allen (2014), if we assume that prices
in each province are fairly stable across the months of a year, the fact
that provinces both import to and export from the same trading part-
ners within a year must be indicative of the fact that traders are not
well-informed about the prices of rice in other geographical locations. In
this dissertation, we scrutinize the author's claims and make findings that
differ. In particular, we find empirical evidence to show that (1) within
time periods shorter than a year, trade between most pairs of provinces
is almost unilateral as opposed to bilateral; and that (2) differences in

seasonality, coupled with the need for consumers to smooth out their consumption of rice across the months of a year, are largely responsible for causing province pairs to engage in "two-way trade" – that is, to both import to and export from the same trading partners within a year. In other words, we find that Allen (2014) may very possibly have over-estimated the importance of information frictions in preventing trade from taking place between pairs of provinces in the Philippines.

In order to answer our research questions, we build an original model to predict the amount of trade that would take place between every pair of provinces within a given period of time, such as a quarter of a year. The model assumes perfectly competitive markets and perfect information across space. We solve the model using linear programming and concepts from transportation theory and compare the model's solutions with actual trade flow data. Due to its assumptions on perfect competition, the model's solution is a Pareto optimal set of trade flows between every pair of provinces in the Philippines, where the exporting province has a surplus and the importing province a deficit of rice. The solution serves as a Pareto optimal benchmark, against which we can compare actual trade flow data, to evaluate how far away from Pareto optimality Philippine rice markets are. The solution, or predicted trade flows, of our model captures the features of observed trade flows very well even though the model assumes perfect information.

In Figure a2, the horizontal axis represents pairs of provinces, which have been ordered in ascending order according to the magnitude of trade flows which took place between them. Each dot represents a pair of provinces, and the vertical axis captures the trade flows (in kgs) between each pair. Red dots represent actual trade flows and blue dots represent the trade flows predicted by our model. Figure a2 shows that the solution of our model assumes a distribution that is very similar to the distribution of actual trade flows.

Figure a2. Distribution of trade flows, 2009
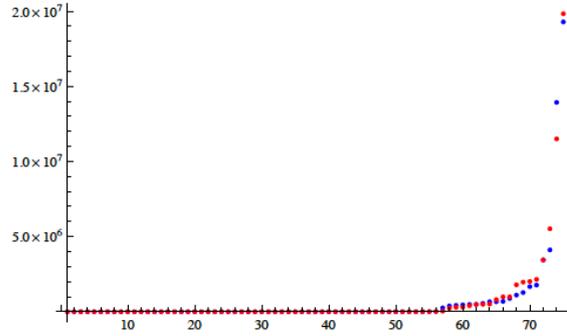
In Figure a3, each dot represents a pair of provinces, the horizontal axis captures the actual shipping distance (in kilometers) between pairs of provinces and the vertical axis captures the trade flows (in kgs) between them. Red dots represent actual trade flows and blue dots represent the trade flows predicted by our model. This figure shows that our model is able to predict the identities of each province's trading partners, as well as the magnitude of trade flows between pairs of provinces, very well.

Figure a3. Shipping distances against trade flows, 2009

Actual (red) & Solution (blue)
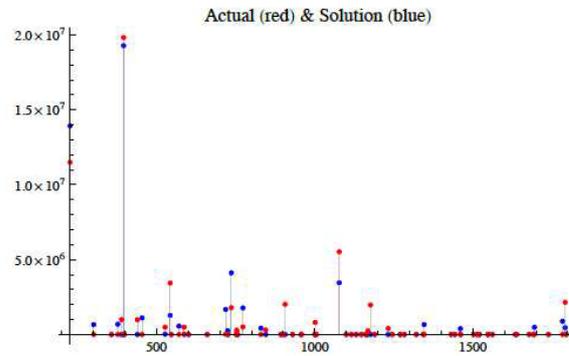
Finally, when we regressed the model's predicted trade flows against actual trade flows we obtained regression coefficients very close to 1 and adjusted R-squared values between 0.6 and 0.93. The results are significant at the 99% confidence level, and they suggest a very good fit between the model's Pareto optimal solution and the actual trade flows. The findings of this research suggest that previous work may have over-estimated

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the significance of information asymmetries in preventing arbitrage from taking place between rice markets in the Philippines. Our results also indicate that non-observable trade costs, including packaging, storage and logistics costs, play a large role in obstructing the trade of rice between surplus and deficit markets. The policy recommendations are clear-cut. Better transportation, packaging, storage, and logistics facilities, which would help to reduce trade costs, are of tremendous importance in ensuring that rice markets are better integrated across space. In other words, we would expect price differentials between regions to converge closer to the observed trade costs, as the above-mentioned services improve.

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1 Introduction and identification of the research issues

In the northern island of Luzon of the Philippine archipelago lies a vast and expansive range of highlands – the Philippine Cordillera mountain range. Over the past 2,000 years, rice has been cultivated on terraces following the shape of the mountain contours, creating a landscape of such breathtaking beauty that these rice terraces have been given a place amongst the other beautiful landscapes comprising the UNESCO (United Nations Educational, Scientific and Cultural Organization) World Heritage List. Immediately south of the Cordillera mountain range lies the Central Luzon region, a vast expanse of low-lying plains made up of alluvial soil which makes the land there extremely fertile in the cultivation of rice. For this reason, Central Luzon produces three-quarters of the country's total rice harvest and is known as the traditional rice granary of the Philippines.

Not all regions in the Philippine archipelago, however, enjoy such a comparative advantage vis-a-vis the production of rice. Consider Cotabato province of the Soccsksargen region, for example. It was a scorching day, and people in Cotabato province were famished after months of prolonged drought had destroyed almost all the crops their farmers had managed to produce for the current planting season. On Sunday, 27th March 2016, thousands of farmers and their families in 7 municipalities of Cotabato province – Arakan, Antipas, President Roxas, Magpit, Makilala, Mlang, and Tulunan – leaped onto trucks bound for Kidapawan City, the capital of Cotabato. They were fervent in their anger and disappointment over the government's lack of action in seeking to alleviate the famine they were faced with. If the government was to remain indifferent about this dire situation, they must gather at Kidapawan City to

rally for the attention of the authorities, or so they thought. They would block highways leading into Kidapawan City until the government acceded to their requests for 15,000 sacks of rice to feed their starving families. Victor Lumundang, a young lad of 18 from Antipas, was one of them. His mother, Germa Lumundang begged him to stay, but he left her with the words "Ma if I go, I might bring home rice." His family of 6 was desperate for food, after barely managing to survive on scavenged taro and greens for the past few months.

On the morning of Friday, 1st April 2016, just a few minutes before ten, a loudspeaker blared in Kidapawan City. "Clear the highway, or there will be legal consequences", said the chief of police. The 4,000 odd protestors, amongst which Victor Lumundang stood, were adamant and refused to budge. "Tell the governor we are hungry. Tell the governor we will not go," they chanted. Gun shots rang. Three were killed. About a hundred were injured. Unfortunately, Victor was embroiled in the bloodshed.

Several hours later, Germa Lumundang watched over her son at the Midway Hospital in Kidapawan City. She was told that 3 bullets had penetrated his upper thighs - two on the left and one on the right; and that another had ripped past his throat. "I can't talk to him anymore," said Germa. "When I got here, he didn't have a voice anymore. It's hard for him to talk. If he wants something from us, he'll gesture instead. If something hurts somewhere, he'll signal to us where." All her son wanted, Germa said, was to bring home rice.[1]

The sharp contrast between Luzon and Cotabato highlights the large degree of heterogeneity in the suitability for rice cultivation across the different geographical regions of the Philippines. It also shows how important the redistribution of rice from rice-surplus to rice-deficit areas within the country is, to national food security. This research aims to answer the following questions.

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[1]Kidapawan and the rice riots. (2016). Rappler. Retrieved 8 July 2016, from [http://www.rappler.com/newsbreak/in-depth/129386-riceriots- kidapawan].

First, are rice markets in the Philippines well arbitraged across geographical space? Second, what exactly are the economic factors which make it difficult for rice to be redistributed from the surplus to the deficit areas, in the most economically efficient way?

The economics of why rice-deficit areas do not receive sufficient quantities of rice imports cannot be divorced from the politics of why this is so. Since economics and politics tend to be heavily intertwined, we shall approach the research questions by considering both the economic and political backgrounds of rice markets in the Philippines. Having said that, the primary focus of this research is economics-based, and our main concern is to contribute to the economic literature on spatial market integration within developing nations. The potential for the study of economics to help in enhancing food security involves analyzing the extent by which the prices of food staples are well arbitraged across geographically distinct markets within a country. This is because the prices of staples serve as an indicator of the degree by which each regional market has a surplus or deficit of the good. Further, a lack of arbitrage across regional markets may suggest the presence of market inefficiencies, and it is the duty of the economist to discover what the causes of these inefficiencies are. In the following sections of this introductory chapter, we shall consider several features that characterize the national market for rice within the Philippines. The primary motivating force behind this dissertation is to evaluate the efficiency of arbitrage between rice surplus and rice deficit markets and to identify the major obstacles which prevent more trade from taking place between them. This is a task which should be attempted only after having fully understood the characteristics of the national market for rice.

1.1 Characteristic number one: Large heterogeneity in regional comparative advantage vis-a-vis the production of rice

1.1.1 General geographic description of the Philippines

As we saw in the section above, the unique geographic composition of the Philippines results in a great deal of heterogeneity in each region's suitability for rice cultivation. Since the main focus of this paper is on the spatial market integration of rice, it is apt that we begin the study with a thorough understanding of the geographic makeup of the country.

The Philippines consists of three main island groups, namely Luzon, the Visayas, and Mindanao. Each island group is organized into several regions for administrative purposes. Luzon consists of Regions I to V, CAR (i.e. the Cordillera Administrative Region) and NCR (i.e. the National Capital Region). The Visayas consists of Regions VI to VIII and XVIII. Mindanao consists of Regions IX to XIII and ARMM (the Autonomous Region in Muslim Mindanao). Each region is further made up of several provinces, and there are 81 provinces at present. Figure 1 below is a political map of the Philippines, showing the way in which regions and provinces are demarcated.

Table 1 summarizes the 18 regions in the Philippines and the island group each of them belongs to, and Table 2 lists the provinces which comprise each region.

Luzon and Mindanao are by themselves large islands, whereas the Visayas is a group of many islands situated somewhere in-between Luzon and Mindanao. The insular chain of islands spans approximately 2,500 kilometers from north to south and 1,000 kilometers from west to east. There are altogether 7,100 islands of heterogeneous size in all and highlands account for more than 65 percent of this total area. These highlands are complemented by extensive

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Figure 1: Philippines political map

A geographical map of the Philippines with each region depicted in a particular color.

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Table 1: Regions and island groups in the Philippines

Region	Island group	Area	Population
National Capital Region (NCR)	Luzon	611.39 km^2	12,877,253
Ilocos Region (Region I)	Luzon	13,012.60 km^2	5,026,128
Cordillera Administrative Region (CAR)	Luzon	19,422.03km^2	1,722,006
Cagayan Valley (Region II)	Luzon	28,228.83km^2	3,451,410
Central Luzon (Region III)	Luzon	22,014.63km^2	11,218,177
Calabarzon (Region IV-A)	Luzon	16,873.31km^2	14,414,774
Mimaropa (Region IV-B)	Luzon	29,620.90km^2	2,963,360
Bicol Region (Region V)	Luzon	18,155.82km^2	5,796,989
Western Visayas (Region VI)	Visayas	12,828.97km^2	4,477,247
Negros Island Region (Region XVIII)	Visayas	13,350.74km^2	4,414,131
Central Visayas (Region VII)	Visayas	10,102.16km^2	6,041,903
Eastern Visayas (Region VIII)	Visayas	23,251.10km^2	4,440,150
Zamboanga Peninsula (Region IX)	Mindanao	17,056.73km^2	3,629,783
Northern Mindanao (Region X)	Mindanao	20,496.02km^2	4,689,302
Davao Region (Region XI)	Mindanao	20,357.42km^2	4,893,318
Soccsksargen (Region XII)	Mindanao	22,513.30km^2	4,545,276
Caraga (Region XIII)	Mindanao	21,478.35km^2	2,596,709
Autonomous Region in Muslim Mindanao (ARMM)	Mindanao	12,525.79km^2	3,781,387

Table 1 provides a summary of the island group which each region belongs to, each region's total land area, and its population, as of May 19, 2016. Source: Highlights of the Philippine Population 2015 Census of Population. Philippine Statistics Authority. Retrieved 9 October 2016, from [https://www.psa.gov.ph/content/highlights-philippine-population-2015-census-population].

Table 2: Regions and provinces belonging to each region

Region	Provinces
National Capital Region (NCR)	
Ilocos Region (Region I)	Ilocos Norte, Ilocos Sur, La Union, Pangasinan
Cordillera Administrative Region (CAR)	Abra, Apayao, Benguet, Ifugao, Kalinga, Mountain Province
Cagayan Valley (Region II)	Batanes, Cagayan, Isabela, Nueva Vizcaya, Quirino
Central Luzon (Region III)	Aurora, Bataan, Bulacan, Nueva Ecija, Pampanga, Tarlac, Zambales
Calabarzon (Region IV-A)	Batangas, Cavite, Laguna, Quezon, Rizal
Mimaropa (Region IV-B)	Marinduque, Occidental Mindoro, Oriental Mindoro, Palawan, Romblon
Bicol Region (Region V)	Albay, Camarines Norte, Camarines Sur, Catanduanes, Masbate, Sorsogon
Western Visayas (Region VI)	Aklan, Antique, Capiz, Guimaras, Iloilo
Negros Island Region (Region XVIII)	Negros Occidental, Negros Oriental
Central Visayas (Region VII)	Bohol, Cebu, Siquijor
Eastern Visayas (Region VIII)	Biliran, Eastern Samar, Leyte, Northern Samar, Samar, Southern Leyte
Zamboanga Peninsula (Region IX)	Zamboanga del Norte, Zamboanga del Sur, Zamboanga Sibugay
Northern Mindanao (Region X)	Bukidnon, Camiguin, Lanao del Norte, Misamis Occidental, Misamis Oriental
Davao Region (Region XI)	Compostela Valley, Davao del Norte, Davao del Sur, Davao Occidental, Davao Oriental
Soccsksargen (Region XII)	Cotabato, Sarangani, South Cotabato, Sultan Kudarat
Caraga (Region XIII)	Agusan del Norte, Agusan del Sur, Dinagat Islands, Surigao del Norte, Surigao del Sur
Autonomous Region in Muslim Mindanao (ARMM)	Basilan, Lanao del Sur, Maguindanao, Sulu, Tawi-Tawi

Table 2 summarizes the provinces belonging to each of the 18 regions in the Philippines, as of 30 June 2016. Source: List of Provinces. Philippine Statistics Authority, Philippines Standard Geographic Code Interactive. Retrieved 9 October 2016, from [http://nap.psa.gov.ph/activestats/psgc/listprov.asp].

alluvial lowlands mainly concentrated in the larger islands of Luzon, Mindanao, Negros, and Panay.

1.1.2   Rice surplus regions

The Luzon island group is the largest in size, with a total land area of 140,039 square kilometers. It accounts for 46.7 percent of the total national land area. (Bureau of the Census and Statistics, 1968). It is within Luzon that Central Luzon, or Region III, is located. With a total land area of 18,231 square kilometers, a large proportion of which is comprised of a massive expanse of alluvial plains, Central Luzon is the largest rice surplus region of the nation. On average, the region supplies more than a third of the country's total rice crops, and exports approximately two-fifths of its rice supplies to the major rice deficit areas in the other parts of the Philippines such as the highly populous Rizal province and the National Capital Region (NCR). For this reason, Central Luzon is known as the traditional rice granary, or rice basin, of the Philippines. Its alluvial soil gives it a large comparative advantage in rice cultivation, which is the main occupation of its inhabitants. Amongst its six provinces – Bulacan, Nueva Ecija, Pampanga, Tarlac, Bataan, and Zambales – Nueva Ecija is the largest and produces the most rice. With a land area of 550,718 hectares, the province boasts the highest yields in the Philippines, with yields in the dry season averaging 4.6 tons per hectare and wet-season yields averaging 3.8 tons per hectare on irrigated farms (Dawe et al. (Eds.), n.d.). According to the BAS-PhilRice survey, an irrigated rice farmer typically cultivates rice on 94% of his farm land (3.16 hectares), and other crops on the remaining 6% (0.19 hectare) (PhilRice-BAS, 2004). The average per capita consumption of rice in the province of Nueva Ecija is 120 kilograms a year. In order to feed a family of five at this average level of consumption, a typical irrigated rice farm only needs 0.23 hectares of paddy cropped once per year. This means that 93% of

Figure 2: Quantities of rice produced in selected geographical regions, in 1970 and 2002
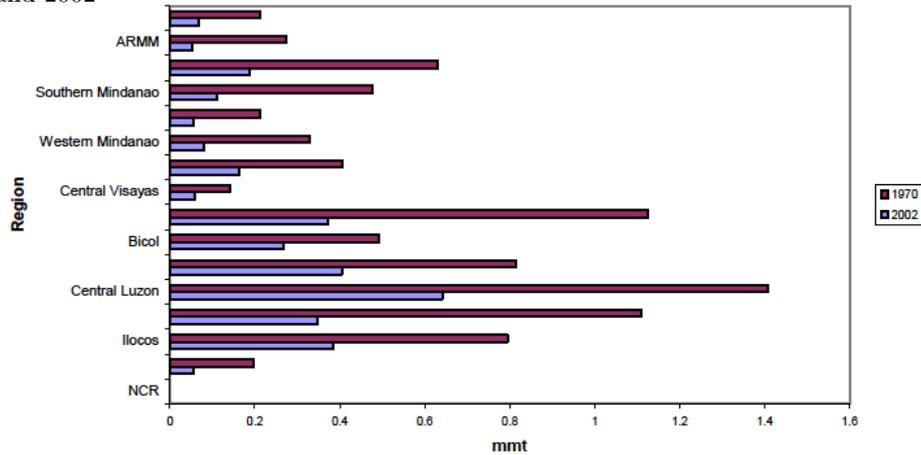
Figure 2 is a horizontal bar chart which plots the quantities of rice produced in particular geographical regions in 1970 and 2002 respectively. Source: Intal Jr. et al., 2008.

irrigated farmland is surplus to a rice farming family's consumption needs, in this province (Dawe et al. (Eds.), n.d.).

Apart from Central Luzon (Region III), other major rice-producing regions are Western Visayas (Region VI), Cagayan Valley (Region II), Ilocos Region (Region I), and Soccsksargen (Region XII) (Philippine Food and Nutrition Security Atlas, 2012). According to a study conducted by the Department of Agriculture at the Philippines Bureau of Agricultural Statistics (BAS), Central Luzon contributed 16.3% of the gross national supply of rice in 2002, followed closely by Western Visayas which contributed 13.1% of the gross national supply, and Cagayan Valley which contributed 12.9% (Intal Jr. et al., 2008). Figure 2 reflects the quantities of rice produced by each region in 1970 and 2002.

At the provincial level, Nueva Ecja in Central Luzon, Iloilo in Western Visayas, and Isabela in Cagayan Valley supplied the largest proportion of rice in the Philippines in 2012 (BAS, 2012). Other rice-surplus provinces include Ilo-

Figure 3: Percentage share of top 10 rice-producing provinces in 2004

Cagayan	3.94
Isabela	7.33
Pangasinan	5.58
Nueva Ecija	7.78
Tarlac	3.31
Camarines Sur	3.46
Leyte	2.88
Iloilo	5.72
Negros Occidental	2.65
North Cotabato	2.88
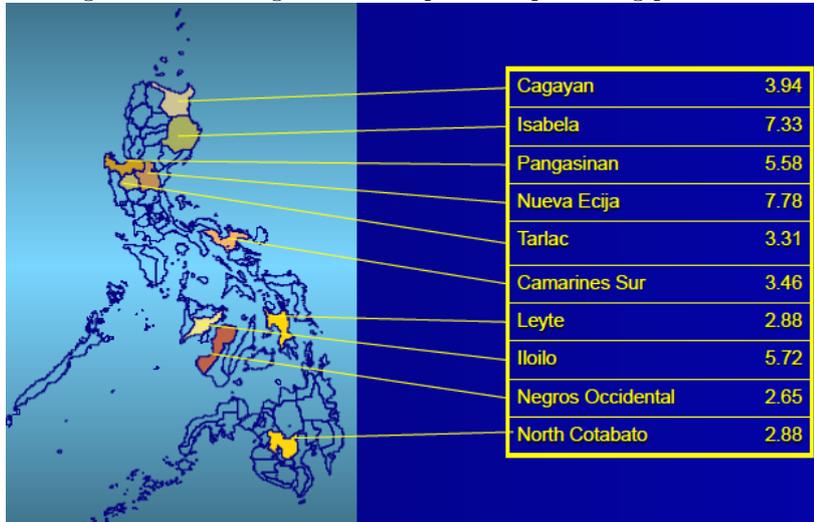
Figure 3 depicts the percentage of aggregate national rice supply produced by each of the top 10 rice-producing provinces in 2004. Source: Reyes et al. (2005).

cos Norte, Occidental Mindoro, Oriental Mindoro, Negros Occidental, Southern Leyte, Davao del Norte, Davao del Sur, Agusan del Sur, and Surigao del Sur (Picana, 2012 and Cerrero et al., 2013). Figure 3 indicates the contribution of the top 10 rice-producing provinces in 2004 to aggregate national rice supply.

1.1.3 Rice deficit regions

In sharp contrast to the rice surplus situation in the above-mentioned regions, there are regions that suffer from a severe lack of rice for consumption, due to infertile soils and a lack of comparative advantage in rice cultivation. Studies conducted by Llanto et al. (2012) and Cerrero et al. (2013) identify the highly populous Rizal province (in Calabarzon (Region IV-A)) and the National Capital Region (NCR) as large deficit areas. According to Llanto et al. (2012), the NCR does not produce any rice but depends entirely on foreign imports and

imports from its surrounding regions, such as Visayas and Mindanao, to feed its population.

Figures 4 - 7 are bar graphs showing the (per capita) net surplus of rice in different provinces in the Philippines, in years 1995, 1999, 2008, and 2012, respectively. They were created by this author, based on data extracted from the BAS on the annual production of rice and the annual per capita production of rice. Data on the gross annual provincial production of rice is provided by the BAS in metric tons. We multiply these figures by a constant conversion factor of 0.58, in order to account for the amount of weight that is lost when wet paddy gets converted into milled rice. This conversion factor (of 0.58) is based on the findings of Hayami et al. (1999). We then deflate the gross annual production of milled rice by each province's population in the respective year and subtract from this the province's per capita level of rice consumption, in order to derive our estimates for the per capita net surplus of rice in each province. By looking at these figures, we can glean that the amount of surplus or deficit in each province hardly changes over time. This suggests that geography and natural comparative advantage have a large role to play in contributing to the amount of rice available for consumption at the provincial or regional level.

While geographical landscapes such as mountains and infertile soils cause certain regions to be naturally disadvantaged with respects to rice cultivation, temporary adverse shocks to production may worsen rice deficits or turn surpluses into deficits overnight. In other words, location-specific rice supplies are often uncertain, because the Philippines lies on the earthquake belt in the Asian Pacific region and is also vulnerable to typhoons, flash floods, and droughts. A good example of how adverse weather shocks have had a heterogeneous impact on the supply of rice in different markets would be the effect of the El Niño – complex weather patterns resulting from variations in ocean temperatures –

Figure 4: Net per capita surplus of rice (/kg) in each province in 1995

Net Per Capita Surpluses, 1995

Figure 4 is a bar chart depicting the net per capita surplus of rice in each province, in 1995. Net surpluses are measured in per kilogram terms. The figure was created by this author, using production statistics from the BAS on the annual production of rice and the annual per capita production of rice, and population statistics provided by the Philippine Statistics Authority.

Figure 5: Net per capita surplus of rice (/kg) in each province in 1999

Net Per Capita Surpluses, 1999

Figure 5 is a bar chart depicting the net per capita surplus of rice in each province, in 1999. Net surpluses are measured in per kilogram terms. The figure was created by this author, using production statistics from the BAS on the annual production of rice and the annual per capita production of rice, and population statistics provided by the Philippine Statistics Authority.

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Figure 6: Net per capita surplus or deficit of rice (/kg) in each province in 2008

Net Per Capita Surpluses, 2008

Figure 6 is a bar chart depicting the net per capita surplus of rice in each province, in 2008. Net surpluses are measured in per kilogram terms. The figure was created by this author, using production statistics from the BAS on the annual production of rice and the annual per capita production of rice, and population statistics provided by the Philippine Statistics Authority.

Figure 7: Net per capita surplus or deficit of rice (/kg) in each province in 2012

Net Per Capita Surpluses, 2012

Figure 7 is a bar chart depicting the net per capita surplus of rice in each province, in 2012. Net surpluses are measured in per kilogram terms. The figure was created by this author, using production statistics from the BAS on the annual production of rice and the annual per capita production of rice, and population statistics provided by the Philippine Statistics Authority.

Figure 8: Impacts of ENSO (El Niño Southern Oscillation) on different geographical locations within the Philippines

Figure 8 shows the severity of droughts and floods caused by the ENSO phenomenon in the different geographical locations across the Philippines, from the year 1977-1978 to the year 1998-1999. This figure was created by Reyes et al. (2005), using data provided by the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA). Source: Reyes et al. (2005) and the Philippine Atmospheric Geophysical and Astronomical Services Administration (PAGASA).

on Mindanao. This group of islands is extremely vulnerable to the impacts of El Niño because of its proximity to the equator. Figure 8 illustrates how the ENSO (El Niño Southern Oscillation) has had a different impact on the amount of rainfall in different regions of the Philippines, between years 1977 and 1999. Since rice supplies are heavily determined by the amount of rainfall, it is easy to see how the ENSO has affected rice supplies in different markets across geographical space to a different extent.

Closely related to the problem of rice-deficiency, and perhaps, even more, a matter of grave concern, is the problem of a loss of self-sufficiency in formerly

rice-surplus areas. A representative example of a region which has experienced a severe loss of self-sufficiency would be Soccsksargen (Region XII), where the April 2016 rice riot mentioned in the introduction of this paper took place. Soccsksargen is located in Mindanao, an island group which has traditionally been perceived as a major source of cereals and grains, second to Central Luzon (Gloria-Pelicano et al., 2013). The region's status as a rice-surplus area is now under question, however, because of the problem of crop shifting and a loss of self-sufficiency with regards to rice production.

In fact, the recent decrease in rice production within Mindanao is only one side of the story leading to the island group's loss of self-sufficiency. This is because the demand for rice has also been increasing across all the regions and provinces of this island group. Amongst the regions of Mindanao, the Autonomous Region in Muslim Mindanao (ARMM) experienced the most pronounced surge in rice demand, due to its burgeoning population.

Figure 9, which was created by Emelie Gloria-Pelicano et al. (2013), plots the rice self-sufficiency ratio of different regions in Mindanao, from 1990 to 2009. Given that a 100% self-sufficiency ratio means that a region produces just enough to meet its gross demand for rice, the figure shows that apart from Soccsksargen (Region XII), all the other regions in Mindanao failed to achieve rice self-sufficiency. Amongst these, the Davao region experienced the largest rice deficit. Emelie Gloria-Pelicano et al. (2013) observe that the area dedicated to rice production in Davao decreased from 108,374 hectares in 2005 to 97,487 hectares in 2007. They also note that the region is currently reliant on foreign imports of rice to meet its gross consumption demands for the staple.

In fact, even though Figure 9 shows that self-sufficiency was achieved in Soccsksargen, it is questionable whether this always the case, since Soccsksargen was the very venue where the 1st April 2016 rice riots took place. The region

has also witnessed several other rice riots in the past. For instance, in 1998, more than 5,000 farmers barricaded the Kidapawan national highway leading to a National Food Authority (NFA) warehouse, demanding seedlings and two sacks of rice per family; and in 2008, over 2,000 farmers in Kidapawan took to the streets to object the decline in the supply of cheap rice[2].

To this end, we observe that there is a large degree of heterogeneity with respects to the different geographical locations' comparative advantage in rice production, within the Philippines. For example, Figure 10, which was taken from the Philippine Food Security Information System (PhilFSIS)'s website, depicts large differences in the amount of quarterly rice supply in 2012, across the different provinces of the nation. Rice deficit regions suffer from a lack of rice due to three main reasons. First, they may be naturally disadvantaged in the production of rice due to traditional geographical reasons. Second, their geographical locations may cause them to be particularly vulnerable to adverse shocks to rice production. Third, they may have experienced crop shifting and therefore a decline in rice output (on the supply side of the equation), coupled with a rapid growth in population (on the demand side of the equation). A major motivating factor behind this paper is to contribute to improving the economic efficiency in the redistribution of rice from areas where it is in surplus, to areas where it is in deficit.

1.2 Characteristic number two: Domestically-produced rice is much more expensive than foreign-produced rice

The second characteristic of rice markets in the Philippines has to do with the fact that domestic rice prices are significantly higher than rice prices

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[2]Kidapawan and the rice riots. (2016). Rappler. Retrieved 8 July 2016, from [http://www.rappler.com/newsbreak/in-depth/129386-riceriots- kidapawan].

Figure 9: Rice self-sufficiency rate in different regions within Mindanao, 1990-2009
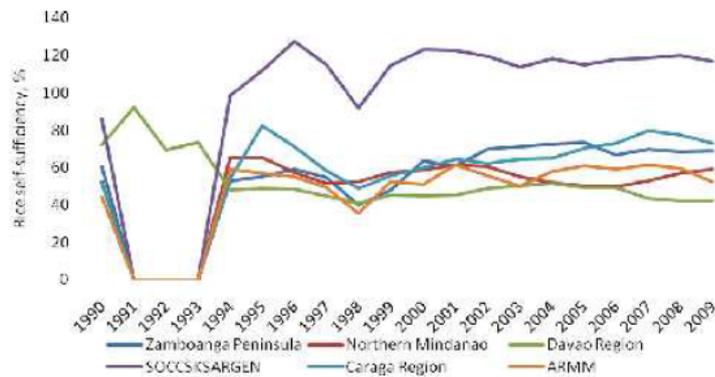
Fig. 10. Rice self-sufficiency in Mindanao under average PH losses, 1990-2009.

Figure 9 plots the rice self-sufficiency rate measured in percentage terms, in different regions within the Mindanao island group, from 1990 to 2009. Data on the rice self-sufficiency rate seems to be missing between the years 1991 and 1993. Source: Gloria-Pelicano et al. (2013).

in the international market for rice. Each gray dotted line in Figure 11 below traces the wholesale price of regular milled rice in a particular regional center in the Philippines across time, while the green dotted line traces the export price of 100% broken second-grade (milled) rice produced in Thailand across time. Price data on domestic prices within the Philippines was obtained from the BAS website, while export price data on Thai rice was obtained from the Food and Agricultural Organization (FAO) website which provides time series data on monthly rice export prices from major origins. The latter was converted into Philippine pesos (PHP) per kilogram by the author, using the exchange rate at each relevant point in time.

The comparison between domestic rice prices and foreign rice prices is striking, because it shows us how much more expensive domestically produced rice within the Philippines is, as compared to rice produced in Thailand – a

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Figure 10: Rice supply by quarter in 2012

RICE SUPPLY BY QUARTER, 2012
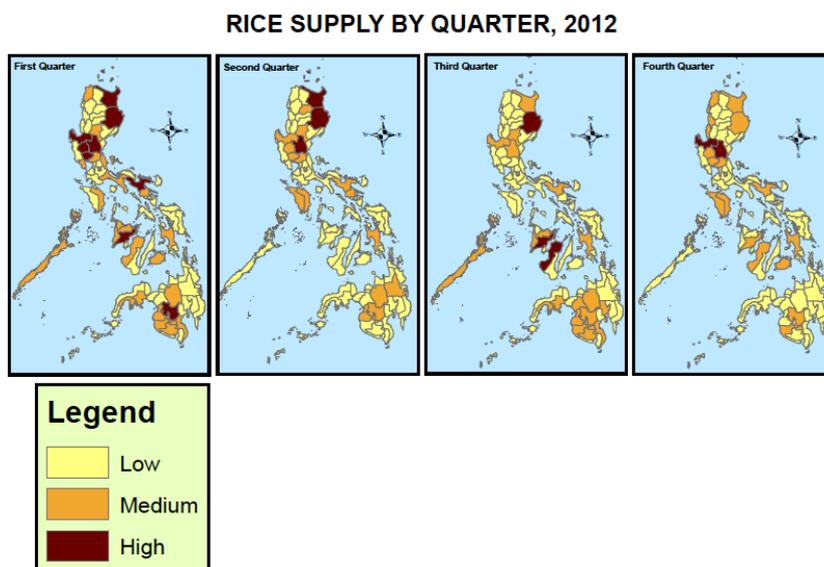
Figure 10 shows the level of domestic rice supplies in individual provinces across the Philippines, in each of the four quarters of the year 2012. Source: Price and market watch: Rice Sufficiency. Philippine Statistics Authority, Philippine Food Security Information System. Retrieved 8 July 2016, from [http://philfsis.psa.gov.ph/index.php/id/22].

Figure 11: Rice prices in regional centers within the Philippines versus international rice prices, between 2006 and 2015

PHP/kg
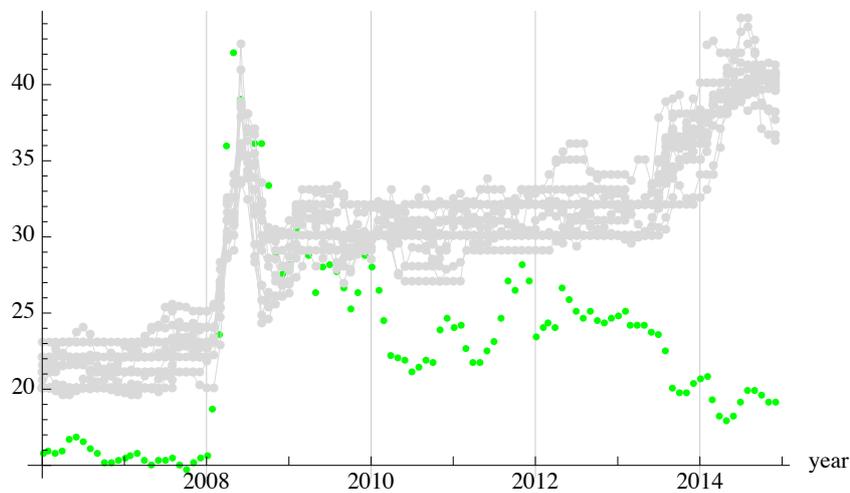
Figure 11 is a time-series plot, which traces the evolution of rice prices within individual regional centers in the Philippines and in the international rice market, between 2006 and 2015. Each gray dotted line represents rice prices within a particular regional center in the Philippines, while the green dotted line represents the price of Thai white (100% broken second grade) rice in the international rice market. The horizontal axis plots the year, and the vertical axis the price of rice in PHP / kg. The time-series plot was created by this author, using data on domestic prices within the Philippines provided by the BAS, and data on Thai rice prices provided by the Food and Agricultural Organization (FAO).

major source of foreign imports to the Philippines. Further, while Thai rice was already significantly cheaper than domestically produced rice at the beginning of the time series in 2006, we observe a further widening of the price gap between these two sources of rice towards the end of the time series. In 2015, for example, we see domestic rice prices in some regional centers that are about 2-3 times more expensive than Thai rice! Figure 11 agrees with the observations made in previous studies, such as that of Regalado (2000), who wrote that imported rice was priced at 10.75 PHP / kg in 1995, which was less than half the price of domestically-produced rice which was priced at PHP 24 / kg in the same year. This is echoed by Intal Jr. et al.(2008), who note that even though import volumes exceeded the minimum access quota[3] by a large margin - thus resulting in very high tariff rates being imposed on foreign rice imports - imported rice was still substantially cheaper than domestically produced rice in most years.

Why are rice prices within the Philippines so much higher than world rice prices? There are three main reasons contributing to the exorbitant domestic rice prices, and they are as follows.

1. Historical land tenure systems that created a situation where a large percentage of farms operate at very small scales, even today. This makes it almost impossible for rice producers to reap economies of scale.

2. Protectionist policies adopted by the Filipino government.

3. Excessively high trade costs, that make it more costly for deficit regions to import rice from surplus regions within the nation, than to import rice from abroad. This is the major concern of this thesis, as the model which we develop and solve in Chapter 6 aims to understand the nature of the high trade costs within the Philippines, and to provide feasible policy

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[3]Please refer to the section on foreign trade in Chapter 4 of this thesis, for greater details on the Philippines' foreign importation policies with regards to rice.

recommendations with regards to solving this problem.

Having said so, it is important to note that the first and second reasons are not standalone factors. A lack of economies of scale, or the presence of protectionist policies, cannot explain why domestic rice prices are significantly higher than international rice prices unless combined with each other or combined with the fact that domestic trade costs are very high (i.e. the third reason).

Chapters 4 and 5 are devoted to explaining each of the above factors in depth. However, it is apt to say a few words on each of them at this juncture, so that the reader can proceed with a clear understanding of the exact nature of the research problem that this thesis aims to tackle.

1.2.1   Inefficient production and lack of scale economies

Scholars who have researched extensively on rice markets in the Philippines, such as Hayami et al. (1999) and Fang (2015), point out that domestic rice prices are significantly higher than international rice prices because the average operational farm size in the Philippines is very small and this makes it impossible for farmers to reap economies of scale. The lack of scale economies in the agricultural sector has its roots in the nation's historical legacy, which can be traced back to the period of Spanish colonial rule between 1571 and 1898, or even earlier. While it is impossible to do justice to the entire history of agricultural tenure systems and land reform policies, we will briefly discuss, in Subsection 4.3.2 of Chapter 4, some of the more prominent historical events that shaped the agricultural land market today.

The fact that rice farmers in the Philippines operate at very small scales is evident if we were to compare the situation of land use in the Philippines with that in Thailand. As the table below illustrates, the average operational farm size in the Philippines was only 2 hectares in 2002, as compared to the

Table 3: Changing distribution of operational farm size in the Philippines

Changing Distribution of Operational Farm Size in the Philippines

	Average operational farm size (ha)	*Percentage of farms below 1 ha*	*Percentage of farms above 10 ha*
1971	3.6	13.5	4.9
1991	2.1	36.6	2.4
2002	2.0	40.1	2.0

Source: Otsuka, Liu & Yamauchi (citing the Philippines Census of Agriculture of various years)

Changing Distribution of Operational Farm Size in Thailand

	Average operational farm size (ha)	*Percentage of farms below 1 ha*	*Percentage of farms above 10 ha*
1978	3.7	16.4	6.0
1991	3.4	21.5	4.5
2003	3.1	13.1	2.1

The top half of Table 3 shows the average operational farm size in hectares, the percentage of farms below 1 hectare, and the percentage of farms above 10 hectares in the Philippines, in 1971, 1991, and 2002. The bottom half of Table 3 shows the average operational farm size in hectares, the percentage of farms below 1 hectare, and the percentage of farms above 10 hectares in Thailand, in 1978, 1991, and 2003. Source: Fang (2015), citing Otsuka et al. (2014).

average operational farm size being 3.1 hectares in Thailand in 2003. Further, the percentage of farms operating at a size of less than 1 hectare was 40.1% in the Philippines in 2002, as compared to a much smaller percentage of 13.1% in Thailand in 2003.

Although the government implemented a series of land reforms in the 1970s to convert share tenancy to leasehold tenancy, and to transfer land ownership to tenants, these reforms placed severe restrictions on the trading of farm lands, rendering the present day market for agricultural land inactive and leading to inefficiency in land use (Llanto et al., 2003 and Hayami et al., 1999, p. 82). Further, Hayami et al. (1999) observe, in their field research conducted in Tubuan village of Laguna province, that the conversion of sharecropping tenancy arrangements to leasehold tenancy arrangements under the land reform programs of the Filipino government did not serve to significantly improve the

Table 4: Size distribution of operational holdings of paddy field in East Laguna Village, 1966-1995

Years	Holding	< 1 ha	1-1.9 ha	2-2.9 ha	3-4.9 ha	>4.9 ha	Total	Average size (ha)
1966	Number of farms	5	16	8	14	3	46	2.3
	Percentage of farms	11	35	17	30	7	100	
1976	Number of farms	13	20	8	11	2	54	2.0
	Percentage of farms	24	37	15	20	4	100	
1987	Number of farms	14	23	7	7	2	53	1.7
	Percentage of farms	26	44	13	13	4	100	
1995	Number of farms	13	20	8	8	2	51	1.9
	Percentage of farms	25	39	16	16	4	100	

Table 4 was recreated by this author using data furnished by Hayami et al. (1999, p. 97). It depicts the number and percentage of farms operating at each of 5 different bands of operational holdings, in years 1966, 1976, 1987, and 1995.

efficiency of rice production in the village. For example, the authors observe that "statistically significant yield differences were not found between large and small farms in most comparisons for 1976 and 1989" (Hayami et al., 1999, p. 101-102). This observation is largely attributable to the fact that the land reform programs conducted throughout the 1970s and 1980s did not change the distribution of farm sizes (in East Laguna village) in a significant manner. The authors also note that not only did the land reform programs fail to bring about an increase in the operational scales of farmers but that there was a tendency for farm sizes to decrease between 1966 to 1995 (Hayami et al., 1999, p. 96), because of increased population pressure. For example, Table 4 depicts a fall in the average operational holding per farm from 2.3 hectares in 1966 to 2 hectares in 1976, and to 1.7 hectares in 1987. It also indicates a rise in the percentage of farms smaller than 2 hectares from 46 percent in 1966 to 64 percent in 1995 and a fall in the percentage of farms 3 hectares or larger from 37 percent to 20 percent over the same time frame.

