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**Working Paper**

## The impact of improved transport connectivity on income, education, and health: The case of the roll-on/roll-off system in the Philippines

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**ADB Working Paper Series**

**THE IMPACT OF IMPROVED TRANSPORT CONNECTIVITY  
ON INCOME, EDUCATION, AND HEALTH: THE CASE OF  
THE ROLL-ON/ROLL-OFF SYSTEM IN THE PHILIPPINES**

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No. 792  
November 2017

**Asian Development Bank Institute**

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**Abstract**

This paper studies the impacts of providing an efficient and affordable transport system within a country through the experience of the Philippines. In 2003 the roll-on/roll-off (Ro-Ro) policy was implemented to provide an integrated mode of inter-island transfer. We offer three analyses that examine the effects of this policy at the household as well as the municipality level. Our first analysis shows that agricultural households largely benefit from Ro-Ro port operation, as we notice higher incomes for both agricultural and non-agricultural activities. Our results also suggest that the island location of agricultural households relative to Ro-Ro ports does not hinder the gains from the Ro-Ro policy. Meanwhile, our second analysis exhibits higher school attendance in municipalities near the Ro-Ro ports, which we observe for both males and females. Interestingly, we observe the increase much earlier in females than in males. Finally, our third analysis reveals lower household consumption of alcoholic beverages and tobacco in areas near the Ro-Ro ports. Overall, the results of our paper demonstrate several additional effects beyond economic growth of strengthening the physical linkages between the local economies within a country. More importantly, it highlights the crucial role of the transport system in a country's socio-economic development.

**Keywords:** roll-on/roll-off policy, agriculture, education, household expenditure

**JEL Classification:** O18, R20, R28

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# 1. INTRODUCTION

The literature recognizes the importance of a transport system in a country's development. Several studies show that investment in transport infrastructure leads to economic growth (Easterly and Rebelo 1993), reduced income inequality (Estache 2003; Brennenman and Kerf 2002; Galiani et al. 2005; Jalan and Ravallion 2002; Jacoby 2000; Gannon and Liu 1997; Lee et al. 1997; Lavy et al. 1996; Ferreira 1995; Behrman and Wolfe 1987), and higher productivity (Calderon and Serven 2003; Demetriades and Mamuneas 2000; Canning 1999; Fernald 1999; Baltagi and Pinnoi 1995; Holtz-Eakin 1994; Aschauer 1989). We also know from the economic geography literature (e.g. Fujita, Krugman, and Venables 2001) that an improved transport system exhibits agglomeration forces that affect the allocation of resources. However, dispersion forces (such as high wages in cities) typically mitigate these agglomeration effects, allowing the periphery to exist.

In countries with an archipelagic structure, such as the Philippines, which is comprised of about 7,500 islands, building a comprehensive transportation network is a tremendous challenge. Nevertheless, having a reliable and affordable transport system is crucial in facilitating the movement of goods and services within the country and thus spurring economic growth. Moreover, a comprehensive transportation network can play a key role in providing equal growth and development opportunities throughout the country.

The Philippines transport system is composed of road, railway, air, and water transport. Road transport accounts for about 98% of passenger traffic and 58% of cargo traffic (ADB 2012), while water transport remains the predominant mode of inter-island transfer. It is important to note that the majority of the country's transport infrastructure is situated in Metro Manila, its capital city. Hence, much of the economic development is concentrated in the National Capital Region, while the rest of the regions experience slow progress.<sup>1</sup> One notable characteristic of the country's transport system is its weak connectivity, which is often blamed for poverty and underdevelopment in small island economies, as it limits trade and economic integration (Basilio et al. 2010). Furthermore, its weak logistics network constrains livelihood opportunities, especially in rural areas (ADB 2012).

To strengthen the inter-island linkages, the government implemented the roll-on/roll-off (Ro-Ro) policy in 2003. The primary goal of this policy was to create a more efficient and affordable mode of inter-island transfer that would benefit local trade and tourism. The Ro-Ro system was designed to expand the country's transport system by integrating the sea and road networks, paving the way for enhanced connectivity. Its concept was to allow trucks and other vehicles to board the Ro-Ro vessel directly at the point of embarkation and roll away from the Ro-Ro vessel directly onto the road at the point of destination, greatly reducing the transport times. For instance, it reduced the travel time between Mindanao and Luzon islands by about 12 hours (ADB 2012). Moreover, the Ro-Ro system effectively eliminated the need for loading and unloading cargo, thereby lowering the shipping cost by about 30%. Furthermore, the Ro-Ro policy newly integrated many ports into the road network, which allowed for enhanced connectivity.

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<sup>1</sup> Data show that the National Capital Region, where Manila is located, showcased the biggest growth of around 35% in 2012 to 2014, while the rest of the regions registered less than 5% growth during the same period, except for Calabarzon, Central Luzon, and Central Visayas.

The aim of this paper is to provide empirical evidence on the effects of the Ro-Ro policy on various socio-economic outcomes in the Philippines. Firstly, we investigate the impact of the Ro-Ro policy on agricultural households' income. More specifically, we observe how Ro-Ro port operation affected their entrepreneurial activities. Since one of the main goals of the Ro-Ro policy is to reduce the inter-island transport cost significantly, we naturally expect this policy to influence the decision of agricultural households to engage in certain activities. Secondly, we evaluate changes in children's school attendance in areas near the Ro-Ro ports. Although the Ro-Ro policy was not designed to have an impact on children's education, we nonetheless investigate the possible transfer of gains from parents to children through human capital investment. Lastly, we check for possible changes in consumption behavior by studying household expenditure on food, alcohol, and tobacco, as improved transport connectivity could affect the availability and price of various consumption goods in addition to any income effect.

Our study will be useful to policy makers and researchers, as we will demonstrate the benefits of improving a country's transport system. The specific results from each of our three topics will also reveal the mechanisms by which a transport policy such as the Ro-Ro policy in the Philippines affects households and municipalities. The rest of this paper is organized as follows. We provide the policy background in Section 2, then we explain our empirical strategies and cite our data sources in Sections 3 and 4, respectively. In Section 5 we present and discuss our results, and finally we provide our conclusion in Section 6.

## 2. POLICY BACKGROUND

The Philippines implemented the Ro-Ro policy in 2003 to provide an affordable mode of inter-island transfer through the establishment of a more efficient Ro-Ro ferry terminal system (RRTS). This policy enabled the government to expand the country's transport system with minimal infrastructure investment through the conversion of pre-existing private non-commercial ports into commercial ports under the RRTS. The goals of the Ro-Ro policy development were (1) to lower the transport cost of sending products within the country; (2) to enhance inter-island linkages for local tourism and commerce; (3) to facilitate government programs for agriculture, fisheries, and food security; (4) to encourage private sector participation in the RRTS; and (5) to promote the development of the RRTS.

