When Small Gets Too Big: Exploring Diseconomies of Scale in Island Economies

Diseconomies of scale in public services in Small Island Developing States (SIDS) and policy options

Working paper

20-11-2024

Paul Tauxe

Economisch Bureau Amsterdam
onderzoek - advies - interim-management

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Author: Paul Tauxe

Amsterdam, Economisch Bureau Amsterdam, november 2024

Herengracht 514, 1017 CC Amsterdam

Abstract

Small Island Developing States (SIDS) face environmental, social, and economic challenges, like diseconomies of scale. The literature review in this study synthesizes the determinants of diseconomies of scale and the loss of economies of scale in SIDS, along with strategies to address these. In addition, this study analyzes data from 2018 to 2022 of 215 countries to find solutions that policymakers can apply to mitigate the diseconomies of scale experienced by small island economies. Based on a ordinary least squares linear regression, this study establishes correlations between final public consumption expenditures and determinants of diseconomies of scale in islands. The analysis concludes that imports and the use of natural resources are likely to create diseconomies of scale in the public sector. In contrast, high population density and exports may allow for economies of scale. Overall, being a small island economy is *ceteris paribus* associated with an increase in public consumption expenditure of one percentage point of GDP compared to other countries.

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1. Introduction

Small Island Developing States (SIDS) are 57 islands scattered across the globe that were officially recognized in 1992 as a special bloc of developing nations. These islands are characterized by environmental, social and economic challenges such as small population, high transportation costs due to isolation, limited or polluted natural resources, imperfect competition and conflicts between native inhabitants and foreigners.

Due to their unique issues, SIDS receive assistance from the global community, like the United Nations Action Programme, which aims to promote sustainable economic growth, for example.

Among the barriers to economic development of SIDS, scientific literature almost unanimously mentions diseconomies of scale. Strictly spoken, diseconomies of scale refer to the increase in unit production costs as quantities produced increase. For SIDS however, the inability to realize economies of scale seems more relevant from a policy perspective as it refers to high cost of production due to low scale. Therefore, this research applies a broad definition of diseconomies of scale that includes the inability to realize economies of scale. Economies of scale occur when unit production costs decrease as quantities produced increase.

The numerous vulnerabilities that SIDS face create multiple diseconomies of scale, which constitute a significant barrier to economic development. Currently, diseconomies of scale do not appear to have been specifically studied for small island economies, either theoretically or empirically in the scientific literature. Consequently, this analysis aims to enrich the literature by compiling existing knowledge on the subject in the literature review and to provide new solutions that can be applied by economic development policies through the econometric analysis. This study addresses the question: How can governments of SIDS mitigate diseconomies of scale or realize economies of scale?

To answer this question, ordinary least squares regressions arer performed on final government consumption expenditure and determinants of diseconomies of scale listed in the literature review. Results from that analysis offer insights into diseconomies of scale policies to realize economies of scale.

The empirical results corroborate the literature review by suggesting that the use of natural resources and reliance on imports increase public consumption expenditure, reflecting diseconomies of scale. The results also indicate that higher population density may decrease public consumption expenditure. In addition, the econometric analysis suggests that exports may enable economies of scale.

Finally, the study suggests that being a small island economy is *ceteris paribus* associated with an increase in public consumption expenditure of 1 percentage point of GDP compared to other countries.

The following of this working includes, in order: a literature review on the diseconomies of scale experienced by islands (chapter 2), the method used for the econometric analysis (chapter 3), the empirical results (chapter 4), a discussion (chapter 5) and a conclusion summarizing the main findings (chapter 6).

2. Literature Review

Diseconomies of scale negatively impact firms' profitability and may arise from public regulations or laws

Diseconomies of scale occur when the average cost of an economic organization increases as the quantities produced grow. Conversely, economies of scale refer to the situation where the average cost decreases as the volume of production increases. Figure 1 provides an example illustrating economies and diseconomies of scale.