1.2.2 Rice protectionist policies

One of the two main goals of the National Food Authority (NFA) is to protect domestic rice producers from foreign competition.[4] Naturally, the policies which the government (or NFA) has taken with the goal of protecting domestic rice producers, serve to push up domestic rice prices relative to the world price of rice, by a large margin. The protectionist policies of the government are mainly two-fold.

First, there is a quantitative restriction (QR), or quota, imposed on the amount of rice that private traders can import from abroad. This significantly discourages foreign importation by the private sector and allows the NFA to nearly monopolize foreign imports. The ability of the NFA to monopolize foreign rice imports allows it to use foreign import quantities as an instrument to stabilize rice prices during periods of price volatility (Fang, 2015). In fact, the NFA had complete monopoly over legal rights to authorize the foreign importation of rice until 2001, when the WTO forced the country to open up its rice market. However, the NFA continued to be the largest importer of rice even after 2001, because it managed to negotiate with the WTO to allow it to impose a 40% tariff on rice imported by private traders within the bounds of the QR, and a 100% tariff outside the bounds of the QR (Fang, 2015, p. 38). Since the NFA is the only entity that has the privilege of importing tariff-free, private importers continue to be discouraged from importing from abroad. For example, in 2008, the NFA imported 2.3 million metric tons of rice. The quantity of rice imported by private traders from abroad in the same year paled in comparison, at a level of 75,000 metric tons (i.e. only 3.2% of the NFA's foreign imports of rice) (Fang, 2015, p. 40). The QR on the private importation of rice from abroad serves to restrict the amount of foreign-produced rice supplied to domestic consumers

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[4]The other is to ensure that domestic consumers have a constant and affordable access to rice.

within the Philippines, and results in a wedge between the international price of rice and the domestic price of rice. Ironically, Intal Jr. et al.(2008) observe that import volumes by the private sector have largely exceeded the QR, resulting in rice being imported at a 100% full tariff rate. However, in spite of the higher tariff rate, prices of imported rice were still significantly lower than domestically-produced rice, at both the wholesale and retail levels. Regalado (2000) observes that long queues were formed in 1995 for cheap imported rice which was priced at 10.75 PHP / kg when domestically-produced rice was priced at 24 PHP /kg.

The second form of protectionism practiced by the NFA is price-fixing, where the NFA imports heavily from abroad and adjusts the supply of foreign imports into the market in accordance with domestic consumption needs, thereby controlling the domestic price of rice. This enables the NFA to keep the price of rice received by rice producers and wholesalers at above-world-price levels (Dawe, 2001).

1.2.3 Large trade costs

The third reason why domestic prices are significantly higher than the world price of rice has to do with the fact that trade costs are very high within the country. In their comprehensive summary of the existing literature on trade costs in international trade theory, Anderson et al. (2004) define trade costs as "all costs incurred in getting a good to a final user other than the marginal cost of producing the good itself: transportation costs (both freight costs and other shipping-related costs), policy barriers (tariffs and non-tariff barriers), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail)". With respects to domestic trade, as is the case with inter-regional or inter-provincial trade of rice within the Philippines, policy barriers and costs

associated with the use of different currencies are not applicable, so the term entails only transport costs, information costs, and local distribution costs.

Let us consider the role that differences in local distribution costs have to play, in driving the observed price discrepancies across regional markets. The term is synonymous with barriers to entry, where wholesalers and retailers in particular markets wield market power that enables them to limit the quantity of rice imported from other markets. Mears et al. (1974), Intal Jr. et al. (2008) and Hayami et al. (1999) are in unison in refuting the possibility of large wholesalers monopolizing the market. Their meticulous analyses suggest that contract costs, legal costs and distribution costs (i.e. costs related to market power) are very small in comparison with transportation costs (which includes logistics, storage, and processing costs). For example, Mears et al. (1974) observe that high markups from the farm gate to wholesale level are in large part the result of inefficiencies in logistics, storage, and transport facilities, which lead to high processing and trade costs, rather than market power. They also note that the wholesale market for rice in the Philippines is largely efficient and that the price differential between most markets is less than the transport costs incurred from shipping rice between them. That is, "when transport costs include shipping costs and the premium to cover for risks, the price differential disappears before the shipment arrives". Further, price differentials converge closer to the shipping cost as infrastructure and transport services improve. (Intal Jr. et al. (2008), citing Mears et al. (1974)). These findings are echoed by Hayami et al. (1999), who wrote that none of the private buyers in their sample had a disproportionately large share of the wholesale market for rice and that the incomes and profits of wholesalers are largely proportional to the volumes of rice that they procure. Hayami et al. (1999) further observe that rice traders compete so strongly with each other that it is almost impossible for any

single buyer to procure rice from farmers at depressed prices, or prices lower than the prevailing market prices. Put in their very own words, "in a small village where so many middlemen are operating, it should not be difficult for a farmer to find out if a price offered by a buyer for his product is appropriate, simply by checking with his neighbors who deal with other middlemen." (Hayami et al., 1999, p. 190). These observations support the argument that there is hardly any form of market power at the wholesale and retail levels and that differences in local distribution costs across geographical markets are likely to be small.

To this end, trade costs which drive up domestic rice prices within the Philippines relative to world rice prices are largely transportation costs and (at this point of the discussion) information costs. For example, in an article entitled "Why does the Philippines import rice?", researchers at the International Rice Research Institute (IRRI) highlight that transport infrastructure, particularly good-quality roads, is highly inadequate in the Philippines and this hinders the trade of rice within the country. This is echoed by Fang (2015), who notes that during the administration of Benigno Aquino III, excessive rice imports were found rotting away in overflowing warehouses due to substandard storage conditions, and the excess rice had to be distributed to day care centers for children because they simply could not be preserved long enough for shipment to rice deficit regions (Fang, 2015, p. 8). In fact, the Philippines National Congress suggests that for every kg of rice that the NFA imports from abroad, 2.47 PHP gets wasted due to inefficient storage and handling (Congress of the Philippines, 2010). These sorts of trade costs affect the transport of rice from surplus to deficit regions adversely and hinder the convergence of large price gaps between the different regional rice markets.

1.2.4 Why high domestic rice prices are detrimental to national food security

By this point, it is clear that rice prices within the Philippines are substantially above the world price of rice. It is important at this juncture to explain why high rice prices are detrimental to national food security, and why the factors which lead to the exorbitant domestic rice prices within the Philippines ought to be treated as a research issue to be resolved.

Perhaps the most direct and obvious reason why high domestic rice prices are a problem to food security has to do with the fact that rice occupies a massive proportion of the consumption basket of the average consumer. It is the staple food of 80% of Filipinos, contributes 48% to the daily energy supply of Filipinos (Tiongco et al. (2011) citing the FAO (2006)), and has a 13% weight in the consumer price index. It is also a large source of income for millions of farmers, wholesalers (or traders), and retailers (Reyes et al., 2005). The last point has been substantiated by Cororaton et al. (2009), who estimate that rice was cultivated on a third of the nation's total arable land in 2007, accounting for 35.7% of the total agricultural output value in the Philippines that year. In contrast to countries such as Japan and South Korea, where the importance of rice in the consumption basket of the average citizen has been falling over time (see Figure 12), rice consumption continues to be on an increasing trend in the Philippines, at least up till 2008 where the time period in Figure 12 ends. This is further substantiated by Figure 13, which shows that the total consumption of milled rice in the Philippines has been increasing stealthily from around 3,000,000 tons in 1972 to around 13,000,000 tons in 2012. It also shows that while the production of milled rice has been increasing, production growth has lagged behind consumption growth ever since 1996. Together, Figures 12 and 13 imply that the transition from a largely rice-based diet to a more diversified

Figure 12: Trends in per capita rice consumption in selected Asian countries
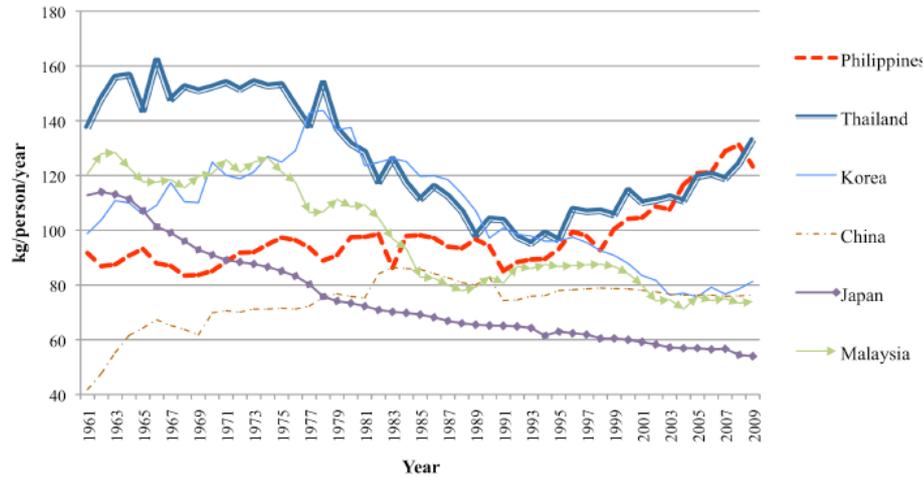
Figure 12 is a time-series plot of the per capita rice consumption in selected
Asian countries, between 1961 and 2009. The horizontal axis depicts the year,
and the vertical axis the per capita rice consumption in kg / person / year.
Source: Fang (2015), based on IRRI rice statistics, 2014.

diet comprised of more expensive food items such as meat and dairy products
has yet to take place in the Philippines.

Further, to make matters worse, high domestic rice prices weigh the most
heavily on the poorest echelons of society. This is in tandem with Engel's law,
an observation in economics that posits that as income rises, the proportion of
income spent on food falls, even if actual expenditure on food rises. For example,
a comprehensive and highly enlightening study conducted by the Southeast
Asian Regional Center (SEARCA) for Graduate Study and Research, under
the commissioning of the Philippine Rice Research Institute (PRRI), finds that
the high consumption of rice at the national level is largely fueled by the poor
(Lantican et al., 2011). The authors of the study point out that there is an
inverse relationship between the share of rice in per capita expenditure and the
income of a consumer. This is captured very succinctly in Figures 14 and 15

Figure 13: Production and consumption of milled rice in the Philippines
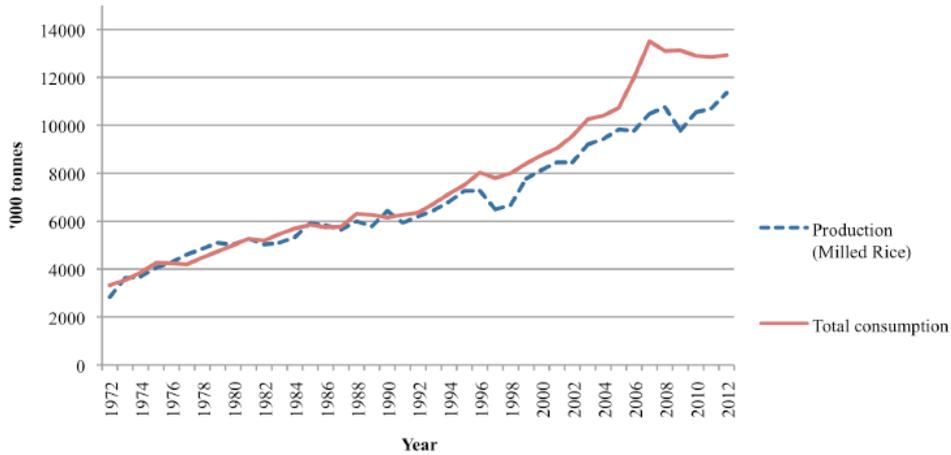
Figure 13 is a time-series plot of the aggregate quantities of rice produced and milled within the Philippines, between 1972 and 2012. The horizontal axis depicts the year, and the vertical axis the production and consumption of milled rice, per 1000 tons. Source: Fang (2015), based on data from the US Department of Agriculture (USDA) furnished by IRRI rice statistics, 2014.

below. Figure 14 (15) shows that the lower the income group (socioeconomic class) that a consumer belongs to, the larger the share that rice occupies in his / her consumption basket. This is largely attributable to the fact that rice serves as a relatively less expensive source of calories, as compared to non-staple crops, meat, and dairy products. Further, unlike India and China, where inferior grain commodities such as sorghum serve as substitutes for rice amongst the poor, there is no inferior substitute for rice in the Philippines. Figures 14 and 15 suggest that high domestic rice prices are detrimental to national food security because they serve as a tax on consumers, the more so the lower the income of the consumer.

In fact, high domestic rice prices penalize not only low-income consumers but also low-income regions more so than their higher-income counterparts. The same study by Lantican et al. (2011) finds that spending on different food

Figure 14: Per capita expenditure shares of selected food commodities by income group, 2008-2009
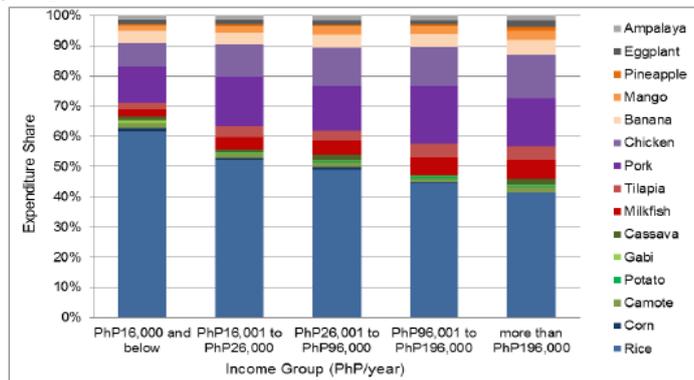
Figure 14 shows the per capita expenditure shares of selected food commodities, for each of 5 income groups in the Philippines, between 2008 and 2009. Source: Lantican et al., 2011, p. 29.

Figure 15: Per capita expenditure shares of selected food commodities by socioeconomic class, 2008-2009
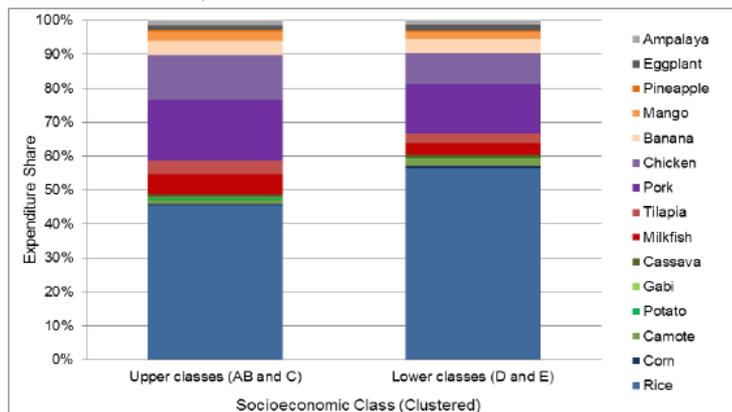
Figure 15 shows the per capita expenditure shares of selected food commodities, for each of 2 socioeconomic classes in the Philippines, between 2008 and 2009. Source: Lantican et al., 2011, p. 30.

Figure 16: Per capita expenditure shares of selected food commodities by region, 2008-2009
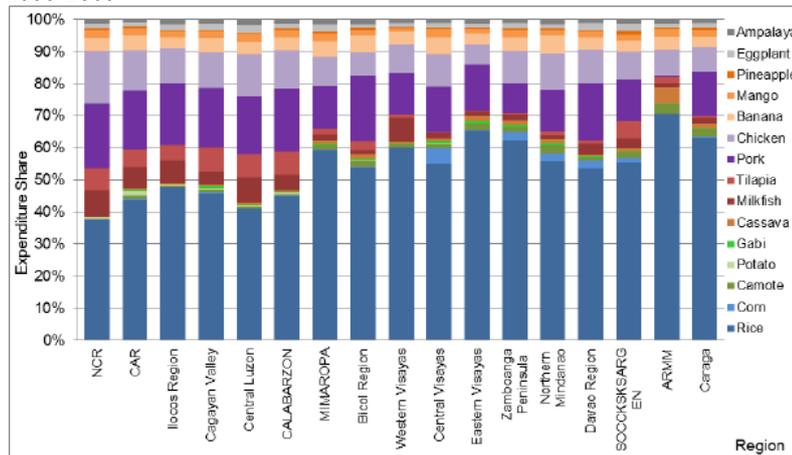
Figure 16 shows the per capita expenditure shares of selected food commodities, for different regions within the Philippines, between 2008 and 2009. Source: Lantican et al., 2011, p. 36.

commodities varies widely across regions and that consumers in more highly urbanized and richer regions – such as Luzon, NCR, and Calabarzon – tend to consume a lot less rice than poor regions such as the ARMM. For example, Figure 16 shows that the country's second poorest region, the ARMM, where the vast majority of consumers are rural consumers, had the largest share of rice consumption and the smallest share of meat and fish consumption in their total food expenditures. In sharp contrast to the ARMM, the nation's richest region, the NCR, had the smallest share of rice consumption and largest fish and meat consumption. These observations show that high domestic rice prices have a more negative effect on a regional market, the lower the GDP of the region is. Hence, high domestic rice prices are definitely undesirable from the viewpoint of national food security.

1.3 Characteristic number three: High degree of vulnerability with regards to fluctuations in the world price of rice

The third characteristic of rice markets in the Philippines has to do with the fact that the nation is extremely dependent on foreign rice imports (conducted mainly by the NFA) to meet its domestic consumption needs. This results in the nation being very vulnerable to price spikes and price volatility in the international market for rice. For example, in Section 1.2.2, we saw that the NFA conducts price-fixing, where it imports heavily from abroad, and adjusts the supply of foreign imports released into the domestic market in accordance with domestic consumption needs. Price-intervention policies of this nature naturally imply that any sharp and unexpected spike in the world price of rice would be passed through from the international level to the domestic regional level. This would definitely have an adverse impact on the welfare of domestic consumers, who are already penalized for their consumption of the staple via rice prices that are higher than the world price, to begin with.

The vulnerability of the Philippines to price spikes in the international market for rice can be further emphasized by considering that according to the US Department of Agriculture (USDA), the Philippines was the largest importer of rice in the world between 2003 and 2011 (Fang, 2015). Table 5 shows that the nation was the top rice importer between 2004 and 2008, accounting for 7.2% of aggregate global rice imports.

The negative effect of price volatility in the world market for rice on Filipino consumers was especially pronounced during the global food crisis of 2007 - 2008. In the first quarter of 2008 alone, the price of rice skyrocketed from 24 - 28 PHP / kg to 38 - 46 PHP / kg (Larin, n.d.). The spike in rice prices was the result of a combination of factors, including a rise in the demand

Table 5: Share of top exporting and importing countries in the world market, 2004-2008

a) Exports

Country / grouping	Cumulative rice exports 2004–2008, (thousand tonnes)*	Percentage share of world total exports
World	148518	100.0%
Top 5 exporters	121776	82.0%
Thailand	43218	29.1%
Vietnam	24250	16.3%
India	21408	14.4%
USA	16593	11.2%
Pakistan	16307	11.0%

b) Imports

Country / grouping	Cumulative rice imports 2004–2008, (thousand tonnes)*	Percentage share of world total imports
World	136947	100.0%
Top 5 importers	36658	26.8%
Philippines	9881	7.2%
Nigeria	8127	5.9%
Iran	7400	5.4%
Saudi Arabia	6006	4.4%
Bangladesh	5244	3.8%

The top half of Table 5 summarizes the quantities of rice exports, and the percentage share of total world exports, in each of the top 5 world exporters of rice, between 2004 and 2008. The bottom half summarizes the quantities of rice imports, and the percentage share of total world imports, in each of the top 5 world importers of rice, between 2004 and 2008. Source: Fang (2015), p. 4, based on data provided by the USDA.

for rice by China and India which was fueled by their burgeoning populations, low global reserves of food following less-than-average harvests in Europe, crop failures in major food producing countries such as Australia, rapid growth in the demand for grain-based biofuels which diverted land away from rice cultivation, and rising oil prices which increased the costs of farm inputs such as fertilizers and pesticides. The initial rise in rice prices caused by these factors was further aggravated by widespread speculation in global markets, where a weakening dollar led investors all over the world to pull out of the foreign exchange market and to invest in commodities instead. The sudden rise in the demand for food commodities further aggravated the spike in rice prices.

As the largest importer of rice in the world at the time of the global food crisis, the Filipino government reacted by arranging massive imports of rice from Vietnam at exorbitant prices (Dawe et al., 2010). For example, in February 2008, President Gloria Macapagal Arroyo personally contacted the Prime Minister of Vietnam, Nguyen Tan Dung, to arrange what was later revealed to be 1.5 million tons of rice imports. The panicked imports of rice by the NFA sent signals across the world, further pushing up the international price of rice in the world market. It also sent a message to domestic consumers that rice was short in supply, and this led to the problem of hoarding, where speculators hoped to make a profit by buying and storing large quantities of rice and selling it at a later point in time when the price had surged to even higher levels than at the time of purchase. The panicked purchases of foreign-produced rice by the Filipino government affected domestic consumers in a very negative way. The findings of Flores (2008), for instance, suggest that 1 in 4 Filipino families had to reduce their consumption of rice during the global food crisis, due to soaring domestic rice prices.

Scholars such as Dawe (2006) have pointed out that the Philippines can-

not help but rely on foreign importation to meet its rice consumption needs, because of a lack of natural comparative advantage – that is, relatively small amounts of land and a shortage of large river deltas – as compared to its neighboring countries. While this is definitely true, Intal Jr. et al. (2008) identified the price-fixing policies conducted by the NFA vis-a-vis its monopoly over foreign importation as a cause of deadweight loss.

The main reason why the NFA continues to exercise a monopoly over the legal right to arrange foreign imports of rice has to do with its goal of keeping domestic farm gate prices above the world price, that is, of shielding domestic producers from foreign competition. However, the NFA's interventionist policies serve to penalize domestic consumers in at least two ways. First, as we saw in Section 1.2.4, the policies impose a regressive tax on domestic citizens' consumption of rice. This is because domestic rice prices are kept artificially higher than world prices, and poor consumers tend to consume a lot more rice than wealthier consumers. Second, they cause domestic rice prices to be largely influenced by movements in the world price of rice, leading to large price volatility and uncertainty during periods of global rice shortages.

Ironically, the NFA's interventionist policies also serve to penalize domestic rice producers – the very ones the policies were intended to protect! This is because the NFA has another policy goal (apart from protecting domestic producers against foreign competition), which is to ensure that rice prices are reasonably affordable to consumers. Due to the conflicting nature of its two goals, and in order to meet the latter goal, the NFA has more often than not resorted to massive, even excessive, imports from abroad. It has also allowed these massive volumes of rice imports to flood the domestic market during periods of rice deficits, making it impossible for domestically grown rice to compete with the cheaper imports. For example, when domestic production fell by about

24% relative to the previous year's output of 7.3 million metric tons in 1998, the Filipino government resorted to importing a record-shattering amount of 2.17 million metric tons of rice. It then released the imports into the domestic market at a price of about one-third that of domestically grown rice (Intal Jr. et al., 2008, p. 9).

Moreover, one other problem related to the NFA's price interventionist policies is that foreign import volumes are often in excess of the storage and transportation capacities of the country. There is no better way to illustrate this, than to recall that according to the Philippines National Congress, for every kg of rice that the NFA imports from abroad, 2.47 PHP gets wasted due to inefficient storage and handling (Congress of the Philippines, 2010). Further, according to the International Rice Research Institute (IRRI), about a third of foreign rice imported by the Philippines in 2011 went to waste because of inefficient transportation, inadequate storage, and market spoilage (Macalintal, n.d.). According to the IRRI, the nation as a whole wastes rice that is worth at least US$535,000 (23 million pesos) every day, or 8.4 billion pesos a year — enough to feed 4.3 million people. Scholars have often questioned whether there is the need for the NFA to import such massive quantities of rice from abroad (Fang, 2015, p. 8, and Dawe et al., 2010). Put in the very own words of rice market expert Tom Slayton (2009), the NFA's imports of rice from abroad during the global food crisis were "mega", even by world standards.

To this end, the NFA's monopoly over the legal right to import rice from abroad, and its control over the quantities of foreign imports supplied to the domestic market, do not serve to benefit either consumers or producers. It would certainly be helpful if the government could (1) relinquish its control over the foreign importation of rice to the private sector, and (2) invest in improving upon the infrastructure for storing and transporting rice across the

different regional markets in the country. The former policy recommendation would allow economic forces of supply and demand to dictate the quantity of rice imported from abroad. This would lower the domestic price of rice relative to the international price of rice, and prevent the problem of excessive foreign importation of rice. The latter policy recommendation would help to reduce the national wastage of rice, and to ensure that rice surpluses, both imported from abroad and produced domestically, get transported efficiently from rice surplus regions to rice deficit regions.

While it is true that the Philippines does not have as large an advantage in the cultivation of rice as its neighboring countries, the massive imports of rice by the NFA, that far exceed the country's ability to store and redistribute the imported rice to deficit regions, serve to expose the country unnecessarily to shocks and volatility in the global market for rice. The world rice market is said to be a "thin" market, as evidenced by the fact that only a little more than 6% of global rice supplies was traded in the world market in 2008. Further, over the past two decades, the trade of rice in the world market has never exceeded 4% of total rice consumption in Asia (see Table 6). The fact that the market is so "thin" implies that price volatility can easily occur from relatively small actions made by a few key influential players (Fang, 2015, p. 3). While reliance on foreign importation may be necessary to a certain degree, this should be carried out by the private sector with fewer barriers to free trade.

Also, it is crucial, from the perspective of national food security, to give priority to ensuring that domestically grown rice surpluses are redistributed efficiently to rice deficit areas. This would certainly help to bolster food self-sufficiency and reduce the negative impact that price shocks and price volatility in the global rice market have on domestic rice prices. It is, therefore, the main concern of this research to identify the factors that prevent domestically grown

Table 6: Total rice consumption, total rice imports, and imports as a percentage of consumption, in Asia and the world

Year	Total rice consumption (thousand tonnes)*		Total rice imports (thousand tonnes)*		Imports as percentage of consumption	
	Asia	*World*	*Asia*	*World*	*Asia*	*World*
1988	295195	323350	7119	12679	2.4%	3.9%
1993	327663	359239	8299	15660	2.5%	4.4%
1998	350993	388125	12986	23208	3.7%	6.0%
2003	366475	412184	11845	25765	3.2%	6.3%
2008	383432	432039	12355	26342	3.2%	6.1%

Table 6 summarizes the quantities of rice consumed and imported in Asia and the world respectively, in the years 1988, 1993, 1998, 2003, and 2008. The final column of the table reflects the percentage of aggregate rice consumption occupied by imports. This table reflects that rice imports occupy only a very small percentage of aggregate consumption, in both the Asian and world markets. Source: Fang (2015), p. 3, based on data from the USDA.

rice from being redistributed efficiently across the regional rice markets within the Philippines.

1.4 Characteristic number 4: Large price gaps across regional rice markets that persist across time

Finally, the characteristic of rice markets in the Philippines which serves as the primary motivation behind this dissertation is significant price gaps across different regional and provincial rice markets, that do not get arbitraged away across many years. To be more precise, the term "significant" in the sentence above means that the observed price gaps between pairs of markets are much larger than the observed components of transport costs incurred by shipping rice between them. For example, while we observe an average price gap of 2.11 Philippine pesos per kilogram (PHP / kg) for regular milled rice between regions VI and VII in 2010, we find that the observable freight rate incurred by shipping rice between these two regions was only 0.38 PHP / kg. In other words, we observe the price differential of regular milled rice between regions VI and VII to be about 5.5 times that of the observable freight rate in 2010! With

such a large price gap, it makes sense to expect that traders in each of these two regions would seize the opportunity to make profits via arbitrage, that is, to buy rice in the cheaper region and sell it in the more expensive region, so that the price gap would converge to the magnitude of the trade costs incurred. However, it is intriguing that no such convergence of prices between this pair of regions takes place over the span of many years. This is illustrated in Figures 17 and 18.

Figure 17 plots the evolution of the wholesale price of regular milled rice in regions VI and VII respectively, between years 2008 and 2015. Prices in region VII are plotted in red, and prices in region VI in blue. It is evident, by looking at this figure, that there is a significant price gap between this pair of regions, and the price gap does not converge across time.

Figure 18 tells the same story as Figure 17, except that it depicts the price gap between two provinces instead of two regions. Camiguin belongs to Region X (Northern Mindanao), and Occidental Mindoro belongs to Region IVB (Mimaropa). We can check from Figures 4 - 7 that the former is a rice-deficit province, and that the latter is a rice-surplus province. In Figure 18, we observe a price gap between these two provinces that is at least 5 PHP / kg, and that persists across at least 6 years (2009 to 2015).

Similarly, when we trace the evolution of the wholesale price of regular milled rice across each of the different provinces within the Philippines between years 2008 and 2015, we observe significant price gaps across each of the different provinces, which do not get arbitraged away across time. This is shown in Figure 19, where each line plots the evolution of the wholesale price of regular milled rice across time in each of the different provinces in the Philippines. Figure A2 in the appendix is analogous to Figure 19. It shows the price spread across all provinces in gray, and the wholesale price of regular milled rice in each particular

Figure 17: Wholesale price of regular milled rice in Region VII (red) and Region VI (blue)
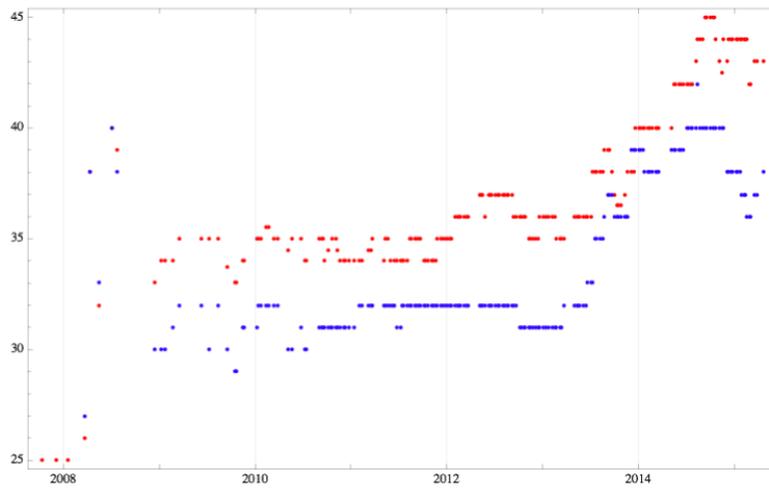
Figure 17 plots the evolution of the wholesale price of regular milled rice in regions VI and VII respectively, between years 2008 and 2015. The horizontal axis captures the year, and the vertical axis captures the wholesale price in PHP / kg. Prices in region VII are plotted in red, and prices in region VI in blue. The figure was created by this author, using time-series data on the wholesale price of regular milled rice in different regions provided by the BAS.

Figure 18: Wholesale price of regular milled rice in Camiguin (blue) and Occidental Mindoro (yellow)
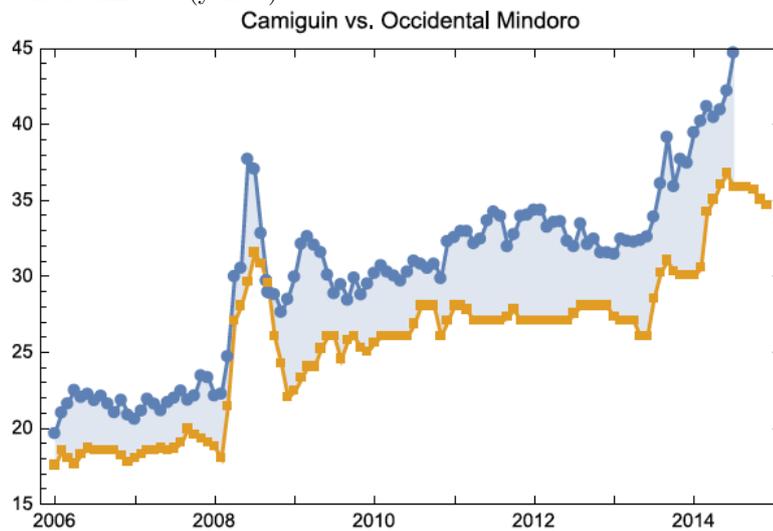
Figure 18 plots the evolution of the wholesale price of regular milled rice in Camiguin and Occidental Mindoro respectively, between years 2006 and 2015. The horizontal axis captures the year, and the vertical axis captures the wholesale price in PHP / kg. Prices in Camiguin are plotted in blue, and prices in Occidental Mindoro in yellow. The figure was created by this author, using time-series data on the wholesale price of regular milled rice in different provinces provided by the BAS.

Figure 19: Evolution of rice prices in provinces across time
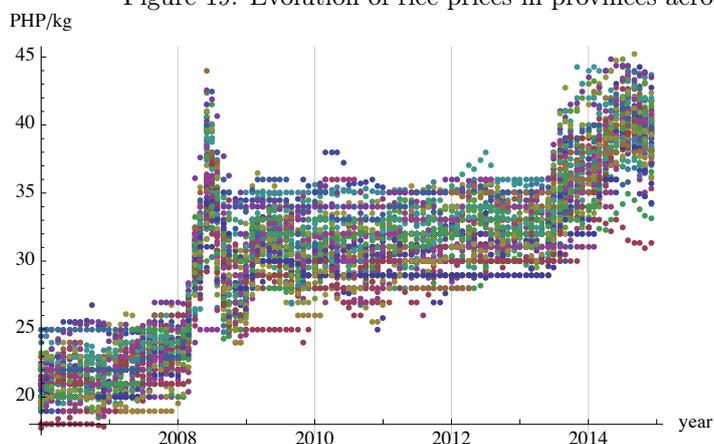
Figure 19 shows the time-series plots of the wholesale price of regular-milled rice in each province within the Philippines, between 2006 and 2015. The figure was created by this author, using time-series data on the wholesale price of regular milled rice in different provinces provided by the BAS.

province in blue. By referring to Figure A2 in the appendix, the reader will be able to locate the time series plot for each particular province and compare it to the price spread across all 81 provinces.

Since the motivating factor behind this dissertation is to understand whether Philippine rice markets are well arbitraged across space, it is important that we conduct some eye-balling of price gaps between markets and compare them with the observable trade costs incurred in moving rice between them. How large are observable trade costs as compared to the price gaps between markets? Do there seem to be any opportunities for traders to make profits via arbitrage, given the observable trade costs?

Tables 10 and 11 below summarize the basic freight costs, the total observable freight costs (in real terms expressed in 2006 values), and the difference in the wholesale price of regular milled rice in each of two trading regions, where the first region has a surplus and the second region a deficit of rice. Observable

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freight costs consist of the following.

1. The basic freight rate set by the Philippines Port Authority (PPA). This rate is calculated in accordance with the distance in miles between the origin and destination port, and there is a formula which applies to each of three different distance bands: 0 – 100 miles; 101 – 300 miles; and more than 300 miles. Table 7 summarizes the basic freight rate stipulated by the Maritime Industry Authority Memorandum Circular MC62. This law came into effect in 1991, and it applies to all port operators in the Philippines who are authorized to charge freight rates under MC59.[5]

2. Wharfage charges, or charges on cargo. There are three major governing authorities, and each of them has their own rules for wharfage charges. Table 8 summarizes each of these rules.

3. Cargo handling charges, which are comprised of arrastre and stevedoring fees. Each port has its own arrastre and stevedoring charges, and Table 9 shows the charges levied by several ports, some of which we consider in our calculations of total observable freight costs (see Tables 10 and 11).

In Table 10 below, we consider Region III as an origin and the NCR as a destination. Our estimations of the observable transportation costs between this pair of regions are based on the assumption that rice is exported from Subic Bay (in Region III) to the Port of Manila (in the NCR). The former is governed by the Subic Bay Metropolitan Authority, while the latter is governed by the Philippines Port Authority.

We compute the basic freight cost based on the shipping distance between this pair of ports, which is about 113 miles, according to the sea routes database

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[5]Source: Guidelines on Rollback of Interisland Liner Freight Rates Per The Order Dated 14 August 1991 of the Marina Board. Maritime Industry Authority. Retrieved 5 May 2016, from [http://marina.gov.ph/policies/listMC.html].

Table 7: Basic freight rates (PHP)

Distance (miles)	Basic freight rate
0-100	59.0620+(0.4471 × Distance)
101-300	48.6491+(0.4172 × Distance)
>300	38.2340+(0.3871× Distance)

Table 7 summarizes the basic freight rate stipulated by the Maritime Industry Authority Memorandum Circular MC62 (enforced in 1991), for each of three different distance bands: 0 – 100 miles; 101 – 300 miles; and more than 300 miles. Source: Maritime Industry Authority. (1991). "Guidelines on Rollback of Interisland Liner Freight Rates Per The Order Dated 14 August 1991 of the Marina Board". Retrieved 5 May 2016, from [http://marina.gov.ph/policies/listMC.html].

Table 8: Wharfage charges levied by major governing authorities (PHP / metric ton)

Philippines Port Authority	Cebu Port Authority	Subic Bay Metropolitan Port Authority
5.04	4.3	1.684

Table 8 summarizes the wharfage charges stipulated by each of three major port governing authorities. Source: Official websites of the governing port authorities.

Table 9: Cargo handling charges (PHP / metric ton)

	Port of Cotabato	Subic Bay	Port of Iloilo	Port of Manila	Port of Cebu	Port of Zamboanga
Palletized cargo						
Arrastre	20.30	62.85	24.15	112.35	39.12	56.20
Stevedoring	10.90	42.38	10.35	23.90	15.46	16.70
Non-palletized cargo						
Arrastre	26.00	62.85	31.00	144.00	50.03	72.20
Stevedoring	15.35	42.38	14.65	33.80	21.73	23.45

Table 9 summarizes the cargo handling charges levied by several ports, some of which we consider in our calculations of total observable freight costs (see Tables 10 and 11). Source: Official websites of the governing port authorities.

of the website "ports.com". We then convert the basic freight rate into real terms in each year, based on a CPI inflator / deflator which has 2006 as its base year. Total observable transport costs are comprised of the sum of the basic freight cost, the wharfage charges, and the cargo handling (i.e. arrastre and stevedoring) charges in both the origin and destination. These are also expressed in real terms for each year, with 2006 as the base year. The (real) price gap refers to the difference in the annual average wholesale price of regular milled rice in each of the two regions.

Comparing the price gap with the total observable transport costs in each year, we can evaluate whether there are opportunities for traders to make profits via arbitrage, in the absence of unobservable trade costs. An entry "yes" in the last column of the table indicates that the price gap was larger than the total observable trade costs, while an entry "no" indicates otherwise.

In Table 11, we consider Region VI as an origin and Region VII as a destination. Our estimations of the observable transportation costs between this pair of regions are based on the assumption that rice is exported from the port of Iloilo (in Region VI) to the port of Cebu (in Region VII). The former is governed by the Philippines Port Authority, while the latter is governed by the Cebu Port Authority. We compute the basic freight cost based on the shipping distance between this pair of ports, which is about 82 miles and convert the basic freight rate into real terms in each year, with 2006 as the base year. Total observable transport costs are calculated in the same way as in Table 10 above and expressed in real terms. The (real) price gap refers to the difference in the annual average wholesale price of regular milled rice in each of the two regions. Similar to Table 10, an entry "yes" in the last column of the table indicates that the price gap was larger than the total observable trade costs, while an entry "no" indicates otherwise.

Table 10: Observable freight rates between Region III and NCR

Year	Basic freight rate	Total observable transport cost	Absolute price gap	Opportunity for profits via arbitrage?
1991	0.096	0.176	0.350	yes
1992	0.104	0.192	0.109	no
1993	0.111	0.204	0.214	yes
1994	0.117	0.216	0.394	yes
1995	0.125	0.231	0.016	no
1996	0.136	0.250	0.028	no
1997	0.144	0.266	0.667	yes
1998	0.159	0.294	0.120	no
1999	0.166	0.307	0.077	no
2000	0.179	0.329	0.713	yes
2001	0.189	0.349	0.032	no
2002	0.194	0.359	0.335	no
2003	0.200	0.368	0.260	no
2004	0.209	0.385	0.395	yes
2005	0.224	0.413	0.452	yes
2006	0.238	0.439	0.110	no
2007	0.244	0.451	1.325	yes
2008	0.260	0.479	1.331	yes
2009	0.267	0.492	0.067	no
2010	0.277	0.510	0.279	no

The second column in Table 10 summarizes the basic freight rate incurred by shipping rice between Region III and the NCR. The third column summarizes the total observable transport costs incurred, which is the sum of the basic freight rate, the wharfage charges, and the cargo handling (i.e. arrastre and stevedoring) charges in both regions. The fourth column reflects the absolute price gap in the wholesale price of regular milled rice in these two regions. Finally, the last column indicates whether there seem to be opportunities for traders to make profits via arbitrage. If the absolute price gap in a particular year is greater than the total observable transport costs in that year, we indicate that there seem to be opportunities for traders to make profits via arbitrage, with an entry "yes". On the other hand, if the absolute price gap in a particular year is less than the total observable transport costs in that year, we indicate that there are no opportunities for traders to make profits via arbitrage, with an entry "no".