The RRTS is composed of a network of terminals that are linked by Ro-Ro vessels, wherein the Ro-Ro operation is characterized by the process of loading trucks or other vehicles from the road directly onto the Ro-Ro vessel without offloading the cargo. This new system made shipping much simpler by eliminating the need for portside facilities and equipment, as in the containerized method. As an effect, the inter-island transport cost fell by about 30 to 40% for passengers and cargo, respectively.<sup>2</sup>

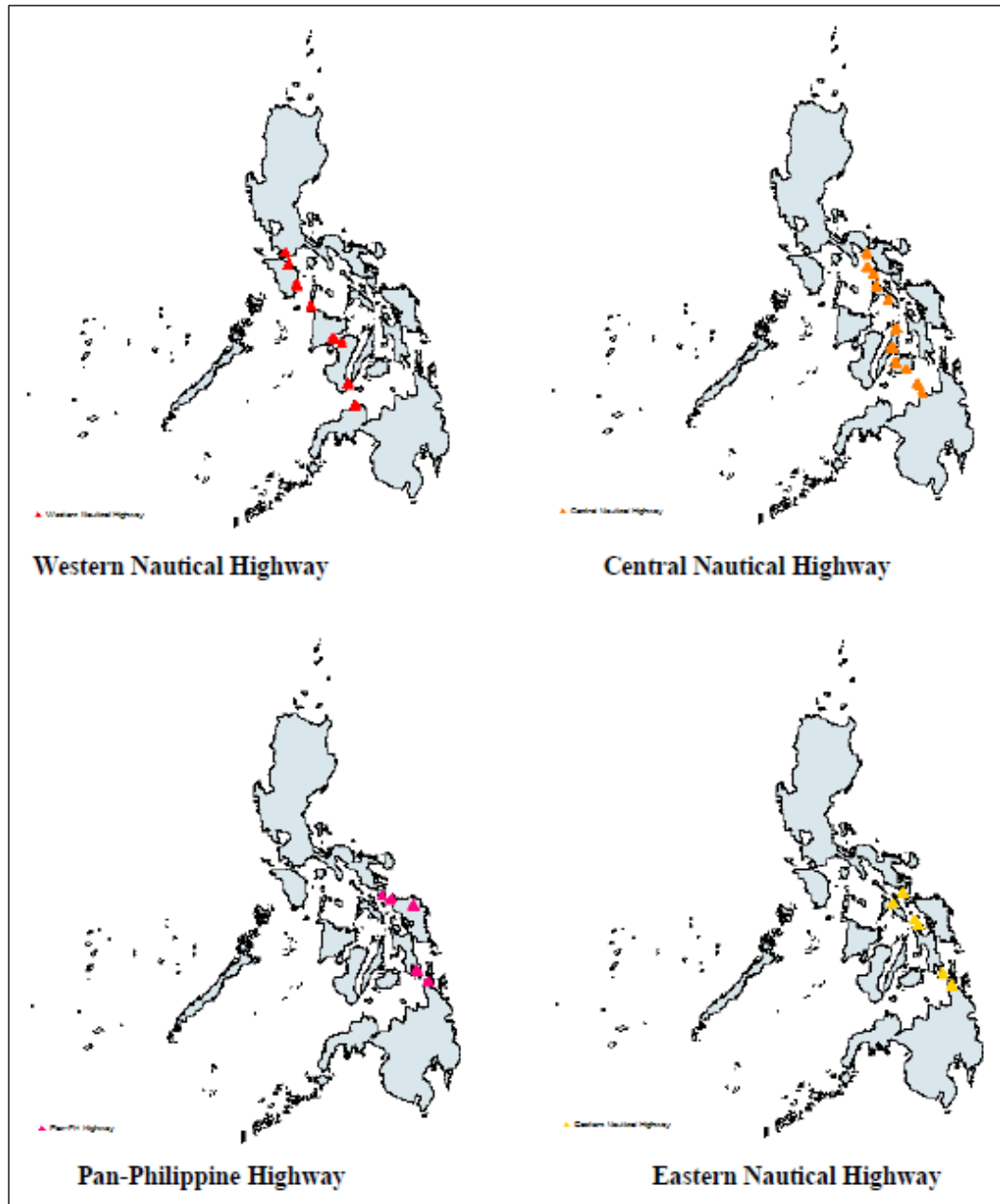
The Ro-Ro policy identifies the RRTS as part of the national highway system, as it creates a seamless network of connections between nautical highways and national roads. The RRTS is comprised of three nautical highways—namely the Western Nautical Highway, Central Nautical Highway, and Eastern Nautical Highway—along with the links provided by the Maharlika/Pan-Philippine Highway. The operation of the Western Nautical Highway, combined with the existing roads and bridges of

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<sup>2</sup> See "The Asia Foundation's Roll-on Roll-off Transport: Connecting Maritime Southeast Asia." Accessed 29 May 2016. <https://asiafoundation.org/resources/pdfs/4PagerRoRoPHLetter.pdf>

the Maharlika/Pan-Philippine Highway, kick-started the system in 2003. The Maharlika/Pan-Philippine Highway was the first major highway built in the 1960s, designed to connect Luzon, Visayas, and Mindanao<sup>3</sup> islands. This highway is comprised of roads and bridges and aimed to stimulate agricultural growth and regional development. Meanwhile, a further expansion of the RRTS took place in 2008 and 2009, with the addition of the Central Nautical Highway and Eastern Nautical Highway, respectively, which completed the interconnections of the major island groups in the country. Figure 1 shows a map of the nautical highways.

**Figure 1: Map of Nautical Highways**



<sup>3</sup> Luzon, Visayas, and Mindanao are the three main island groups of the Philippines (see Appendix 1 for the figure).



### 3. EMPIRICAL STRATEGIES

The goal of this paper is to unveil the impacts of the Ro-Ro policy in the Philippines. To achieve this goal, we evaluate the changes in (1) agricultural household income; (2) children's education; and (3) households' consumption of food, alcoholic beverages, and tobacco in areas near the Ro-Ro ports. Due to differences in data availability as well as the nature of the research questions, we utilize different empirical approaches. We discuss each of our models in the following sections.