Table 11: Observable freight rates between Region VI and VII

Year	Basic freight rate	Total observable transport cost	Absolute price gap	Opportunity for profits via arbitrage?
1991	0.096	0.133	0.551	yes
1992	0.104	0.144	0.441	yes
1993	0.111	0.154	0.489	yes
1994	0.117	0.163	0.458	yes
1995	0.125	0.174	0.116	no
1996	0.136	0.189	0.627	yes
1997	0.144	0.200	0.303	yes
1998	0.159	0.221	0.602	yes
1999	0.166	0.231	1.111	yes
2000	0.178	0.248	0.540	yes
2001	0.189	0.263	0.477	yes
2002	0.194	0.270	0.809	yes
2003	0.200	0.277	0.696	yes
2004	0.209	0.290	1.570	yes
2005	0.224	0.312	1.564	yes
2006	0.238	0.331	2.260	yes
2007	0.244	0.340	1.222	yes
2008	0.259	0.361	4.222	yes
2009	0.267	0.371	1.346	yes
2010	0.277	0.385	2.117	yes

The second column in Table 11 summarizes the basic freight rate incurred by shipping rice between Region VI and Region VII. The third column summarizes the total observable transport costs incurred, which is the sum of the basic freight rate, the wharfage charges, and the cargo handling (i.e. arrastre and stevedoring) charges in both regions. The fourth column reflects the absolute price gap in the wholesale price of regular milled rice in these two regions. Finally, the last column indicates whether there seem to be opportunities for traders to make profits via arbitrage. If the absolute price gap in a particular year is greater than the total observable transport costs in that year, we indicate that there seem to be opportunities for traders to make profits via arbitrage, with an entry "yes". On the other hand, if the absolute price gap in a particular year is less than the total observable transport costs in that year, we indicate that there are no opportunities for traders to make profits via arbitrage, with an entry "no".

Tables 10 and 11 show that the absolute price gaps between pairs of regions are often very much larger than the observable transport costs incurred by shipping rice between them. This is true, even after inflation over the years has been taken into account for.

The presence of significant trade costs between pairs of regions that do not get arbitraged away across time raises a pressing question which we shall answer in this dissertation, that is, the question of whether Philippine rice markets are well arbitraged or integrated across space. In Chapter 3, where we review the existing literature, we shall see that findings have been made that suggest that Philippine rice markets are well arbitraged across space. However, these findings seem very puzzling when we consider the significant price gaps between pairs of regions that persist across time and the observable freight costs, which are very much smaller in magnitude than the observed price gaps. In this thesis, we shall re-examine the factors which prevent trade from taking place between pairs of markets, using a novel method which has not been considered before in the existing literature (please see Chapter 6 for the details on our model).

2 Significance of study and research questions

In Chapter 1, we introduced rice markets in the Philippines and identified the following four characteristics of these markets as research issues. First, there is large heterogeneity in each market's comparative advantage vis-a-vis the production of rice. Second, domestically-produced rice is more expensive than foreign-produced rice by a factor of two or three. Third, due to the nation's heavy reliance on imports of rice from abroad, national rice markets within the Philippines are very susceptible to volatility in the world price of rice. Finally, there are significant price gaps in the price of rice across regions that do not get arbitraged away across time.

The four research issues we identified share a common theme, that is, they speak of the importance of ensuring that rice supplies respond quickly and accurately to price signals in all markets across space and that the commodity is affordably priced. In Section 1.2.4 of Chapter 1, we saw that rice prices have large welfare implications in the Philippines because rice accounts for a large proportion of the average consumer's consumption basket. Further, the lower the income of a consumer, the larger the proportion of his income he devotes to rice. For these reasons, there are profound links between food security, national welfare, and the efficiency in which rice is redistributed from the markets where it is produced in surplus to the markets where it is in deficit. When rice markets are efficient and spatially integrated, rice prices serve as a signal, indicating to buyers and sellers the degree by which the commodity is in surplus or deficit within a particular market. In the absence of information frictions, traders respond to rice prices by using opportunities to make profits via arbitrage, that is, by buying rice in markets where the good is cheap, and selling it in markets where it is expensive. This results in rice being redistributed in an efficient manner from locations where it is in surplus to locations where it is in deficit.

Arbitrage will continue to take place, up to the point where the price in the importing market equals the price in the exporting market plus the trade cost involved in moving the rice between them.

On the other hand, when markets are not integrated, price signals will not be transmitted from markets where there is a deficit to markets where there is a surplus, prices will be more uncertain and volatile, and farmers in the different locations will not be able to specialize according to long-term comparative advantage or to realize potential gains from trade (Baulch, 1997). In their literature review on the performance and efficiency of agricultural distribution services, Intal Jr. et al. (2001) mention five ways in which a fragmented, or non-integrated, agricultural economy has a negative impact on the welfare of a country. First, when markets for agricultural commodities are not integrated, food producers receive below-market prices for their produce and consumers pay above-market prices for the food they consume. Second, an unanticipated over or under-supply of a crop, due to supply shocks such as natural calamities or unexpectedly large harvests, cannot be mitigated efficiently if markets are not integrated. This is because the price of the crop in different markets will not be an accurate reflection of the excess demand or supply of the crop in each particular market, as it would in an integrated distribution system. Third, when prices do not reflect competitive market forces of supply and demand in an accurate manner, unpredicted spikes in demand may result in an increase in import volumes when they should actually serve to increase the quantity of sales and exports by domestic producers. Fourth, a lack of spatial integration between domestic markets may result in additional pressure by domestic producers for protection against foreign competition. Finally, high domestic food prices, which are the result of a lack of market integration, lead to demands for higher wages (Intal Jr. et al., 2001).

For the above reason, evaluating the degree by which rice markets in the Philippines are integrated across space has tremendous importance for food security, and is the primary motivating factor behind this thesis.

In particular, this dissertation will aspire to answer the following two research questions.

- First, are rice markets in the Philippines well arbitraged across space, ceteris paribus, that is, given the existing state of transportation and communications infrastructure?

- Second, we noted in Chapter 1 that many regions suffer from a lack of rice for consumption and that enormous amounts of rice get wasted across the nation every day. What exactly are the factors which prevent more trade from taking place between rice-surplus and rice-deficit markets?

The rest of this dissertation is structured as follows. In Chapter 3, we shall review and analyze the existing literature on the spatial integration of markets for basic agricultural commodities in developing nations. Having done so, we shall give special attention to two prominent papers which have tried to evaluate spatial integration within the specific context of rice markets in the Philippines. We shall also illustrate how these papers have findings which disagree with each other, and how they are unable to provide conclusive and clear-cut answers to the research questions that we are trying to answer in this dissertation. At the end of this chapter, we shall explain how this dissertation contributes to the study of spatial market integration, and how it can help to fill in a void in the existing literature.

In Chapter 4, we provide a comprehensive and detailed description of how rice markets in the Philippines operate. We shall examine each of the following aspects of domestic rice markets, including production in Section 4.1, consumption in Section 4.2, and distribution in Section 4.3. We shall also study

how the government's imports of rice from abroad affect players in the domestic market in Section 4.4, and finally, how special vested interests and pork-barrel politics are responsible for the current state of land allocation and infrastructure in the Philippines.

Further, since transportation and logistics costs are a large component of the trade costs incurred in shipping rice across the different regional markets, it is necessary that we study how the transportation and logistics sectors in the Philippines operate. This shall be the concern of Chapter 5.

In Chapter 6, having laid the groundwork for understanding the workings and potential sources of inefficiencies in Philippine rice markets, we formulate an original theoretical model to answer our research questions and test the predictions of the model by comparing its solutions against actually observed trade flow data. In Chapter 7, I describe my field research in Laguna province, where I had the opportunity to speak to at least several representatives of every stage of the vertical supply chain. My findings are very much coherent with the implications of the theoretical model in Chapter 6.

Finally, we conclude in Chapter 8 and make relevant policy recommendations based on the findings of the model.

3 The existing literature

3.1 Survey and critical analysis of the existing literature

In order to exemplify the ways in which this dissertation contributes to the existing literature, we first consider some of the earliest attempts to test for spatial market integration.[6]

3.1.1 Early tests of market integration

Some noteworthy examples include the works of Richardson (1978) and Ravallion (1986), who conducted empirical tests to check if prices comoved across geographically distinct domestic food markets. The common assumption of these papers was that market integration implies that price changes in one market would be transmitted on a one-for-one basis to other markets either instantaneously or over a number of observations. Hence, these early works estimated regression correlation coefficients of price levels or price changes in different markets, as a measure of the degree of market integration in developing countries. One example of an empirical test for the correlation of price levels in different markets would be of the following specification (Intal Jr., 2001, describing Sexton et al., 1999, p. 569):

$$P_{1t} = \alpha_0 + \alpha_1 P_{2t} + e_t.$$

In the regression specification above, P_{1t} and P_{2t} are the prices of a commodity in regional markets 1 and 2 at time t respectively, and e_t is an error term. The market is said to be integrated in the short run if: $\alpha_0 = 0$ and $\alpha_1 = \alpha_2 = 1$. The main problem with testing for the correlation of price levels, however, is that of spurious correlation. For example, country-wide factors that affect all regional markets in the same way, such as inflation and

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[6]Note that each of these works defines "spatial market integration" somewhat differently and that the criteria for market integration adopted by these authors do not necessarily conform with our criterion of Pareto efficiency.

economic depressions, may affect all prices simultaneously and spuriously raise the correlation coefficients between price levels (Intal Jr., 2001, p. 24).

One way to address this problem would be to estimate the correlation coefficients of price *change*s, instead of price *level*s, in different markets. This method, however, is also not entirely free from statistical problems. For example, it is still unable to address the problem of heteroskedasticity, which is common in high-frequency price data. It may also underestimate the degree of market integration if there are lags in the price response between markets (Intal Jr., 2001, citing Barett, 1996, p. 826). In view of the statistical problem of lags in price response across markets, researchers such as Gupta et al. (1982) and Alexander and Wyeth (1994) have allowed price comovement to be less than perfect, and prices to be determined simultaneously instead of instantaneously between integrated markets. Recent tests for market integration have also adopted "more sophisticated approaches" such as cointegration analysis, a methodology that was first introduced by Ravallion (1986) (Intal Jr., 2001).

Cointegration analysis has the benefit of avoiding statistical issues related to bivariate correlation. It adopts an error correction form, which allows for distinct short and long run dynamics, and country-wide effects such as common inflationary and seasonal factors (Barett, 1996, p. 826). In its most basic form, the Ravallion (1986) model can be specified as follows, for N regions and n time period lags:

$$P_{it} = \sum_{j=1}^{n} a_{ij} P_{it} + \sum_{j=0}^{n} b_{ij} P_{1t} + C_i X_t + e_{it},$$

where the subscripts $i \in 1, 2, ..., N$ and $j \in 1, 2, ..., n$ denote the regional market of concern and the time period lag, respectively. P_{1t} is the price in the "central" market at time t, P_{it} is the price in the ith regional market at time t, and X_t is a vector of nation-wide factors such as the inflation index at time t. a_{ij} and b_{ij} are parameters to be estimated; and e_{it} is an error term. The basic idea behind

Ravallion (1986)'s model is to regress the current price in each regional market i on its own time-lagged prices and the present and past prices in the central market 1, as well as on common nation-wide or trend factors such as inflation and seasonality. The price in the central market is assumed to be an exogenous variable in predicting local market prices in each market i.

Ravallion (1986) applied the above specification to test if regional markets in Bangladesh were integrated and discovered that there were substantial impediments to trade between Dhaka and the main rural markets which provided supplies to Dhaka.

As an extension to its basic form specified above, the Ravallion (1986) model can also be transformed into an error correction representation of a cointegrated system (Intal Jr., 2001, citing Barrett, 1996). Two stationary price series are cointegrated if they share a stable long run linear relationship. In other words, two markets are said to be integrated if their price series are cointegrated in both directions.

That being said, there are certain statistical problems related to the Ravallion (1986) model. First, the model is based on the implicit assumption that price shocks originate from the "central" market, which is not necessarily true for supply shocks. Second, because the model imposes a linear approximation to a non-linear function, the accuracy of its findings may be compromised if trade flows are discontinuous and there are strong seasonality patterns in agricultural demand (Barrett, 1996).

Moreover, a common setback of all the above approaches, including the Ravallion (1986) model, is that they completely ignore the role of transport costs in contributing to the price gaps between geographically distinct markets. For this reason, Barret (1996) and Baulch (1997) highlight that the tests conducted in the aforementioned works should not be regarded as necessary nor sufficient

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conditions for market integration.

3.1.2 Baulch (1997)'s test of market integration in Philippine rice markets using observed components of transport costs

Baulch (1997) was the first to consider the role of transport costs in driving price dispersions across geographically distinct markets. In particular, he utilized a methodology of testing for spatial market integration, known as the parity bounds model (PBM)[7], to evaluate the degree of integration amongst Philippine rice markets. The PBM distinguishes between the following three types of regimes which a pair of markets i and j can be in. First, defining P_t^i and P_j^t as the price of a good in markets i and j respectively at time t, and C_t^{ij} as the trade costs incurred in moving the good across the two markets at time t, a pair of regional markets are said to be at the parity bounds (or belonging to regime 1) if the price differential between them is equal to the transportation cost, that is, if $E\{P_t^j\} = P_t^i + C_t^{ij}$. They are said to be within the parity bounds (or belonging to regime 2) if the price differential between them is less than the transportation cost, that is, if $E\{|P_t^i - P_t^j|\} < C_t^{ij}$. Finally, they are said to be outside the parity bounds (or belonging to regime 3) if the price differential between them exceeds the transportation cost, that is, if $E\{|P_t^i - P_t^j|\} > C_t^{ij}$.

Based on a maximum likelihood function developed in earlier work by Sexton, Kling, and Carman (1991), Baulch estimated the probability, or maximum likelihood, for any two markets to be at, within, or outside, the parity bounds, using observed sea freight rates and nominal rice prices in several selected regions in the Philippines. Baulch (1997)'s results predict that Philippine rice markets are either at or within the parity bounds almost 100% of the time. In other words, Baulch (1997) finds that Philippine rice markets are well arbi-

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[7]The PBM is based on earlier work on stochastic frontier and switching regression models by Aigner, Lovell and Schmidt (1977), Spiller and Wood (1988), and Sexton, Kling, and Carman (1991).

traged across space and that price dispersions between geographically distinct markets tend to get arbitraged away very efficiently in the short run, under the assumption that perfect competition holds. Phrased differently, Baulch (1997) finds that the transmission of price signals across rice markets in the Philippines is complete within a single period (of a month), and that there are hardly any opportunities for traders to make profits via arbitrage, given the observable transportation (or sea freight) rates that he utilized in his estimations.

There are two disadvantages of Baulch (1997)'s approach. First, he predicted the probability for region pairs to trade with each other, using only price and observable freight rate data, but did not compare his results with actual trade flows. Second, Baulch (1997)'s estimates of trade costs are based solely on observable freight rates and do not include unobservable trade costs such as packaging and storage costs. Do the predictions of Baulch (1997)'s paper agree with actually observed trade flow data? This is an interesting question which we ought to consider, before proceeding any further with our discussion of the existing literature.

The following table, which was extracted from Baulch (1997)'s paper, summarizes the estimated probabilities for each of seven pairs of regions to be at, within, or outside the parity bounds. Notice that Baulch (1997) predicts that Regions VI and VII are at the parity bounds 99.9% of the time. This implies that we should expect to observe a price gap between Region VI and Region VII that is fairly constant over time and almost exactly equal to the observable freight rates involved in shipping rice between them.

However, as Figure 17 (in Chapter 1) illustrates, we do not observe anything like this, when we plot the wholesale price of regular milled rice in Region VI and Region VII respectively, between 2008 and 2015. Contrary to Baulch (1997)'s predictions, we observe that the price gap between these two regions

Table 12: Baulch (1997)'s estimated regime probabilities for Philippine rice markets

	Regime 1	Regime 2	Regime 3
Region II-Manila	0.939	0.061	6.3E-06
	(0.000)	(0.039)	(0.965)
Region III-Manila	0.582	0.417	3.1E-07
	(0.000)	(0.000)	(0.994)
Manila-Region VII	0.754	0.246	6.6E-08
	(0.000)	(0.000)	(0.997)
Manila-Region IX	0.357	0.642	2.2E-06
	(0.000)	(0.000)	(0.980)
Region VI-Manila	0.774	0.225	3.2E-08
	(0.000)	(0.000)	(0.15)
Region VI-Region VII	0.999	0.001	1.2E-10
	(0.00*)	(0.00*)	(0.992)
Region VI-Region IX	0.871	0.128	4.8E-07
	(0.000)	(0.004)	(0.992)
Region VII-Region IX	0.211	0.789	0.000
	(0.005)	(0.000)	(0.881)

Notes: P-values in parentheses. Asterisk indicates that P-values may be invalid as edge of parameter space was encountered during estimation.

Table 12, which was extracted from Baulch (1997), summarizes the probabilities for each of seven pairs of regions to be at, within, or outside the parity bounds, as estimated by Baulch (1997). A pair of regional markets are said to be at the parity bounds (or belonging to regime 1) if the price differential between them is equal to the transportation cost, within the parity bounds (or belonging to regime 2) if the price differential between them is less than the transportation cost, and outside the parity bounds (or belonging to regime 3) if the price differential between them exceeds the transportation cost. Source: Baulch (1997, Table 4).

tends to narrow and widen rather arbitrarily across time. Further, if we were to reconsider Table 11 (in the last section of Chapter 1), we would notice that the absolute price gap between Region VI and Region VII is often very much larger than the observable freight costs. This is true even after inflation over the years has been taken into account for. Assuming that the cost of shipping rice between this pair of regions remains fairly stable over time, it appears that Region VI and Region VII must not be at the parity bounds almost 100% of the time.

As the results of our model (please see Chapter 6) will suggest, the observed discrepancies between Baulch (1997)'s predictions and the observed price data can be explained, if we recall that Baulch (1997) made use of only observable freight costs in estimating unit trade costs. By excluding the other aspects of trade costs, such as packaging and storage (i.e. logistics) costs, it is highly possible that Baulch (1997) may have under-estimated the full magnitude of trade costs, leading to results that predict trade between region pairs when trade costs are in actual fact larger than the price gap between them.[8] Based on the results of our model, we believe that trade costs inclusive of logistics costs may be significantly higher than what sea freight rate schedules alone suggest. In other words, we believe that Baulch (1997) may have over-estimated the probability for pairs of regions to be at the parity bounds when they are actually within the parity bounds. Having said that, we must stress that our findings do not alter the main message of Baulch (1997), that is, that the combined probability for pairs of regions to be at or within the parity bounds is close to 100% at any time. In other words, our findings confirm that there are

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[8]For example, a 2010 study conducted by the World Bank on agricultural trade in the Philippines suggests that the performance of agricultural value chains continues to be adversely affected by deficiencies in logistics. Although the study focused on the domestic trade of corn and bananas, instead of rice, it highlighted that trade costs are high due to a lack of basic infrastructure and physical linkages to market outlets, and poor service of inter-island logistics. The study recommends investing in infrastructure and making improvements to export logistics (World Bank, 2010).

hardly any opportunities for traders to make profits via arbitrage, given the sum of both observable and unobservable trade costs incurred in shipping rice across space.

3.1.3 Allen (2014)'s model of information frictions to explain persistent price gaps across Philippine rice markets

In sharp contrast to Baulch (1997), who concluded that Philippine rice markets are well integrated across space, Allen (2014) identifies significant and persistent price dispersions across rice markets in the Philippines that do not get arbitraged away over time. Allen (2014) argues that the lack of arbitrage must be due to market failure caused by information asymmetry, and supports his argument by documenting a number of observed patterns in trade flows and prices that seem to imply the presence of imperfect information. For example, as evidence to support his claim that information frictions are tremendous in the Philippines, Allen (2014) points to the fact that about 50% of importing provinces export rice to destinations from which they import (that is, they engage in "two-way trade").

In addition, he estimates that the reduction in trade flows that accompany an increase in distance are much larger than the increase in observed freight costs that accompany the same increase in distance, and argues, based on these estimates, that transport costs play only a small role in explaining why price gaps do not get arbitraged away over time.

> "...freight costs result in only a slight decline in the effect of distance on trade flows. Hence, there appear to exist other frictions contributing to the gravity relationship between trade flows and distance." (Allen, 2014, p. 7)

Based on the claim that information asymmetries are the main reason for a lack

of spatial arbitrage, Allen (2014) develops a theoretical model that incorporates information frictions into a perfect competition model of trade, where heterogeneous farmers engage in a costly search process to decide where to sell their crops. Next, he uses bilateral trade flows, observed prices, and observed freight costs, to test how well his model is able to predict actual trade flows between province pairs. He shows that when information frictions are set to zero in his model, its predictive power falls, as compared to when information frictions are incorporated.

Differing from Allen (2014), we do not find empirical support for imperfect information playing a significant role in explaining the price gaps. In what follows, we shall go through some of Allen (2014)'s claims that are in support of information asymmetries and show how these observations in trade flows can be explained by factors unrelated to information asymmetry. As an empirical exercise, we obtain the same commodity flow data set as the one which Allen (2014) used in his paper and analyze his claim that a large fraction of provinces engaging in two-way trade is suggestive of the fact that information frictions are large. As evidence to support his claim that information frictions are tremendous in the Philippines, Allen (2014) points to the fact that about 50% of importing provinces export rice to destinations from which they import (that is, they engage in "two-way trade"). According to Allen (2014), if we assume that prices in each province are fairly stable across the months of a year, the fact that provinces both import to and export from the same trading partners within a year must be indicative of the fact that traders are not well-informed about the prices of rice in other geographical locations.

Data on the quantity (in kilograms) and value (in Philippine pesos) of rice exported from specific origin ports to specific destination ports is available from the National Statistics Office of the Philippines (NSO), through the Domestic

Trade Statistics System (DOMSTAT). In particular, trade flow data is derived from cargo manifests recorded by the Philippines Port Authority (PPA) and comprises information on the port of origin, port of destination, description of the commodity, quantity shipped, and value shipped. There are two frequencies at which trade flow data is observed. First at an annual frequency, and second in every 4th quarter of a year, between 1995 to 2009. By aggregating the port-to-port trade flow data to the provincial level, we obtain a data set of province-to-province bilateral trade flows of rice at the annual level, and for every 4th quarter of a year. There are 40 origin provinces and 50 destination provinces in the sample.

First, we verify that it is indeed true that a large proportion of province pairs engage in two-way trade with each other within a year. That is, they both import from and export to each other within a year. This is reflected in Figure 20, which shows the fraction of exports sent to locations imported from in each year in our panel data on rice trade flows.

However, the question we should really be asking, is not the number or fraction of province pairs which engage in two-way trade with each other per se, but rather, for each pair of provinces that engaged in two-way trade, how much rice actually flows in the direction of the surplus province to the deficit province, as opposed to in the opposite direction? In order to answer this question, we devise a numerical index, which we term the trade flow unidirectionality index. The index captures the amount of rice that gets shipped in one direction as opposed to the other, for every pair of provinces that engaged in two-way trade within a year (t). The index is defined as follows:

$$\left| \frac{X_{ijt} - X_{jit}}{X_{ijt} + X_{jit}} \right| \in [0,1], i,j = [1,...,M+N],$$

where X_{ijt} represents the quantity of rice exported from province i to province

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Figure 20: Fraction of exports sent to locations imported from, 1995-2009
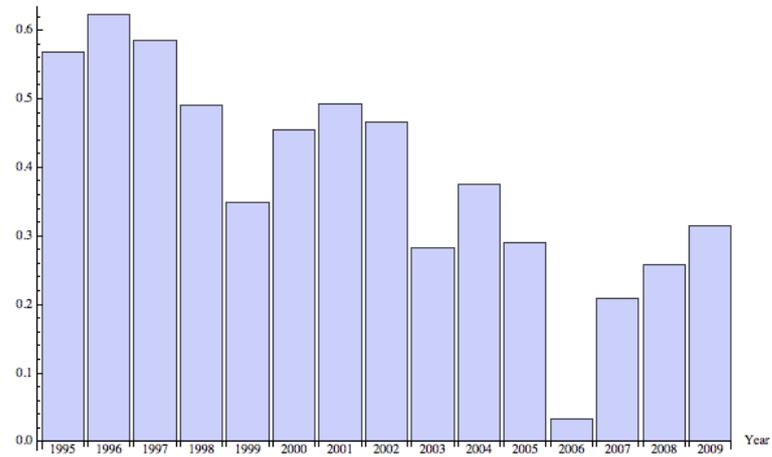
Figure 20 is a bar chart which depicts the fraction of exports sent to locations imported from in each year in our panel data on rice trade flows. This figure is based on the author's calculations, using data on the quantity of rice exported from specific origin ports to specific destination ports, provided by the National Statistics Office of the Philippines (NSO) through the Domestic Trade Statistics System (DOMSTAT).

j in year t; and X_{jit} represents the quantity of rice exported from province j to province i in year t. We assume that there is a total of M rice-surplus provinces and N rice-deficit provinces so that the total number of provinces is $M + N$. If the quantity of rice that province i exports to province j is about the same as the quantity of rice that it imports from province j, we would expect to obtain a value for the above measure that is close to zero, since X_{ijt} would be roughly the same in magnitude as X_{jit}. On the other hand, if the bulk of rice flows in one direction as opposed to the other, we would expect to obtain a value for the above measure that is close to 1.

We calculate the trade flow unidirectionality index between every pair of provinces which engaged in two-way trade with each other, across all the years in our panel data (which starts in 1995 and ends in 2009). We then count the number of times each value of the index is observed, for discrete values between 0 and 1. The logic behind our analysis is simple. If we find that the index has values close to 0 most of the time, we would be convinced that information frictions are large, since the quantity of rice that gets exported from a surplus province to a deficit province is roughly the same as the quantity of rice that gets exported from the deficit province to the surplus province, for every pair of provinces that engaged in two-way trade with each other. If, however, we discover that the index has values close to unity most of the time, we would have a reason to doubt the claim that two-way trade is really caused by a lack of information. This is because a high frequency of the index having a value of 1 suggests that the bulk of trade flows is actually uni-directional as opposed to bi-directional, with rice being exported from surplus to deficit regions most of the time.

We calculate the values of the above index for every province pair that engaged in two-way trade within a year, for every year in the data set (i.e. 1995

Figure 21: Bar chart of trade flow unidirectionality index between pairs of provinces, 1995-2009

Values of the trade flow unidirectionality index
1995-2009
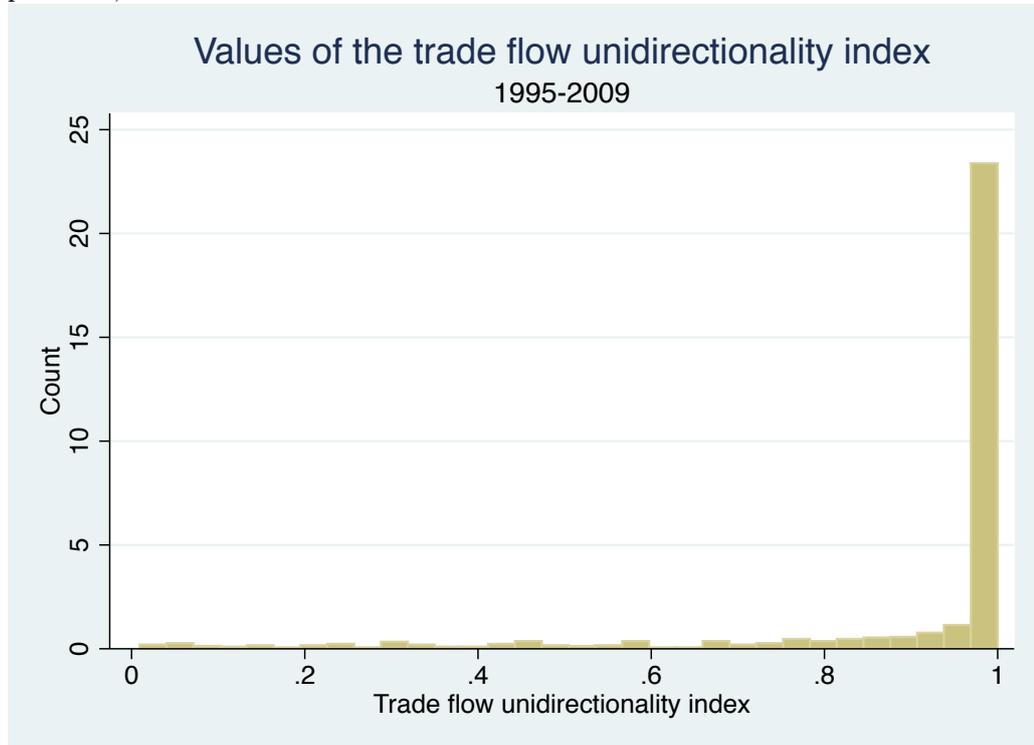
Figure 21 is a bar chart depicting the number of times each discrete value of the trade flow unidirectionality index is observed. The horizontal axis captures the values of the index (which lies between 0 and 1), and the vertical axis captures the number of times each value is observed.

- 2009). The results of this empirical exercise are represented by the bar chart in Figure 21, where the count for each discrete value of the index is visualized. As Figure 21 illustrates, we find that our index is very close to 1 most of the time. This implies that for most of the province pairs engaged in two-way trade, the bulk of trade flows occurred in a single direction. In other words, it is very likely that information asymmetry is not the main reason behind the two-way trade.

Why then, do provinces engage in two-way trade within a year? We

Figure 22: Peak rice harvesting month in each province, for 3 harvesting seasons
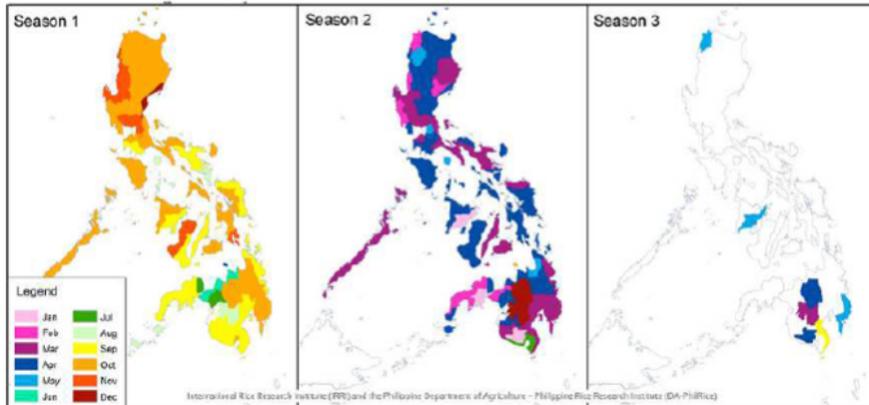
Figure 22 depicts the peak harvesting month in each province, for each of 3 harvesting seasons in a year. Each month is indicated by a particular color which is shown in the legend. Source: International Rice Research Institute (IRRI) website.

believe that this has a lot to do with differences in seasonality. As we can see from Figure 22, different provinces across the archipelago have different peak rice harvesting months. In order to illuminate the effect of differences in seasonality on trade between provinces, we extract data on the quantity of rice harvested in provinces within each quarter of a year, from the Bureau of Agricultural Statistics (BAS) website. We then divide the quarterly harvests of each province by that province's population count, to get a measure of the per capita harvest in each quarter.

For every quarter $q = \{1, 2, 3, 4\}$ of year $y \in [1995, 2009]$, we calculate a province's (per capita) harvest in quarter q, as a ratio of that province's annual (per capita) harvest. Focusing exclusively on pairs of provinces (is and js) which engaged in two-way trade during year y, we then compare province i's per capita harvest in quarter q of year y, with province j's per capita harvest in quarter q of year y, by mirroring their bar charts back-to-back. The paired bar charts of province pairs which engaged in two-way trade in 2000 are presented in Figure

23.

Figure 23 shows that there are significant differences in the amounts of rice harvested in province i relative to that in province j, across the quarters of the year. This provides a reason for these pairs of provinces to engage in two-way trade. In a quarter where province i has a relatively larger (per capita) harvest than province j, it exports. On the contrary, in a quarter where province i has a relatively smaller (per capita) harvest than province j, it imports. In summary, we believe that differences in seasonality combined with the need for consumers to smooth out their consumption of rice over the different months of a year, rather than information asymmetries, are the main reason for the high incidence of two-way trade.

Next, in order to further substantiate our argument that differences in seasonality and the need for consumption smoothing are sufficient conditions for two-way trade, we conduct the following empirical analyses, based on the approach suggested by Morduch (2005), for testing theories of risk-sharing between markets for agricultural commodities across geographical space. The empirical exercises we shall describe henceforth were conducted with the aim of showing that the high occurrence of two-way trade amongst rice markets in the Philippines is not so much due to information asymmetries as the need to insure provinces against seasonal and other idiosyncratic risks to consumption.

In particular, we ask the following 3 questions and make use of the method developed by Morduch (2005) to answer them.

1. To what extent is a province's production level of rice affected by idiosyncratic shocks on average?

2. To what extent is a province's consumption level of rice affected by idiosyncratic shocks on average?

3. How much smoother is consumption as compared to production, on aver-

Figure 23: Quarterly (per capita) harvest of rice in two-way-trading province pairs
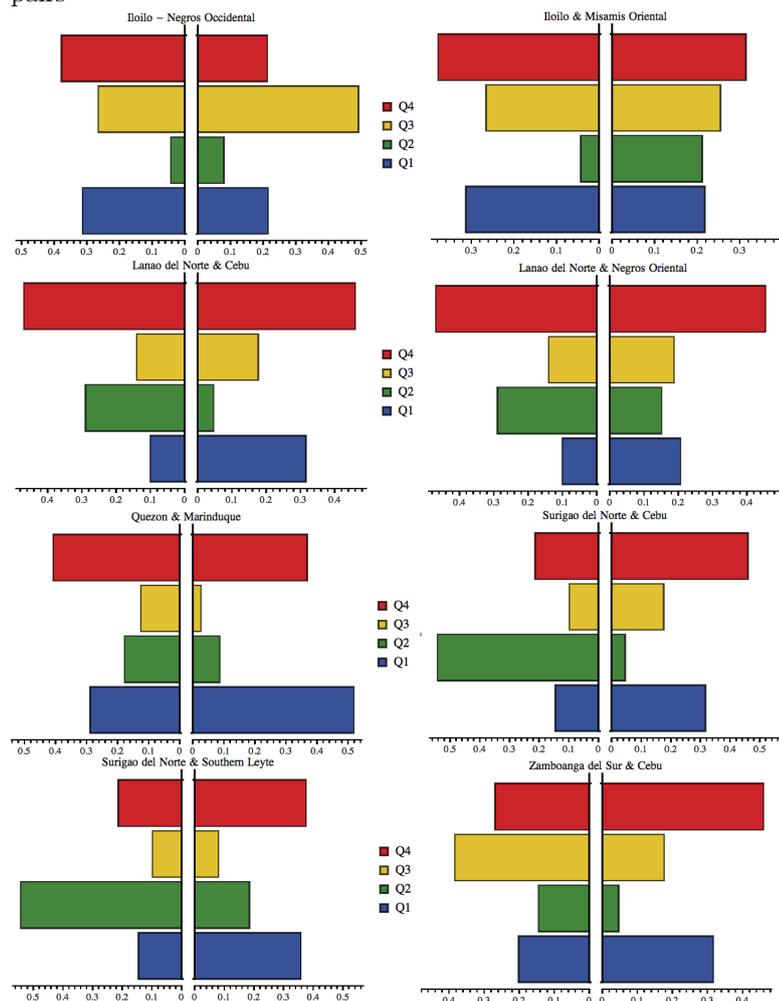
Figure 23 is a paired bar-chart, which reflects each province's (per capita) harvest in quarter q, as a ratio of that province's annual (per capita) harvest, for pairs of provinces which engaged in two-way trade with each other in the year 2000.

age? In other words, how large a role does consumption-smoothing across space play, in eliminating a province's total production risk?

The logic behind these questions goes along the following lines. If on the average, a province's consumption level is significantly smoother than its production level of rice, this would serve as statistical evidence that provinces trade with each other to insure themselves against seasonal and idiosyncratic risks vis-a-vis production.

First, to answer question 1 ("to what extent is a province's production level of rice affected by idiosyncratic shocks on average?"), we decompose the observed rice production level of each province i in each year t, that is, Y_{it}, as a multiplicative function of the following 4 terms: (i) a base production level of rice specific to the province (Y_i); (ii) a factor which scales the base level of production up and down in accordance to common shocks to the nation as a whole (τ_t); (iii) a factor which scales the base level of production up and down in accordance to idiosyncratic shocks to the province (τ_{it}); (iv) a measurement error term (ϵ_{it}).

In other words,

$$
\begin{aligned}
Y_{it} &= Y_i \tau_t \tau_{it} \epsilon_{it} \\
\Rightarrow \ln Y_{it} &= \ln Y_i + \ln \tau_t + \ln \tau_{it} + \ln \epsilon_{it}.
\end{aligned}
$$

The measurement error and idiosyncratic shocks to production (on average) are contained in the residual, and their combined magnitude can be inferred from the $(1 - R^2)$ of the regression.

Second, to answer question 2 ("to what extent is a province's consumption level of rice affected by idiosyncratic shocks on average?"), we decompose the observed rice consumption level of each province i in each year t, that is, C_{it}, as

a multiplicative function of the following 4 terms: (i) a base consumption level of rice specific to the province, which we assume to be equal to the province's base production level of rice ($C_i = Y_i$); (ii) a factor which scales the base level of consumption up and down in accordance to common shocks to the nation as a whole (τ_t); (iii) a factor which scales the base level of consumption up and down in accordance to idiosyncratic shocks to the province (τ_{it}); (iv) a measurement error term (ϵ_{it}).

That is,

$$C_{it} = Y_i \tau_t \tau_{it} \epsilon_{it}$$
$$\Rightarrow \ln C_{it} = \ln Y_i + \ln \tau_t + \ln \tau_{it} + \ln \epsilon_{it}.$$

Finally, to answer question 3 ("how large a role does consumption-smoothing across space play, in eliminating a province's total production risk?"), we follow the approach of Morduch (2005), which goes like this. The relative importance of the time and space components can be gauged by comparing the variation in consumption if risk-sharing is complete (but intertemporal smoothing is not possible) to the variation of consumption with no smoothing at all. If consumption smoothing is not possible, neither across space nor time, then consumption in each period must equal production: $C_{it} = Y_{it}$. Then, the variance of a province's consumption (between time period 1 and time period T) is:

$$\frac{1}{T} \sum_{t=1}^{T} (Y_{it} - Y_i)^2,$$

where Y_i is province i's sample average production of rice.

On the other hand, if consumption smoothing is possible and complete, subject to the condition that the average provincial consumption over the entire

sample is still Y_i, then consumption in each period becomes: $C_{it} = \theta_i Y_t$. Here, Y_t is the total national production in year t, and θ_i is the share of total national rice production allocated to province i. Under these assumptions, the fraction of national rice production over the entire sample attributable to province i is:

$$\theta_i = \frac{\frac{1}{T}\sum_{t=1}^{T} Y_{it}}{\frac{1}{T}\sum_{t=1}^{T}\sum_{i=1}^{N} Y_{it}} = \frac{Y_i}{\sum_{i=1}^{N} Y_i}.$$

A measure of the potential for risk-sharing in eliminating a province's total risk is then:

$$\frac{\sum_{t=1}^{T}(\theta_i Y_t - Y_i)^2}{\sum_{t=1}^{T}(Y_{it} - Y_i)^2}.$$

This is the variance of consumption over time under complete sharing for province i, as a fraction of the variance under autarky (i.e. when trade conducted with the aim of consumption-smoothing is not possible). Table 13 contains our computations for each of the formulae described above. Our findings can be interpreted as follows. On average, while 79.1% of a province's per capita rice production is subject to idiosyncratic shocks, only 62.5% of its per capita rice consumption is idiosyncratic. Phrased differently, these figures show that on average, consumption smoothing helps to mitigate about 16.6% of the idiosyncratic components in consumption. Further, we find that the average variance of consumption under complete risk-sharing is nearly 70% of the variance under autarky. These findings are evidence against the claim that information frictions are the driving force behind the two-way trade because they illustrate that on the average, a province's consumption is significantly smoother than its production of rice. In other words, provinces in the Philippines do trade with each other to insure themselves against seasonal and idiosyncratic risks vis-a-vis production.

In the empirical analyses conducted above, we analyzed Allen (2014)'s claims that information frictions are very high in the Philippines, based on his

Table 13: Results of emprical analysis on the average percentage of production and consumption subject to idiosyncratic shocks

$(1-R^2)$ from regression of total production (Y_{it}) on year & province fixed effects	$(1-R^2)$ from regression of total consumption (C_{it}) on year & province fixed effects	Ratio of variance of consumption under complete risk - sharing to variance under autarky
0.791	0.625	0.703267

The first column of Table 13 indicates the percentage of a province's per capita rice production that is subject to idiosyncratic shocks, on average. The second column indicates the percentage of a province's per capita rice consumption that is subject to idiosyncratic shocks, on average. The last column indicates the ratio of the variance of consumption under complete risk-sharing across space, to the variance of consumption when no risk-sharing takes place.

observation that a large proportion of province pairs engage in two-way trade. We then provided a critique of this claim, by illustrating how two-way trade could be caused by a set of factors completely unrelated to information frictions.

In what follows, we analyze another claim of Allen (2014)'s, which he provided as evidence to support his argument that information frictions are very large. That is, that the reduction in trade flows that accompany an increase in the distance between province pairs are much larger than the increase in observed freight costs that accompany the same increase in distance. As a critique of this claim, we show that Allen (2014)'s measures of distance – which are based on overwater (straight line) distances measured in pixels – may not represent the distance of the actual routes through which crops are transported well enough. First, consider Figure 24 below, which is a scatterplot diagram we created, to depict the relationship between overwater distances measured in pixels and the freight costs estimated by Allen (2014). It is easy to see that not only is there no clear linear relationship between Allen (2014)'s estimations of freight costs and straight line distances measured in pixels, but that estimated freight costs do not even seem to be increasing with distance.

Figure 24: Relationship between overwater distances measured in pixels and freight costs estimated by Allen (2014)

Figure 24 depicts the relationship between overwater distances measured in pixels and the freight costs estimated by Allen (2014) measured in PHP.

Table 14: Relationship between shipping distance and quantity of rice traded

Dependent variable:	Log quantity shipped (/ kg)
Log shipping distance (/km)	-0.704***
Origin-year fixed effects?	Yes
Destination-year fixed effects?	Yes
R-squared (within)	0.7478
Observations	585

Table 14 shows the regression coefficient of our analysis, when we regress log bilateral trade flows on log shipping distance, conditional on origin-year and destination-year fixed effects. Each observation is an origin-destination-year triplet in which trade occurred. Stars indicate statistical significance: *$p<.10$, **$p<.05$ and ***$p<.01$.

In contrast to the approach used by Allen (2014) to measure shipping distances, we make use of actual shipping distance data obtained from "www.searates.com", a website that provides the most competitive routes of shipping from any origin to any destination in the world. Here, we obtain overwater and overland distances between markets that are connected by sea, by land, and by a combination of the two. We believe that this data is much more in line with the actual distance through which crops are transported since it is possible that ports may be connected by a combination of sea and land via the Nautical Highway System, which came into effect in 2003.[9] Using our data on the distance between provinces, we obtain higher elasticities of trade flows with respects to distance than Allen (2014) did, when we regress log bilateral trade flows on log shipping distance, conditional on origin-year and destination-year fixed effects. For example, while Allen (2014) reports that a 10% increase in shipping distance is associated with a 4.2% decline in bilateral trade flows, we find that a 10% increase in shipping distance is associated with a 7.04% decline in bilateral trade flows.

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[9]The Philippines Nautical Highway System, which is also known as the Road Roll-on / Roll-off (RoRo) Terminal System, is a network comprised of highway and vehicular ferry routes. It was opened to the public on April 12, 2003, and has been appraised for reducing the handling costs of goods, including agricultural cash crops, throughout the country.

3.2 Contribution to the literature

At the present time of writing, there is no single study that is able to provide a clear and conclusive answer to the research questions that we are trying to answer, that is, the questions of whether rice markets in the Philippines are well arbitraged across space, and what factors serve to prevent more rice from being redistributed from rice-surplus to rice-deficit markets. In Chapter 6, we depart from the approaches taken by the existing literature and develop an original model of our own.

We find that our model is able to contribute significantly to the existing literature on spatial market integration because it is able to answer both the research questions we want to address. On top of that, we believe that our model may also have the potential to make an impact on international trade theory because of the following observation. At present, there is no theoretical framework in the international trade literature that can serve as a testable workhorse model for explaining the way in which homogenous and perishable commodities such as food staples are traded across space. To see why this is so, please consider the following.

The classic Ricardian model highlights differences in technology; the Heckscher-Ohlin model highlights differences in factor endowments; and the new or new "new trade" theory highlight consumers' love of variety and heterogeneity in firm productivity levels as reasons for trade. However, while all of these existing theories are useful in explaining the bilateral trade of goods across product categories (as in the case of the Ricardian and Heckscher-Ohlin model), or across different varieties of a differentiated product (as in the case of the new and new "new trade" theories), they are silent on the factors that drive the unilateral trade of goods within a non-differentiated (or homogenous) and

perishable product category.[10]

In order to understand the above statement better, let us consider that homogenous and perishable food commodities such as rice are exported from locations where they are produced in surplus to locations where they are in deficit, but not in the opposite direction. In the case of developing nations, where product differentiation of agricultural goods does not take place on a degree as prevalent as in developed nations, rice deficit locations hardly export any rice to the regions they import from, and the existing theoretical models on bilateral trade flows do not describe this kind of unilateral trade flows well. Table 15 below summarizes the types of trade patterns that existing models in the literature were designed for analyzing and illustrates what exactly is needed for modeling the trade of perishable and non-differentiated agricultural crop commodities. The model that we develop in Chapter 6 of this dissertation is a first step towards filling in the void in the last column of Table 15. In particular, our model helps to explain the trade flows of rice, which is a non-differentiated (or homogenous) perishable commodity, across geographically distinct markets in the Philippines. It has a very high goodness of fit with actual trade flow data, and this observation supports the model's hypothesis that the minimization of unit trade costs incurred in shipping a homogenous perishable commodity from markets where the good is in surplus to markets where it is in deficit, is the main driving factor behind the trade of such goods.

Our model's predictions are helpful in constructing policy recommendations for bolstering food security at the national level, and for enhancing the capacity for producers in food surplus regions to reap the benefits of comparative advantage and gains from trade vis-à-vis production. Before proceeding to describe and explain our model in detail, however, it is necessary that we

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[10]The characteristic of the tradable good being *perishable* is vital to the mechanisms of our model since the model assumes that the good cannot be stored for purposes of investment and speculation, and must be sold and consumed soon after it is made available on the markets.

Table 15: Summary of existing workhorse models in international trade theory, and what is needed for modeling perishable commodity trade flows

Model	Ricardian model	Heckscher-Ohlin model	New trade theory	New "new trade" theory	What's needed for modeling perishable commodity trade flows
Reason for trade	Technological differences	Differences in factor endowments	Love for variety	Love for variety and heterogeneity in firm-level productivity	Differences in amount of surplus or deficit across markets
Inter / intra-sectoral trade	Inter-sectoral trade	Inter-sectoral trade	Intra-sectoral trade	Intra-sectoral trade	Intra-sectoral trade
Type of goods traded	Non-differentiated goods	Non-differentiated goods	Varieties of a differentiated good	Varieties of a differentiated good	A non-differentiated good
Characteristics of trade	North-South trade	Each partner exports a different good to each other. Trade is bilateral.	North-North trade	North-North trade	Trade of the same good. Trade is unilateral.

first embark on a study of the characteristics of rice markets, as well as the transportation and logistics sectors, in the Philippines. This will be the concern of the next two chapters.

4 Detailed description of Philippine rice markets

4.1 Production

Although the Philippines does not produce enough rice to meet its gross national demand, the nation is the world's eighth-largest producer of rice (Ricepedia, Philippines, n.d.). As we can see from Figure 25, total (irrigated and non-irrigated) rice production in the Philippines has been on a slight upward trend between 1970 and 2010. In 2010, at least 4.35 million hectares of land in the Philippines was devoted to the production of rice (Philippine Rice Research Institute, 2011).

There are two main cropping seasons of rice. The first (wet) season takes place between September and November, while the second (dry) season takes place between March and May (Reyes et al., 2005). Hayami et al. (1999) observe that in each cropping season, as much as 60 and 90 per cent of rice is sold during the month where harvest is at its peak. Since there is a lot of heterogeneity in terms of the month when each province experiences its peak harvest, this observation is in tandem with our argument (in Chapter 3) about differences in seasonality and the need for consumers to smooth out their consumption of rice across geographical space.

By looking at Figure 26, which plots the amount of paddy rice (palay) supplied between 1970 and 2010 in million metric ton units, we observe that the supply of rice is very much affected by exogenous shocks in the form of natural calamities such as the ENSO (El Niño Southern Oscillation). For example, in Figure 26, we see a sharp dip in the supply of palay in 1998, and Figure 27 tells us that this is attributable to 1998 being a strong El Niño year. Further, while the supply of palay peaked in 2008 at 16.82 million metric tons, natural calamities including the ENSO brought it down in succeeding years. According to the Philippine Rice Research Institute (2011), the fact that the gross national

supply of palay in 2010 was 6.2% less than that in 2008 is attributable to a drought caused by the El Niño phenomenon in the first semester and strong typhoons in the fourth quarter of the year.

On a positive note, palay yield has more than doubled since 1970, in spite of the nation's land resource constraints. Yield experienced an all-time high in 2007 at 3.8 metric tons / hectare, although it has been decreasing ever since then due to the negative effects of weather-related shocks. In answering the question of why there is not enough rice available for consumption in rice deficit markets, it is natural that we question the extent to which this phenomenon is the result of a low level of productivity in the Philippines.

Are Filipino farmers a lot less productive than farmers in other rice-producing nations? Figure 28 suggests not. As we can see from this figure, although Thailand and India have more land harvested to rice than the Philippines, the Philippines is more productive in terms of the yield of palay per unit area than the former two countries. For example, in 2009, the Philippines had an average yield of 3.59 megatons / hectare, whereas Thailand and India only had 2.87 and 2.98 megatons / hectare, respectively. This observation is further supported by Dawe (2006a), who highlights that the Philippines was able to achieve self-sufficiency in the 1970s and even became a small net exporter of rice in the early 1980s, in spite of its land resource constraints. According to Dawe (2006a), this was the effect of the Green Revolution (which took place between the late 1960s and 70s), when new irrigation techniques, improved rice varieties, and fertilizers were adopted in the Philippines, allowing the nation to overcome its natural disadvantages in the endowment of land. The decline in the nation's self-sufficiency of rice ever since the 1990s is mainly the result of its burgeoning population and the fact that all Filipino farmers have already adopted the technology package introduced during the Green Revolution.

Figure 25: Area harvested to paddy rice between 1970 and 2010

AREA HARVESTED TO PADDY RICE, 1970-2010
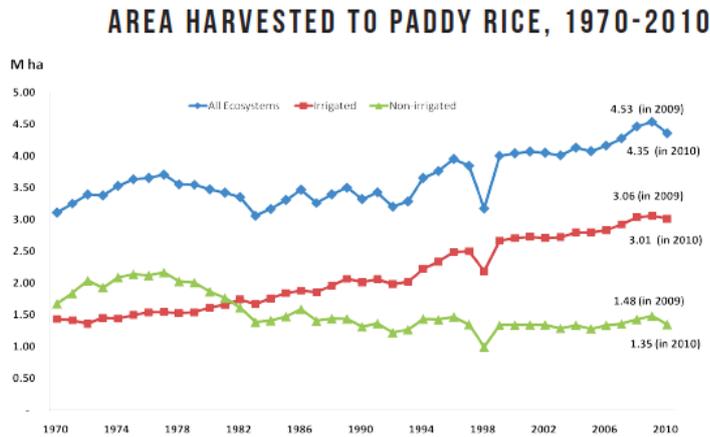
This figure plots how the area harvested to paddy rice evolved between the year 1970 and the year 2010, for different types of ecosystems. Source: Philippine Rice Research Institute (2011).

As we have already noted in earlier chapters, there is a lot of heterogeneity with regards to each geographical region's comparative advantage vis-a-vis rice cultivation. The vast majority of irrigated rice is cultivated on the central plain of Luzon, while the majority of rainfed rice is produced in Cagayan Valley and along the coastal plains of Ilocos, as well as in Iloilo Province (in Western Visayas). The major rice-producing parts of the Philippines include Central Luzon (Region III), Western Visayas (Region VI), Cagayan Valley (Region II), Ilocos (Region I), and Soccsksargen (Region XII) (Philippine Food and Nutrition Security Atlas, 2012).

On the other hand, rice-deficit regions include the highly populous Rizal province (in Calabarzon (Region IV-A)), the National Capital Region (NCR), and the Autonomous Region in Muslim Mindanao (ARMM). Although many different factors serve as constraints to the production of rice in these areas, researchers have identified climate change, burgeoning population, declining land area, and a high cost of factor inputs amongst them. In addition, some ar-

Figure 26: Paddy rice production between 1970 and 2010

PADDY RICE (PALAY) PRODUCTION, 1970-2010
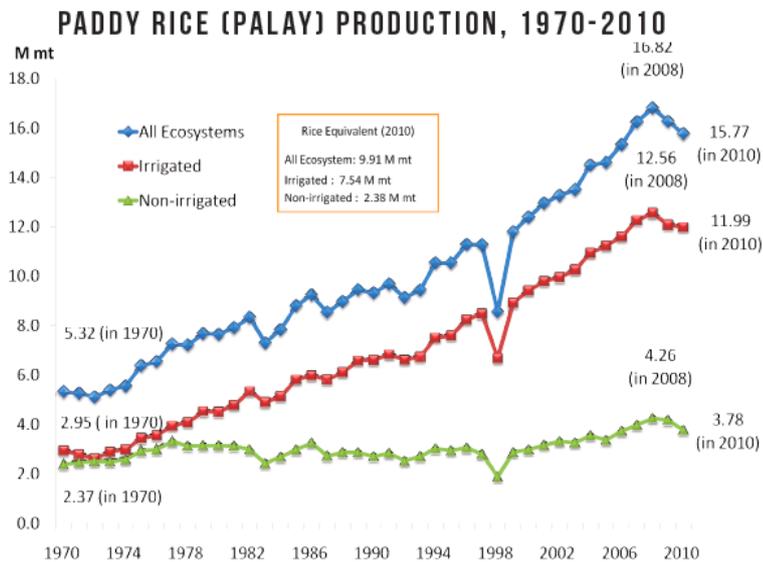
This figure plots how the quantity of paddy rice produced in the Philippines evolved between the year 1970 and the year 2010, for different types of ecosystems. Source: Philippine Rice Research Institute (2011).

Figure 27: Paddy rice production and intensity of ENSO between 1980 and 2004
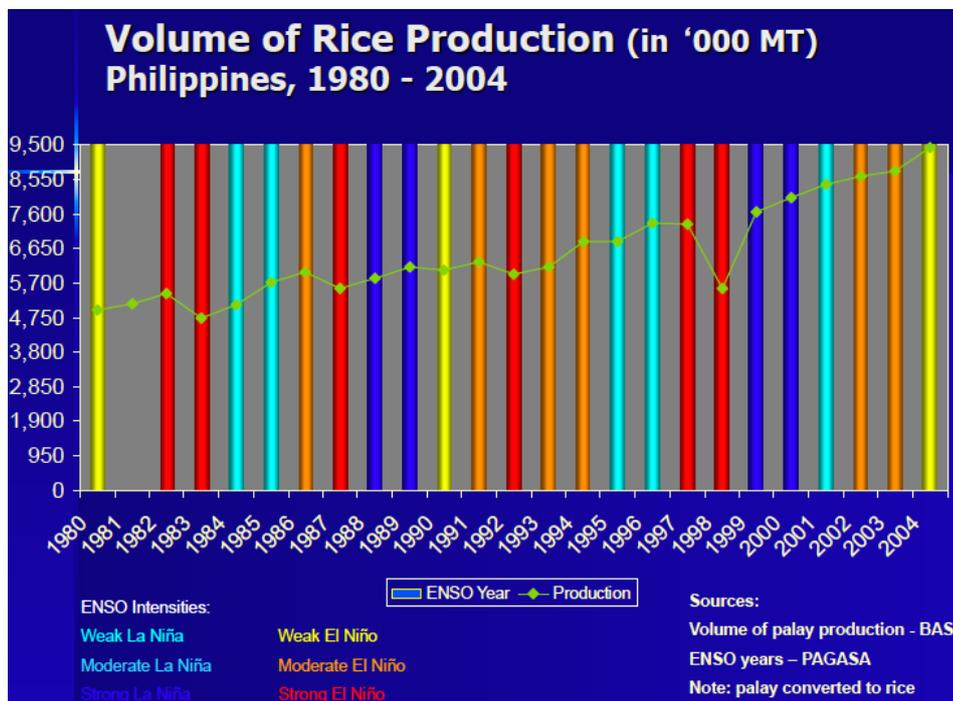
The green line in Figure 27 traces the volume of aggregate national rice production between the year 1980 and the year 2004. The colored bars in the background indict the intensity of the ENSO phenomenon within each particular year. Source: Reyes et al. (2005).

Figure 28: Yield of paddy in selected countries, in 2000 and 2009

COMPARATIVE YIELD OF PADDY RICE, SELECTED ASIAN COUNTRIES, 2000 AND 2009
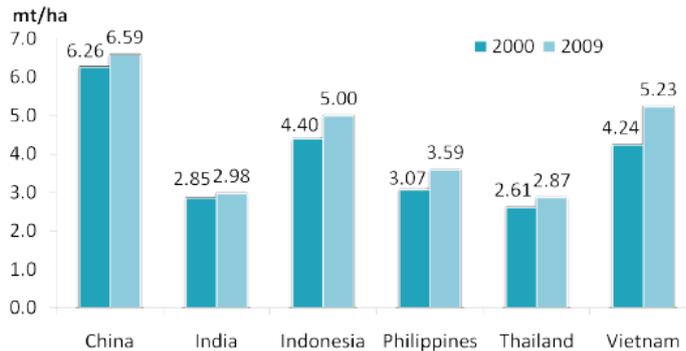
Figure 28 shows the yield of paddy rice in selected Asian countries in the year 2000 and the year 2009. Source: Philippine Rice Research Institute (2011).

eas such as Soccsksargen (Region XII), which used to record surpluses of rice, have now become rice-deficit regions due to crop shifting and the conversion of agricultural land to residential, commercial, and industrial land.

At the national level, despite relatively high yields of palay (see Figure 28), the Philippines has experienced a fall in its self-sufficiency of rice over the past one and a half decades. For example, national self-sufficiency of rice dwindled from 91% in 1990 to 80% in 2010, due to rapid population growth, rising per capita demand for rice, and exhaustion of the Philippines land resources by the 1960s (see Figure 29). Intal Jr. et al.(2008) observe that rice farmers may have chosen to cultivate other crops in place of rice because of increases in the opportunity cost of labor and land, inability to compete with rice imported cheaply from abroad by the NFA, and a lack of infrastructure support for agriculture by the Filipino government (Intal Jr. et al., 2008, p. 2). Fur-

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Figure 29: Rice import dependency and sufficiency ratios, 1990-2010
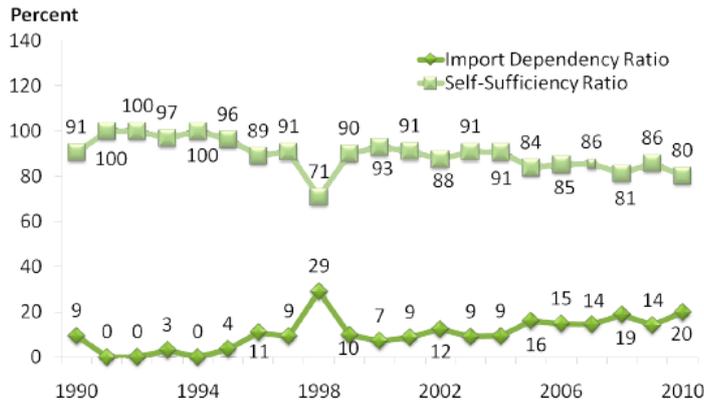
Figure 29 traces the evolution of the Philippines' import dependency ratio and self-sufficiency ratio for rice, between the year 1990 and the year 2010. Source: Philippine Rice Research Institute (2011).

ther, Baulita-Inocencio et al. (1995) highlight that the dismal amount of public spending on infrastructure for agriculture is a large causal factor behind the slow growth of rice output since 1990.

Why is the amount of public spending dedicated to rice cultivation so constrained, to begin with? There are several factors at play, but some of the most obvious ones include the Filipino government's budgetary and debt problems (Intal Jr. et al., 2008), the competing demand for water by other sectors (Intal Jr. et al., 2008), and the lack of political representation of rice farmers (Fang, 2014). We shall examine the last point in greater detail in Section 4.3 below.

4.2 Consumption

Rice is the staple food of about 80% of Filipinos and has a 13% weight in the consumer price index (Reyes et al., 2005). Although regions differ in terms of their per capita consumption of rice (see Figure 16 in Chapter 1 and Table

Figure 30: Rice consumption by region / million metric tons, 1970-2002
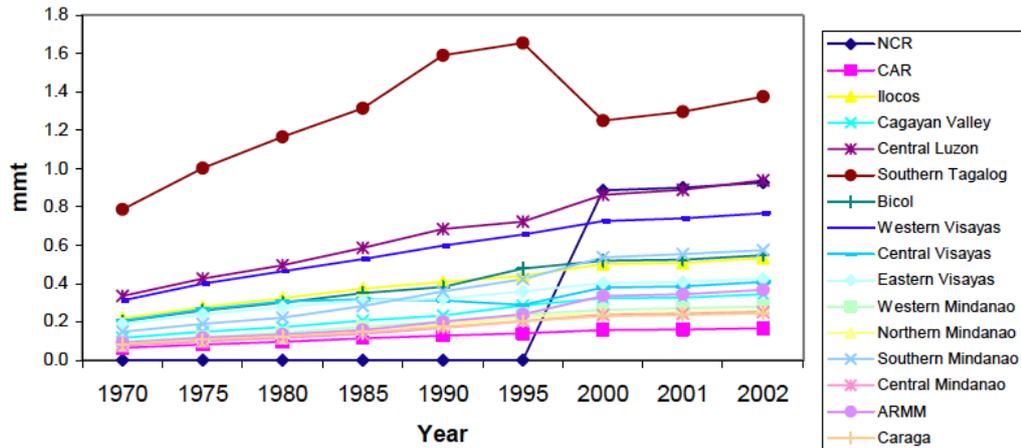
Each line in Figure 30 plots the aggregate rice consumption per million metric tons in each region, between 1970 and 2002. Source: Intal Jr. et al., (2008), using data from the BAS.

16 below), the national demand for rice has risen sharply across all regions ever since 1970 (see Figure 30) and has continued to surge even after 2000. This is reflected in Table 16, which illustrates that the national per capita consumption of rice increased by 13% between 1999/2000 and 2008/2009. Shifts in consumer tastes from other crops such as corn to rice have contributed significantly to the growth in the national per capita consumption of rice. This is evidenced by the fact that the per capita rice consumption in Central Visayas (Region VII) - a region that has traditionally consumed corn as its staple - increased by a staggering 41%, from 67 kg per year in 1999/2000 to 95 kg per year in 2008/2009.

There is no region where the per capita rice consumption has not increased ever since 1999/2000. In 2008/2009, Central Visayas (Region VII) still recorded the lowest per capita consumption of rice, most probably because of the preference for corn by the people living in the region. On the other hand, the

Table 16: Per capita rice consumption by region, in 1990-2000 and 2008-2009

Region	Per Capita Rice Consumption (kg)		Percent Change
	1999/00	2008/09	
Philippines	106	119	13
NCR	90	101	12
CAR	121	132	9
Ilocos Region	118	125	6
Cagayan Valley	116	122	6
Central Luzon	111	123	11
CALABARZON	108	113	4
MIMAROPA	108	136	26
Bicol Region	111	124	12
Western Visayas	122	134	10
Central Visayas	67	95	41
Eastern Visayas	113	127	13
Zamboanga Peninsula	90	109	21
Northern Mindanao	91	116	28
Davao Region	108	113	5
SOCCSKSARGEN	103	137	32
Caraga	114	128	13
ARMM	122	145	18

This table summarizes the per capita rice consumption at the aggregate national level, and in each region in the Philippines, between the year 1999/2000 and 2008/2009. The final column summarizes the percentage change in the per capita rice consumption between the year 1999/2000 and the year 2008/2009. Source: Philippine Rice Research Institute (2011).

ARMM recorded the highest per capita consumption of rice. According to the Philippine Rice Research Institute (2011), the fact that rice consumption did not increase much in Calabarzon can be attributed to rapid urbanization and income growth in the region, because these factors may have made it possible for the people living in Calabarzon to substitute rice for more expensive food groups such as meat and non-starchy vegetables.

Figure 31, which was created by Reyes et al. (2005), paints a very striking picture of the relationship between rice consumption and production in the Philippines. The figure shows that between March 1992 and November 1995,

Figure 31: Time series plot of various indicators of supply, demand, and stock inventories, between 1992-1995
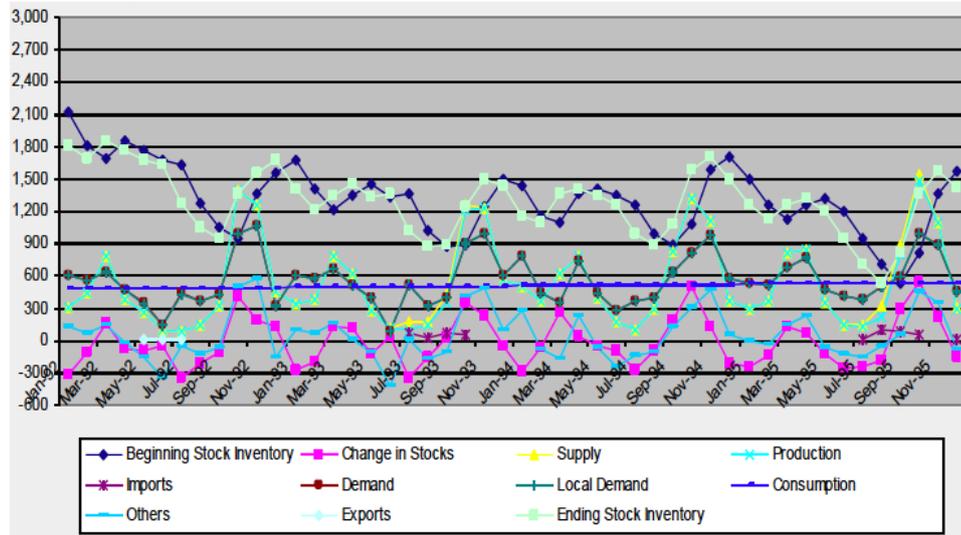
This figure traces the time-series path of various indicators of rice supply, demand, and stock inventories, between 1992 and 1995. Source: Reyes et al. (2005).

the national consumption level of rice remained fairly time invariant (or constant throughout time), whereas production (and inventory levels) experienced cyclical fluctuations across the months of each year. This observation serves as solid evidence in support of our argument in Chapter 3 that differences in the seasonality of rice across provinces, and the need for consumers to engage in consumption smoothing over the months of a year, is a strong factor that gives rise to the two-way trade of rice between province pairs.

As we examined in Section 1.2.4 of Chapter 1, there is an inverse relationship between the income of a family and the amount of rice it consumes as a fraction of household income. According to Dawe et al. (Eds.) (n.d.), rice

alone occupies over 20% of the value of total consumption of the poorest 30% of households. Similarly, using data from the 1997 Family Income and Expenditures Survey (FIES), Balisacan (2000) discovered that net rice consumption as a percentage of total consumption was highest amongst the lowest two deciles of the population ranked by income. For the lowest decile (i.e. the poorest 10% of the population), the share was around 7.5%, and for the second lowest decile, it was about 2%. In contrast to the bottom two deciles, the share of net rice consumption was negative for deciles 4 to 8 (i.e. households in the middle of the income distribution). Dawe (2006b) identifies the following 4 groups of people as people likely to belong to the lowest two deciles of the population ranked by income: the urban poor; the rural landless; nonrice farmers; and small rice producers who do not produce enough rice to meet even their family's consumption needs (Dawe et al. (Eds.) (n.d.), p. 44-45). The inverse relationship between a family's income and the amount of rice it consumes as a fraction of household income tells us that high domestic rice prices are very much detrimental to the welfare of the poor.

4.3 Distribution: the vertical supply chain of rice

What are the channels through which rice flows, from the time it is harvested at the farm gate, to the time it reaches the consumer? Who are the participants involved in the vertical supply chain of rice, and what are their roles? Answers to these questions can be found in Hayami et al. (1999), who surveyed both farm and non-farm households in East Laguna Village eleven times between 1966 and 1997, as well as a report entitled "Marketing costs structure for palay / rice 2013" published by the Philippines Statistics Authority in 2015 (BAS 2015). We summarize our findings from these two sources below.

Although there are variations in the exact stage of the vertical supply chain at which each of the different groups of participants is active, the basic path through which rice flows from farmers to consumers is illustrated in Figure 32. Rice producers, or farmers, are active furthest upstream in the vertical supply chain of rice. According to both sources mentioned above, the bulk of paddy that is harvested by farmers gets passed from the farm gate to wholesale level through the hands of middlemen known as collectors. It is also common that a large-scale collector of the independent trader type employs several small-scale commission agents known as agent collectors.

Hayami et al. (1999) explain the difference between the roles of an independent collector and agent collector as follows. To become an independent trader, one has to commit to a rather hefty fixed capital investment, such as the purchase of a truck which is used to transport wet paddy collected from farmers to interprovincial rice millers located in trading centers. In addition, independent traders are also exposed to trade risks, since the selling price of paddy to mills varies depending on the moisture content of the rice. This implies that miscalculations of the quality of paddy when offering prices to farmers can result in major losses for an independent trader. In contrast, agent collectors who operate on a commission basis are free from fixed capital investments and trade risks, since they receive payment from independent traders.

Collectors sell the rice they collect from farmers to large interprovincial rice mills, which are located in "core" provinces - that is, large provinces where trading centers are found. These may be within or outside the province where the farmer plants his rice, depending on where the farm is situated. Rice miller traders tend to operate only in core provinces because, in order to keep a mill in operation over the months beyond the peak harvesting seasons, it is necessary to procure paddy from a diverse range of provinces with heterogeneous harvesting

seasons (Hayami et al., 1999).

At the wholesale level, it is common for rice to get passed from a rice miller trader to other wholesale traders known as distributors. The term "trader" refers to any participant who buys and sells rice. These may be small, medium, or large scale. Finally, rice enters the retail level when it is sold by either a rice miller trader or distributor to a retailer. The retailer then sells to consumers at some marked up price.

Figure 32 illustrates the flow of rice from upstream to downstream and Figure 33 illustrates the hierarchical relationship between the different groups of agents in the vertical supply chain of rice. It is also important to note that we have simplified the channels of rice marketing to a great extent in both of these figures, for the sake of parsimony. In reality, rice may flow through many more stages, and the relationships between the agents involved may be a lot more complicated than what we have depicted. For example, Figure 34, which was extracted from the "Marketing costs structure for palay / rice 2013" report (BAS, 2015) depicts the marketing channel of rice in Nueva Ecija province. Since Nueva Ecija is one of the largest suppliers of rice in the entire country, the marketing channel of rice in this province is also very complex.

In Nueva Ecija, rice is collected from farmers by barangay assemblers, provincial assemblers, cooperatives, and agent collectors (or agents) who serve as middlemen between farmers and wholesalers. Large and medium-sized distributors and miller traders are active at the wholesale level. We observe that it is common for distributors to play the role of collectors too. For example, provincial assemblers and municipal assemblers both collect and distribute rice. Further, middlemen such as buying stations, cooperatives, and agents, as well as large distributor traders (or wholesalers) may also collect rice from other regions.

According to the BAS report, cooperatives oversee the milling and distribution of rice to identified buyers which include institutional buyers, wholesalers, and retailers. On the other hand, agents help to make the disposal of rice easier for farmers, since they are actively involved in price negotiations between farmers and large-scale assemblers. At the wholesale level, distributor and miller traders procure rice from assemblers, cooperatives, and assemblers, and sell the rice to retailers who in turn market to consumers.

It is apt to include a small note of clarification to our description of the distribution of rice. In Allen (2014)'s empirical analysis, he makes use of province-month-commodity *wholesale* prices for the purpose of observing "the market price that producers would receive" (see "Section 2.2 Data" and "Appendix B.2 Price" in Allen (2014)'s paper). However, his model is based on the assumption that heterogeneous *farmers* engage in a costly search process to decide where to sell their crops. We believe that this analysis does not capture the workings of rice markets in the Philippines in an accurate manner, due to the following reasons.

First, the market price that farmers receive should be the farm gate price and not the wholesale price. (The latter is the price that rice millers and distributors at the wholesale level receive, when they make transactions with retailers.) Second, the role of searching for the price of rice in other provinces and deciding where to sell rice is usually overseen by agent collectors on behalf of farmers, because farmers may not want to make the fixed capital investment of buying a truck to haul rice to rice millers. Farmers are also often involved in credit-tying arrangements with agent collectors, who may advance credit to farmers with interest rates, in order to ensure a steady procurement of paddy. Due to these informal transactions between farmers and agent collectors, it is actually the common practice for the former to leave the job of price searching to

Figure 32: Flow of rice in vertical supply chain of rice
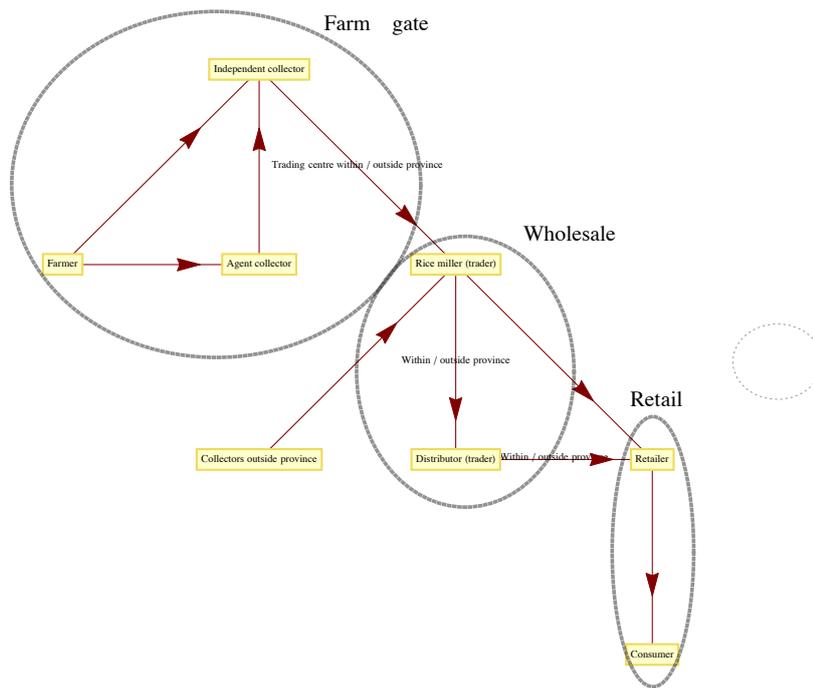
Farm   gate

Independent collector

Trading centre within / outside province

Wholesale

Farmer

Agent collector

Rice miller (trader)

Within / outside province

Retail

Collectors outside province

Distributor (trader)   Within / outside prov

Retailer

Consumer

This figure was reproduced by the author, based on the writings of Hayami et al. (1999). It depicts the vertical supply chain of rice in the Philippines at the most fundamental level. The participants at the farm gate to wholesale level are farmers, agent collectors, and independent collectors. Collectors serve as "middle-men" between farmers and wholesalers. Participants at the wholesale level are rice miller traders and distributor traders, who may operate at various degrees of scale. Rice miller traders are usually located in trading centers found in core provinces. After passing through the hands of one or more wholesalers, rice finally reaches the retail level, where it is sold by retailers to consumers.

Figure 33: Hierarchical relationship between agents in vertical supply chain of rice

Farmgate level	•Landowner (farmer) •Leasehold tenant (farmer)
	•Independent collectors •Agent collectors
Wholesale	•Rice miller trader •Distributor trader
Retail	•Retail store

This figure was reproduced by the author, based on the writings of Hayami et al. (1999). It depicts the hierarchical relationship between the different agents who participate in the vertical supply chain, or distribution, of rice.

Figure 34: Distribution channels of rice in Nueva Ecija province
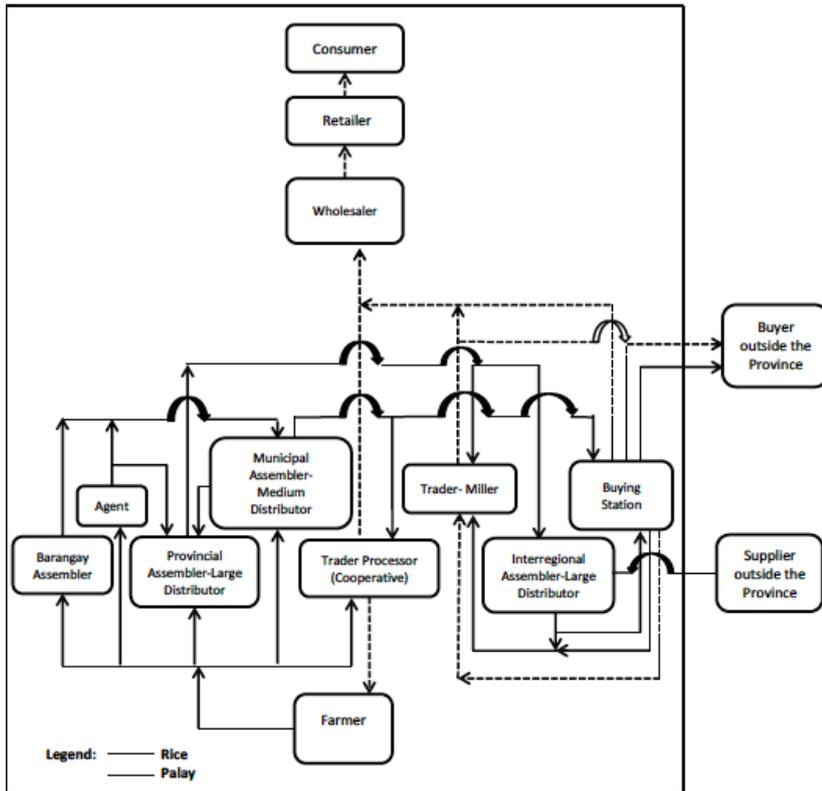
This diagram depicts the distribution channels of rice in Nueva Ecija province at a very detailed level. Although the distribution system in Nueva Ecija province is much more complicated than the basic vertical supply chain of rice that we depicted in Figure 32, the levels at which the various types of participants operate, and the broad classification of the various types of participants, remain consistent between both diagrams. Source: BAS (2015, p. 20).

the latter. We will clarify in our description on each of the different groups of market participants below, that middlemen, that is, collectors and traders, are very well-informed and updated about the price of rice in other geographical markets.

In the following subsections, we turn our attention to the role that specific groups of agents in the vertical supply chain of rice have to play and examine their relationship with one another.

4.3.1 Farmers

In the Philippines, farmers comprise about a third of the national labor force (of approximately 40 million people), and rice farmers comprise about a third of all farmers. It is easy to comprehend that rice farmers are a significant group of workers if we consider that they alone account for more than 10% of the total labor force (Fang (2015, citing Alavi et al. (2012)). Further, writing in 2008, Intal Jr. et al.(2008) remarked that there were more than 3 million rice farmers at the time of writing.

The common consensus among researchers who study rice markets in the Philippines is that even though farmers are numerous, they are poorly organized and have almost no power to set market prices. This is expressed in the writings of Fang (2015), who notes that the organization of rice farmers tends to be in the form of cooperatives that are more often motivated by economic rather than political reasons. For example, cooperatives tend to be more concerned with issues such as water distribution or loan provision, than with issues that have to do with changing government agricultural policy.

Why do farmers lack a common representative voice vis-a-vis agricultural policy? The reason has a lot to do with the fragmentation of their interests. Rice farmers in the Philippines are extremely heterogeneous, and this makes it extremely challenging for them to unite as a group with a common political

purpose. Producer heterogeneity in Filipino rice markets is very much the result of the country's agrarian structure, which we must now turn our attention to, if we want to understand why rice farmers are so poorly represented in the government's agricultural policy-setting agenda.

The term "rice farmer" refers to anyone who produces rice for sale, using seedlings and other factor inputs. The term seems to bring to mind a somewhat homogenous group of producers furthest upstream in the supply chain of rice, but such a conception is very misleading in the case of the Philippines. This is because within farmers there are landlords, that is, producers who own the land upon which rice is produced, and (leasehold) tenants, that is, producers who do not possess the land which they till.[11]

For reasons deeply rooted in history, which will be discussed shortly, there is a tremendous degree of land inequality amongst Filipino rice farmers, and this prevents them from banding politically. Moreover, landlessness amongst farmers is a severe issue, which serves to deprive them of their voice in matters of agricultural policy-making and to marginalize them at the expense of landlord farmers. According to Dawe et al. (Eds.) (n.d.), farmers without land are a numerous group, making up 13% of the rural labor force. This is evidenced by Figure 35, which shows that in most rice-producing provinces, between 60 and 80 % of labor invested in rice production is provided by landless farmers. Yet, despite their large numbers, landless farmers have hardly any voice in

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[11]Sharecrop tenancy, or sharecropping, was widely practiced in the Philippines until 1963 when the Agricultural Reform Code which was signed into effect by President Diosdado Macapagal abolished the practice. Under a sharecropping arrangement, a sharecrop tenant (farmer) produces rice on land belonging to a landlord (farmer) and receives a part of the output in some mutually agreed proportion. The landlord and sharecrop tenant jointly participate in rice production, where the landlord furnishes the land and the sharecrop tenant his labor, with either or both contributing any one or several of the factor inputs of production. The output is then divided between them in proportion to the value of their respective contributions. As opposed to a sharecropping arrangement, a leasehold tenant (farmer) cultivates rice on land belonging to or legally possessed by, a landlord (farmer) who does not contribute to production costs. In return for leasing the land to him, the leasehold tenant pays rent to the landlord either in terms of some fixed rent, or in some percentage of his output, or in both.

Figure 35: Percentage of landless labor in total labor use for rice production
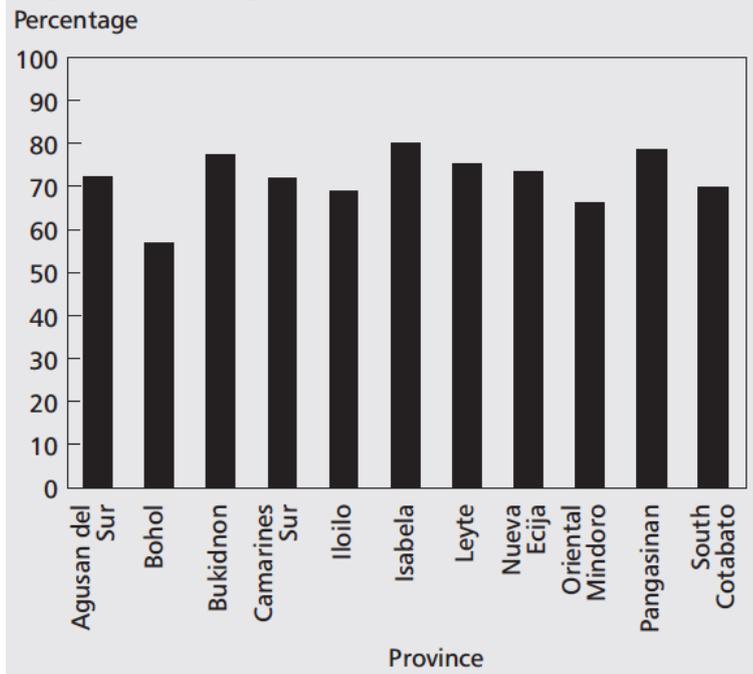
This bar chart reflects the percentage of landless labor in the total labor use for rice production, in various different provinces. Source: Dawe et al. (Eds.) (n.d.), based on data provided by PhilRice-BAS (2003).

politics locally, much less nationally. Landless farmers' lack of political power entrenches them in poverty, to the extent that they are seldom able to provide for the needs of their family for a whole year. Considering that many of them spend 25 - 30% of their yearly income on the consumption of rice alone (Dawe, 2006b), it is not difficult to see that high domestic rice prices, spurred by the government's protectionist policies, serve to penalize landless farmers at the expense of landowners.