#### 3.1 Agricultural Household Income

To analyze the effect of the Ro-Ro policy on the income of agricultural households, we construct a panel fixed-effect model that considers the distance of agricultural households from the nearest Ro-Ro port. Our empirical strategy is similar to that of Banerjee, Duo, and Qian (2012) and Atack et al. (2009) and enables us to observe changes in agricultural household income across time while controlling for unobserved heterogeneity. We consider the following model for agricultural household  $i$  at time  $t$ :

$$y_{it} = \beta_0 + x_{it}'\beta_1 + \beta_2 d_{it} + \beta_3 s_{it} + \beta_4 d_{it} * s_{it} + c_i + e_t + u_{it}$$

where  $y_{it}$  is the household income. In our equation  $x_{it}'$  denotes the transposed  $K$ -dimensional vector of the control variables;  $d_{it}$  represents the geographical distance (straight line) of each household from its nearest Ro-Ro port, which varies with time  $t$ ;  $s_{it}$  is an indicator that is coded 1 if the agricultural household is located on the same island as the Ro-Ro port or 0 otherwise;  $c_i$  is the household fixed effect;  $e_t$  is the time fixed effect; and lastly  $u_{it}$  represents the model residual, which we assume to follow a white-noise process on conditioning on our controls.

The strength of our strategy is that it allows us to incorporate the archipelagic structure of the Philippines into our specification. More particularly, the term  $\beta_4 d_{it} * s_{it}$  permits us to observe the impact of the distance from a Ro-Ro port for agricultural households that are on the same island as the Ro-Ro port against those that are on different islands. For agricultural households located on the same island as the Ro-Ro port ( $s_{it} = 1$ ), the change in income with respect to the change in distance is given by  $\frac{\partial y_{it}}{\partial d_{it}} = \beta_2 + \beta_4$ . Conversely, the change in income with respect to the change in distance for agricultural households located on a different island ( $s_{it} = 0$ ) is given by  $\frac{\partial y_{it}}{\partial d_{it}} = \beta_2$ .

#### 3.2 Children's Education

To investigate the impact of the Ro-Ro policy on children's education, we employ the difference-in-difference (DID) structure based on the seminal work of Ashenfelter and Card (1985). We conduct our analysis at the municipality level and construct a two-period, fully interacted model that accounts for the age level and sex variations in the school attendance in each municipality. Since the Ro-Ro policy commenced in 2003, we use 2000 as our pre-treatment period and 2010 as our post-treatment period. Our DID model is specified as:

$$y_{asmt} = \delta_a(D_m \cdot T_t \cdot S_s \cdot A_a) + \theta_a(D_m \cdot T_t \cdot A_a) + \beta_1 D_m + \beta_2 T_t + \beta_{3a} A_a + \beta_4 S_s + \phi_{asmt} + \mu_m + e_{asmt}$$

where:

$$\phi_{asmt} = \beta_{5a}(D_m \cdot A_a) + \beta_6(D_m \cdot S_s) + \beta_{7a}(S_s \cdot A_a) + \beta_{8a}(D_m \cdot S_s \cdot A_a) + \beta_9(T_t \cdot S_s) + \beta_{10a}(T_t \cdot A_a) + \beta_{11a}(T_t \cdot S_s \cdot A_a)$$

In our equation  $y_{asmt}$  refers to the school attendance rate in municipality  $m$  in period  $t$  for children of age  $a$  and sex  $s$ . As may be noted from our choice of subscripts, our data are stacked by age, sex, municipality, and period. The variable  $D_m$  denotes treatment assignment. This is coded 1 if the municipality is considered to be part of the treatment group or 0 otherwise. Time periods are indicated by  $T_t$ , which is coded 1 for the post-treatment period or 0 for the pre-treatment period. The age level and sex are represented by  $A_a$  and  $S_s$ , respectively.  $S_s$  is coded 1 if the child is male or 0 otherwise.

Meanwhile, the parameters  $\beta_1, \beta_2, \beta_{3a}$ , and  $\beta_4$  denote the average differences among treatment groups ( $D$ ), periods ( $T$ ), age levels ( $A$ ), and sex ( $S$ ), respectively. Additionally,  $\phi_{asmt}$  contains interactions across treatment groups, periods, age levels, and sex, capturing heterogeneity in school attendance. The municipality-level fixed effect is captured by  $\mu_m$ . This term allows us to control for the time-invariant characteristics that are common within municipalities. Finally,  $e_{asmt}$  is the model residual, which we assume to exhibit a white-noise process after conditioning on our control variables.

In our specification the term  $\delta_a S_s + \theta_a$  represents our DID estimator, which shows the impact of Ro-Ro port operation on children's school attendance. We note that we suppress the interaction term for  $\delta_a$ , allowing us directly to estimate separate DID coefficients  $\gamma_{as} = (\delta_a S_s + \theta_a)$  for males and females in the same equation.<sup>4</sup>

### 3.2.1 Treatment Identification

We based the treatment assignment of municipalities on their distances from two groups of ports. In our analysis we distinguish between Ro-Ro and non-Ro-Ro ports in both the pre-treatment and the post-treatment period. Using the straight-line distance formula  $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$ , we compute the distances of each municipality from the nearest Ro-Ro and non-Ro-Ro port. We compare these computed distances and retain the smallest value. If the distance from the nearest Ro-Ro port is smaller than the distance from the nearest non-Ro-Ro port, then we assign the municipality to the treatment group. On the other hand, if the distance from the nearest Ro-Ro port is larger than the distance from the nearest non-Ro-Ro port, then we assign the municipality to the control group.

### 3.3 Household Expenditure on Food, Alcoholic Beverages, and Tobacco

The goal of our analysis is to reveal the change in consumption behavior of households after the operation of Ro-Ro ports through their expenditure on food, alcoholic beverages, and tobacco. To achieve this goal, we construct a three-year panel that spans from 2003 to 2009. We verify changes in household expenditure on food, alcoholic beverages, and tobacco using the following model:

$$Y_{it} = \alpha + \beta_t + \delta I(T_t = 1) + \pi Z_{it} + \gamma_i + \varepsilon_{it}$$

<sup>4</sup> For a complete discussion of the model see Francisco (2016), p. 59-64.

where  $Y_{it}$  is the outcome variable for household  $i$  at time  $t$ . In our equation  $\beta_t$  denotes the year fixed effect;  $I(T_t = 1)$  is an indicator function with the value of 1 if the household is treated in year  $t$  or 0 otherwise;  $Z_{it}$  is a vector containing the characteristics of household  $i$  in year  $t$ ;  $\gamma_i$  is the household fixed effect; and  $\varepsilon_{it}$  is the model residual, which we assume to have zero mean and to be uncorrelated with our control variables.