4.3.2 Brief historical background of agricultural land tenure systems in the Philippines

Our discussion on the political fragmentation of farmers would not be complete without seeking to understand the historical process behind it. This will be the aim of this subsection. Although land inequality and landlessness have always been problems common to all regions within the Philippines, two different types of agricultural land tenure systems, which were rather distinct from each other, existed until the Agricultural Land Reform Code was introduced in 1963 (Hayami et al., 1999, Chapter 4). Which type of system a region adopted was very much dependent on its pre-colonial and colonial historical path. We shall now trace the historical evolution of each of these systems respectively.

Regions located along the coast were historically fragmented, so the accumulation of land in such (coastal) regions had the tendency to take place piece by piece via money-lending and mortgaging related economic activities. In the 1700s, the proliferation of trade with other countries led to the concentration of massive amounts of wealth among merchants and formal owners of the land. These indigenous elite patronized tenant customers, by lending them credit in advance in return for their loyalty (Anderson, 1964). They would also engage in moneylending, and acquire land titles when their borrowers defaulted on a loan. Over time, this gave rise to a paternalistic relationship between landowning indigenous elite and landless tenants, where the former would be in charge of matters such as tax collection, law enforcement, and the distribution of public works (Sidel, 1999).

On the other hand, landlocked regions, such as (inner) Central Luzon, witnessed the development of massive estates (or *haciendas*) that originated when local elites bought over land previously owned by the Spanish colonial

state, in large consolidated amounts. The result of this was large landowning political bosses (or *haciendas*), each having their own tenants in the hundreds or thousands. Hayami et al. (1999) describe the relationship between *haciendas* and their tenants as being a lot less paternalistic than the relationship between money-lending landlords and their tenants in coastal regions. In the case of the former, *hacienda* owners had the tendency to reside in Manila, leaving the management of their land to a farm manager (*encargado*) and several overseers (*katiwala*) (Umehara, 1974). The relationship between them and their tenant farmers was enforced legally, rather than through any sense of obligation. It may be due to the lack of a personal relationship between landowners and tenants, that political uprisings are especially rife amongst tenants of the *hacienda* system today (Dalisay, 1937 and Rivera et al.,1954).

During the Spanish colonialization of the Philippines, which took place between 1571 and 1898, influential landowners made use of the political (i.e. municipal election) system inaugurated by the Spanish colonial state to gain further political power for themselves. For example, many of them took to political office or established strong relationships with elected officials (Sidel, 1999). Their power over the numerous landless tenants continued throughout the American colonial period between 1898 and 1946, since the Americans did not impose land reform in the Philippines (Fang, 2014).

In the aftermath of the Second World War, land tenure systems that originated in landlocked regions and that were based on strict legal contracts became a hotbed for the confrontation between landlords and tenants. Hayami et al. (1999) postulate that this could be largely due to the lack of a personal relationship between *hacienda* owners living in Manila and their tenants, whose welfare the owners had little or no concern for. Tenants were often bound to *hacienda* owners by perpetual debt, and legal contracts forced them to surrender

their rice output to landowners in almost entirety. The exploitative nature of legally-based land tenure systems in landlocked regions such as (inner) Central Luzon gave rise to tenant farmer uprisings, such as the Hukbalahap (or Huk) revolt in the immediate postwar years.

The severity of these uprisings prompted the Filipino government to embark on land reform and to give landless tenant farmers a greater degree of political representation. However, as we shall see, the effectiveness of policies aimed at reducing the degree of income inequality between landowning and landless farmers have been very much constrained, due to loopholes in the law and the fierce resistance of powerful *hacienda* owners. In what follows, we shall trace the historical legacy of agricultural land tenure systems starting from the pre-colonial era, all the way until the present day. The complexity of events that shaped and molded the legal system governing agricultural land ownership in the Philippines makes it impossible to do justice to the entire history of land reform policies, which took place after the independence of the nation from colonial rule. However, we shall briefly discuss some of the more prominent historical events that shaped the agricultural land market today.[12]

4.3.3 Agricultural land ownership before and during Spanish colonial rule

Prior to the colonialization of the Philippines by Spain, the native inhabitants of what constitutes the Philippine archipelago today were mainly of Malay ethnicity. The natives engaged primarily in hunting, fishing, and shifting cultivation, and had a lifestyle that was mostly self-sufficient. They were organized into political units known as *barangay*, each headed by a chieftain (or *datu*) and comprised of less than a hundred households. Within each *Barangay*, members were stratified into different social classes, with serfs and slaves at the

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[12]Subsections 4.3.3 – 4.3.9 draw heavily upon the writings of Fuwa (2000).

bottom of the social hierarchy. Hayami et al. (1982), Putzel (1992) and Wurfel (1988) note that the main source of social power was command over labor, rather than land. The natives were sparsely located along coasts and rivers, and there was no large farms or cultivation of commercial crops for trade during this era (Fegan, 1989).

Colonial rule by the Spanish, which began in 1571, introduced many changes to the allocation and use of agricultural land amongst the natives. While perhaps unintended (Wurfel, 1988), these changes had impacts that were both profound and long-lasting (Fuwa, 2000). The Spanish conquest of the Philippines was primarily motivated by the need to establish a base for galleon trade between Mexico and China, and the spread of the Christian faith. Since the Spanish had little interest in establishing political control over the natives and wished to minimize the cost of colonial administration as much as possible, they relied heavily on the traditional *Barangay* chieftains for political governance. Chieftains (*Datus* or *Caciques*) were thus endowed with the role of colonial headmen, along with the authority to collect taxes, organize compulsory labor, and play the judge in daily conflicts. Such political power, in turn, equipped the chieftains with the ability to collect landholdings from anyone who defaulted on loans advanced for tax payment (Hayami et al., 1982).

It was during Spanish colonial rule that land came to be privatized. The Spanish crown's land ownership was established over massive areas of uncultivated land, and in principle, "all lands except those officially proved to be private or communal possessions belonged to the Spanish crown" (Hayami et al., 1982, Fuwa, 2000). The Catholic Church, in particular, acquired ownership over massive chunks of agricultural land and adopted sophisticated methods to centralize its bureaucracy vis-a-vis the control of land. The effect of these historical events on the distribution of agricultural land in the post-colonial era

was both far-reaching and profound since the majority of land possessed by the Church were leased, sold, and re-distributed via the state to the *Caciques*, who are the ancestors of the political and economic elite today.

In addition to the introduction of the concept of land ownership was a rise in foreign demand for tropical agricultural commodities, which created an increased demand for land holdings, and induced peasants to migrate from coasts and rivers into interior landlocked regions (Fegan, 1989). The increased demand for cash crops by Western countries also enticed Chinese merchants, who were migrants from Fukien and Kwantung, to increase the size of their trading networks in the Philippines. Intermarriages between the Chinese and local elite took place frequently during this time, allowing the two groups to consolidate their power and to form a class of rural elite (*principalia*) (Hayami et al., 1982). In the late 18th century, the *principalia* further increased the amounts of land they possessed either through direct purchases of land previously owned by the Spanish colonial state or by foreclosure on debt from the *Caciques*. This process eventually gave rise to the two different types of agricultural land tenure systems described in the previous subsection - small and medium scale land ownership where landlords resided in provincial towns known as *poblacion*, on the one hand, and patron-client relationships between landowners and tenants in the coastal areas of Luzon, on the other hand. In addition to these two types of wealthy landlords, private *haciendas* were also established via royal grants by the Spanish and purchases of royal land.

To this end, it is evident that most of the present day elite have their roots in the Spanish colonial era. They originate from two original sources: Chinese and Spanish mestizos, on the one hand, and *cacique*, traditional native elites who were descendants of *datu*-turned-colonial administrators, on the other (Putzel,1992 and Fuwa, 2000).

4.3.4 Agricultural land ownership during American colonial rule

When the Americans colonized the Philippines in 1898, they mirrored the example set by their Spanish predecessors in depending upon the Filipino elite for social control (Riedinger, 1995). In particular, the Americans placed emphasis on winning over the elite, so that the latter would not revolt against them like they had against the Spanish, during the revolutionary movement against Spain. This had the effect of further reinforcing the social position of the elite (Wurfel, 1988). Hence, when the Americans established a system of elected legislature, political parties, presidency, and independent judiciary, positions in the bureaucracy and legislature most naturally came to be occupied by the landowning elite (Wurfel, 1988).

On top of introducing elected legislature, the Americans also implemented land policies that further strengthened the political power of the elite. An example would be the purchase of about 200,000 hectares of friar estates by the Americans for $7 million in 1905, which were then sold to the landed oligarchy at cost of purchase (Hayami et al., 1982). Another example would be the introduction of land title deeds in 1902, which opened windows of opportunity for the traditional elite to aggressively expand their land possessions via the purchase of title deeds (Putzel, 1992). In short, American colonial rule had the effect of increasing the extent of economic inequality between the landowning elite and the landless farmers who tilled most of the soil.

4.3.5 1954 - 1955 land reform legislation

The Filipino government's attempts at land reform began in the immediate years following independence, when the US government, interested in developing the Philippines economically as a Cold War ally, prompted the Filipino government to implement social reforms as a condition for aid. It was under

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such conditions that the US government dispatched Robert Hardie, a specialist in land reform, to the Philippines. Hardie drafted a report in 1952, which recommended the abolition of tenancy, the establishment of owner-operated family-sized farms, and fair tenancy practices (Hayami et al., 1999, p. 79). The Hardie report, together with the Agricultural Tenancy Act of 1954 and the Land Reform Act of 1955, formed the backbone of a land reform program under President Ramon Magsaysay. The Magsaysay reform's success was, however, greatly limited, because it was met with fierce resistance by landlords and insufficient funding. Six years after its implementation, the reform was barely able to expropriate 20,000 hectares of land (Takigawa, 1976).

4.3.6   1963 Agricultural Reform Code

The Magsaysay reform was followed by the Agricultural Reform Code, implemented in 1963 by President Diosdado Macapagal. The code was a major advancement in land reform because it emphasized land reform as a means of boosting agricultural productivity. Such a motivation was premised upon the logic that by increasing the operational size of farms, rice producers would be able to reap economies of scale and operate more efficiently. The Code aimed to confiscate land from landlords above a retention limit of 75 hectares and to distribute them to tenants. This would take place over two stages.

First, under 'Operation Leasehold' (i.e. stage one), sharecrop tenancy would be converted to leasehold tenancy with a rent fixed at 25% of average harvest for three years preceding the Operation. This would be followed by 'Operation Land Transfer' (i.e. stage two), under which land ownership would be ceded from landowners to tenants. Land in excess of the landlords' retention limit would be expropriated by the government, and as compensation for handing over their land to the state, landowners would be given 10% of the land value in cash and the rest in interest-free redeemable Land Bank bonds.

However, similar to the Agricultural Tenancy Act of 1954 and the Land Reform Act of 1955 implemented by President Magsaysay, the degree by which the 1963 Agricultural Reform Code was able to have an impact on the degree of inequality in land ownership was limited, because the operations stipulated by the Code were confined to pilot areas in Central Luzon and especially to a pilot project in Nueva Ecija (De los Reyes, 1972). For example, Fuwa (2000) observes that the Code applied only to land upon which rice and corn were cultivated, and this created loopholes where landowners could conveniently evade expropriation by the government by substituting their cultivation of rice and corn with other cash crops. The fact that there were no legal penalties against the conversion of land use, or of land ownership to family members, made it especially convenient for such legal evasions to occur.

4.3.7 Marcos land reform

In an attempt to widen the scope of effective land redistribution, President Ferdinand Marcos, who took office in 1966, extended the scope of land reform to the entire country, converting all sharecrop tenancy arrangements to leasehold tenancy arrangements, and pledging to change the landlords' retention limit from 75 to 7 hectares (Fuwa, 2000, p. 3). In response to political pressure by a highly politicized student and workers' movement, President Marcos enforced the Code of Agrarian Reform in 1971, which declared sharecropping tenancy illegal. In the following year, President Marcos imposed Martial Law, which (initially) placed heavy emphasis on land reform. A month following the commencement of Martial Law, the President issued Presidential Decree No. 27 (PD27), which transferred all rice and corn fields exceeding the retention limit of 7 hectares to tenants who tilled them, at a price equivalent to 2.5 times the value of average annual production, payable to the Land Bank at 6 percent interest rate within a time frame of 15 years (Fuwa, 2000). At the time when

a tenant had completed the process of amortization, he / she would be issued a land title, or Emancipation Patent, which would be transferable only to his / her heirs. On the other hand, landowners would be paid 10 percent the value of their land in cash and 90 percent in Land Bank bonds, as stipulated by the 1963 Code.

Although PD27 did serve to expand the coverage of land reform, its effectiveness was constrained, due to limitations which were also shared by the laws which preceded it (Fuwa, 2000). This had mainly to do with the fact that the fundamental motive behind the Marcos reform programs was to weaken the President's political opponents, many of whom were landowners, and not really to benefit landless farmers (Fang, 2015, citing Crowther, 1986). As a result, the programs met with dismal success, and no more than 1% of the total agricultural land (70,715 hectares) was redistributed (Bello et al., 2004). Moreover, President Marcos was careful not to antagonize all landowners at once and eventually was unable to stick to his announced retention limit of 7 hectares per landlord (Wurfel, 1988).

Some examples of the limitations in the design of PD27 include a clause which excluded "new" farm land established after 1972, which amounted to about 1.24 million hectares between 1971 and 1980; and the limitation of its scope to tenanted areas, which represented about 24 percent of all rice and corn areas, excluding landless laborers and subtenants amounting to 2.5 million in 1975 (Fuwa, 2000, citing Hayami et al., 1990). Further, very much similar to the 1963 Agricultural Reform Code, PD27 permitted landowners to evade expropriation by the government by shifting the crops they cultivated away from rice and corn to other cash crops, or by evicting tenants through means of substituting them with hired labor (Fuwa, 2000).

Therefore, although PD27 did help to enact the transfer of income gains

from landowners to leasehold tenants, it also aggravated the income inequality and intra-class differentiation amongst its beneficiaries (Fuwa, 2000). This has largely to do with the fact that the law was implemented very unevenly across different areas of the country. While some researchers such as Umehara (1997) and Hayami et al. (1999) have noted instances where former tenants benefitted tremendously from the Decree, others have noted instances where only 20 to 30 percent of former tenants benefitted, and instances where no tenants appear to have gained at all. For example, Riedinger (1995, p. 94) and Hayami et al. (1990, p. 67) observe that in some communities prospective reform beneficiaries continued to pay rent or amortization well beyond the 15 years as specified by the law, while others stopped making payments either to the landowners or the government prior to the completion of amortization. The uneven implementation of PD27 is also observed by Otsuka (1991), who notes that conversion of sharecropping tenancy was more extensive in irrigated or favorable rain-fed areas than in unfavorable rain-fed areas, and in areas where the increase in rice yield (between 1970 and 1986) was higher. Mirroring the findings of Otsuka (1991), Fegan (1989) writes that PD27 had little impact beyond Central Luzon, Iloilo, and Isabela and that it had almost no impact in areas such as the Eastern Visayas and Mindanao.

Another reason why PD27 had the effect of worsening the income inequality and inter-class differentiation amongst its beneficiaries has to do with its complete exclusion of the class of landless laborers from its targetted group of beneficiaries. Hayami et al. (1990) write that after 1970, the opportunities for a landless laborer to climb up the "agricultural ladder" by progressing from the role of a tenant farmer to a landowning farmer was virtually closed. This was because in the years following 1970, many landowners grew increasingly reluctant to rent out their land due to fear of losing it to the tenants. Further-

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more, many landowners also resorted to evicting their tenants and participating in self-cultivation via the use of hired landless laborers, since farms upon which land was self-cultivated were exempt from the coverage of the law. For example, in a survey of five sample villages, Otsuka (1991) discovers that about 20 to 30 percent of former tenants reported having been forcefully evicted by their landlords on average. Similarly, Hayami et al. (1990, p. 94) describes a case study where a landowner who owned 30 hectares of rice fields in Nueva Ecija "forced her workers to sign written contracts indicating that they are laborers but not tenants."

To this end, it is evident that although PD27 did have a significant distributional impact, thanks to the income transfer from former landowners to shareholding tenants, it also had a negative effect of worsening the income inequality and intra-class differentiation amongst its beneficiaries. It is apt, at this point, to make a final remark on whether PD27 was able to improve the efficiency of rice cultivation in a significant manner. The general consensus amongst researchers is that if there were any efficiency gains stemming from the Decree, such gains were very limited. This is because even prior to the implementation of the Decree, rice (and corn) fields were traditionally cultivated by small-size family tenants. Hence, PD27 did not alter the operational size of farms in a dramatic manner, and if it did help to increase the amount of scale economies in rice cultivation, such increases were most likely minimal (Fuwa, 2000 and Hayami et al., 1999).

4.3.8 Comprehensive Agrarian Reform Program (CARP) legislation under Aquino Presidency

Upon assuming her post in office, the first step that President Corazon Aquino took to improve land reform was to draft the Philippine Constitution in 1986. The Constitution included a "comprehensive" land reform program,

covering all agricultural lands and natural resources. It also included both tenants and regular farm workers. This meant that the latter group, who had been excluded as potential beneficiaries of land reform policies under the previous Codes, were now protected by law. The second step that President Aquino took to improve land reform was to issue the Executive Order 229 in June 1987. This focused mainly on procedural matters related to land reform (Fuwa, 2000). Between June 1987 and 1988, the newly elected Senate and Lower House of the Congress debated over their respective versions of land reform bills and finally came to a compromise which was instituted in the form of the Comprehensive Agrarian Reform Law (CARL, or Republic Act 6657) in June 1988. According to Fuwa (2000), the CARL comprised of the following clauses:

• A retention limit of 5 hectares, including an additional 3 hectares for each heir of at least 15 years of age and actually engaged in the tilling or management of the land.

• Compensation to previous landowners based on "fair market value".

• Amortization to be paid by beneficiaries of the law over 30 years with 6% annual interest.

• Alternatives to land redistribution, such as the permission granted to corporate landowners to satisfy their land reform obligations by offering their farmworkers the right to purchase capital stock of the land devoted to agricultural activities.

However, despite the promising start of the Comprehensive Agrarian Reform Program (CARP) under President Aquino, Hayami et al. (1999) note that any further attempts by the state to bring about effective land reform in the post-Marcos administration years were greatly hindered by the reconsolidation of the landowning class into an opposition bloc, which took place mainly during President Corazon Aquino's administration years. The effect of this, combined

with six attempted coups during President Aquino's years of office, caused her to give in to the interests of the landowning class (Bello et al., 2004). Moreover, Putzel (1992) and Reidinger (1995) highlight that large landowners may have abused the legal clauses under the auspices of the CARP to avoid having their lands confiscated and distributed to small farmers. An example of such a legal clause would be a law which made it possible for corporate landowners to satisfy their reform obligations by offering their farm workers the "right to purchase capital stock of the corporation proportional to the share of agricultural land to the company's total assets" (Fuwa, 2000, p. 23). Under this scheme, land values could be severely undervalued and non-land assets over-valued, with the effect of significantly reducing the value of the stock offered to farm workers (Putzel, 1992, p. 336-337).

4.3.9 Post CARP legislative politics

In the years after President Aquino's term in office, the framework established by CARP continued to be developed upon by President Ramos. This was again met with fierce opposition by the landowning class, who repeatedly lobbied for political bills aimed at restricting the scope of land reform, some examples being the exemption of all commercial farms from the land reform policies, and the suspension of reform in Mindanao (Fuwa, 2000). Nevertheless, Borras (1999, p. 48) describes President Ramos' leadership vis-a-vis agrarian reform as being relatively stable, to the effect that President Ramos was able to enforce additional legislative rules to supplement the CARP. For example, under the leadership of Erneston Garilao, the Department of Agrarian Reform (DAR) secretary appointed by President Ramos, there was a strengthened emphasis on the formation and workings of "Agrarian Reform Communities (ARCs)". The ARC approach was inaugurated in 1993 and it sought to concentrate DAR resources in selected areas, instead of spreading them thinly over the entire na-

tion. (Borras, 1999). The ARCs also developed basic social services including the provision of water and power to rural areas, support related to investment and marketing, and an agrarian reform beneficiary information and monitoring system. Fuwa (2000), citing Garilao (1988), notes that by the end of 1998, as many as 921 ARCs including more than 350,000 farmer beneficiaries had been established. By the end of President Ramos' term in office, about 90 percent of the "targetted" rice and corn lands and 36 percent of non-rice / corn lands had been redistributed, at least in official terms (Fuwa, 2000, p. 25).

In this sense, the land reform policies enforced by the Filipino government, after the independence of the nation, did succeed in redistributing the majority of economic returns to land from absentee landowners to non-landowning farmers who actually tilled the soil. On the other hand, however, the land reform policies also had several less than desirable effects vis-a-vis the efficiency and equitability of agricultural production (Hayami et al., 1999, p. 82 and Llanto et al., 2003, p. 12-13). These negative effects are as follows. First, the policies rendered the market for agricultural land inactive and thus produced tremendous inefficiency in land use. To be more specific, the policies restricted the trading of agricultural lands and banned their beneficiaries from selling, transferring, or conveying the lands they had acquired, except "via hereditary succession or to the government for a period of ten years". They also make it illegal for banks to foreclose and acquire ownership of properties secured by "emancipation patent of certificate of land ownership award" (Llanto et al., 2003, p. 12). Thus, in the event that a beneficiary of the land reform policies is unable to pay his loans to a bank, the bank has to transfer the emancipation patent or certificate of land award to the government, who would then transfer the land to another beneficiary. Such a law makes the market for agricultural lands inactive and has even given rise to informal land markets where usufruct rights to agrarian

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reform properties are traded. This causes agricultural lands to have lower values than they would under a competitive market for land. It has also had a negative effect of strongly discouraging private financial institutions from extending loans to the beneficiaries of land reform policies because the former tend to perceive emancipation patents and certificates of land award as less than complete instruments of ownership (Llanto et al., 2003, p. 12). The result of this is a lack of formal rural credit, and an inability of agricultural land markets to respond to competitive market forces of demand and supply. This situation, in turn, constrains the potential for agricultural productivity to materialize in the manner envisioned by the land reform programs.

A second negative effect that the land reform programs had was the worsening of income inequality within rural communities. For example, Hayami et al. (1999, p. 82) note that "no direct gain accrued to landless laborers, whose income did not rise or even declined because the strong population pressure on land prevented their wages from rising despite agricultural productivity increases". Similarly, Fuwa (2000, p. 63-64) observes that land redistribution as a standalone policy on its own is insufficient in reducing the degree of income inequality amongst the landowning classes and the landless poor. This is because income inequality can only be reduced if the beneficiaries of land reform policies were equipped with the means to become "competitive in the context of liberalized markets and a sharply reduced role of the state" (Fuwa, 2000, citing de Janvry et al., 1999, p. 14). In other words, land reform policies need to be complemented by additional measures to ensure that incomes are more equitably distributed amongst farms operating at different scales of production. For example, one such additional measure would be the elimination of taxes, output and input subsidies, and subsidized credit schemes that benefit large farms at the expense of small farms (Fuwa, 2000, citing Balisacan, 1996). Another would

be to increase the ease by which the beneficiaries of land reform policies can gain access to complementary inputs and output markets. This could be materialized via the establishment of properly functioning credit markets for small-scale farm owners. In addition, Hayami et al. (1990) and Otsuka (1996) suggest that a progressive land tax should be enacted as a measure of discouraging the re-consolidation of land by former large-scale landowners.

To this end, historical developments gave rise to agricultural land use with a large degree of land inequality and landlessness amongst rice farmers. The result of this is a lack of political representation of landless tenant farmers, a large number of farms operating at minute scales (40.1% operating below 1 hectare in 2002, as shown in Table 3), and an inactive market for land. For example, Hayami et al. (1999) observe, in their field research conducted in Laguna province, that the land reform programs conducted throughout the 1970s and 1980s did not change the distribution of farm sizes (in East Laguna village) in a significant manner. The authors also note that not only did the land reform programs fail to bring about an increase in the operational scales of farmers but that there was a tendency for farm sizes to decrease between 1966 to 1995 (Hayami et al., 1999, p. 96), because of increased population pressure. For example, Table 4 in Subsection 1.2.1, which was recreated by this author based on data furnished by Hayami et al. (1999), depicts a fall in the average operational holding per farm from 2.3 hectares in 1966 to 2 hectares in 1976, and to 1.7 hectares in 1987. It also indicates a rise in the percentage of farms smaller than 2 hectares from 46 percent in 1966 to 64 percent in 1995 and a fall in the percentage of farms 3 hectares or larger from 37 percent to 20 percent over the same time frame.

4.3.10 Wholesalers: rice miller traders and distributor traders

In the previous subsections, we examined the role of farmers and explained how the use of agricultural land in the Philippines gives rise to a situation where there is a large extent of heterogeneity and inequality amongst the incomes and landholdings of farmers. In this subsection, we shall turn our attention to another group of participants in the rice supply system – wholesalers. As shown in Figures 32 and 33, wholesalers consist of rice millers and distributors, who are also often referred to as traders. The term "trader" broadly refers to any participant who buys and sells rice and may also include rice collectors (of the agent and independent type). There are many different types of wholesalers, each operating on a different scale, and it is common to find that rice is passed from hand to hand, following a hierarchical order of wholesalers within a single rice market. To someone unfamiliar with the workings of rice markets in the Philippines, it may seem strange that there are so many traders, each operating at such different degrees of scale. However, Hayami et al. (1992) explain that it is actually very common for agricultural markets of developing economies to be organized in this way. This is because farmers typically operate and sell at very small scales, and this greatly increases the transaction cost per unit of a product collected directly from farmers. Hence, in order to reap the benefits of scale economies, it makes sense for downstream traders to relegate the task of searching for (and contracting with) farmers to upstream traders, such as poor village wives, who have a lower opportunity cost of time.

In fact, Hayami et al. (1999) argue that having a hierarchical chain of traders is vital in keeping large rice mills running through the months of a year. As we considered in Chapter 1 of this dissertation, there is a lot of heterogeneity in the timing in which rice is harvested across geographical space. To keep a mill running throughout the different months of a year, rice millers need to ensure

that they have constant access to paddy from different regions with different harvesting times. For this to be possible, it is inevitable that they rely on a large number of upstream traders to assemble paddy from small-scale farmers over a large number of localities.

One method which rice millers often employ to secure a constant all-year-round supply of paddy is to develop long-term trade relationships with traders further upstream. One such relationship would be credit tying, where rice millers advance credit to participants further upstream, with interest rates ranging between 2 to 5 % per month (Hayami et al., 1999, p. 194).

In fact, some rice millers even engage in credit tying relationships with farmers. In such cases, farmers would sell their produce directly to the rice miller and receive production loans from the latter in advance, at an interest rate of 8% for three months or so. The loan would be repaid together with interest, via deduction from the proceeds of the paddy that the farmers sell to the rice miller upon harvest. Although credit tying relationships between farmers and rice mills make it easier for farmers to purchase the factor inputs necessary for production, they also erode the bargaining power of farmers with regards to the price of rice they receive from the rice mills. This leads to a so-called love-hate relationship between farmers and rice millers (Fang, 2015). On the one hand, farmers often find such relationships enticing, because a lack of formal rural credit makes it extremely difficult for them to obtain the credit they need from other sources. For example, Dawe et al. (Eds.) (n.d.) observes that interest rates from banks in the Philippines are often too exorbitant for farmers to pay, at 15% an annum as compared to a mere 4% per annum in Thailand. He also notes that participants in Philippine rice markets seldom borrow from banks because the paperwork is excessive.

On the other hand, however, credit-tying relationships between farmers

and rice mills penalize the former by limiting their choices over whom to sell to (Fang 2015, p. 88-89). Yet, a survey conducted by the Agricultural Credit Policy Council showed that more than half, and as much as three-quarters, of the loans extended to rice farmers between 1996 and 2005 were of the credit-tying sort between traders and farmers (cited by Llanto, 2008, p. 146).

In light of the fact that farmers are often engaged in informal credit-tying arrangements with traders, it is not difficult to see that it is a lack of properly-functioning banks and not a lack of information (or the presence of information frictions) as suggested by Allen (2014), that cause farmers to have little bargaining power over farm gate prices. Farmers would not have to rely so much on informal credit-tying relationships with traders if financial institutions that could offer them with better access to capital were present. They would then have a lot more freedom in choosing whom to sell their rice to.

4.3.11   Retailers

Retailers are furthest downstream in the vertical supply chain of rice since they sell rice directly to consumers. They are also the customers of wholesalers, hence Hayami et al. (1999) observe in their study of East Laguna village that rice millers often make large efforts to secure a constant flow of demand from retailers. One such effort comes in the form of sales on credit, where miller traders allow retailers to delay their payment of rice orders by two to four weeks. Sales on credit arrangements are however risky because there are no legal institutions to help traders recover defaults by retailers on small amounts of credit (Hayami et al., 1999, p. 195).

4.3.12 Price markups and the possibility of collusion: how much market power do wholesalers and retailers have?

Since the main theme of this dissertation is whether rice markets in the Philippines are well arbitraged (or integrated) across space, our discussion on the mechanisms of rice distribution would not be complete without considering the following (two) types of questions. First, do price markups differ a lot across geographical space? Is it possible that heterogeneity in each market's price markup is responsible for spatial price divergence at the wholesale and retail levels? Second, how large are price markups at the wholesale and retail levels? Do wholesalers and retailers have market power? What is the possibility of them colluding and keeping prices artificially higher than the competitive market price in each market?

We shall answer each question in turn. Let us first address the question of whether price markups differ across geographical space. We downloaded time series data from the BAS' website on the prices of non-fancy rice at the farm gate level, and on the prices of regular milled rice at the wholesale and retail levels, in each province. By creating diagrams which show how rice prices evolved across time in each province at the farm gate, wholesale and retail levels, and by comparing rice prices at each stage of the vertical supply chain within and across provinces, we find that price markups are fairly consistent across space. In other words, we find little evidence to support the hypothesis that heterogeneity in each market's price markup could be responsible for causing prices to diverge across space at the wholesale and retail levels.

Figure A1 in the appendix plots the evolution of rice prices at the various stages of the vertical supply chain across time, in each of 79 provinces. In each time series plot, the vertical axis measures the average monthly rice prices in PHP / kg in each province, and the horizontal axis measures the time period of

Figure 36: Farm gate prices in provinces, January 2006 - December 2014
Farmgate price
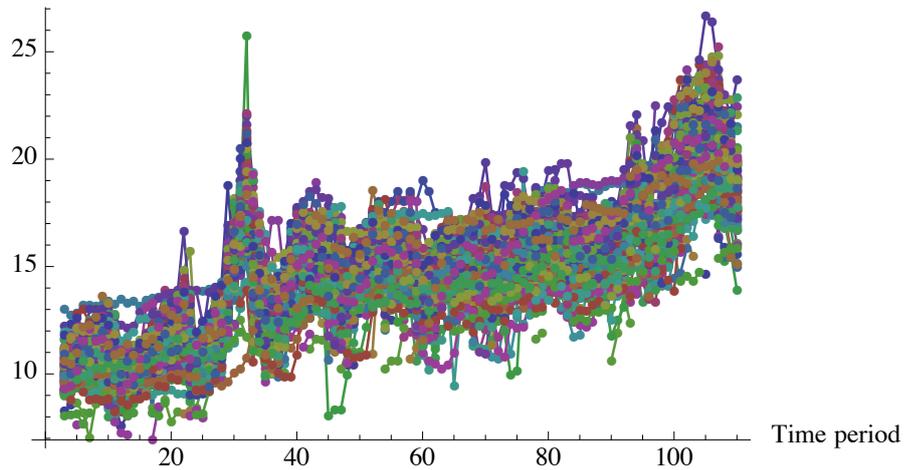
This figure was created by the author, based on monthly price data extracted
from the BAS' website. The vertical axis measures the average monthly farm
gate price of rice in PHP / kg, and the horizontal axis measures the time period
of observation. Each line traces the evolution of prices in a particular province.
The period of observation begins in January 2006 and ends in December 2014.

observation. The time series spans from January 2006 to December 2014, and
price observations are updated once per month. Farm gate prices are plotted in
green, wholesale prices in blue, and retail prices in red. With a small number of
exceptions, we observe that price markups from the farm gate to wholesale level,
and from the wholesale to the retail level, are fairly consistent across provinces.
Furthermore, we observe that wholesale markups are very high in all provinces,
ranging between 10-20 PHP / kg on average; and that retail markups are small,
ranging between 2-3 PHP / kg on average. Figures 36, 37, and 38 are analogous
to Figure A1 in the appendix. These three figures plot the evolution of the
farm gate, wholesale, and retail prices respectively, in all 79 provinces, between
January 2006 and December 2014. These figures illustrate that price markups
do not differ much across geographical space.

Figure 37: Wholesale prices in provinces, January 2006 - December 2014

Wholesale price
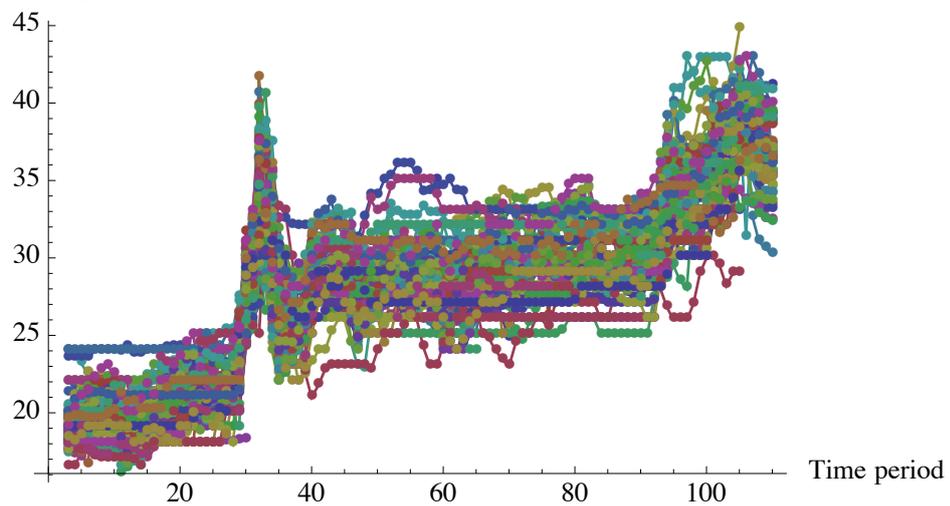
Time period

This figure was created by the author, based on monthly price data extracted from the BAS' website. The vertical axis measures the average monthly wholesale price of rice in PHP / kg, and the horizontal axis measures the time period of observation. Each line traces the evolution of prices in a particular province. The period of observation begins in January 2006 and ends in December 2014.

Figure 38: Retail prices in provinces, January 2006 - December 2014

Retail price
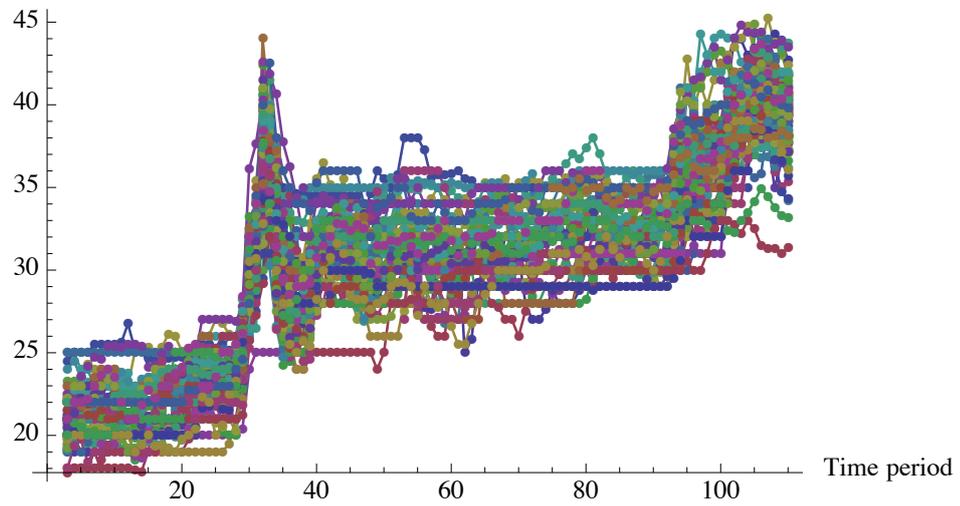
This figure was created by the author, based on monthly price data extracted from the BAS' website. The vertical axis measures the average monthly retail price of rice in PHP / kg, and the horizontal axis measures the time period of observation. Each line traces the evolution of prices in a particular province. The period of observation begins in January 2006 and ends in December 2014.

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Next, we address the second question, which is the question of how large price markups are, and whether wholesalers and retailers have market power. By comparing Figures 37 and 38, which plot the evolution of wholesale and retail prices in individual provinces across time, and by considering the differences between provincial rice prices at the wholesale and retail levels in the time series plots of Figure A1 (see appendix), it is evident that retail markups are extremely small. (By eyeballing the plots in Figure A1, we can surmise that the retail markup is on average, somewhere between 1 - 2 PHP / kg in all provinces.) The small retail markups reflected by these diagrams suggest that retailers have little power in colluding to set prices. Our observation that rice retailers do not have market power is in agreement with the findings of Dawe (Dawe et al. (Eds.), n.d., Chapter 3) who writes that "we can ... be sure that there is no collusion at the retail level: no one claims that rice retailers have monopoly power in selling to consumers". Earlier work by Mangahas et al. (1966) also confirm that market power does not appear at the aggregate level, and if it is ever present, is only significant at a temporary and local level. This is further backed by Rufino (2005), who shows, via time series analysis, that large rice markets in the Philippines are relatively efficient (Intal Jr. et al., 2008, citing Mangahas et al. (1966), and Rufino (2005)).

What about the possibility of collusion by rice traders at the wholesale level? A comparison of the evolution of farm gate and wholesale prices in individual provinces across time (see Figures 36 and 37, and Figure A1 in the appendix) reveals large wholesale price markups (of between 10 to 20 PHP / kg on average). Further, if we were to compare the wholesale price markup in the Philippines with that in Thailand, it is evident that wholesale markups are substantially higher in the former. This is illustrated by Figure 39, which compares the gross marketing margins, that is, the difference between wholesale

Figure 39: Gross marketing margins in the Philippines and Thailand
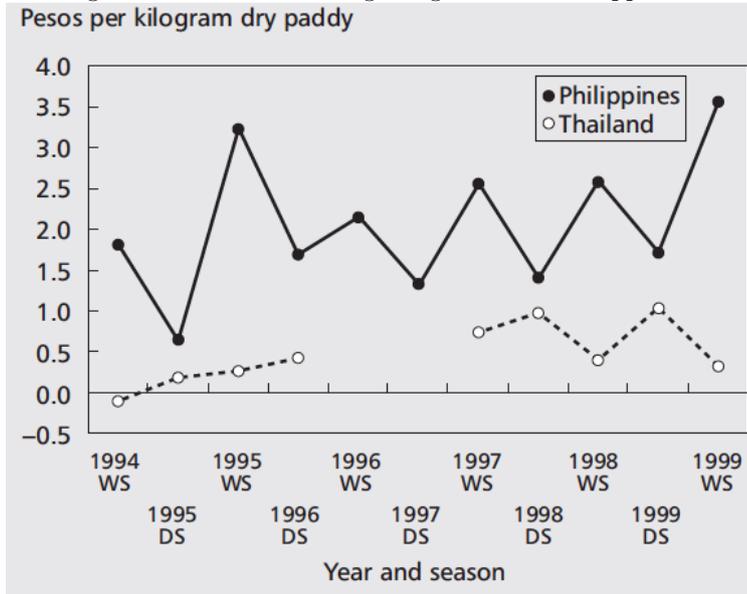
This figure plots the gross marketing margins for rice in the Philippines and Thailand, between 1994 and 1999. The horizontal axis indicates the year and season, where "WS" and "DS" stand for "wet season" and "dry season" respectively. The vertical axis measures the gross marketing margins in PHP / kg. Source: Dawe et al. (Eds.). (n.d.). Chapter 3.

and farm gate prices, in the Philippines (Nueva Ecija to Manila) and Thailand (Suphan Buri to Bangkok).

Writing along similar lines, Intal Jr. et al.(2008) observe that the ratio of farm gate to retail prices is very low in the Philippines (at a share of 0.48 between 2001 and 2003), but that the ratio of wholesale to retail prices is very high (at a constant share of 0.91 between 1991 to 2003). Naturally, the large wholesale markups make us suspect whether these markups are the result of market power on the part of rice traders. For example, Mears et al. (1974) and Hayami et al. (1999, p. 90) write that amongst the general Filipino public, there is a stereotypical image of a monopsonistic / monopolistic rice trader who

engages in both monopsony purchases of rice from farmers at heavily depressed prices, and monopoly sales of rice to retailers at exorbitant prices.

However, based on their analyses of rice markets in the Philippines, both authors clearly refute such a possibility. According to Mears et al. (1974), the existence of a monopsonistic / monopolistic rice trader is almost a myth, because given the lack of storage facilities and the high cost of holding stocks of rice, the probability of loss to a trader who chooses to store his stocks of rice is extremely high. According to the authors, the common perception of a rice trader with large market power is based on an unrealistic assumption that the cost of holding rice is close to zero, which cannot be true. In addition, the authors argue that wholesale markets are very competitive and efficient and that high wholesale markups are largely due to transport costs being too high (Intal Jr. et al.(2008), p. 10, citing Mears et al. (1974)).

Dawe complements the argument of Mears et al. in Chapter 3 of **Why Does the Philippines Import Rice? Meeting the Challenges of Trade Liberalization**, by first explaining that the high wholesale markups are not due to market power on the part of traders, and then by providing a list of reasons why wholesale markups are so high. First, (as we have already witnessed in Subsection 4.3.10) a lack of formal financial institutions that can provide farmers with the credit they need to purchase farm inputs causes them to turn to informal credit-tying relationships with traders. Under such arrangements, traders advance credit to farmers, who pay back with interest when selling their harvest to traders. Not only do these arrangements serve to restrict the freedom of farmers to choose whom to sell their crops to, but they also lower the price that farmers receive at the time of harvest, because of farmers' obligations to pay back their loans with interest. Second, drying machines and milling facilities are often lacking or inadequate in markets, so it is common for paddy to be dried

Table 17: Gross marketing margins and marketing costs by function, Nueva Ecija to Manila (Philippines) and Suphan Buri to Bangkok (Thailand)

Item	Philippines	Thailand	Differential
Transport costs	0.70	0.40	0.29
Drying costs	0.14	0.15	−0.01
Storage costs	0.42	0.07	0.34
Milling costs	0.32	0.23	0.10
Total costs	1.57	0.85	0.72
Gross marketing margin	3.67	0.85	2.82

Table 17 compares the gross marketing margins and marketing costs, that is, the difference between wholesale and farm gate prices, when rice is sold from Nueva Ecija to Manila in the Philippines, with that when rice is sold from Suphan Buri to Bangkok in Thailand. Units of measurement are in PHP / kg of dry palay. Source: Dawe et al. (Eds.). (n.d.). Chapter 3.

manually instead of mechanically. This causes the labor costs associated with the drying of wet paddy to be very high and to occupy a substantial part of wholesale margins. Third, trucks, mills, and warehouses in the Philippines tend to have small capacities. This prevents economies of scale from being reaped and keeps wholesale margins high.

Table 17 compares the marketing costs and gross marketing margins (i.e. the difference between wholesale and farm gate prices) when rice is sold from Nueva Ecija to Manila in the Philippines, with that when rice is sold from Suphan Buri to Bangkok in Thailand. It shows that with the slight exception of drying costs, marketing costs are always higher in the former than latter. In short, the table shows that logistics costs (inclusive of drying, storage, and milling costs) have a large role to play in raising wholesale margins across all markets within the Philippines.

To this end, findings by previous researchers who conducted extensive field work in the Philippines suggest that markets are competitive and efficient in the Philippines. There is very little room for traders or retailers to influence rice prices via monopsonistic or monopolistic practices. Also, although wholesale markups are very high, this has little to do with market power, but more to do with (1) a lack of banks which can provide farmers with loans at low-interest rates, and (2) poor and inadequate transport and logistics facilities. We will pursue the second argument in much greater depth when we develop and solve our theoretical model in Chapter 6.

4.4 The political economy of rice

In this subsection, we consider the role that the Filipino government, or the National Food Authority (NFA), has to play in influencing rice prices and rice supplies in markets across the nation. We shall also explain the relationship between the NFA, rice producers, and rice consumers in a way that is easy to comprehend.

In its implementation of policies related to rice, the NFA has two overarching goals. First, to ensure that consumers, especially those in low-income groups, have access to rice at affordable prices; and second, to keep the income of rice producers (or farmers) relatively on par with that of non-farm workers. Hayami (2007) refers to the first goal as the "food problem", and the second as the "farm problem". According to Hayami (2007), the policy choice of a government favoring either the food problem or farm problem is clear-cut. In the case of the former, the government would adopt policies to keep food prices low at the expense of farmers. (We will see some examples of such policies adopted by the NFA in the discussion that follows.) In the case of the latter, the government would tax consumers in order to protect food producers and keep farm

gate prices high. (Examples of policies which support the farm problem include protectionist trade policies such as import quotas and import tariffs.)

However, agricultural policies become very much more complicated when a government attempts to solve both the food and farm problems at the same time. This is the exact situation that the NFA is placed in. As it tries to balance these two conflicting goals on its agenda, the NFA's rice policies often become "a tinkering exercise combining various, often mutually conflicting policy instruments in ad hoc manners" (Fang (2015), citing Hayami (2007, p. 15)). In order to explain how this is so, let us now consider the NFA's political stance with regards to solving the food and farm problems, respectively.

4.4.1 The food problem

Solving the food problem is crucial to the Filipino government because reasonable and constant rice prices at the retail level are large determinants of the amount of political support that the ruling party can garner for itself. This is especially the case in the Philippines, where (as we saw in Subsection 4.3.1) landless tenant farmers are numerous but lacking in terms of political representation. In other words, consumers have a much larger political voice than the majority of farmers who do not possess their own land. The importance of appeasing consumers by keeping rice prices low is evidenced by the fact that election results have been to a large extent influenced by rice prices ever since the 1950s (Intal Jr. et al., 2008).This is with the exception of 1998, where the incumbent administration failed to win the presidential elections in spite of stable rice prices.

In addition to the issue of rice prices, there is also the issue of ensuring that consumers have a stable supply of rice to eat. Although the Philippines managed to achieve self-sufficiency in the 1970s, diminishing marginal productivity (which set in after all farmers had adopted the new production

and irrigation techniques introduced by the Green Revolution), stagnation in the government's investment in agriculture, increases in the per capita demand for rice, and rapid population growth all worked together to create a situation where per capita consumption could not be served by domestic supplies of rice alone.

In order to keep domestic prices low and to avoid a shortage of rice available for consumption, the NFA currently, relies on massive importations of rice from neighboring countries such as Vietnam and Thailand. The NFA has a monopoly over the right to import rice from abroad tariff-free. This monopoly enables it to use foreign imports as a quick remedy for deficits in domestic markets. For example, the NFA resorted to importing a record-shattering amount of 2.17 million metric tons of rice, which it then released into the domestic market at a price of about one-third that of domestically-grown rice in 1998. It similarly arranged massive imports of rice from Vietnam during the global food crisis of 2007 -2008, which severely depressed the domestic farm gate price of rice (Dawe et al., 2010, and Intal Jr. et al., 2008, p. 9). These policies favor solving the food problem over the farm problem.

4.4.2 The farm problem

Given that the NFA often imports in massive amounts from abroad during times of deficit, it may seem surprising to the reader that the very same institution attempts to solve the farm problem by imposing and maintaining trade policies which are protectionist in nature. These policies keep domestic wholesale and retail rice prices substantially higher than world rice prices. (See Figure 11 for a visual comparison of domestic wholesale versus world prices, between 2006 and 2015.)

Until 2001, the NFA was the only institution which could import rice from abroad, and it made use of this authority to control domestic rice supplies

and prices via the volume and timing of foreign imports. Even after 2001, when the WTO pressurized the Filipino government to open up its rice market to trade, the NFA continued to be the most influential importer of rice. This is largely the result of the implementation of a 40% tariff on all private importation of rice within the bounds of a quota, and a full tariff on all private imports exceeding the quota, which heavily discourages private traders from importing from abroad.[13] By restricting the quantity of rice that private traders can afford to import from abroad, the QR drives an artificial wedge between domestic and world rice prices and keeps the former artificially higher than the latter.

David (1997) observes a sharp rise in the nation's nominal protection rates (NPRs), defined as the percentage difference between domestic and border prices, between 1985 and 1998. This is reflected in Table 18. It is also ironic that NPRs rose from 19% to a staggering 68% in the years immediately following Philippine's accession to the WTO in 1995. According to David (1997), the rise in NPRs in the early to mid-1990s may have been the result of lobbying by landowning farmers, many of whom have personal connections with, or are themselves, members of the government.

4.4.3 Mutually conflicting policy instruments of the NFA

The large increase in NPRs in the early to mid-1990s suggests that the Filipino government may have chosen to place more emphasis on the farm problem than the food problem during those years. However, the following observations suggest that this trend has been reversed ever since the mid-1990s. Between 1970 and the mid-1990s, the NFA operated under a so-called "buy high, sell low" dual price regime. This implied that the NFA would procure palay from farmers at a price that was above the market-determined farm gate price, and

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[13]The quota, or quantitative restriction (QR), is an exception granted by the WTO under Annex 5 of the Agreement on Agriculture, and it applies only to the Philippines and South Korea at present.

Table 18: Nominal Protection Rates (NPRs) of rice in the Philippines, 1970-1998

Year	NPR
1970–1974	4.0%
1975–1979	-13.0%
1980–1984	-13.0%
1985–1989	16.0%
1990–1994	19.0%
1995–1998	68.0%

This table summarizes the nominal protection rates (NPRs) of rice in the Philippines for 6 time periods between 1970 and 1998. Source: David (1997).

market the rice to consumers at a price that was below the market-determined retail price (Fang, 2015, citing the Congress of the Philippines, 2010, p. 2).

In 1995, however, a period of rice deficits within the Philippines prompted the NFA to rely on foreign imports of rice to maintain its year-round 14-day buffer stock (Fang, 2015, citing Sombilla et al., 2006). Ever since this incident, the NFA has been purchasing significantly smaller quantities of rice produced by domestic farmers and substituting its purchases of domestically produced rice with rice imported from abroad. For example, the NFA purchased a meager 1% (or less) of palay produced by domestic farmers between 2005 and 2007. At the same time, as the NFA drastically reduced its purchases of rice from the domestic market, it imported massive amounts of rice from Vietnam and Thailand, especially during times of deficit such as the global food crisis of 2007 - 2008.

The large volumes of rice imported from abroad by the NFA would be justified if they were in tandem with domestic market forces of supply and demand. However, a massive amount of imported rice is wasted day after day in

the NFA's warehouses[14] and the volume of rice imported from abroad sometimes exceed the storage capacities of the NFA's warehouses. For example, in July 2010, the NFA administrator Angelito Banayo created a management team to inspect allegations of overstocked warehouses. This was partly in response to a speech by President Benigno Aquino III, in which the president raised concerns over 177 billion PHP worth of debts incurred by the NFA, due to excessive rice importations over the years (ABS-CBN News, 2010). Based on these observations, economists have often questioned whether there is the need for the NFA to import such massive quantities of rice from abroad (Dawe et al., 2010 and Slayton, 2009), especially since the massive volumes of foreign imports arranged by the NFA serve to depress the domestic farm gate price of rice.

Economists also suggest that the NFA may have chosen to give higher priority to tackling the food problem, as compared to tackling the farm problem, ever since the mid-1990s. This may be due to the fact that the majority of farmers are landless, operate on small scales, and have little political voice. In this light, land reform conducted with the aim of reducing land inequality amongst rice farmers would be helpful in giving domestic rice producers a greater incentive to lobby for their interests.

In short, the overall impression is that in its attempts to solve both the food and farm problems, the NFA has adopted a variety of policy instruments which lead to mutually conflicting results. On the one hand, the NFA adopts protectionist trade policies to discourage private traders from buying rice from abroad. The purpose of this is to keep domestic prices artificially above world prices so that domestic producers can be protected against foreign competition.

On the other hand, however, the NFA imports massive, and sometimes excessive, amounts during times of domestic rice deficit. The purpose of this is

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[14]According to the Philippines National Congress, for every kg of rice that the NFA imports from abroad, 2.47 PHP gets wasted due to inefficient storage and handling (Congress of the Philippines, 2010).

to ensure that domestic consumers have stable access to rice at reasonably low retail prices. However, by allowing foreign imports to flood the domestic market during times of deficit, the NFA's policies serve to heavily depress the farm gate price of rice. This severely reduces the incomes of landless and small-scale producers of rice, who are unable to compete with the much cheaper foreign imports.

It seems that the NFA's monopoly over the legal right to import rice from abroad, and its control over the volume of foreign imports supplied to the domestic market, do not serve to benefit either consumers or producers in the long run. It would certainly be helpful if the government could relinquish its control over the foreign importation of rice to the private sector, and allow economic forces of supply and demand to dictate the quantity of rice imported from abroad. By opening up the domestic market to trade, the government could effectively reduce the domestic retail price of rice relative to the international price of rice. This would benefit domestic consumers and help solve the food problem. On the other hand, by allowing market forces to determine the volume of foreign rice imports, the government could prevent rice from being imported in excess of demand. This would reduce the gross national supply of rice relative to the gross national demand for rice, and lead to an increase in the farm gate price of rice over the long run. In other words, poor farmers would experience a rise in income over the long run, and this would help to address the farm problem.

4.5 Chapter summary

In this chapter, we explored rice markets in the Philippines from an all-rounded perspective. How can we link our findings in this chapter to the research questions that we seek to answer in this dissertation? Let us recall that there

are two research questions which we want to address, and they are as follows. First, are rice markets in the Philippines well arbitraged across space, ceteris paribus (that is, given the existing state of transportation and communications infrastructure)? Second, what factors prevent more trade from taking place between domestic markets where rice is in surplus, and domestic markets where it is in deficit?

With regards to the first question, we examined the possibility that heterogeneous price markups across markets could be responsible for causing spatial price divergence. Our finding was that price markups do not differ much across geographical space (see Figures 36, 37, and 38, which plot the evolution of farm gate, wholesale, and retail prices respectively, in all 79 provinces between January 2006 and December 2014). Hence, we can rule out the possibility of heterogeneity in local distribution costs playing a significant role in causing spatial price divergence.

In addition, we also considered the possibility for wholesalers and retailers to collude, that is, to keep prices artificially above the competitive market price. This is relevant to our second research question because market power amongst wholesalers and retailers would have the effect of driving up the local distribution costs of rice in each market and contributing to trade costs. We find that although wholesale markups are very high across all markets, this is not the result of wholesalers wielding market power, but rather the result of (1) credit-tying relationships between farmers and traders; and (2) poor and inadequate transport and logistics facilities. We also discover that there is actually very little room for traders or retailers to influence rice prices via monopsonistic or monopolistic practices. This rules out the possibility of market power playing a significant role in preventing trade between local markets.

In other words, the factors that have a potential to contribute significantly

to the total trade costs between domestic markets are transport costs, logistics costs, and information costs. We will discuss how large a role each of these factors actually plays, in preventing trade from taking place between surplus and deficit markets, in the next two chapters.

5 Description and analysis of transportation and logistics sectors

The transportation and rice industries are extensively intertwined, because with regional production and consumption imbalances, rice must be transported over extensive distances that require not just one means of transport, but several (Mears et al., 1972). The two largest modes of transportation that meet the rice industry's transport needs are, namely, overwater transport (i.e. shipping) and road transport. In addition to transport costs, logistics costs – which include drying, packaging, storage and handling costs – also add to the costs incurred in shipping rice across markets within the Philippines. Abstracting from Mears et al. (1972) and Arnold et al. (2002), two studies which provide detailed descriptions of the transportation and logistics sectors in the Philippines, we explain the main components of transportation and logistics costs incurred in the interisland trade of rice.

5.1 The logistics of interisland rice trade

5.1.1 Drying

As we observed in Section 4.3 of Chapter 4, farmers either sell their rice directly to rice millers, or to collector agents who then sell the rice to millers. In either case, farmers and traders have to ensure that the moisture levels of palay are low, prior to milling.[15] In the Philippines, very few farmers possess mechanical dryers, so the most common form of drying is manual solar drying, where palay is placed on pavements or cemented roads to be dried under the sun.

However, solar drying leads to a compromise of quality, especially during

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[15]Too much moisture content in palay causes its quality to be compromised.

peak and rainy months, and adds to the labor costs of producing rice. Dawe et al. (Eds.) (n.d.) suggests that rice production costs could be decreased with the mechanization of the drying of palay. This is because rice recovery is very much lower when palay is solar dried than when it is dried mechanically. According to a report published by the Rice Technical Working Group in 1997, average head rice recovery is the lowest in the Philippines, amongst the countries compared in the study (RTWG, 1997).[16]

The implementation of mechanical dryers has, however, been difficult to implement, due to the objection of manual laborers (Dawe et al. (Eds.), n.d., p. 17). For example, Dawe et al. (Eds.) (n.d.) describes how several farmers have had their combine harvester damaged by farm workers worried about the loss of employment, and how other farmers have been hesitant in investing in a mechanical harvester due to fear of sabotage by workers. Based on such observations, Dawe et al. (Eds.) (n.d.) posits that faster growth in nonfarm employment would help provide alternative jobs for farm laborers and spur the mechanization of rice production and distribution. However, stagnant economic growth in the Philippines has hindered job creation in nonfarm sectors, making the realization of mechanization extremely difficult.

5.1.2 Packaging

At the wholesale level, rice is packed into jute bags and stored in warehouses until it is ready to be shipped. Packaging costs are very high, due to poor warehouse facilities and packaging technology. For example, bagging and re-bagging of rice lead to significant amounts of spillage and wastage. Wastage of this form could be reduced significantly if the Philippines adopted the packaging method used in Thailand which does not require bagging. In Thailand, paddy is transported from the farm to the market via the grain tanks of com-

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[16]The countries are Indonesia, Thailand, Vietnam, and the Philippines.

bine harvesters which are directly loaded onto trucks using swinging unloading conveyors. Alternatively, packaging costs could be reduced by using bags of better quality, such as those used in Indonesia and Vietnam, which can be used for 3 or more times on average, as compared to bags in the Philippines which can only be used at most twice on average (Beltran et al., 2016).

In a recent study conducted by IRRI, Beltran et al. (2016) highlight that packaging costs in the Philippines are almost double that in Indonesia and Vietnam, and more than double that in Thailand. Table 19, which was extracted from Beltran et al. (2016)'s paper, reflects that packaging costs are 0.21 PHP/kg higher in the Philippines than in Indonesia, 0.22 PHP /kg higher in the Philippines than in Vietnam, and 0.30 PHP / kg higher in the Philippines than in Thailand.

5.1.3 Storage

In the Philippines, seasonality and a lack of openness to foreign trade create the need for rice to be stored for longer periods of time than in Thailand and Vietnam, both of which have a lesser degree of seasonality of production and a greater openness to trade than the Philippines. However, storage facilities are poorer in the Philippines as compared to in the latter two countries. For example, while rice is stored in modern silos in Thailand and Vietnam, there are no such facilities in the Philippines, where rice is stored in small conventional warehouses that operate at small capacities (Beltran et al., 2016).[17]

Typical warehouses in the Philippines have a maximum capacity of only about 50 tons of bagged rice neatly piled. The small capacity for storing rice translates into high rental costs. Moreover, farmers operating at small scales

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[17]In Table 19, we observe that the average storage rental cost in the Philippines is roughly on par with that in Thailand and Vietnam. This reflects the fact that although modern silos demand higher rental fees than conventional warehouses, rice is stored for longer periods of time in the Philippines than in the latter two countries.

Table 19: Differential gross marketing margins (GMMs) and marketing costs, by function, in PHP / kg of milled rice

Item	Philippines (PH)	Indonesia (IND)	Thailand (TH)	Vietnam (VN)	Differential PH vs IND	Differential PH vs TH	Differential PH vs VN
Gross marketing margins (GMM)	9.06	5.61	5.27	4.55	3.45	3.79	4.51
Total marketing cost	4.63	4.97	2.73	3.78	-0.33	1.91	0.85
Drying cost	0.26	0.62	0.33	0.52	-0.36	-0.07	-0.26
Transport cost	2.09	2.22	1.08	1.76	-0.12	1.02	0.33
Milling cost	1.38	1.22	0.89	0.93	0.16	0.48	0.44
Storage cost	0.19	0.40	0.20	0.23	-0.21	-0.02	-0.04
Packaging cost	0.45	0.24	0.14	0.22	0.21	0.30	0.22
Cost of working capital	0.27	0.28	0.09	0.11	-0.01	0.18	0.16
Returns above major cost	4.43	0.65	2.54	0.77	3.78	1.89	3.66

This table, which was extracted from Beltran et al. (2016), compares the gross marketing margins (GMMs) and marketing costs in the Philippines with that in three other rice-producing Asian countries, namely, Indonesia, Thailand, and Vietnam. The GMM is defined as the difference between the price of 1 kg of rice at the wholesale market and the price of 1 kg of dry paddy in milled rice equivalent, at the farm gate. The GMM is composed of marketing costs, which include the drying cost, transport cost, milling cost, storage cost, packaging cost, cost of working capital, and returns to management (i.e. the income of market players). Beltran et al. (2016) note that there are limitations in the calculation of returns to management because there are components of marketing costs which are unobservable, such as government fees and management costs. Therefore, they calculate the return above major cost as a proxy for returns to management. The return above major cost is defined as the difference between the GMM and the total major marketing costs. Source: Beltran et al. (2016).

usually do not even own their own storage facilities and have to resort to storing rice in their own houses, although the opportunity cost of doing so is large because of the possibility of spoilage (Arnold et al., 2002).

5.1.4 Handling

Palay, or rice, needs to be loaded and unloaded several times, from the farm gate to the wholesale level, and from the wholesale to the retail level. For example, when rice traders export rice to retailers, the product needs to be packaged and shipped in break-bulk (i.e. non-containerized) form since retailers usually require the product to be delivered in delivery bags (Arnold et al., 2002). These bags are handled manually by workers who are paid on average 1.50 PHP per bag-movement. According to Arnold et al. (2002), wastage in the form of damage, spillage, pilferage, prolonged loading and unloading, and double handling (i.e. re-bagging due to the poor condition of bags) account for about 1% of handling costs on average. In other words, about 0.015 PHP is wasted on average, for every bag-movement.

5.2 The transportation of rice in interisland rice trade

Transportation costs refer to the costs incurred in transporting palay from the farm gate to the wholesale markets. As Table 19 illustrates, transportation costs are about 1.02 PHP / kg higher in the Philippines than in Thailand, and 0.33 PHP / kg higher in the Philippines than in Vietnam. This is largely attributable to the fact that Thailand and Vietnam have more efficient transportation networks than the Philippines, which allow their marketing players to transport larger volumes of rice per liter of fuel (Beltran et al., 2016).

5.2.1 Overwater transport

Inter-island shipping has been the main mode of transporting rice across the different stages of the vertical supply chain. Although the domestic shipping industry was deregulated in 1994, shipping costs remain persistently high, to the extent that traders have often reported that freight rates charged by domestic shipping lines are much higher than those charged by foreign shipping lines. According to the Maritime Industry Authority (1998), a multitude of factors contributes to high domestic freight rates such as fuel costs; interest rates; insurance premiums; low port efficiency; and taxes on shipping operations.

5.2.2 Overland transport

The second largest mode of transporting rice is via roads. These tend to be built along coasts and valleys, in order to avoid the numerous mountain ranges. In highlands, roads are often narrow, winding, and treacherous, and this increases land travel distances and overland transport rates. Further, it is extremely expensive to maintain roads in the provinces of Leyte and Samar, which are very prone to typhoons.

A major development to the road transport system took place in 2003 when the government inaugurated the Philippines Nautical Highway System, an integrated set of highway segments and vehicular ferry routes complemented by a roll-on roll-off (Ro-Ro) policy. The Ro-Ro system carries vehicular trucks with commodities loaded on them across the sea, without requiring the goods to be loaded or unloaded from the trucks and containerized in cargo form. By not requiring cargo handling equipment nor the construction of new ports to accommodate the system, the nautical highway has reduced the logistics costs and shipping time involved in transporting goods domestically, by a significant degree. Figure 40 shows the "RoRo Food Highway" with its three main trunks:

Figure 40: The three main trunk lines of the Philippines Nautical Highway System
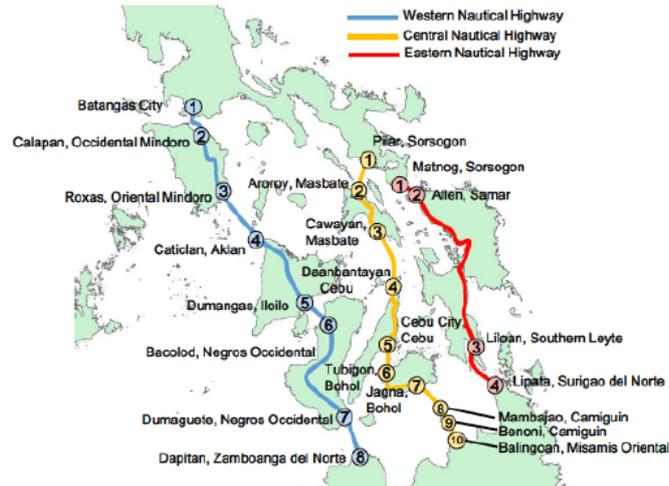
Figure 40 shows the "RoRo Food Highway" with its three main trunks: (1) a main route along the nautical highway from Manila to Dapitan / Dipolog / Iligan; (2) the grains highway linking Cagayan de Oro to Batangas via bulk-handling ships and facilities in transporting grains; and (3) the long haul route cutting through Cagayan de Oro, Dumaguete, Batangas and Manila. Source: Odchimar et al. (2015).

(1) a main route along the nautical highway from Manila to Dapitan / Dipolog / Iligan; (2) the grains highway linking Cagayan de Oro to Batangas via bulk-handling ships and facilities in transporting grains; and (3) the long haul route cutting through Cagayan de Oro, Dumaguete, Batangas and Manila.

5.2.3 Trucks in the Philippines

After being dried, rice is hauled by truck from farmers or agent collectors, to miller traders. Here, cost wastages are often incurred due to an underuse of

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truck capacity. In order to understand the above statement better, it is useful to compare the cost of truck fuel consumption in the Philippines with that in Thailand. According to Dawe et al. (Eds.) (n.d., p. 16), fuel consumption is on average 0.14 PHP / kg cheaper in Thailand than in the Philippines. This cost difference is not the result of differences in fuel prices, which are nearly on par in both countries, but rather the result of differences in truck capacity usage which allow farmers and marketing agents in Thailand to haul more tons of rice per liter of gas. For example, as compared to the Philippines, where trucks usually operate at about 70% capacity, trucks in Thailand operate at full capacity almost all the time. The underuse of trucks is due to an over-supply of marketing agents in the Philippines, which makes the coordination of truck usage very difficult. For this reason, high price markups at the wholesale level are in fact partially the result of having too many, instead of too few, marketers at the wholesale level of the vertical supply chain. In other words, high wholesale price markups are not the result of market power and collusion by wholesalers, but rather the result of inefficiencies from having too many wholesalers.

In addition to the inefficiencies caused by having too many marketing agents, economies of scale are also prevented by poor road conditions. This is due to two reasons. First, poor road conditions make it practically impossible for large trucks to be used. For example, Dawe et al. (Eds.) (n.d., p. 17) observes that trucks in the Philippines usually have a capacity of only half that of trucks used in Thailand. This is due to roads in the Philippines having more potholes and fewer lanes than that in Thailand, which renders the maneuver of large trucks impossible. Second, poorer road conditions in the Philippines serves to increase the driving time from rice farms to the capital. For example, although the distance from Suphan Buri to Bangkok is about 170 km and that from Nueva Ecija to Manila is 130 km, the driving time in the former is only

about 1.5 to 2 hours, whereas that in the latter is at least more than 2.5 hours Dawe et al. (Eds.) (n.d., p. 17). In short, poor road conditions prevent scale economies in trucking from being reaped and drive up the cost of transport due to increased driving time.

5.3   Chapter summary

In this chapter, we explored the different components of logistics and transportation costs involved in shipping rice between different markets within the Philippines. Our findings can be summarized as follows.

First, the lack of jobs in nonfarm sectors has created an excess supply of farm labor and an under-usage of mechanical equipment. Over-reliance on manual labor (as opposed to machinery) serves to keep the cost of drying palay high. Second, poor warehouse facilities and packaging technology lead to spoilage and unnecessary wastage between the time that rice leaves the hands of the farmer and reaches the hands of the consumer. Third, handling costs are high because there is a lot of wastage in the form of damage, spillage, pilferage, prolonged loading and unloading, and double handling of rice.

With regards to transport costs, fuel costs, interest rates, insurance premiums, port charges, and taxes on shipping operations all contribute to the shipping component of trade costs. Moreover, trucking is very expensive, because of an under-usage of truck capacity and an inability to reap economies of scale via the use of larger trucks. The under-usage of truck capacity is mainly the result of having too many tiers of wholesalers, which gives rise to a situation where wholesalers cannot coordinate with one another to ensure that trucks are filled to maximum capacity. On the other hand, the difficulty in using large trucks to transport rice is the result of poor road conditions which renders the maneuver of large trucks impossible.

In Section 1.2.3 of Chapter 1, we posited, based on Anderson et al. (2004)'s definition of "trade costs", that the factors which prevent trade from taking place between rice-surplus and rice-deficit markets could be a combination (or a subset) of any of the following: market power, transport costs, logistics costs, and information costs. Based on our analysis of rice markets in the Philippines thus far, it is clear that market power hardly exists at any level of the vertical supply chain (see Chapter 4). It is also clear that transport costs and logistics costs are very high, and are therefore part of the equation in preventing trade from taking place between many pairs of markets.

This leaves us with a final task, that is, the task of discovering whether information costs have a significant role to play in preventing arbitrage, and if so, how large its role is, in relation to transport and logistics costs. Previous studies do not agree with each other in this respect. For example, Baulch (1997)'s findings suggest that there is very little information friction between markets, but Allen (2014) argues that information frictions have a large role to play in preventing arbitrage.

It is important to clarify the role that information costs have to play in preventing arbitrage because policies aimed at improving transportation and logistics differ fundamentally from policies aimed at reducing information costs. This will be the theme of the following chapter.

6 A model of interprovincial rice trade flows in the Philippines

In this chapter, we return to the main focus of this dissertation, which is to address the following two research questions. First, are rice markets in the Philippines well arbitraged across space, ceteris paribus (that is, given the existing state of transportation and logistics facilities)? Second, what factors prevent more rice from being traded between surplus and deficit markets?

In answering the first research question, we adopt an approach where we treat existing transport infrastructure and logistics facilities as exogenously given. The logic behind this approach is as follows. In Chapter 5, we examined the nature of transportation and logistics costs and explained how these costs are very high in the Philippines. Hence, it is already clear that transport and logistics costs have a large role to play in preventing trade from taking place between many pairs of markets where there is a price differential. Our emphasis in this chapter, therefore, is not to further emphasize the role of transport and logistics costs in preventing trade from taking place, but rather, to consider if information costs have a significant role to play in preventing trade from taking place between rice-surplus and rice-deficit markets.

In order to do so, we build a theoretical model to predict the Pareto optimal volume of trade that would take place between every pair of provinces within a given period of time, such as a quarter of a year. The model assumes perfectly competitive markets and perfect information (i.e. no information asymmetries) across space. We solve the model using linear programming and concepts from transportation theory and compare the model's solutions with actual trade flow data. A high quality of fit between the Pareto optimal solution of the model and the actual trade flow data would suggest that rice markets are very close to

Pareto optimality and information frictions (which are a type of market failure) are not present. On the other hand, a poor fit would suggest otherwise.

In what follows, we first explain the theoretical setup of our model and then provide a brief description of the data sets that we use to solve the model. Having done so, we provide the results, discuss its implications and conclude.

6.1   The logic behind the model

In this section, we build a model to evaluate how well rice markets in the Philippines are integrated across space. We define "spatial market integration" as a situation where markets are able to achieve Pareto optimal outcomes[18] given the existing transport and logistics costs involved in shipping a homogenous good across them. Hence, the concept of spatial market integration adopted in this dissertation includes the criterion of markets being well arbitraged across space.[19] Put simply, our research question asks whether rice markets in the Philippines are able to achieve competitive (Walrasian) equilibria, given the existing state of transportation and logistics infrastructure. To achieve our aim, it is necessary that we first establish a theoretical benchmark under which all rice markets achieve Pareto optimality in a general equilibrium. Having established such a benchmark, we can then compare actual data against the benchmark, to evaluate the degree by which rice markets are Pareto optimal.

From the policy-making perspective, the factors which prevent rice from being transferred from rice-surplus to rice-deficit areas come in a variety of forms. We distinguish between two types of factors. The first type of factors exists even when markets are spatially integrated and are able to achieve Pareto optimal outcomes.   This type of factors is comprised of transportation and

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[18]A feasible allocation $(x_1, ..., x_I, y_1, ..., y_J)$ is Pareto optimal if there is no other feasible allocation $(x_1^{'}, ..., x_I^{'}, y_1^{'}, ..., y_J^{'})$ such that $u_i(x_i^{'}) \geq u_i(x_i)$ for all $i = 1, ..., I$ and $u_i(x_i^{'}) > u_i(x_i)$ for some i (Mas-Colell, Whinston, and Green, 1995).

[19]Note that our definition of the term differs from that which is common in the existing literature, such as the definition adopted by Baulch (1997).

logistics costs that make it unprofitable for surplus regions to export to deficit regions.

On the other hand, the second type of factors is those which lead to market failure and sub-optimal equilibria.[20] Examples include information asymmetries between rice traders, the existence of market power (which prevents rice from being competitively priced and sold), and lack of buyers or sellers. In Chapters 4 and 5, we provided evidence in favor of the argument that there are a large number of buyers and sellers at every stage of the vertical supply chain. This rules out the possibility of market power and a lack of buyers and sellers. The aim of our theoretical model, therefore, is to examine whether information asymmetries are present.

6.2   Setup of the model

Solving the following model will give us our theoretical benchmark. There are a large number of provincial rice markets in the Philippines, each inhabited by producers, traders, and consumers. The markets are perfectly competitive, and rice is produced and consumed in all of them. Each consumer – taking the retail price of rice at the market where he lives as given – maximizes his utility from the consumption of rice, subject to income constraints. Similarly, each producer – taking the farm gate price of rice as given – seeks to maximize profits from his production and sale of rice to traders. Finally, each trader seeks to maximize his profits from the sale of rice – procured from producers in the region where he is located – to consumers in whichever of the rice markets yields him the highest profit. Traders take the equilibrium wholesale price of rice in each of the regional markets as given. In addition, there is a profit-maximizing

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[20]Market distortion, or market failure, is defined as a situation in which some of the assumptions of the welfare theorems do not hold and in which, as a consequence, market equilibria cannot be relied on to yield Pareto optimal outcomes (Mas-Colell, Whinston, and Green, 1995).

national transportation sector that provides logistics and shipping services to traders at a unit trade cost that is linearly increasing in shipping distance. We assume that the unit trade cost charged by the transportation sector is inclusive of not only transport costs, but also of logistics (i.e. packaging, storage, loading, and unloading) costs.

This model does not explicitly solve for the equilibrium in each provincial market, but assumes, based on the First Fundamental Theorem of Welfare Economics[21], that all markets tend toward a competitive equilibrium that is weakly Pareto optimal. The theorem states that this will be the case when every market maintains the properties of:

1. perfect competition (and therefore perfect information),

2. price-taking behavior of producers, traders, and consumers, and

3. local non-satiation of preferences, that is, that no two market allocations will give any market participant the same level of satisfaction.[22]

We assume that all the above properties hold.

Next, based on the above assumption that all provincial rice markets are in a competitive equilibrium that is weakly Pareto optimal, we build a model that solves for an optimal transportation scheme whereby rice is redistributed from markets where it is in surplus to markets where it is in deficit. Invoking the Second Fundamental Theorem of Welfare Economics, we argue that the equilibrium outcome of such a model is indeed feasible because the theorem states that out of all possible Pareto optimal outcomes, one can achieve any

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[21]Mas-Collel, Whinston, and Green (1995) state the First Fundamental Theorem of Welfare Economics as follows. Let $(x, y) = (x_1, ..., x_C, y_1, .., y_S)$ be a specification of a consumption vector $x_c \in X_c$ for each consumer $c = 1, ..., C$ and a production vector $y_s \in Y_s$ for each firm $s = 1, ..., S$. Consider a price vector p. If preferences are locally nonsatiated and if (x^*, y^*, p) is a price equilibrium with transfers, then the allocation (x^*, y^*) is Pareto optimal. In particular, any Walrasian equilibrium allocation is Pareto optimal.

[22]The preference relation $\succeq_c$ on the consumption set X_c is locally nonsatiated if for every $x_c \in X_c$ and every $\varepsilon > 0$, there is an $x_c^{'} \in X_c$ such that $\left\| x_c^{'} - x_c \right\| \leq \varepsilon$ and $x_c^{'} \succ_c x_c$.

particular one by enacting a lump-sum wealth redistribution and then letting the market take over.[23]

Intuitively, we can think of an initial state where all provincial markets are in autarky. All participants are price-takers, and local demand is equal to the local supply in every market. We can move from this initial state of Pareto optimality to one with a higher level of national welfare, by opening up the provincial markets to trade, and enacting a lump sum transfer of wealth from consumers in surplus provinces to consumers in deficit provinces. With less wealth and local prices unchanged, consumers in the surplus provinces would demand less rice, so the excess supply of rice can be shipped to deficit regions. Consumers at the deficit regions can then buy the rice imported from surplus regions using the amount of wealth that was redistributed to them. The price of imported rice would be equal to the price of rice at the origin, plus the trade costs incurred in shipping the rice to the destination. The markets would then move to another state of Pareto optimality, where the new equilibrium price of rice would be somewhere in between the price in an origin market and a destination market. Under this new equilibrium, the marginal utility of rice consumption would be equalized across all markets and gross national welfare would be higher than before.[24]

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[23]The Second Fundamental Theorem of Welfare Economics is formulated as follows. We consider a national-level economy composed of $C > 0$ consumers, $S > 0$ producers, and a single commodity: rice. Let the initial resources in the economy - that is, the economy's endowments - be represented by a vector $\bar{\omega} \in \mathbb{R}$. Each consumer $c = 1, ..., C$ is characterized by a consumption set $X_c \subset \mathbb{R}$ and a preference relation $\succeq_c$ defined on X_c. We assume that these preferences are complete and transitive (i.e. rational). Each producer $s = 1, ..., S$ is characterized by a production set, $Y_s \subset \mathbb{R}$. We assume that every Y_s is nonempty and closed. Consider an economy specified by $(\{(X_c, \succeq_c)\}_{c=1}^{C}, \{Y_s\}_{s=1}^{S}, \bar{\omega})$, and suppose that every Y_s is convex and every preference relation $\succeq_c$ is convex [i.e., the set $\{x'_c \in X_c : x'_c \succeq_c x_c\}$ is convex for every $x_c \in X_c$] and locally nonsatiated. Then, for every Pareto optimal allocation (x^*, y^*), there is a price vector $p = (p_1, ..., p_L) \neq 0$ such that (x^*, y^*, p) is a price quasi-equilibrium with transfers.

[24]Another way to understand this is to assume that there is a benevolent social planner who takes on the role of collecting rice from surplus markets and redistributing it to deficit markets so that the marginal utility of rice consumption is equalized across all the markets.

6.3 The Hitchcock-Koopmans transportation problem

In mathematics, the transportation problem studies how to distribute a commodity from multiple origins to multiple destinations in the most cost-efficient way, while operating within supply and demand constraints. Our model is based on the linear programming formulation of the transportation problem, which is also known as the Hitchcock-Koopmans transportation problem. In this subsection, we explain the problem's computational procedure with regards to the redistribution of rice from surplus to deficit provinces in the Philippines.

In what follows, we shall refer to an origin (i.e. surplus) province as $i \in M$ and a destination (i.e. deficit) province as $j \in N$. The Hitchcock-Koopmans transportation problem can then be expressed as follows.

$$\min \phi = \sum_{i=1}^{M} \sum_{j=1}^{N} c_{ij} x_{ij}$$

$$s.t.$$

$$\sum_{j=1}^{N} x_{ij} \leq s_i, i = 1, 2, ..., M$$

$$\sum_{i=1}^{M} x_{ij} \geq d_j, j = 1, 2, ..., N$$

$$x_{ij} \geq 0, \forall ij \tag{1}$$

where x_{ij} is the quantity of rice exported from origin i to destination j; c_{ij} is the unit trade cost of moving a unit of rice from i to j; s_i is the surplus of rice available at each origin i; d_j is the deficit of rice (and hence the demand for rice) at each destination j; M is the total number of origin provinces; and N is the total number of destination provinces.

We assume that trade costs (inclusive of logistics costs) are increasing in

shipping distance in a linear fashion so that

$$c_{ij} = \rho.Distance_{ij} \qquad (2)$$

where the constant $\rho > 0$ and $Distance_{ij}$ is the actual shipping distance between provinces i and j. In the results that we report in Subsection 6.5, we set the constant $\rho = 1$. The data on inter-province rice trade flow described in Section 6.4 allows us to formulate a unique transport problem for every year and for every 4th quarter of a year, between 1995 to 2009. In other words, the data gives us the flexibility to formulate and solve a total of 15 annual-level transport problems (one for every year in the data set), and 15 quarterly-level transport problems (one for every 4th quarter of a year in the data set).

This is how we distinguish between surplus and deficit provinces. In each period of time, the total supply of rice that is available to a province is defined as

$$Harvest_t + Imports_t,$$

where:

$Harvest_t$ is the quantity of rice harvested in that province during the given frame of time (t); and

$Imports_t$ is the province's foreign imports of rice during time t.

Defining the total consumption needs of the province during the given time frame as $Consumption_t$, it follows that the province has a surplus of rice if:

$$Harvest_t + Imports_t - Consumption_t > 0$$

and a deficit of rice if:

$$Harvest_t + Imports_t - Consumption_t < 0.$$

In terms of the availability of data, we face a restriction here, because we are only able to observe foreign imports arranged by the government (NFA). This excludes the quantities of imports by the private sector. Due to the restrictions that we face with regards to availability of data, we experiment with two different specifications of calculating a province's supply or deficit during a specific time period t.