To check the consistency of our results, we account for differences in household income using the following model:

$$Y_{it} = \alpha + \beta_t + \beta_k + \beta_{kt} + \delta_0 I(T_t = 1) + \delta_k I(T_t = 1) * J(Inc = k) + \pi Z_{it} + \gamma_i + \varepsilon_{it}$$

We add  $\beta_k$  to capture differences in household income groups;  $\beta_{kt}$ , which contains the interaction between the household income group and the year; and  $\delta_k$  to show the impact of the Ro-Ro policy on household expenditure for each income group.

### 3.3.1 Treatment Identification

We likewise base our treatment assignment on the geographic distance of households from the nearest Ro-Ro and non-Ro-Ro ports. In this study we use households that are near the non-Ro-Ro ports as our counterfactual. With the aid of the straight-line distance formula, we compute the distances of each household from a Ro-Ro and a non-Ro-Ro port. Then we compare these values and retain the smallest. Households that are nearest to a Ro-Ro port are assigned to the treatment group, while households that are nearest to a non-Ro-Ro port are assigned to the control group.

Given that our data structure is a three-year panel for 2003, 2006, and 2009, we match our treatment assignment with the timing of nautical highway operations. As previously discussed, the operation of the Western Nautical Highway and Maharlika/Pan-Philippine Highway inaugurated the Ro-Ro terminal system in 2003. Subsequently the Central Nautical Highway opened in 2008 and the Eastern Nautical Highway in 2009. This means that we have the same set of households assigned to the treatment and control groups in 2003 and 2006. Meanwhile, we assign additional households to the treatment group in 2009, due to the operation of the Central Nautical Highway and Eastern Nautical Highway.

## 4. DATA

### 4.1 Household Income and Expenditure

The data for our analysis on agricultural household income as well as household expenditure on food, alcoholic beverages, and tobacco are mainly sourced from the Family Income and Expenditure Survey (FIES) of the Philippine Statistics Authority (PSA). The FIES collects information on household-level characteristics, consumption, income, and expenditure. It has conducted this survey every three years since 1985. We used the FIES three-year panel for 2003, 2006, and 2009.

In terms of sample selection, we limit our samples to agricultural households included in the three-year panel for our analysis on agricultural household income. We focus on agricultural households, because they tend to have a low income and suffer the most from poverty. On the other hand, we use all the samples for our analysis on household expenditure. We deflate the income data using the region-specific and year-specific consumer price index (CPI) for all commodities, sourced from the PSA.

## 4.2 Children's Education and Related Data

Our primary source of data is the Census of Population and Housing (CPH) survey of the PSA, from which we compute the school attendance rate of 5 to 21<sup>5</sup> year olds in each municipality. The CPH is a nationally representative survey designed to gather information on the size and distribution of the Philippine population. The survey contains information about the demographic, social, economic, and cultural characteristics of the population. We utilize data on sex, date of birth, and school attendance. In addition, we employ the Statement of Income and Expenditure (SIE) of the Department of Finance's Bureau of Local Government Finance to calculate the per capita tax revenue in each municipality, which we use as a proxy for household income. The SIE contains financial information on local government units in the Philippines. We use the total employed population in calculating the per capita tax revenue to obtain a more precise proxy for household income.

## 4.3 Ports and Geographic Data

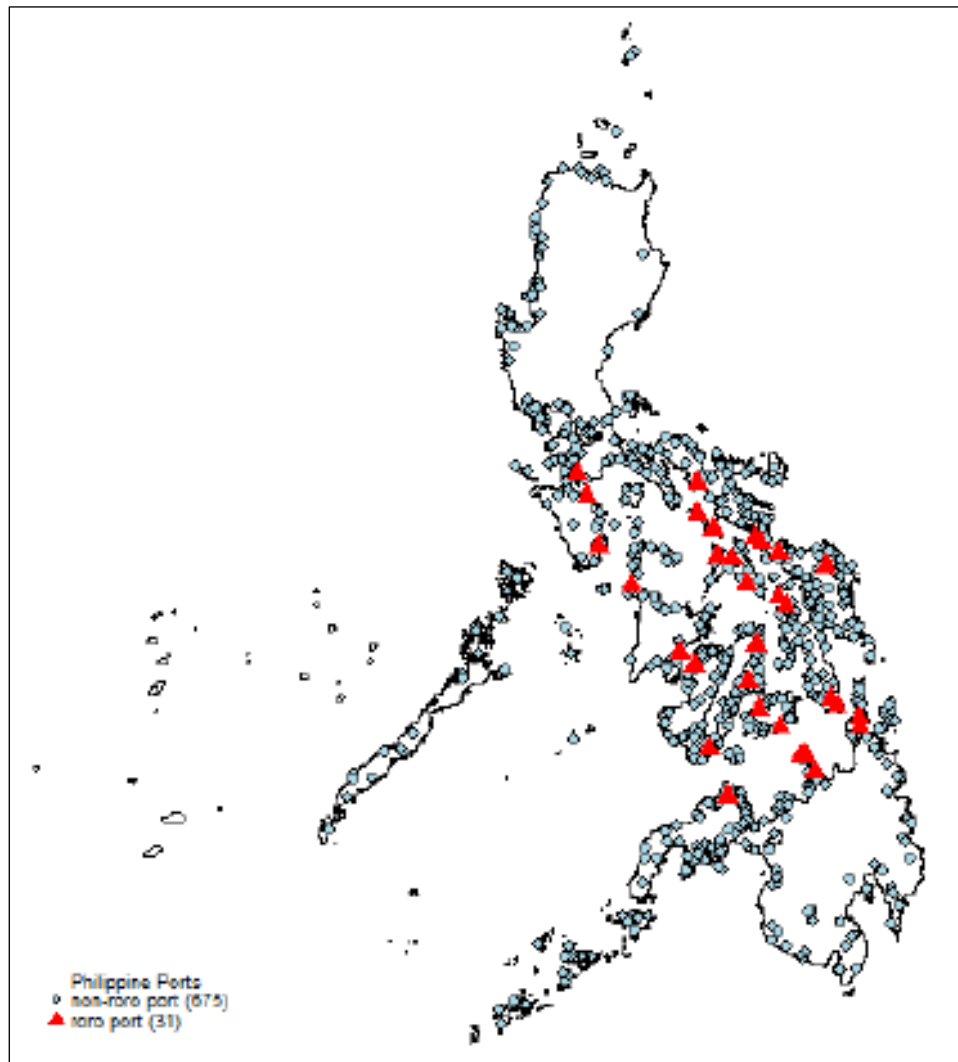
We obtain our list of Ro-Ro ports from the Philippine Ports Authority. We combine this list with the information from the Philippine Ports Inventory provided by the PSA. This document contains the list of all the ports in the Philippines with information on their status (i.e. operational or non-operational). We only include public ports in our data set.