6.3.1 Specification #1

In the first specification, we simply ignore the foreign imports by the private sector, and calculate each province i (j)'s surplus (deficit) during time t as follows:

$$Surplus_{it} = Harvest_{it} + NFAImports_{it} - Consumption_{it} > 0 \qquad (3)$$

$$Deficit_{jt} = Harvest_{jt} + NFAImports_{jt} - Consumption_{jt} < 0 \qquad (4)$$

where $NFAImports_{i(j)t}$ is the quantities of rice imported into a province $i(j)$ by the government. Data on the total quantity of rice harvested in each province ($Harvest_{i(j)t}$) is available for download from the BAS' website, at the annual and quarterly frequency. On the other hand, data on the per capita consumption of rice in each province is also available from the same website at an annual frequency for specific reference years: 1995, 1999-2000, 2008, and 2012. Multiplying the per capita consumption of rice in each province during a particular reference year by the province's population during that year gives us an estimate of the province's gross consumption of rice during year t ($Consumption_{i(j)t}$). Population count data at the provincial level is available from the National Statistics Office (NSO)'s Census of Population and Housing for years 1990, 2000, and 2010. Using the data on the total quantity of rice harvested in province-

years, and the data on gross province-level rice consumption, which we calculate by multiplying the BAS' per capita consumption data with the NSO's population count data, we solve the transport problem based on surpluses and deficits computed according to the above specification for the year 2000.[25]

Conventional methods of solving the transport problem – such as via the simplex method – dictate that for a feasible solution to exist, it is necessary that the transport problem is balanced. That is, total surpluses (at the national level) must be equal to total demand (at the national level): $\sum_{i=1}^{M} s_i = \sum_{j=1}^{N} d_j$. However, because the data we use to compute surpluses and deficits is incomplete, we have $\sum_{i=1}^{M} s_i < \sum_{j=1}^{N} d_j$. One way to get a balanced transport problem would be to multiply each s_i by a constant scale factor, which is equal to:

$$\frac{\sum_{j=1}^{N} d_j}{\sum_{i=1}^{M} s_i}.$$

Alternatively, there are also other ways to solve a transport problem without gross surpluses and deficits being balanced, such as the dual-matrix approach (Ji et al., 2002).

6.3.2 Specification #2

In the second specification, we assume that all surpluses (that is, all that remains in a province after consumption is deducted from harvest + foreign imports) get exported; and that all deficits (that is, the amount of rice demanded by a province that falls short of harvest + foreign imports) are imported. This specification allows us to obtain a balanced transport problem from the trade flow data which is described in Section 6.4. Under this specification, we compute the annual or quarterly surplus of each province over time t, by subtracting that

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[25]Note that the year 2000 is the only year for which both rice consumption data at the provincial level and province population count data exists.

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province's total domestic imports from its total domestic exports over the given year or quarter. If net domestic exports (i.e. total domestic exports - total domestic imports) over the given time frame (t) are positive, then the province is a surplus province and vice versa:

$$\forall i \in \{1, ..., M\}:$$

$$Surplus_{it} = NetDomesticExports_{it}$$

$$= TotalExports_{it} - TotalImports_{it}$$

$$= Harvest_{it} + Imports_{it} - Consumption_{it} > 0,$$

$$(5)$$

and

$$\forall j \in \{1, ..., N\}:$$

$$Deficit_{jt} = NetDomesticImports_{jt}$$

$$= TotalImports_{jt} - TotalExports_{jt}$$

$$= Consumption_{jt} - (Harvest_{jt} + Imports_{jt}) > 0, \quad (6)$$

where $Surplus_{it}$ is province i's gross surplus; $Deficit_{jt}$ is province j's gross deficits; $NetDomesticExports_{it}$ is province i's net exports to other provinces; $NetDomesticImports_{jt}$ is province j's net imports from other provinces; $TotalExports_{i(j)t}$ is province i (or province j)'s total exports to other provinces; and $TotalImports_{i(j)t}$ is province i (or province j)'s total imports from other provinces within year / quarter t.

Table 20: A transportation array with M origin provinces and N deficit provinces

Origin (i) / Destination (j)	$i = 1$	$i = 2$		$i = M$	d_j
$j = 1$	x_{11}	x_{21}		x_{M1}	d_1
$j = 2$	x_{12}	x_{22}		x_{M2}	d_2
$j = N$	x_{1N}	x_{2N}		x_{MN}	d_N
s_i	s_1	s_2		s_M	

6.3.3 The transportation array

Having identified the surplus and deficit provinces, and having computed the exact amount of each of their surpluses and deficits during the specific time frame t, we can represent the transport problem by a rectangular array with M columns, corresponding to the origin provinces $i = \{1, 2, ..., M\}$ and N rows, corresponding to the destination provinces $j = \{1, 2, ..., N\}$.

The (i, j)th cell of the array contains the values of x_{ij}, that is, the quantity of rice exported from origin i to destination j. The total quantity of each origin i's surplus (s_i) is given in a marginal column, and the total quantity of each destination j's deficit (d_j) is given in a marginal row. At any stage of the algorithm, absence of an entry of x_{ij} implies that x_{ij} is nonbasic (i.e. non-occupied) and hence of zero value. A zero-valued basic (i.e. occupied) variable is indicated by a zero entry (degeneracy).

6.4 Data and empirical observations

6.4.1 Rice prices

Data on rice prices is available from two sources: (1) the Bureau of Agricultural Statistics (BAS)' statistical database, and (2) a weekly newsletter entitled "Price Situationer of Selected Agricultural Commodities" published under the auspices of the BAS. We rely mainly on data extracted from the BAS' statistical database in our analysis and use the Price Situationer mainly for double-checking the statistical reliability of the former.

Time series data on the prices of several different grades of rice - rice special, rice premium, well-milled rice, and regular milled rice - in each of 82 provinces are available for download from the BAS' website. These province-level prices are also available at the different stages of the vertical supply chain. The BAS defines the price of rice at each particular stage of the supply chain as follows. The "farm gate price" refers to the price received by farmers for the sale of their products at the first point of sale, net of freight costs. The "wholesale price" refers to either wholesale buying and / or wholesale selling prices. The former is the price that traders pay for crops that they buy in bulk from producers, while the latter is the price at which traders at the wholesale level of the supply chain sell their commodities in bulk to other distributors at the wholesale level, or to retailers. The monthly wholesale prices that are reported in the BAS' statistical database are computed by taking the average of wholesale buying and wholesale selling prices of multiple traders interviewed at each specific province in each month. Finally, the "retail price" refers to the price received by retailers when they sell rice to consumers in the marketplace.

In this paper, we choose wholesale prices as the relevant price for empirical analysis, since the National Food Authority has an incentive to stabilize farm gate and retail prices, and has been noted to intervene in farm gate and retail

markets (Intal Jr. et al., 2008). Moreover, wholesale prices are the prices that traders in exporting provinces receive when they sell rice to importing provinces. We also choose to focus on the prices of regular milled rice (rather than the other grades of rice) in our analysis, since this is the most commonly transacted type of rice.

6.4.2 Commodity trade flow

Data on the quantity (in kilograms) and value (in Philippine pesos) of rice exported from specific origin ports to specific destination ports is available from the National Statistics Office of the Philippines (NSO), through the Domestic Trade Statistics System (DOMSTAT). In particular, trade flow data is derived from cargo manifests recorded by the Philippines Port Authority (PPA) and comprises information on the port of origin, port of destination, description of the commodity, quantity shipped, and value shipped. There are two frequencies at which trade flow data is observed. First at an annual frequency, and second in every 4th quarter of a year, between 1995 to 2009. By aggregating the port-to-port trade flow data to the provincial level, we obtain a data set of province-to-province bilateral trade flows of rice at the annual level, and for every 4th quarter of a year. There are 40 origin provinces and 50 destination provinces in the sample.

6.4.3 Shipping distances

In order to find out the distance through which rice is transported when it gets shipped between specific pairs of provinces, we make use of actual shipping distance data obtained from "www.searates.com", a website that provides the most competitive routes of shipping from any origin to any destination in the world. Using the website's search engine, we obtain overwater and overland distances (in kilometers) between markets that are connected by sea, by land,

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and by a combination of the two.

In contrast to Baulch (1997), who made use of observable freight rates as a proxy for total trade costs, we do not attempt to estimate the actual magnitude of trade costs. This is because there are many aspects of trade costs which are unobservable. Hence, we simply assume that total trade costs are a positive linear function of shipping distance. In other words, we assume that the total trade cost between a pair of markets increases linearly with the actual shipping distance between them.

As additional exercises, we also experiment with various specifications of distances as proxies for the total trade costs incurred in shipping rice between province pairs. More specifically, we assume that total trade costs are a positive *non-linear* function of shipping distance and that total trade costs are increasing in tandem with actual shipping distances raised to some positive constant "α". We then solve the transport problem for the 4th quarter of each year using various values of α, such as 2, 3, 0.9, 0.8, and 0.7. However, since we did not obtain a significantly improved fit under these hypothetical experiments, we choose to report the results of our model based on the assumption that total trade costs are a positive *linear* function of shipping distance.

6.5   Results

Using rice trade flow data that is observed at an annual and 4th-quarterly frequency, we solve the transport problem for every year and every 4th quarter of a year, from 1995 to 2009. In determining our origin (i.e. surplus) and destination (i.e. deficit) provinces, we also experiment with two different specifications of surplus / deficit. In the first specification, we compute a province's surplus as the sum of its gross harvest and foreign imports by the government, net of its gross consumption (see specification #1 in 6.3). In the second specification, we

compute a province's surplus as the sum of its gross domestic imports, net of its gross domestic exports (see specification #2 in 6.3). We then aggregate the predicted trade flows and actual trade flows from the provincial level up to the regional level for analysis. The solution of each and every transport problem serves as a theoretical benchmark, against which we compare the actual (observed) trade flows between pairs of regions during the respective year or 4th quarter of a year.

The solutions of transport problems defined by specification #1 predict the distribution of actual trade flows fairly well, but not the actual magnitude of the trade flows. This could be due to the fact that specification #1 is based on inaccurate calculations of surpluses and deficits, which exclude foreign imports of rice by the private sector and the buffer stock of provinces.

On the other hand, the solutions of transport problems defined by specification #2 predict both the distribution of actual trade flows, as well as their signs and magnitudes, fairly well. For example, the vertical axis in Figure 41 represents the trade flows (/kg) between every pair of surplus and deficit regions in the transport problem for the year 2005, defined under specification #2. The horizontal axis represents the index (or identity) of each region pair, where we have ordered all the region pairs in ascending order of the trade flow between them. Predicted trade flows based on the transport problem's solution are marked in blue, and actual trade flows in red. We can see a very close fit between the distribution of the predicted trade flows and the actual trade flows from the figure.

In order to assess how well our predicted trade flows fit the actual trade flows statistically, we conduct an OLS regression of predicted trade flows on actual trade flows; and of actual trade flows on predicted trade flows, where we set the constant to zero in both cases. In the first regression, we obtain a

Figure 41: A plot of predicted trade flows and actual trade flows of ordered province pairs, for the year 2005

Year 2005, Specification #2
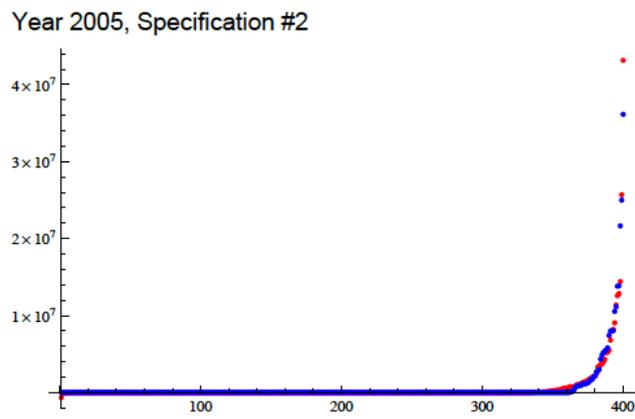
In Figure 41, the horizontal axis represents the identity of region pairs, where we have ordered all the region pairs in ascending order of the trade flow between them. The vertical axis represents the predicted and actual trade flows (in kgs) between region pairs.

Figure 42: A plot of actual shipping distances against predicted trade flows and actual trade flows, for the year 2005

Actual (red) & Solution (blue)
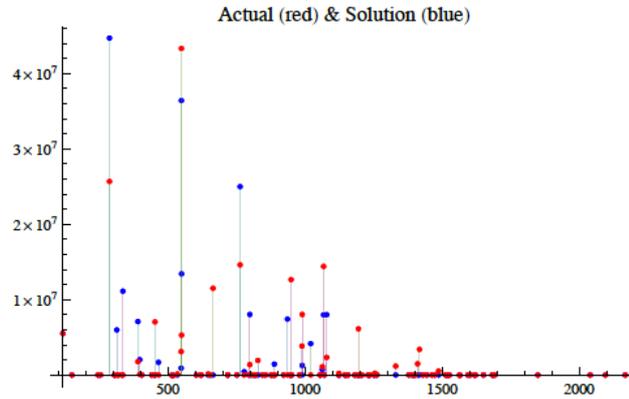
In Figure 42 above, the horizontal axis represents the shipping distance between region-pairs, and the vertical axis the predicted and actual trade flows between them.

regression coefficient of 0.996 and in the second, a coefficient of 0.724. Both are statistically significant at the 99% confidence level. The adjusted R-squared is 0.690.

The goodness of fit of our model, measured by the value of the adjusted R-squared, increases sharply when we solve the transport problem at the quarterly frequency instead of at the annual frequency. This is to be expected, since a lot more consumption smoothing – due to differences in seasonality – takes place between provinces over the course of a year as opposed to over a quarter. Analogous to Figure 41, the figures in Appendix A3 plot the indexes of region pairs (ordered in increasing magnitude of the trade flows which took place between them) against the predicted and actual trade flows between them when we solve the transport problem for the 4th quarter of each year in our data set.[26]

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[26]We exclude years 2007 and 2008 because there was a global food crisis during these two years which led to a severe shortage of rice throughout the Philippines. Hoarding of rice and speculation of rice prices were rife, implying that the markets would most likely have deviated

Table 21: OLS regressions of predicted trade flows on actual trade flows, for transport problem 2005

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.996***
Adjusted R-squared	0.690
Observations	113

Table 21 summarizes the regression coefficient and the adjusted R-squared when we regress the predicted trade flows of the transport problem for the year 2005, on actually observed trade flows. Stars indicate statistical significance: *p<.10, **p<.05 and ***p<.01.

Table 22: OLS regressions of actual trade flows on predicted trade flows, for transport problem 2005

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.724***
Adjusted R-squared	0.690
Observations	113

Table 22 summarizes the regression coefficient and the adjusted R-squared when we regress the actually observed trade flows in the year 2005, on the predicted trade flows of the transport problem for the year 2005. Stars indicate statistical significance: *p<.10, **p<.05 and ***p<.01.

Predicted trade flows are represented by the blue dots, and actual trade flows by the red dots. Analogous to Figure 42, the figures in Appendix A4 plot the actual shipping distance against the predicted and actual trade flows between region pairs. Here, we observe that not only are the signs and magnitudes of actual trade flows very similar to those of predicted trade flows, but that year-to-year changes in the pairs of regions that trade with each other also follow the model's predictions very closely. For example, the model predicts positive trade flows between regions VI and XIII, but no trade between regions X and XIII in the 4th quarter of 2006. Both of these predictions are observed in the actual trade flow for that quarter. On the other hand, the model predicts large and positive trade flows between regions X and XIII, but no trade between regions VI and XIII in the 4th quarter of 2009. Once again, both of these predictions are observed in the actual trade flow for that quarter.

In addition, we regress predicted trade flows on actual trade flows, and actual trade flows on predicted trade flows, for the 4th quarter of every year between 1995 and 2009. The regression constant was set to zero in all cases. As the tables in Appendix A5 show, the adjusted R-squared coefficients are significantly higher than 0.5. For example, the adjusted R-squared of the regression of actual (predicted) trade flows on predicted (actual) trade flows is 0.928 for the 4th quarter of 2009. All results are significant at the 99% confidence level. This suggests a very high goodness of fit between the trade flows predicted by the transport model and the actual trade flows.

Two observations, in particular, help to support the credibility of our empirical findings. The first has to do with the fact that we make use of actual shipping distance data to estimate the actual trade costs between regional markets. Here, we obtain overwater and overland distances between markets that

from a state of Pareto optimality. Indeed, we did not obtain a good fit when we solved the transport problem for the 4th quarter of these years. In either case, the adjusted R-squared was less than 0.3.

are connected by sea, by land, and by a combination of the two. This is a novel approach that has not been adopted before in the literature, since previous studies made use of only the observable components of freight rates (as in the case of Baulch (1997)), or the straight line distances between regional markets (as in the case of Allen (2014)), as proxies for actual trade costs. We believe that actual shipping distances are much more reliable measures of the trade costs between markets than the proxies used in previous studies. This is because it is highly possible that for many pairs of markets, crops may be transported via the Nautical Highway System, which is an integrated network of highway and vehicular ferry routes connecting the major islands of Luzon, the Visayas, and Mindanao. (Please refer to Subsection 5.2.2 in Chapter 5 for further details on the Nautical Highway System). In these cases, straight line distances may differ substantially from actual shipping distances, since actual shipping routes that utilize the Nautical Highway System may be far from linear. Sea routes may also differ substantially in kilometers from Nautical Highway routes since the latter combines road and sea. This is depicted very clearly in Figure 43 below, where the sea route linking Nueva Ecija to Iloilo is traced in blue and the Nautical Highway route in brown and green. The former, which involves shipping a good from Nueva Ecija to Port Manila, then to Port Bacolod in Negros Occidental, and finally to Iloilo, is 966 kilometers in distance. In contrast, the latter is only 844 kilometers in distance. This difference of 122 kilometers, depending on which route was taken, certainly cannot be captured by the straight line distance between the origin and destinations. The fact that we obtain adjusted R-squared coefficients above 0.9 in the years after the Nautical Highway System was inaugurated (i.e. 2003) when we regress predicted trade flows on actual trade flows, gives credence to the approach adopted by our analyses. (Please see the results in Appendix A5).

Figure 43: An example of two different shipping distances between a pair of markets, depending on which route was taken
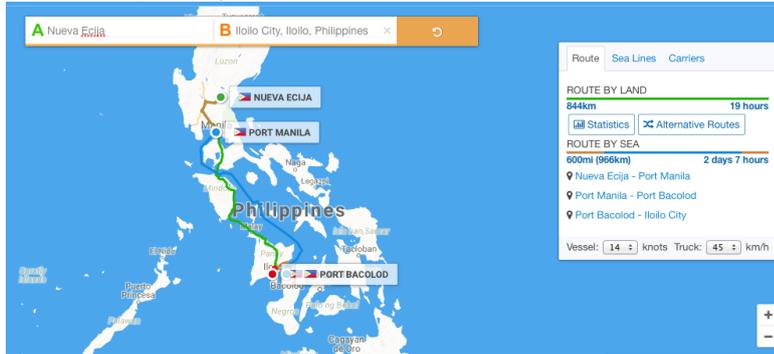

Figure 43 shows captured output from SeaRates.com [www.searates.com], where the sea route linking Nueva Ecija to Iloilo is traced in blue and the Nautical Highway route in brown and green. This figure illustrates how straight line distances between province pairs may not be accurate reflections of the actual shipping distances between them, since sea routes may differ substantially in kilometers from Nautical Highway routes.

A second observation which lends credence to our theoretical approach has to do with the fact that although we obtained very high measures of goodness of fit between our model's predictions and actual trade flows in regular (i.e. non-crisis) years, our model's predicted trade flows deviate very significantly from the actual trade flows in the years 2007 and 2008. This supports the accuracy of our theoretical model because 2007 and 2008 coincide with the global food crisis. During these two years, hoarding of rice and speculation of rice prices were rife, implying that markets would most likely have deviated from a state of Pareto optimality. Indeed, we did not obtain a good fit when we solved the transport problem for the 4th quarter of these years. This is evident when we compare the predicted versus actual trade flows between pairs of provinces in Figure 44 and Figure 45. Further, when we regress predicted trade flows against actual trade flows for the 4th quarters of 2007 and 2008, the adjusted R squared's were 0.011 and 0.415 respectively. (Please see Table 23 and Table 24).

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Figure 44: A plot of actual shipping distances against predicted trade flows and actual trade flows, for the 4th quarter of a global food crisis year, 2007
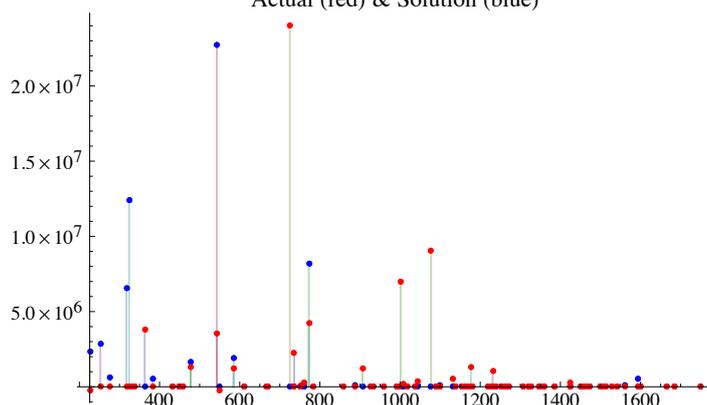

In Figure 44 above, the horizontal axis represents the shipping distance between region-pairs, and the vertical axis the predicted and actual trade flows between them. The figure shows that the predicted trade flows of our model have a very poor fit with actual trade flows during the years of the global food crisis.

Table 23: OLS regressions of predicted trade flows on actual trade flows, for the 4th quarter of a global food crisis year, 2007

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.148***
Adjusted R-squared	0.011
Observations	84

Table 23 summarizes the regression coefficient and the adjusted R-squared when we regress the predicted trade flows of the transport problem for the 4th quarter of 2007, on actually observed trade flows. Stars indicate statistical significance: *p<.10, **p<.05 and ***p<.01.

Figure 45: A plot of actual shipping distances against predicted trade flows and actual trade flows, for the 4th quarter of a global food crisis year, 2008

Actual (red) & Solution (blue)
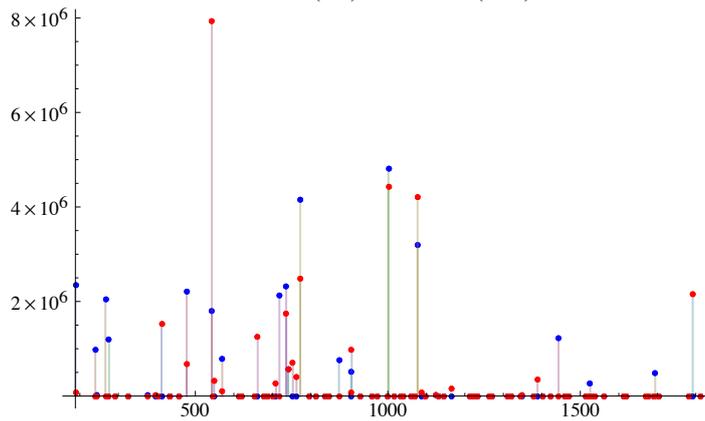
In Figure 45 above, the horizontal axis represents the shipping distance between region-pairs, and the vertical axis the predicted and actual trade flows between them. The figure shows that the predicted trade flows of our model have a very poor fit with actual trade flows during the years of the global food crisis.

Table 24: OLS regressions of predicted trade flows on actual trade flows, for the 4th quarter of a global food crisis year, 2008

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.777***
Adjusted R-squared	0.415
Observations	93

Table 24 summarizes the regression coefficient and the adjusted R-squared when we regress the predicted trade flows of the transport problem for the 4th quarter of 2008, on actually observed trade flows. Stars indicate statistical significance: *p<.10, **p<.05 and ***p<.01.

6.6 Chapter summary

In this chapter, we developed a theoretical model to discover whether arbitrage is efficient among Philippine rice markets. Answering this question is tricky, because there is the need to differentiate between (i) whether there are no opportunities to make profits from arbitrage due to transportation and logistics costs being too high, and (ii) whether opportunities to make profits from arbitrage are present, but traders are not able to make use of these opportunities due to the presence of imperfect markets. The existing literature is inconclusive with regards to this question. On one end of the spectrum we have the findings of Baulch (1997), which suggest that the transmission of price signals across rice markets in the Philippines is complete within a single period (of a month), and that there are hardly any opportunities for traders to make profits via arbitrage, given the observable transportation (or sea freight) rates that he utilized in his estimations. On the other end of the spectrum, we have the findings of Allen (2014), which point out a seeming lack of arbitrage between markets and suggest the presence of information asymmetries as the reason for this.

In order to answer the question of whether arbitrage is efficient ceteris paribus, we first assume that markets are weakly Pareto optimal. We then build a model which solves an optimal transportation scheme where rice is redistributed from markets where it is in surplus to markets where it is in deficit. Although our model is based on the assumption of perfect competition and hence perfect information, its results capture the features of actual trade flows very well.

The results of our findings can be summarized into 3 points. First, Philippine rice markets are spatially integrated (i.e. Pareto efficient) ceteris paribus, that is, given the existing transportation and logistics infrastructure available to them. Second, we do not find empirical support for imperfect information play-

ing a significant role in explaining the price gaps between markets. Finally, we believe that previous works such as Baulch (1997)'s paper, which utilized only observed freight costs in their analysis of spatial integration, may have under-estimated the magnitude of trade costs inclusive of logistics costs.[27] The latter may be significantly higher than what observed tariff or freight rate schedules suggest, and may even be prohibitive of trade.

In conclusion, we did not find opportunities to make huge and substantial profits from arbitrage, given the current magnitude of trade costs inclusive of logistics costs. Our results tell us that improving the existing transportation and logistics facilities is absolutely necessary in ensuring that a greater amount of trade takes place between domestic rice-surplus and rice-deficit markets.

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[27]In contrast to Baulch (1997), who made use of observable freight rates as a proxy for total trade costs, we do not attempt to estimate the actual magnitude of trade costs. This is because we are aware that unobservable trade costs that have to do with storage, packaging, and handling, are in fact sizeable (see 5.1 of Chapter 5). Hence, we simply assume that total trade costs are a positive linear function of shipping distance. In other words, we assume that the total trade cost between a pair of markets increases linearly with the actual shipping distance between them.

7 Field research in Laguna province

"Surprisingly little is known about traders. Part of the reason appears to be due to the importance of private information: "Information is one source of success in the trading business, so traders are understandably hesitant to disclose details of their businesses" (Hayami et al. (1999) p. 185)...In the four qualitative interviews I conducted with farmers and in three of the five interviews I conducted with traders, the interviewee had little knowledge of prices in nearby cities, let alone in other provinces. The two traders I spoke with knowledge of prices elsewhere (who were both amongst the largest traders in the province) emphasized the substantial effort required to keep their information up to date. Both did so by directly contacting traders in other markets on a frequent basis, and a substantial portion of their produce was sold to retailers and traders elsewhere in the Philippines." Allen (2014, p. 5-6).

In Allen's 2014 *Econometrica* paper, he describes the traders in Camarines Sur province (which he visited) as being shrouded in mystery and "hesitant to disclose details of their businesses". He also observes that not only farmers but even traders, do not have up-to-date information on the prices of rice in other markets in the Philippines.

In order to understand the nature of the businesses which farmers and traders engage in, I visited Laguna province in 2016, to conduct field research on the rice distribution system in the Philippines. I chose to visit Laguna province, because Laguna is home to the International Rice Research Institute (IRRI), and is known to have a rice distribution channel that conforms to what is commonly practiced in Luzon, which is the largest island group in the Philippines. Thanks to the resourcefulness of my field assistant Ms. Fe Gascon from the IRRI, I

was able to interview several participants at every stage of the vertical supply chain, including rice farmers, traders, millers, and retailers. In what follows, I shall attempt to document, to the best of my ability, the observations which I made during my stay in Laguna province. I also observed many ways in which the theoretical model in Allen (2014)'s paper detracts from the actual situation of rice markets in the Philippines, and I shall explain each of these instances in the rest of this chapter.[28]

7.1   The rice distribution system in Laguna

The rice distribution system in Laguna is largely representative of the manner in which rice is transacted in markets throughout Luzon, although the degree of complexity of each market's vertical supply chain may differ slightly.[29] (Please refer to Figure 46 for a graphical representation of the rice distribution system in Laguna).

There are a large number of farmers at the most upstream level of the supply chain, each operating at different scales. Due to the lack of rural finance in the Philippines, all farmers borrow credit from the rice collector (or trader) whom he / she transacts with, prior to each rice planting season.[30] These credit loans are used to purchase farm inputs such as fertilizers and crop seedlings, and they are to be repaid at the time of harvest at some pre-determined interest rate. Informal credit-tying relationships between farmers and traders are very much long-term because they require mutual trust. For example, the farmer trusts that the trader will purchase his / her palay at the highest possible farm gate

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[28] According to the researchers at IRRI whom I interacted with, including my field assistant Ms. Fe Gascon, markets in Luzon have a common distribution system for rice. This includes Camarines Sur province, which is the location which Allen (2014) visited.

[29] Please refer to Figure 34 for an example of a more complicated distribution system in the province of Nueva Ecija. The system is more complex in this province than in Laguna, because there are a larger number of rice collectors and distributors, each of whom operates on different scales.

[30] There are two rice planting / harvesting seasons in Laguna, namely the dry and the wet seasons.

price at the time of harvest, while the trader trusts that the farmer will not default on his / her loan. For this reason, all the farmers and traders whom I interviewed mentioned that they have transacted with each other for the past five to ten years.

However, this is by no means evidence of the fact that farmers are ill-informed about the competitive farm gate price, or about the price of palay in other markets. This is due to the following reasons. First, traders from other regions and provinces (including Manila, Quezon, Nueva Ecija, Batangas, and Cavite) frequently make visits to rice buying stations within Laguna, where they offer to purchase palay from the local farmers. There have been instances where farmers chose to transact with traders from other markets instead of with their usual local trader when the price differential was significant. Second, local traders within Laguna are also landowning farmers who themselves produce and sell palay. Hence, it does them no good to depress the farm gate price of rice, since they also receive the competitive farm gate price for their own produce. For example, one of the traders whom I spoke to disclosed that she does not charge any fees for her rice collection services and that the only commission she earns from dealing with her farmer clients is in the form of interest on informal credit loans. She also disclosed that she usually charges a constant and low interest rate of about 2% per season. Third, in a closely-knit rural community, farmers and traders are often relatives sharing blood ties, so attempts to engage in monopsonistic or monopolistic business practices tend to be heavily frowned upon. Moreover, farmers are actually very vocal and persistent in insisting that they receive the highest possible price for their produce. For example, many of the farmers I spoke to said that they always it make a point to check the farm gate price received by the other farmers in the village, and if they learn that it is possible for them to receive a higher price from a different trader, they are

willing to bargain with their own local trader for a higher price, or to transact with the other trader instead. Hence, it is usually the case that a typical farmer would receive the same price for his / her palay, regardless of which trader he / she chooses to transact with.

If in any case, a farmer makes a decision to transact with his / her local trader, even though he / she could fetch a better price from dealing with a different trader, this is usually not due to a lack of information, but rather due to the Filipino value of *utang na loob*, that is, the obligation to appropriately repay a person who has done one a favor with kindness and loyalty.

Traders operate at the second-most upstream level of the distribution system and serve as middlemen between farmers and rice millers (i.e. wholesalers). In each harvesting season, they collect palay from the farmers whom they have a long-term relationship with and deliver the palay to millers in multiple markets. Since traders are usually landowning farmers, it is customary for them to receive the same farm gate price for the palay produced on their own farms, as the price which their sellers (i.e. farmer clients) receive. In return, they charge interest on the credit loans which they make to their sellers at the start of each planting season.

There is no lack of information on the part of traders, with regards to the farm gate price in other geographical markets. In fact, the traders I spoke to mentioned that they communicate very frequently with rice millers (i.e. wholesalers) in different markets, via phone calls. They also explained that phone calls are not expensive, based on the local standard of living. To be precise, a whole week of unlimited phone calls costs only 100 PHP (about 2 USD or 220 JPY), regardless of destination. This observation definitely contradicts the empirical estimations of Allen (2014), who estimates the median fixed cost of acquiring information on the price of rice in other markets to be 4,406 PHP

(about 98 USD). Allen writes that "while (the estimated median fixed cost of 4,406 PHP) is certainly more than the cost of a phone call, it seems realistic for the entire cost of determining the market conditions in a potential destination" (Allen, 2014, p. 29). However, my field assistant ensured me that the Philippines has had fairly extensive mobile phone coverage as early as a decade ago and that mobile phones are not costly or difficult for farmers, let alone traders, to purchase.

On top of frequently updating themselves on the price of rice offered by millers in different markets, traders also communicate amongst themselves very often and regularly, via the phone. This is to update their knowledge of the prices that the buyers (i.e. the rice mills) are offering them, for each and every quality and variety of palay. In other words, traders make consistent efforts to update their knowledge of the prices that different millers are offering. Hence, there is little doubt that traders are able to make well-informed decisions on whom to sell their palay to.

Within Laguna, millers, who also serve as wholesalers, purchase palay from traders within and outside the province and convert the palay into milled rice. They then sell the milled rice to owners of retail stores at competitive wholesale prices, which are determined by the variety and quality of the rice. Rice quality is measured using proper testing equipment and priced accordingly.

The question which we want to answer, now, is whether information frictions are present, at the wholesale level. The millers whom I spoke to ensured me that the answer is no. First, they visit local markets on a daily basis during the wet season when the price of rice fluctuates wildly, in order to update their knowledge on local rice prices. Second, an integral aspect of their job involves communicating with retailers in markets across the country via phone calls and the internet, on a day-to-day basis. The Philippines Wholesale Rice Directory

is an example of a website where wholesalers and retailers from markets all over the country interact, by exchanging information on the quality and prices of rice.[31] In other words, all it costs for a wholesaler to obtain the most up-to-date information on rice wholesale prices is the cost of internet connection, or of making phone calls. Millers are also quick to take advantage of opportunities for arbitrage. For example, an operations manager at a rice mill whom I interviewed told me that milled rice produced in Laguna often gets exported to locations as far as Mindoro, via RORO (roll-on-roll-off) ferry services.

Finally, retailers are located at the most downstream level of the rice distribution system. There are many retailers in the market, and they are all members of an association of retailers. From what I gathered by speaking to several retailers, the association serves as a "Panopticon", where any retailer who tries to engage in non-competitive buying or selling practices will be frowned upon by the other members. Due to the highly competitive nature of the retail market, all retailers adhere to a standard formula for deciding their profit margins. It is customary for a retailer to purchase rice from one or several millers, at the wholesale price demanded by the miller. This is based upon the quality and variety of rice. They will then sell the rice at a retail price which takes into account the transportation cost of trucking or shipping rice from the rice mill to the retail store, the labor costs for loading and unloading the rice, and the cost of packaging the rice when it is sold to consumers.

An owner of a retail store disclosed that she usually earns a net profit of 120 PHP per cavan, or about 2.5 PHP per kg, of rice. She also provided an example of how she sets the retail price of regular milled rice in her store. In her example, the miller sells her a cavan (equivalent to 49 kg) of rice, at a wholesale price of 1800 PHP. To this she adds the cost of trucking, which is 10 PHP per cavan; the commission her agent charges, which is 5 PHP per cavan; the cost

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[31]See, for example, [https://www.olx.ph/all-results/q-rice-wholesale/].

Figure 46: The rice distribution system in Laguna
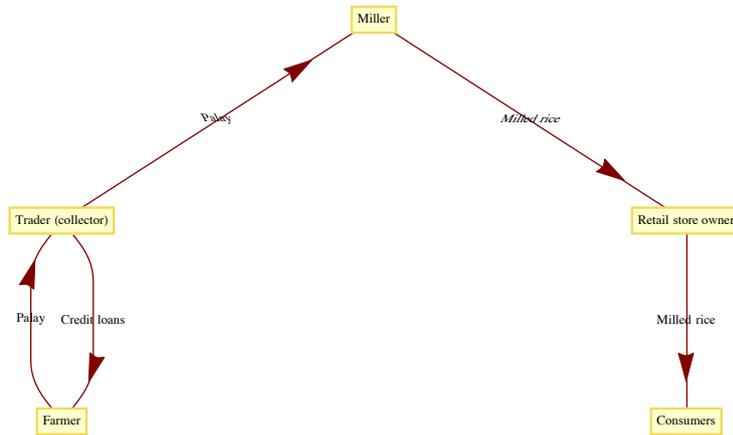
This figure depicts the rice distribution system in Laguna province, based on the first-hand observations of the author.

of labor for loading and unloading, which is 5 PHP per cavan; and the cost of packaging, which is 20 PHP per cavan. This adds up to a cost of 1840 PHP per cavan or roughly 37.5 PHP per kg. To this, she imposes a retail margin of about 2.5 PHP per kg, which means that she will sell her rice to consumers at a retail price of 40 PHP per kg. According to this retailer, all other retailers also adhere to this method of determining their retail prices. Further, retail prices could fluctuate on a daily basis during the wet season, but this fluctuation is entirely due to volatility in the wholesale price of rice due to differences in quality.

To this end, my observations are very much in line with the results of the theoretical model developed in Chapter 6. There are no significant information frictions at the farm gate, wholesale, and retail levels of the vertical supply chain of rice, and the main components of farm gate to wholesale, and wholesale to retail markups, are largely transportation and logistics costs.

7.2 Some remarks on the model developed by Allen (2014)

It is evident that the theoretical model developed in Allen (2014) does not paint an accurate portrait of the rice distribution system in the Philippines. The paper posits that farmers in the Philippines are not able to make use of opportunities for arbitrage because it is very costly for farmers to learn about the prices of their crops in other markets. It describes a model based on the following assumptions. First, there are a large number of markets, each inhabited by consumers and an exogenous mass of farmers. Farmers are heterogeneous in the size of the amount of land they own. They are informed about their local price and the true distribution of prices (net of transport costs), but not about prices in other markets. Each farmer has a reservation price of his / her own, which is an increasing function of the size of his land-holdings. This assumption reflects the fact that farmers with more land have more crops to sell, so their potential gains from finding a higher price are greater than that of farmers with less land.

In order to acquire information on the price of crops in other markets, farmers must engage in an undirected sequential search process, where he / she draws the name of a single market and pays a fixed market-invariant search cost of f_{ic} in order to learn about the price in that particular market. If the price in the market (minus transport costs) exceeds the farmer's reservation price, he / she will stop searching and choose to sell his / her crops in that market. Otherwise, the farmer will draw the name of a new market, pay the same fixed cost of f_{ic} to learn about the price in the new market, and decide whether or not to sell his / her crops there. This process continues until the farmer finds a destination where the price exceeds his / her reservation price. In the model, the probability that a farmer from region i draws the name of region j conditional upon searching is $s_{ijc} > 0$. The probability that a farmer in region i will search for prices in region j, denoted $\{s_{ijc}\}_j$, is assumed to be the same for all farmers

in region i.

In other words, the search probability (s_{ijc}) and the fixed search cost (f_{ic}) are two types of information frictions embedded in the model. The former captures the reasons why farmers in each market tend to search certain destinations more intensively than others, while the latter captures the fixed cost incurred by searching each particular destination.

For every destination market j, there exists a threshold landholding size (φ_{ic}^*) that indicates the maximum amount of land a farmer in an origin market i must own, in order for him / her to be willing to sell to that market. This is defined as follows:

$$\varphi_{ic}^* = \frac{f_{ic}}{K_{ic}(p)}$$

where $K_{ic}(p) \equiv \int_p^{p_{ic}^{max}} (p' - p) dF_p^{ic}(p')$ is the value of search, since it captures the per unit benefit of continuing to search as a function of the current updated price p. The value of search is strictly decreasing in p because the greater is the current price offer at hand, the lower is the value of continuing to search. As a result, the threshold landholding size (φ_{ic}^*) is strictly increasing in p: as the price in hand (p) increases, farmers willing to sell at that price are also those who own more land.

Based upon the above assumptions, Allen (2014) conducts structural estimations of transportation costs and information frictions, using time series data on wholesale prices and trade flows respectively. He finds that estimated transport costs account for about 47% of total estimated trade frictions (on average), and that information costs account for the remaining 53% of total estimated trade frictions. This implies an estimated median (fixed) search cost of 4,406 PHP (98USD), for learning about the price in another market.

Finally, in order to test the predictive power of his theoretical model, Allen (2014) compares the predicted trade flows of two different versions of

his model with actually observed trade flows - one version where search costs are set to zero, and another where search costs are positive. In the figure below, which was extracted from Allen (2014)'s paper, the green regression line captures the fit between the model's predicted trade flows against actual trade flows, when search costs are set to zero. On the other hand, the blue regression line captures the fit between the model's predicted trade flows against actual trade flows, when search costs are positive. Since the former has an R-squared of 0.05, which is lower than that of the latter, which is 0.166, Allen (2014) posits that the predictive power of his model improves significantly when information frictions are being taken into account.

There are several ways in which this model detracts from the actual situation of the rice distribution system in the Philippines. First, Allen (2014) conducts structural estimations of transport costs and search costs, where he finds that transport costs and search costs account for 47% and 53% of total trade costs, respectively, on average. Based on these estimations, he posits that search costs account for more than half of total trade costs. However, the median fixed search cost that is based on these estimations is 4,406 PHP, implying that it costs about 98 USD to make one search. This is very much higher than the actual costs of making phone calls in the Philippines, which is only about 100 PHP (2 USD) for a week worth of unlimited calls.

Second, Allen (2014) models information frictions amongst producers, that is, farmers, but he makes use of wholesale price data to conduct his estimations. This approach seems to ignore the structure of the rice distribution system in the Philippines because the prices which producers receive are farm gate prices and not wholesale prices.