Figure 2 shows the location of both Ro-Ro and non-Ro-Ro ports in the country, and it is notable that most Ro-Ro ports are in the areas of Luzon, Visayas, and Mindanao, which are facing problems of poverty and underdevelopment.

Meanwhile, the data on geographic coordinates or specific locations are from the Data Kit of Official Philippine Statistics (DATOS) of the PSA. The DATOS enables us to compute the distances required in our analyses. Finally, we combine all our data using the Philippine Standard Geographic Code (PSGC) as an identifier. The PSGC is also sourced from the PSA. It is composed of a nine-digit code, with parts corresponding to a specific administrative division of the Philippines.

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<sup>5</sup> We note that the survey question on school attendance is only asked for individuals aged 5 years and above, while the survey question on employment is only asked for individuals aged 15 and above.

**Figure 2: Map of Ports in the Philippines**

Note: Only operational ports are included.

Sources: PSA's Philippine Ports Inventory and Philippine Ports Authority.

## 5. RESULTS

We assess the impacts of the Ro-Ro policy in the Philippines by performing three separate analyses at the household and municipality levels. In this study we investigate the changes in agricultural household income; children's education; and households' expenditure on food, alcoholic beverages, and tobacco. We present our estimates in the following sections.

### 5.1 Agricultural Household Income

Our analysis of agricultural household income is important, because agricultural households comprise the poorest segment of the Philippine population. While the causes of poverty may vary depending on the location, some of the attributed factors are the lack of access to finance and non-farm opportunities, especially in rural areas.

Therefore, understanding how government policies such as the Ro-Ro policy affect agricultural households would be beneficial for future policy decisions.

Our estimates of marginal effects in Table 1 show that the distance from a Ro-Ro port is indeed an important factor for agricultural household income. As our results exhibit, agricultural households that are closer to Ro-Ro ports have a higher family income. This finding is consistent even if we allow for variation in island location. In fact, we notice that the impact of a Ro-Ro port is relatively larger for agricultural households that are on different islands. Our results therefore suggest that Ro-Ro port operation brings income opportunities to agricultural households that are near the area, and an island location does not limit these opportunities.

**Table 1: Log of Total Family Income**

Log of distance from the nearest Ro-Ro port	-0.209343** (0.090491)
Log of distance from the nearest Ro-Ro port × same island as a Ro-Ro port	0.179476** (0.091062)
HH labor force (above 15 but less than 60 yrs)	0.059166*** (0.009992)
With a car	0.222654*** (0.080144)
With a motorcycle	0.214667*** (0.061287)
With access to electricity	0.049596* (0.027291)
Sex of the household head	0.105184 (0.075442)
Age of the household head	0.003371 (0.002581)
Years of education of the household head	-0.000355 (0.006920)
Year fixed effect	YES
<b>Marginal Effects of Distance from the Nearest Ro-Ro Port:</b>	
On the same island	-0.029868*** (0.010198)
On a different island	-0.209343** (0.090491)
<i>N</i>	3,892
<i>R-squared:</i>	
<i>within</i>	0.083
<i>between</i>	0.0039
<i>overall</i>	0.0017

Notes: \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. The standard errors reported in parentheses are heteroskedasticity-robust. The marginal effects are computed using the Delta method.

There are two components of agricultural household income, namely (1) income from agricultural sources/activities and (2) income from nonagricultural sources/activities. In Table 2 we examine the effect of Ro-Ro port operation on the income from agricultural sources/activities. Our marginal effect estimates imply that Ro-Ro port operation stimulated agriculture-related activities on nearby islands. Based on our results, agricultural households on nearby islands that are geographically closer to the Ro-Ro port have a higher income from agricultural sources/activities. A possible explanation is that the presence of a Ro-Ro port on a nearby island may have stimulated agricultural productivity through improved access to inputs and technology. The study by Benziger (1996) notes that the use of fertilizer per unit of land and machinery per work also increases with access to infrastructure and urban markets, thus leading to higher land and labor productivity. Similarly, the study by Khandker, Lavy, and Filmer (1994) observes greater use of agricultural input and extension services with improved access to infrastructure.

**Table 2: Log of Total Income from Agricultural Sources/Activities**

Log of distance from the nearest Ro-Ro port	−0.199040** (0.084028)
Log of distance from the nearest Ro-Ro port × same island as the Ro-Ro port	0.178996** (0.084694)
HH labor force (above 15 but less than 60 yrs)	0.048616*** (0.010787)
With a car	0.268230*** 0.085638
With a motorcycle	0.221301*** 0.068425
With access to electricity	0.057021* 0.030425
Sex of the household head	0.098479 0.093909
Age of the household head	0.001750 0.002775
Years of education of the household head	−0.003052 0.007437
Year fixed effect	YES
<b>Marginal Effects of Distance from the Nearest Ro-Ro Port:</b>	
On the same island	−0.020045* (0.010690)
On a different island	−0.199040** (0.084028)
<i>N</i>	3,892
<i>R-squared</i>	
<i>within</i>	0.0522
<i>between</i>	0.0001
<i>overall</i>	0.0003

Notes: \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. The standard errors reported in parentheses are heteroskedasticity-robust. The marginal effects are computed using the Delta method.

Meanwhile, our estimates in Table 3 suggest that agricultural households that are located on the same island as a Ro-Ro port shifted to non-agriculture-related activities. We view this finding positively, since one of the factors attributed to rural poverty is the lack of non-farm opportunities for agricultural households. A relevant study (Fan and Chan-Kang 2004) explains that infrastructure and road access often encourage small non-farm businesses. One study (Fan and Rao 2002) also highlights the importance of non-farm opportunities to agricultural households, as these helped the poor to survive during the post-green revolution in many Asian countries.

**Table 3: Log of Total Income from Nonagricultural Sources/Activities**

Log of distance from the nearest Ro-Ro port	-0.263973 (0.221448)
Log of distance from the nearest Ro-Ro port × same island as a Ro-Ro port	0.191621 (0.222453)
HH labor force (above 15 but less than 60 yrs)	0.106646*** (0.022470)
With a car	-0.056328 (0.145430)
With a motorcycle	0.134804 (0.131336)
With access to electricity	0.011163 (0.066439)
Sex of the household head	0.038321 (0.189253)
Age of the household head	0.016227** (0.007306)
Years of education of the household head	0.016914 (0.014545)
Year fixed effect	YES
<b>Marginal Effects of Distance from the Nearest Ro-Ro Port:</b>	
On the same island	-0.072352*** (0.020883)
On a different island	-0.263973 (0.221448)
<i>N</i>	3,891
<i>R-squared</i>	
<i>within</i>	0.0578
<i>between</i>	0.0396
<i>overall</i>	0.0348

Notes: \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. The standard errors reported in parentheses are heteroskedasticity-robust. The marginal effects are computed using the Delta method.



In summary, our findings in this section reveal that Ro-Ro port operation is beneficial for agricultural households in general. Our results are consistent with previous studies (Escobal 2001; Malmberg, Ryan, and Pouliquen 1997), which reveal that transport infrastructure provides opportunities to the local population, as it contributes to the profitability of both farm and non-farm sectors. One of our important findings in this section is that agricultural households close to Ro-Ro ports found non-farm opportunities, while agricultural households on nearby islands increased their agricultural income, probably due to better inputs and easier access to markets for their products.

## 5.2 Children's Education

Many regard education as a key policy tool in fighting poverty in the Philippines. Despite government efforts to provide free access to primary and secondary education, which the Constitution mandates, the education sector still faces problems with low enrollment and completion rates in rural and highly disadvantaged areas. In this section we study the impact of Ro-Ro port operation on children's education by examining changes in municipality-level school attendance.

The results of our analysis are shown in Table 4, in which we observe significant increases in school attendance for both males and females in municipalities near the Ro-Ro ports. This impact is observed earlier in females, as the enrollment at the pre-primary level increased. We note that prior to 2012 the pre-primary level was non-compulsory in the Philippines. Hence, this result implies some improvement in parents' capability to send their children to school. Furthermore, we observe a solid increase in the school attendance of females at the secondary and tertiary levels. Several studies (Orbeta 2003; Johanson 1999) mention that school attendance and educational attainment are relatively high for females compared with males in the Philippines, since the population believes that education increases their labor participation (Quisumbing, Estudillo, and Otsuka 2004; Sakellariou 2004). In addition, a study (Orbeta 2003) explains that employment opportunities are more readily available for school-age males than for females, providing males with the option to leave school. On a positive note, we also see a consistent increase in male school attendance from age 6 to age 20. This implies that male children in areas near the Ro-Ro ports are going to school, where they should be. Our finding is important, because school-age males have a tendency to drop out of school due to financial problems.

Using the total population of children in school for each age level, we compute the equivalent increase in school attendance using our beta estimates, which we show in Table 5. Based on our results, the largest equivalent increases in school attendance for males and females are observed at the primary level. We also notice that the increase in male students at the primary and secondary levels is larger than that of female students. Our results are similar to those of a study (Levy 1996) conducted in Morocco, where increases in children's school attendance were apparent in areas with improved roads.

**Table 4: Estimates of School Attendance**

	Male	Female
<b>Pre-primary Level</b>		
Age 5	0.01610 (0.00991)	0.02016** (0.00977)
<b>Primary Level</b>		
Age 6	0.03682*** (0.00957)	0.05557*** (0.00988)
Age 7	0.03910*** (0.00715)	0.02170*** (0.00650)
Age 8	0.01809*** (0.00591)	0.00910 (0.00571)
Age 9	0.01147** (0.00503)	0.00866 (0.00544)
Age 10	0.01285** (0.00529)	0.01271** (0.00521)
Age 11	0.01192** (0.00519)	0.00757 (0.00535)
Age 12	0.01727*** (0.00543)	0.00654 (0.00518)
<b>Secondary Level</b>		
Age 13	0.01865*** (0.00644)	0.01790*** (0.00558)
Age 14	0.02185*** (0.00655)	0.02040*** (0.00582)
Age 15	0.03063*** (0.00687)	0.02886*** (0.00693)
Age 16	0.02929*** (0.00765)	0.02497*** (0.00785)
<b>Tertiary Level</b>		
Age 17	0.01663** (0.00839)	0.03286*** (0.00863)
Age 18	0.02036** (0.00839)	0.02104** (0.00905)
Age 19	0.02854*** (0.00891)	0.01820** (0.00901)
Age 20	0.02233*** (0.00854)	0.02712*** (0.00872)
Age 21	0.01452 (0.00903)	0.02207** (0.00925)
N:		
<i>observations</i>	104,598	
<i>groups</i>	1,539	
R-squared:		
<i>within</i>	0.8491	
<i>between</i>	0.0016	
<i>overall</i>	0.7965	

Notes: \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. The model controls for provincial and municipality-level fixed effects. Heteroskedasticity-robust standard errors are reported in parentheses.

**Table 5: Equivalent Increases in School Attendance**

Age	Total Population (in School)		Beta Estimates		Equivalent Number of Individuals		
	Male	Female	Male	Female	Male	Female	Total
<b>Pre-primary Level*</b>							
5	243,731	225,557	0.01610	0.02016	3,923	4,548	8,471
				<i>Subtotals</i>	3,923	4,548	8,471
<b>Primary Level</b>							
6	241,516	226,035	0.03682	0.05557	8,892	12,560	21,452
7	239,119	222,901	0.03910	0.02170	9,350	4,836	14,187
8	224,904	212,718	0.01809	0.00910	4,067	1,936	6,003
9	251,031	233,958	0.01147	0.00866	2,880	2,026	4,905
10	251,208	230,433	0.01285	0.01271	3,227	2,928	6,155
11	230,498	219,521	0.01192	0.00757	2,747	1,662	4,409
12	245,050	227,684	0.01727	0.00654	4,231	1,488	5,720
				<i>Subtotals</i>	35,395	27,436	62,831
<b>Secondary Level</b>							
13	227,768	217,218	0.01865	0.01790	4,248	3,888	8,136
14	237,953	222,833	0.02185	0.02040	5,200	4,545	9,745
15	231,182	216,106	0.03063	0.02886	7,080	6,238	13,318
16	226,494	209,953	0.02929	0.02497	6,635	5,242	11,877
				<i>Subtotals</i>	23,163	19,913	43,076
<b>Tertiary Level</b>							
17	221,126	204,314	0.01663	0.03286	3,678	6,713	10,391
18	212,907	197,510	0.02036	0.02104	4,334	4,156	8,490
19	205,122	190,479	0.02854	0.01820	5,854	3,466	9,320
20	191,839	177,356	0.02233	0.02712	4,285	4,809	9,094
21	177,994	162,945	0.01452	0.02207	2,585	3,597	6,181
				<i>Subtotals</i>	20,736	22,741	43,477
<b>Total Significant Increase</b>					<b>83,217</b>	<b>74,637</b>	<b>157,855</b>

Note: \* Not compulsory prior to 2012.