Third, Allen (2014) points to the large number of province pairs which engage in two-way trade, as evidence to support the argument that information

Figure 47: Goodness of fit of Allen (2014)'s model, based on assumptions of perfect information versus assumptions of information frictions
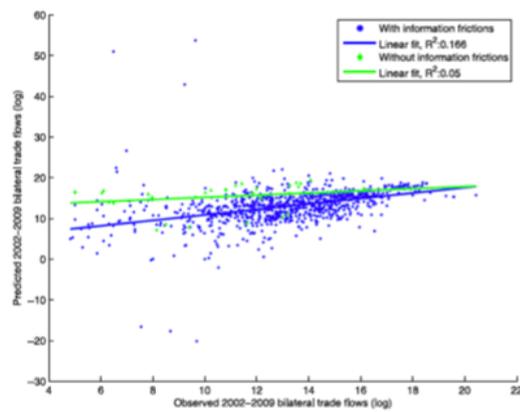
This figure was extracted from Allen (2014)'s paper. The green regression line captures the fit between the model's predicted trade flows against actual trade flows when search costs are set to zero. On the other hand, the blue regression line captures the fit between the model's predicted trade flows against actual trade flows, when search costs are positive. Since the former has an R-squared of 0.05, which is lower than that of the latter, which is 0.166, Allen (2014) posits that the predictive power of his model improves significantly when information frictions are being taken into account for. Source: Allen (2014).

frictions are large. However, the respondents I spoke to in Laguna were consistent in pointing out that palay cannot be stored for lengthy periods of time after harvest, due to weather and moisture conditions which tend to compromise the quality of the palay. Thus, it makes sense for province pairs to engage in two-way trade for the purpose of consumption smoothing.

To this end, my findings in Laguna support the results of the theoretical model discussed in Chapter 6, because they are consistent with the model's implications that markets are well arbitraged across space, and that there are no huge opportunities to make profits via arbitrage, given the current magnitude of trade costs inclusive of logistics costs.

8 Conclusion

The unique geographic composition of the Philippines results in a large extent of heterogeneity in each region's suitability for rice cultivation. For example, while 93% of irrigated farmland is surplus to a rice farming family's consumption needs in Nueva Ecija (Dawe et al. (Eds.), n.d.), poor families in Manila and Rizal seldom have enough rice to meet their basic caloric needs. Rice deficit regions suffer from a lack of rice due to three main reasons: first, they may be naturally disadvantaged in the production of rice due to traditional geographical reasons, second, their geographical locations may cause them to be particularly vulnerable to adverse shocks to rice production, and third, they may have experienced crop shifting and therefore a decline in rice output (on the supply side of the equation), coupled with a rapid growth in population and burgeoning demand for rice (on the demand side of the equation). Differences in comparative advantage vis-a-vis rice production speak of the importance in ensuring that rice surpluses are redistributed from surplus to deficit markets in an economically efficient manner.

Next, there is the problem that domestic rice prices are very much higher than the competitive world price of rice (see Figure 11 in Chapter 1). For example, Regalado (2000) observes that imported rice was priced at 10.75 PHP / kg in 1995, which was less than half the price of domestically-produced rice which was priced at PHP 24 / kg in the same year. High domestic rice prices are detrimental to national food security because rice occupies a massive proportion of the consumption basket of the average consumer in the Philippines. It is the staple food of 80% of Filipinos, contributes 48% to the daily energy supply of Filipinos (Tiongco et al., 2011), and has a 13% weight in the consumer price index. It is also a large source of income for millions of farmers, wholesalers, and retailers (Reyes et al., 2005). Further, high domestic rice prices serve as a

regressive tax on poor consumers, since there is an inverse relationship between the share of rice in per capita expenditure and income (Lantican et al., 2011).

There are three main reasons why domestic rice prices are so much higher than competitive world prices. First, land tenure systems lead to small-scale production and make it impossible for rice producers to reap economies of scale. Second, there is a quantitative restriction (QR) on the amount of rice that private traders can import from abroad, and this creates a wedge between domestic rice prices and the competitive world price of rice. Third, domestic interisland trade costs are very high.

Based on these observations, it is clear that effective land reform policies aimed at increasing the scale of production by farmers, and foreign trade policies aimed at giving the private sector more freedom to import rice from abroad, would certainly help to lower domestic rice prices relative to the world price of rice. However, we are also aware of the fact that the existing land use system and trade policies of the Filipino government are the results of years of historical and political factors. Therefore, making changes to these systems is not an easy feat that can be performed quickly. Having said so, it follows that the main concern of this thesis is to understand why domestic trade costs are so high. In other words, we want to shed light on the various factors that contribute to domestic trade costs. We also want to understand the exact nature of these trade costs, that is, whether the trade costs have to do with market failures, such as market power and information frictions, or whether they are mainly comprised of transportation and logistics costs.

In addition to a shortage of rice for consumption in rice deficit regions and high domestic rice prices, there is another threat to national food security. Domestic rice prices are extremely vulnerable to exogenous shocks in the form of fluctuations in the international market for rice. For example, during the

global food crisis of 2007- 2008, the price of rice skyrocketed from 24 - 28 PHP / kg to 38 - 46 PHP / kg in the first quarter of 2008 alone (Larin, n.d.). A major contributing factor behind the high pass-through rate of world rice price to domestic rice prices has to do with the NFA's foreign trade policy. In particular, the NFA conducts price-fixing, where it imports heavily from abroad, and often in excess of the gross domestic demand for rice. It then adjusts the supply of foreign imports released into the domestic market in accordance with domestic consumption needs.

While it is true that the Philippines does not have as large an advantage in the cultivation of rice as its neighboring countries, the massive imports of rice by the NFA that far exceed the country's ability to store and redistribute the imported rice to deficit regions, serve to expose the country unnecessarily to shocks and volatility in the global market for rice. The world rice market is said to be a "thin" market, as evidenced by the fact that only a little more than 6% of global rice supplies were traded on the world market in 2008 (Fang, 2015). While reliance on foreign importation may be necessary to a certain degree, this should be carried out by the private sector with fewer barriers to free trade.

However, as noted above, changing the government's foreign trade policy is not a feat that can be performed quickly, since players who have special vested interests in the existing system are bound to lobby against the change. Hence, ensuring that domestically grown rice surpluses are redistributed efficiently to rice deficit areas may be a more realistic feat for the government to achieve in the short run. This would certainly help to bolster food self-sufficiency and reduce the negative impact that price shocks and price volatility in the global rice market have on domestic rice prices. It is, therefore, the main concern of this research to identify the factors that prevent domestically-grown rice from being redistributed efficiently across the regional rice markets within the Philippines.

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In particular, we seek to answer the following research questions.

1. First, are rice markets in the Philippines well arbitraged across space, ceteris paribus (that is, given the existing state of transportation and communications infrastructure)?

2. Second, what are the various factors that contribute to domestic trade costs, and what is their nature? (Do trade costs have to do with forms of market failure, such as market power and information frictions, or are they are mainly comprised of transportation and logistics costs?)

In order to answer our research questions, we build an original model to predict the amount of trade that would take place between every pair of provinces within a given period of time, such as a quarter of a year. The model assumes perfectly competitive markets and perfect information across space. We solve the model using linear programming and concepts from transportation theory and compare the model's solutions with actual trade flow data. Due to its assumptions on perfect competition, the model's solution is a Pareto optimal set of trade flows between every pair of provinces in the Philippines, where the exporting province has a surplus and the importing province a deficit of rice. The solution serves as a Pareto optimal benchmark, against which we compare actual trade flow data, to evaluate how far away from Pareto optimality Philippine rice markets are.

The solution, or predicted trade flows, of our model captures the features of observed trade flows very well even though the model assumes perfect information. For example, when we regressed the model's predicted trade flows against actual trade flows we obtained regression coefficients very close to 1 and adjusted R-squared values between 0.6 and 0.93. The results are significant at the 99% confidence level, and they suggest a very good fit between the model's Pareto optimal solution and the actual trade flows.

The findings of this research suggest that previous work may have over-

estimated the significance of information asymmetries in preventing arbitrage from taking place between rice markets in the Philippines. They also indicate that non-observable trade costs including packaging, storage, and logistics costs play a large role in discouraging the trade of rice between surplus and deficit markets. The policy recommendations are clear-cut. Better transportation, packaging, storage, and logistics facilities, which would help to reduce trade costs, are of tremendous importance in ensuring that rice markets are better integrated across space. In other words, we expect price differentials between pairs of regions to converge closer to the observed trade costs, as the above-mentioned services improve.

Finally, the theoretical model that we built in Chapter 6 also contributes to the existing literature on international trade theory in the following way. At present, there is no theoretical framework in the international trade literature that can serve as a testable workhorse model for explaining the way in which homogenous and perishable commodities such as food staples are traded across space (see Table 15). While existing theories are useful in explaining the bilateral trade of goods across product categories, as in the case of the Ricardian and Heckscher-Ohlin model, or across different varieties of a differentiated product, as in the case of the new and new "new trade" theories, they are silent on the factors that drive the unilateral trade of goods within a non-differentiated homogenous product category. Our model is a first step towards explaining the trade of non-differentiated and perishable products across space. It can be extended in future work to explain the trade of food staples on a more general or globally applicable level.

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Appendix

A1. Time series of farm gate, wholesale, and retail prices in provinces, January 2006 - December 2014

The figures below were created by the author, using price data on the farm gate, wholesale, and retail price of regular milled rice extracted from the BAS' website.The vertical axis measures rice prices in PHP / kg, and the horizontal axis measures the time period of observation. The time series starts in January 2006 and ends in December 2014. Farm gate prices are plotted in green, wholesale prices in blue, and retail prices in red. Prices are unavailable at certain stages of the vertical supply chain (i.e. incomplete) for some provinces.

5.Apayao

6.Agusan del Norte

7.Agusan del Sur

8.Aurora

9.Basilan

10.Bataan

11.Batangas

12.Benguet

13.Biliran

14.Bohol

15.Bukidnon

16.Bulacan

17.Cagayan

18.Camarines Norte

19.Camarines Sur

20.Camiguin

21.Capiz

22.Catanduanes

23.Cavite

24.Cebu

25.Compostela Valley

26.Davao del Norte

27.Davao del Sur

28.Davao Oriental

29.Eastern Samar

30.Guimaras

31.Ifugao

32.Ilocos Norte

33.Ilocos Sur

34.Iloilo

35.Isabela

36.Kalinga

219

37.Laguna

38.Lanao del Norte

39.Lanao del Sur

40.La Union

41.Leyte

42.Maguindanao

43.Marinduque

44.Masbate

220

45.Misamis Occidental

46.Misamis Oriental

47.Mountain Province

48.Negros Occidental

49.Negros Oriental

50.North Cotabato

51.Northern Samar

52.Nueva Ecija

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53.Nueva Vizcaya
54.Occidental Mindoro
55.Oriental Mindoro
56.Palawan
57.Pampanga
58.Pangasinan
59.Quezon
60.Quirino

61.Rizal

62.Romblon

63.Samar

64.Sarangani

65.Siquijor

66.Sorsogon

67.South Cotabato

68.Southern Leyte

223

69.Sultan Kudarat

70.Sulu

71.Surigao del Norte

72.Surigao del Sur

73.Tarlac

74.Tawi−tawi

75.Zambales

76.Zamboanga City

224

77.Zamboanga del Norte

78.Zamboanga del Sur

79.Zamboanga Sibugay

A2. Time series plots of the wholesale price of regular milled rice in individual provinces, against the price spread across all provinces, between January 2006 - December 2014

The figures below were created by the author, using average monthly price data on the wholesale price of regular milled rice extracted from the BAS' website. The vertical axis measures rice prices in PHP / kg, and the horizontal axis measures the time period of observation, between January 2006 and December 2014. The wholesale price of regular milled rice is indicated by the blue line, and the spread of the wholesale price of rice across all provinces is indicated by the gray mass. Prices are unavailable for some provinces.

Agusan del Norte   Agusan del Sur

Aurora   Basilan

Bataan   Batangas

Benguet   Biliran

Bukidnon

Cagayan

Camarines Norte

Camarines Sur

Camiguin

Capiz

Catanduanes

Cavite

North Cotabato

Nueva Ecija

Nueva Vizcaya

Occidental Mindoro

Oriental Mindoro

Palawan

Pampanga

Pangasinan

232

Quezon

Rizal

Samar

Sarangani

Sorsogon

South Cotabato

Sultan Kudarat

Surigao del Norte

233

Surigao del Sur

Tarlac

Tawi−tawi

Zambales

Zamboanga City

Zamboanga del Norte

Zamboanga del Sur

Zamboanga Sibugay

234

A3. Plots of predicted trade flows and actual trade flows of ordered province pairs, for the 4th quarters of individual years

Analogous to Figure 41 in Chapter 6, the figures below plot the indexes of region pairs (ordered in increasing magnitude of the trade flows which took place between them) against the predicted and actual trade flows between them when we solve the transport problem for the 4th quarter of each year in our data set. Predicted trade flows are plotted in blue and actual trade flows in red. We exclude the years 2007 and 2008 because these are the years of the global food crisis and we did not get a good fit for these two years.


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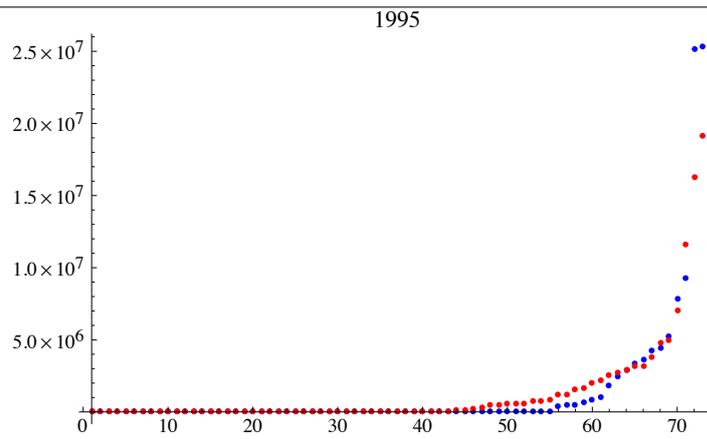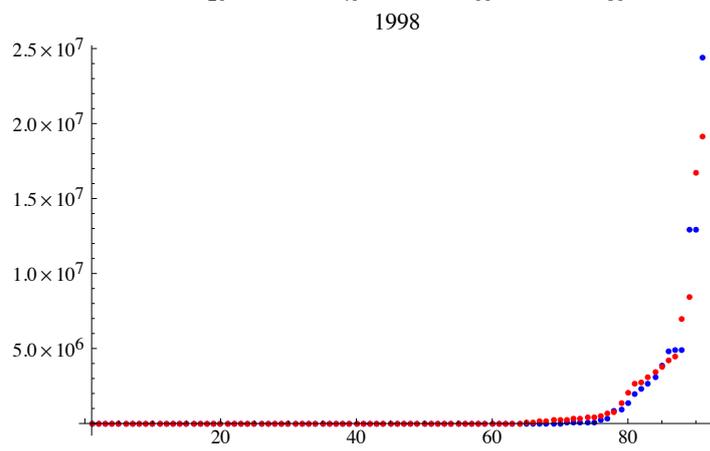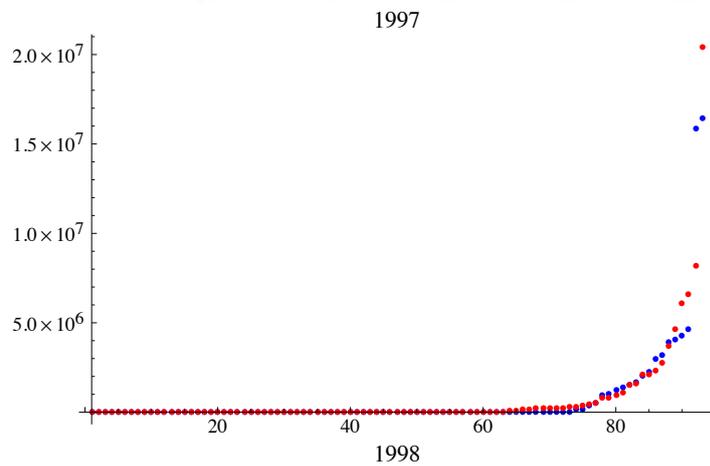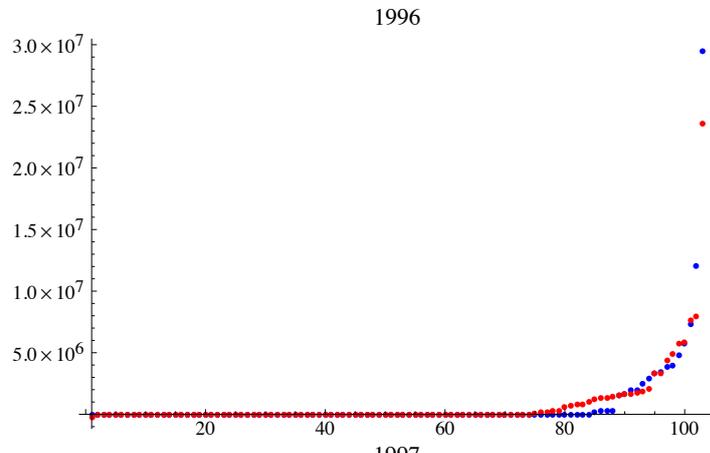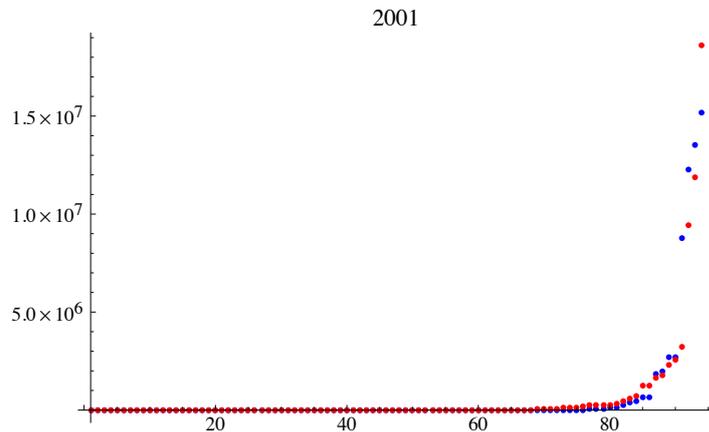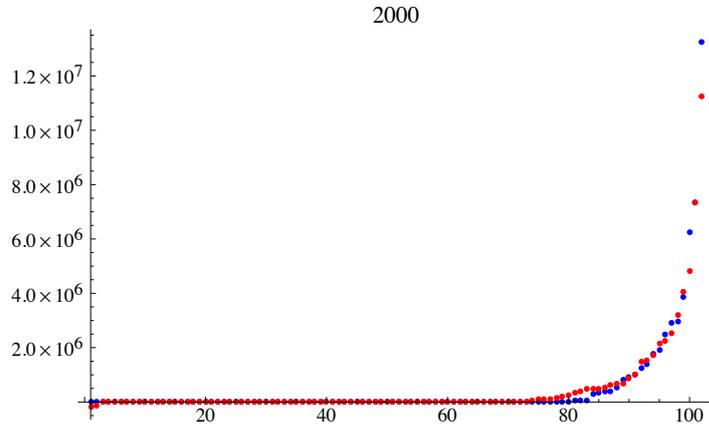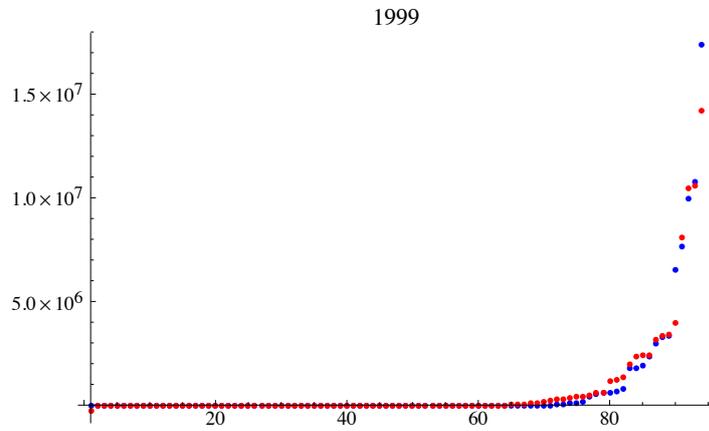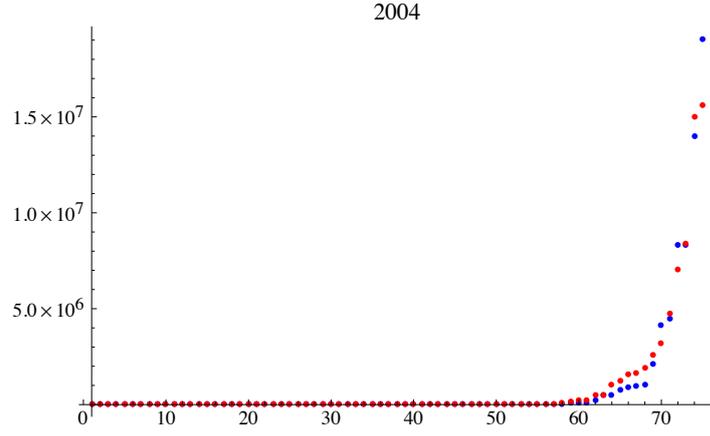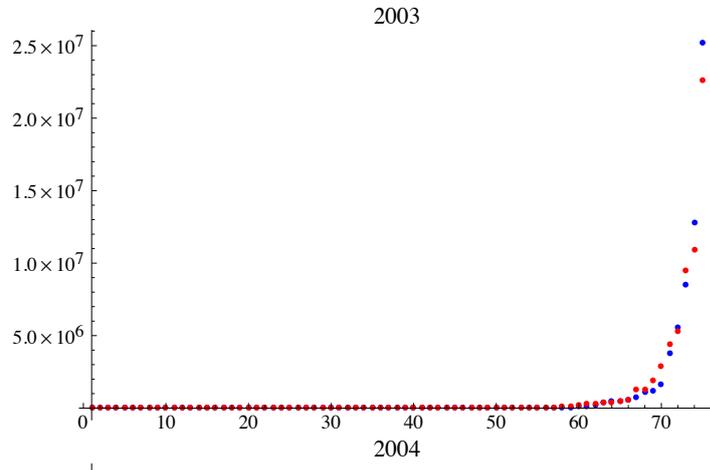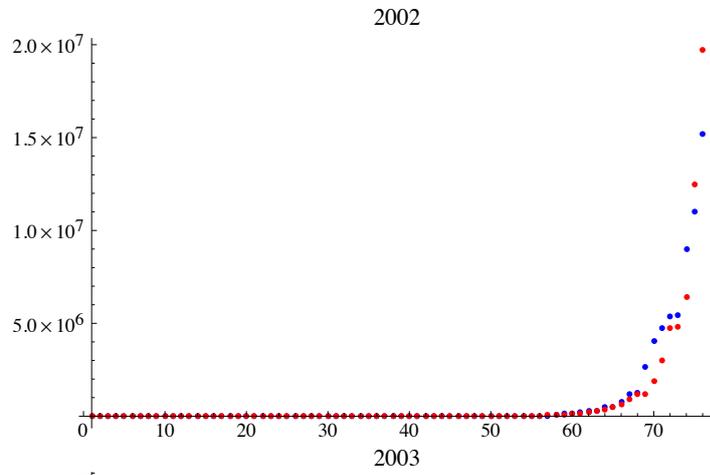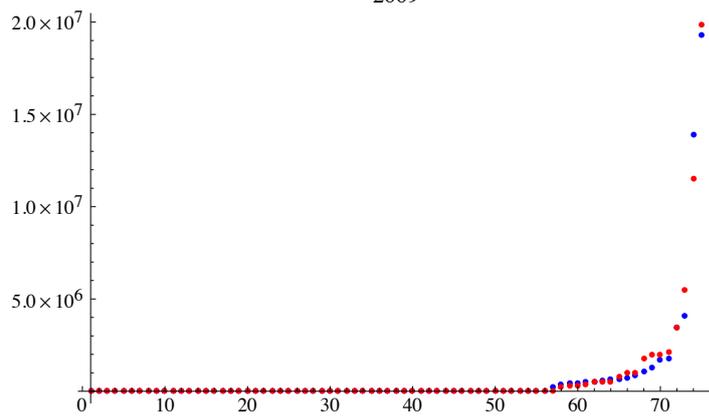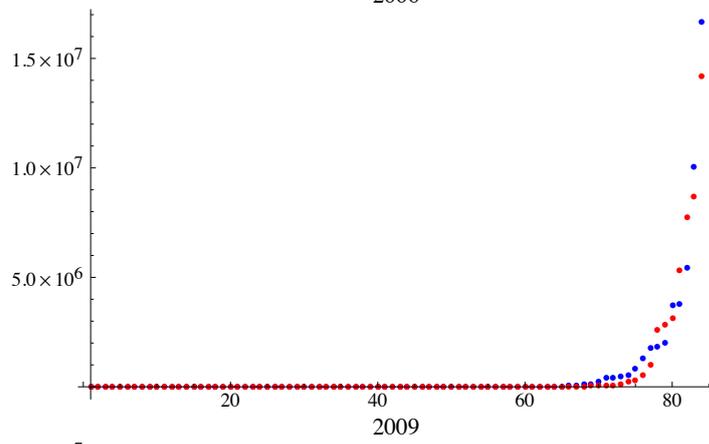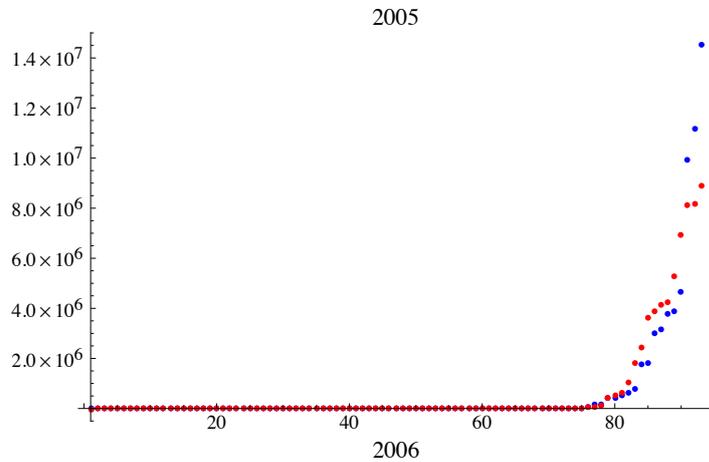
A4. Plots of actual shipping distances against predicted trade flows and actual trade flows, for the 4th quarters of individual years

Analogous to Figure 22, the figures below plot the actual shipping distance against the predicted and actual trade flows between region pairs, for the 4th quarter of individual years in our data set. Predicted trade flows are plotted in blue and actual trade flows in red. Here, we observe that not only are the signs and magnitudes of actual trade flows very similar to those of predicted trade flows, but that year-to-year changes in the pairs of regions that trade with each other also follow the model's predictions very closely. For example, the model predicts positive trade flows between regions VI and XIII, but no trade between regions X and XIII in the 4th quarter of 2006. Both of these predictions are observed in the actual trade flow for that quarter. On the other hand, the model predicts large and positive trade flows between regions X and XIII, but no trade between regions VI and XIII in the 4th quarter of 2009. Once again, both of these predictions are observed in the actual trade flow for that quarter. We exclude the years 2007 and 2008 because these are the years of the global food crisis and we did not get a good fit for these two years.

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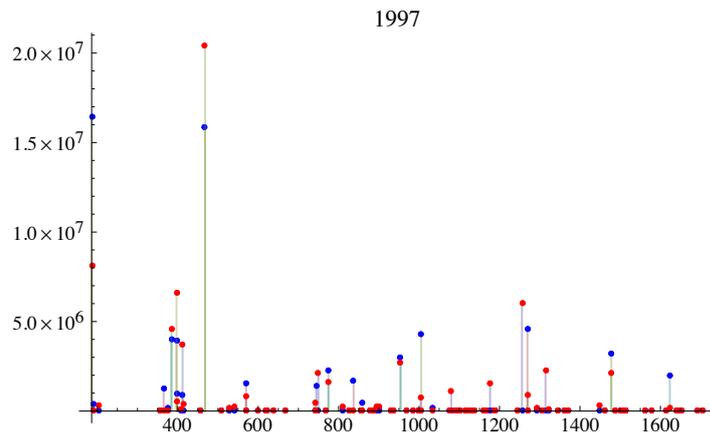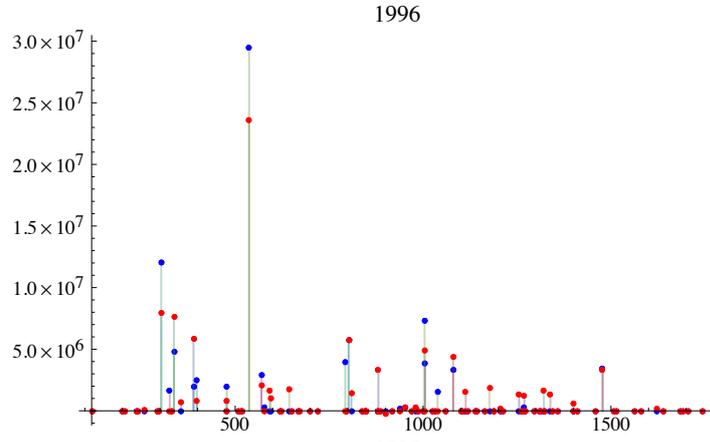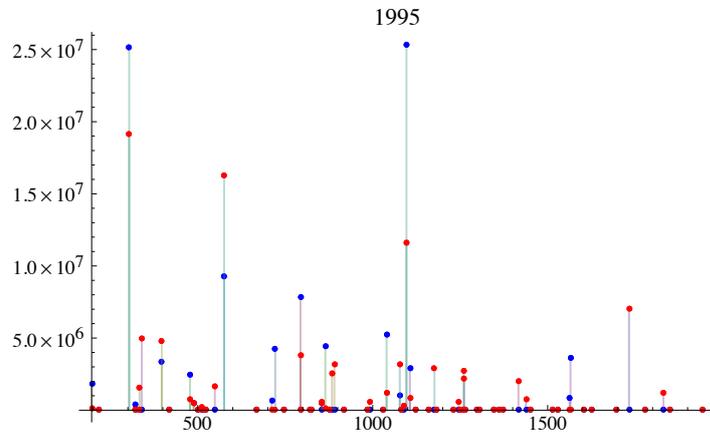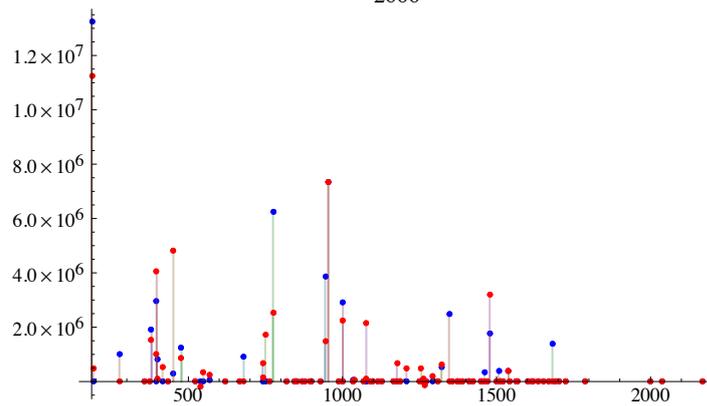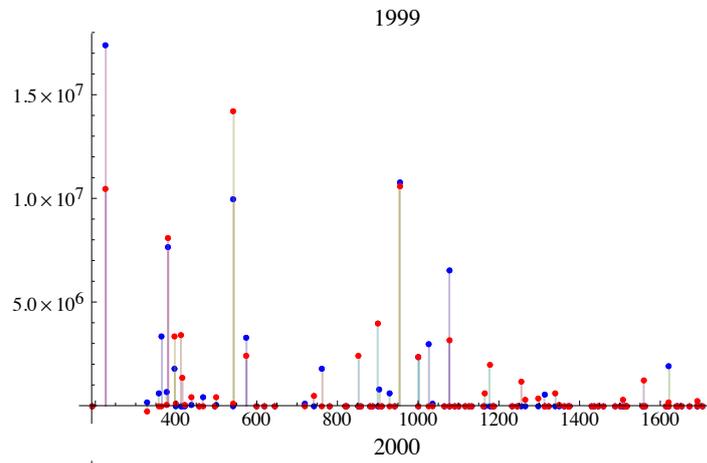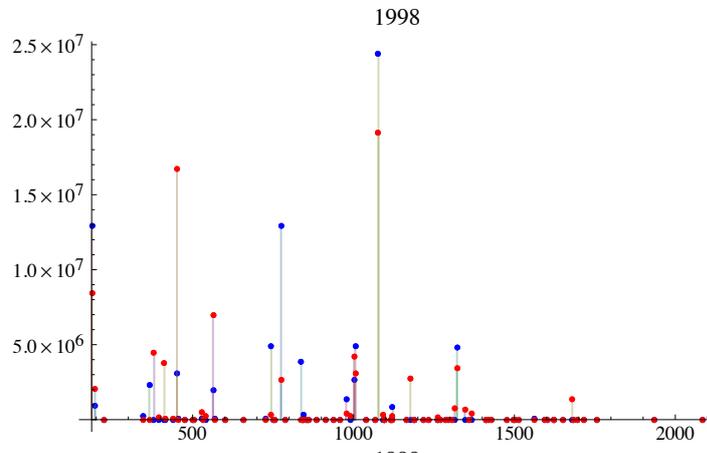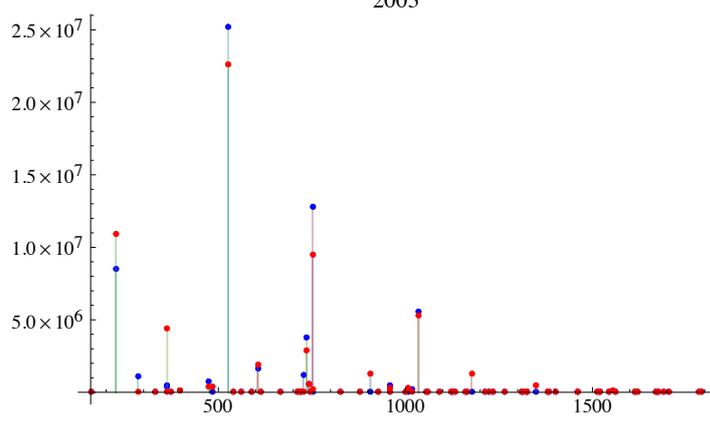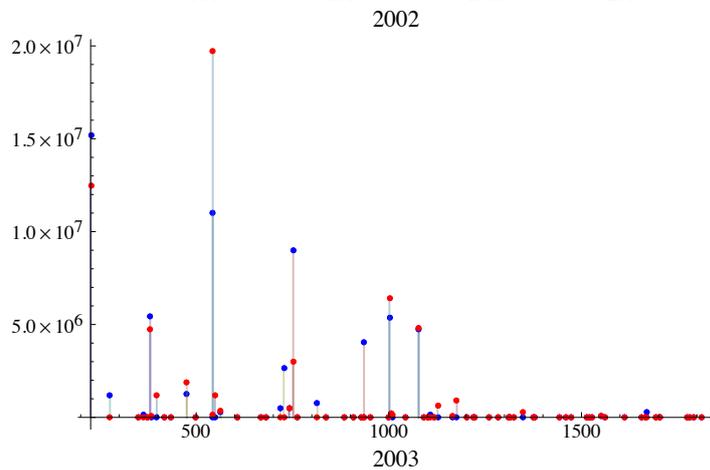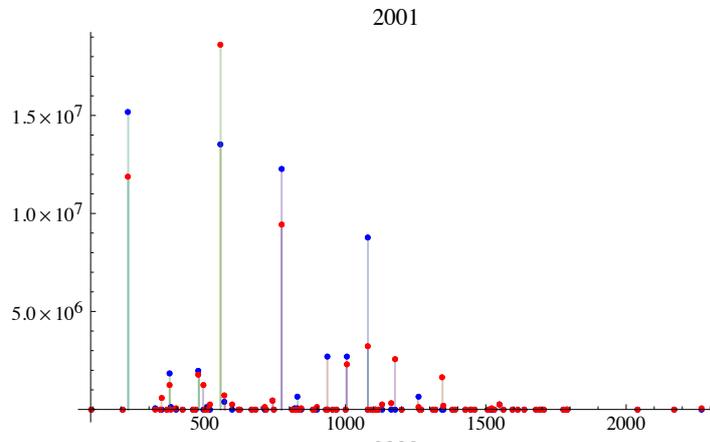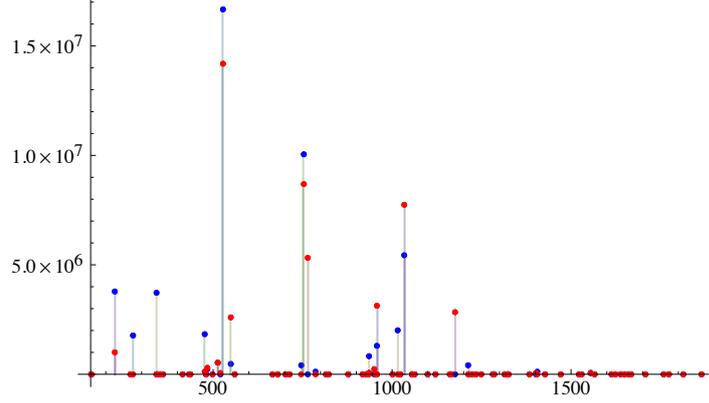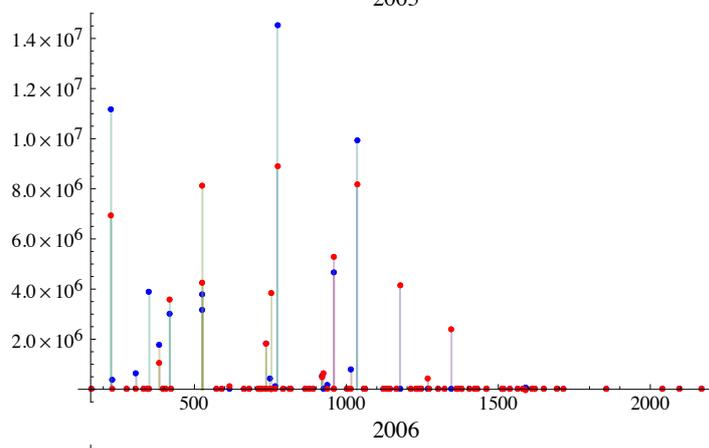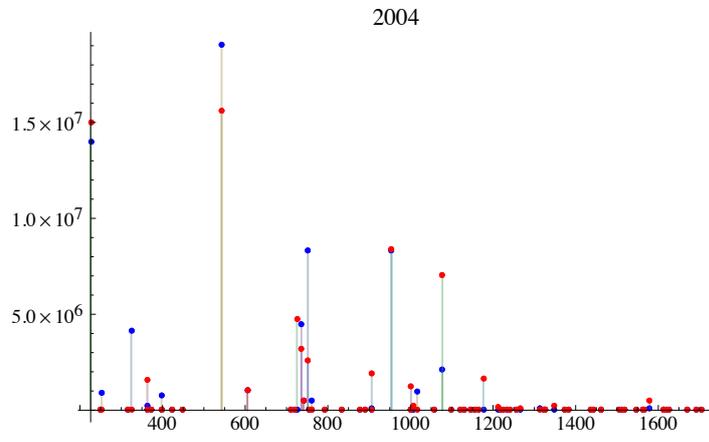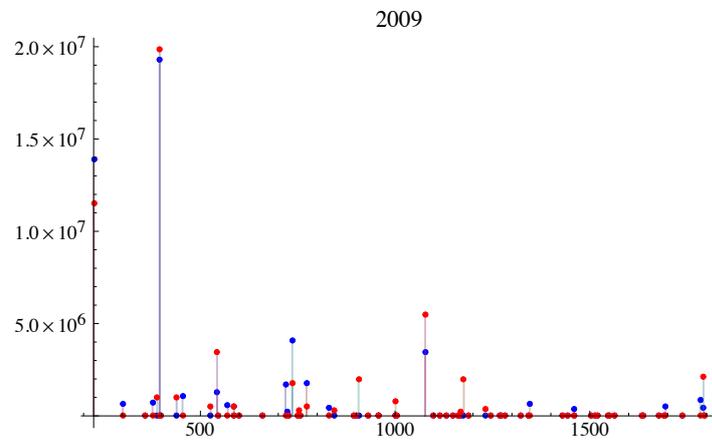
A5. OLS regressions of predicted trade flows on actual trade flows, for the 4th quarters of individual years

The tables below summarize the regression coefficients and adjusted R-squared's when we regress the predicted trade flows of the transport problem for the 4th quarters of individual years, on actually observed trade flows. Stars indicate statistical significance: *p<.10, **p<.05 and ***p<.01. We exclude the years 2007 and 2008 because these are the years of the global food crisis and we did not get a good fit for these two years.

- 1995

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.645***
Adjusted R-squared	0.673
Observations	73

- 1996

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.785***
Adjusted R-squared	0.881
Observations	103

- 1997

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.839***
Adjusted R-squared	0.704
Observations	93

- 1998

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.692***
Adjusted R-squared	0.575
Observations	91

- 1999

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.809***
Adjusted R-squared	0.771
Observations	94

- 2000

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.795***
Adjusted R-squared	0.782
Observations	102

- 2001

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.887***
Adjusted R-squared	0.855
Observations	94

- 2002

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.961***
Adjusted R-squared	0.766
Observations	76

- 2003

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.898***
Adjusted R-squared	0.951
Observations	75

- 2004

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.846***
Adjusted R-squared	0.830
Observations	75

- 2005

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.721***
Adjusted R-squared	0.737
Observations	93

- 2006

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.832***
Adjusted R-squared	0.799
Observations	84

- 2009

Dependent variable:	Predicted trade flows (kg)
Actual trade flows (/kg)	0.948***
Adjusted R-squared	0.928
Observations	75