As discussed in some studies (Albert et al. 2012; Maligalig et al. 2010; Orbeta 2003), income remains a primary consideration for sending children to school in the Philippines. In support of our previous findings, we likewise evaluate the changes in household income in municipalities near the Ro-Ro ports. As a proxy for household income, we use data on the tax revenue of each municipality sourced from the Statement of Income and Expenditure (SIE) of the Department of Finance (DOF). Based on our result, shown in Table 6, we confirm the increase in household income in areas near the Ro-Ro ports, which likewise indicates the increased capacity of households to send children to school.

Our results in this section therefore suggest that the Ro-Ro policy may have a long-term effect on the economy of municipalities near the Ro-Ro ports. As we have observed, the benefits that households gain are transferred to their children in the form of human capital investment. By sending children to school, households are also improving the quality of the work force in the long run and thus laying the foundation for sustained growth.

**Table 6: Log per Capita Tax Revenue**

Treatment	−0.1992341*** (0.0603927)
Year	0.2880480*** (0.0199620)
Treatment × year	0.0692498** (0.0346459)
N:	
<i>observations</i>	2,870
<i>groups</i>	1,435
R-squared:	
<i>within</i>	0.2015
<i>between</i>	0.0041
<i>overall</i>	0.0195

Notes: \*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. Heteroskedasticity-robust standard errors, clustered by province and municipality, are reported in parentheses.

### 5.3 Expenditure on Food, Alcohol, and Tobacco

The implementation of the Ro-Ro policy may have brought income opportunities to households located near the Ro-Ro ports. However, income also affects the access of households to certain commodities, like alcohol and tobacco (Wagenaar, Salois, and Komro 2009). Several studies note that different aspects of income, like the magnitude of change in income over time, duration of exposure to a certain income level, and instability of income, affect individuals' health status (Chen, Martin, and Matthews 2007; Duncan et al. 2002; McDonough et al. 1997). Typically, studies find that alcohol consumption and tobacco consumption rise with income, for example Cawley and Ruhm (2012). However, others argue that, in times of an economic downturn, the alcohol consumption increases (Pierce et al. 1994). For example, Davalos, Fang, and French (2011) use data from the US to show that state unemployment rates are positively associated with a rise in the probability of excessive drinking. Meanwhile, the evidence for tobacco consumption is also mixed. While some researchers find that a higher income leads to higher rates of smoking (e.g. Ruhm 2005), other studies show that economic downturns lead to higher unemployment rates, which are often associated with a greater prevalence of smoking (e.g. Gallus, Ghislandi, and Raya 2015).

In this section we verify this behavior in the Philippines by studying the changes in households' consumption of food, alcohol, and tobacco. Performing ideal demand estimation would be more appropriate to answer our research question. However, due to the scarcity of data on prices, we resort to difference-in-difference strategy, which will likewise provide us with some useful results.

Firstly, we examine the change in the family income of households located near the Ro-Ro ports (Table 7). Column (a) shows that there was a general increase in the family income of about 4%. However, we lose this result when we limit our samples to households with alcoholic beverage and tobacco expenditure, in columns (b) and (c), respectively.

**Table 7: Log per Capita Family Income**

	(a)	(b)	(c)
Treatment*year	0.0428** (0.0212)	0.0318 (0.0250)	0.0480* (0.0249)
<b>Controls:</b>			
Year	Yes	Yes	Yes
Treatment	Yes	Yes	Yes
Urban/rural			
1 – urban	0.0313 (0.1222)	–0.4176*** (0.1098)	0.0100 (0.1610)
Total members employed	0.0157*** (0.0049)	0.0185*** (0.0058)	0.0144** (0.0058)
<b>Household class of worker</b>			
<i>Worked for a private establishment</i>	–0.0480 (0.0352)	0.0067 (0.0452)	–0.0167 (0.0441)
<i>Worked for the government</i>	0.0613 (0.0435)	0.0794 (0.0547)	0.1097*** (0.0547)
<i>Self-employed w/o any employee</i>	–0.0761** (0.0359)	–0.0163 (0.0464)	–0.0449 (0.0453)
<i>Employer in own f.o.b./farm</i>	0.0022 (0.0383)	0.0600 (0.0490)	0.0193 (0.0480)
<i>Worked w/ pay in own f.o.b./farm</i>	–0.1792 (0.1184)	–0.1066 (0.1648)	–0.0550 (0.1695)
<i>Worked w/o pay in own f.o.b./farm</i>	–0.0799 (0.0633)	–0.0826 (0.0877)	–0.0831 (0.0803)
<b>Household type</b>			
<i>Extended family</i>	–0.1850*** (0.0121)	–0.1920*** (0.0147)	–0.1972*** (0.0149)
<i>With 2/ more nonrelated members</i>	–0.0257 (0.1245)	0.1148 (0.1697)	–0.1848 (0.1661)
<i>N</i>	16,603	11,653	11,521
<i>R-squared</i>	0.0451	0.0529	0.0516

Notes: (a) All the samples, (b) including only those with alcoholic beverage expenditure, and (c) including only those with tobacco expenditure.

f.o.b. – family-operated business.

\*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. The standard errors reported in parentheses are heteroskedasticity-robust, clustered by households.

Looking at Table 8, we find no significant change in household food consumption. Since we are working with total expenditure data, we can only study changes in the aggregate family consumption instead of looking at individual food items. We run separate regressions for specific groups of food (e.g. starch). The results are not reported, as we are unable to detect any major change in terms of expenditure shares. Our results suggest that food choices have not changed, despite the higher income. One might conjecture that the additional income was spent on other items.

**Table 8: Log per Capita Food Expenditure**

	(a)	(b)	(c)
Treatment*year	0.0042 (0.0143)	0.0104 (0.0181)	0.0258 (0.0185)
<b>Controls:</b>			
Year	Yes	Yes	Yes
Treatment	Yes	Yes	Yes
Urban/rural			
1 – urban	–0.0941 (0.1032)	0.1394 (0.1832)	–0.0394 (0.1117)
<b>Per capita national income quintile</b>			
<i>Second quintile</i>	0.2630*** (0.0080)	0.2694*** (0.0098)	0.2637*** (0.0096)
<i>Third quintile</i>	0.4768*** (0.0102)	0.4748*** (0.0127)	0.4650*** (0.0127)
<i>Fourth quintile</i>	0.6812*** (0.0124)	0.6812*** (0.0162)	0.6936*** (0.0163)
<i>Fifth quintile</i>	0.9235*** (0.0160)	0.9042*** (0.0225)	0.9213*** (0.0230)
<i>N</i>	19,551	13,218	13,238
<i>R-squared</i>	0.2528	0.2488	0.2559

Notes: (a) All samples, (b) including only those with alcoholic beverage expenditure, and (c) including only those with tobacco expenditure.

\*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. The standard errors reported in parentheses are heteroskedasticity-robust, clustered by households.

Interestingly, Table 9 suggests that households' expenditure on alcoholic beverages decreased with the operation of the Ro-Ro ports. In column (b) we try to let this effect vary by income quintile; however, we find no significant differences among the income groups. The interaction of treatment and year, on the other hand, remains significant and consistent with our estimate in column (a).

It is important to note that, since we estimate our expenditures separately, we are unable to identify the direction of the relationship between changes in household income and alcoholic beverage expenditure. However, one plausible explanation is that the increase in income that we observed in Table 7 may be a result of increased access to job opportunities in areas near the Ro-Ro ports, providing households with more productive use of their time.

Meanwhile, we notice a decrease in the expenditure on tobacco for households living near the Ro-Ro ports (Table 10). Column (b) shows no significant differences in the effect among income groups; however, the interaction of treatment and year remains significant and similar to our result in column (a). Tobacco often complements alcohol consumption. Thus, the similar decrease in tobacco expenditure is not surprising. In fact, several studies (Auld 2005; Kenkel and Ping 1999) recognize the correlation between the consumption of alcoholic beverages and the consumption of tobacco.

**Table 9: Log per Capita Alcoholic Beverage Expenditure**

	(a)	(b)
Treatment*year	−0.1959** (0.0778)	−0.2045** (0.0962)
<b>Treatment*year*per capita national income quintile</b>		
<i>Second quintile</i>		0.0002 (0.0881)
<i>Third quintile</i>		0.0466 (0.1030)
<i>Fourth quintile</i>		−0.0350 (0.1262)
<i>Fifth quintile</i>		−0.1349 (0.1537)
<b>Controls and Interactions:</b>		
Year	Yes	Yes
Treatment	Yes	Yes
Per capita national income quintile	Yes	Yes
Per capita national income quintile*year		Yes
Urban/rural		
1 – urban	−0.2285 (0.8939)	−0.1960 (0.8716)
<i>N</i>	13,218	13,218
<i>R-squared</i>	0.0411	0.0414

Notes: (a) Basic model and (b) model with income variation.

\*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. The standard errors reported in parentheses are heteroskedasticity-robust, clustered by households.

**Table 10: Log per Capita Tobacco Expenditure**

	(a)	(b)
Treatment*year	−0.1477** (0.0703)	−0.1923** (0.0809)
<b>Treatment*year*per capita national income quintile</b>		
<i>Second quintile</i>		0.0166 (0.0772)
<i>Third quintile</i>		0.0193 (0.0942)
<i>Fourth quintile</i>		0.0506 (0.1187)
<i>Fifth quintile</i>		−0.0422 (0.1765)
<b>Controls and Interactions:</b>		
Year	Yes	Yes
Treatment	Yes	Yes
Per capita national income quintile	Yes	Yes
Per capita national income quintile*year		Yes
Urban/rural		
1 – urban	0.1377 (0.4844)	0.1772 (0.4907)
<i>N</i>	13,238	13,238
<i>R-squared</i>	0.0314	0.0354

Notes: (a) Basic model and (b) model with income variation.

\*, \*\*, and \*\*\* indicate significance at the 10%, 5%, and 1% alpha levels, respectively. The standard errors reported in parentheses are heteroskedasticity-robust, clustered by households.

In summary, our results in this section show that the Ro-Ro port operation lowered the household consumption of alcohol and tobacco in areas near a Ro-Ro port. We take the observed increase in family income as an indication of the increased availability of job opportunities near the Ro-Ro port, taking idle time away from households.

## 6. CONCLUSION

The results presented in this study demonstrate how the Ro-Ro policy affected households and municipalities in the Philippines. Our estimates showed that the government's effort to improve the efficiency and affordability of inter-island transport within the country resulted in several opportunities that benefitted the communities living near the Ro-Ro ports.

In our first analysis, we confirmed that Ro-Ro port operation stimulates both farm and non-farm activities for agricultural households. We also noticed that an island location does not hinder the benefits of Ro-Ro port operation. Interestingly, we found indications that agricultural activities on nearby islands are encouraged by Ro-Ro port operation. In contrast, non-agricultural activities flourish on the islands where the Ro-Ro ports are located.

In our second analysis, we discovered an increase in children's school attendance in the municipalities near the Ro-Ro ports. Particularly, our estimates exhibited an increase in female school attendance from as early as the pre-primary level until the tertiary level. Additionally, we noticed a consistent increase in male school attendance for ages 5 to 20. Overall, our results revealed that the benefits gained from Ro-Ro port operation are transferred to children in the form of human capital investment, which is expected to benefit local economies in the long run.

Finally, in our third analysis, we noticed a decrease in the consumption of alcoholic beverages and tobacco along with an increase in income in the areas near the Ro-Ro ports. Alcoholic beverages and tobacco are usually consumed together; hence, the similar decreases in household consumption are not surprising.

Overall, this paper underscores the benefit of providing an efficient and affordable mode of transfer within a country. Although the archipelagic structure of the Philippines makes it geographically different from most other countries, its experience with the Ro-Ro policy strongly demonstrates that the benefits of such kinds of policy extend beyond the reduction of transport costs. Our results exhibit some examples of unintended gains from linking local economies together, which could easily be overlooked by policy makers. An important take-away from our paper is that the greatest gains from this kind of policy are earned by those that are located near the infrastructure. Thus, the location of infrastructure proves to be an important factor in designing targeted policies. On a final note, this paper may not have fully unveiled the overall impact of the Ro-Ro policy, as we only focused on three topics. For future studies we encourage other researchers to broaden the scope to uncover not only economic gains but also economic losses from this policy.



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## APPENDIX 1: MAJOR ISLAND GROUPS OF THE PHILIPPINES