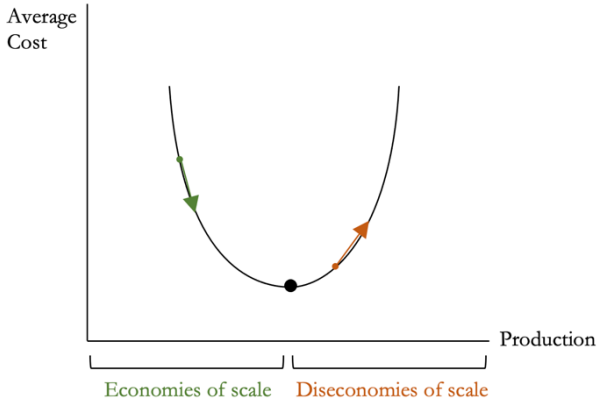


Figure 1: Example illustrating economies and diseconomies of scale

Source: Economisch Bureau Amsterdam (2024)

To produce as efficiently as possible, companies minimize their average costs. An illustration of this minimum is represented by the black dot in Figure 1. The production volume needed to reach this point is called the *minimum efficient scale*.

Canback et al. (2006) tested several hypotheses on economies and diseconomies of scale based on the work of the 2009 Nobel laureate Oliver Williamson. Employing weighted regressions on data from manufacturing companies listed on the stock exchange and headquartered in the United States in 1998, the authors conclude that diseconomies of scale negatively influence the growth and profitability of companies. This influence manifests through atmospheric consequences, bureaucratic insularity, and limitations on incentives[1].

According to Wiseman (2014), diseconomies of scale result from public laws. The author explains that regulatory efforts to mitigate negative externalities stemming from production activities often occur post facto, risking irreversible damage. Moreover, existing regulatory levels may become outdated as the economic environment evolves (Wiseman, 2014). Indeed, an economic activity may, at its inception, create negligeable negative externalities that do not require regulation. But the increase in production leads to a significant rise in damages caused to society. These damages result in costs that give rise to diseconomies of scale. Wiseman (2014) proposes regulating economic activity at its beginning. This regulation involves threshold for total damage per industry. If this threshold is about to be reached, industry agents face heavier regulation to prevent exceeding the limit. The threshold is not dependent on the number of agents in the industry and is flexible. Thus, this system minimizes the creation of diseconomies of scale by internalizing externalities from the outset of the activity (Wiseman, 2014). And through its flexibility, it minimizes future costs by considering the reduction in harm as industries innovate or contract (Wiseman, 2014).

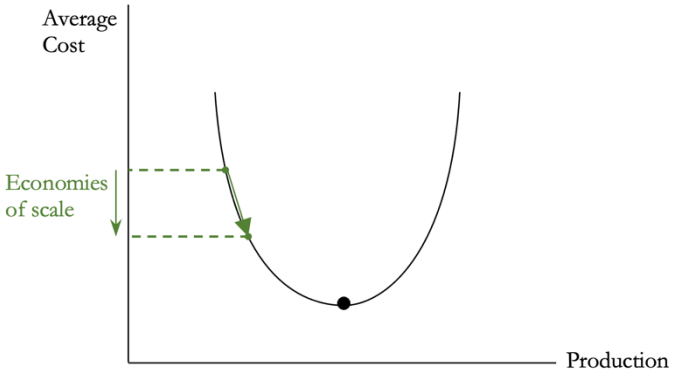
[1] Atmospheric consequences represent the situation where employees often struggle to grasp the purpose of company activities and everyone's small contribution to the whole (Canback et al., 2006). Bureaucratic insularity leads to a decrease in accountability from upper management to lower levels of the organization as the company grows, resulting in a detachment from operational reality (Canback et al., 2006). Incentive limits in employment relationships occur when companies have limited means to boost employee motivation due to potential internal conflicts and unethical behavior (Canback et al., 2006).

Factors influencing diseconomies of scale in islands include population decline and small population size, high transportation costs, conflicts between locals and migrants, import of human capital, imperfect competition, and environmental issues

Now that the general theory has been introduced, we focus on the determinants of diseconomies of scale in island economies. A general characteristic of islands is their low population size. One can conceptualize the link between a small population and economies of scale as follows:

An organization has an opportunity to achieve economies of scale up to a certain point, see Figure 2.

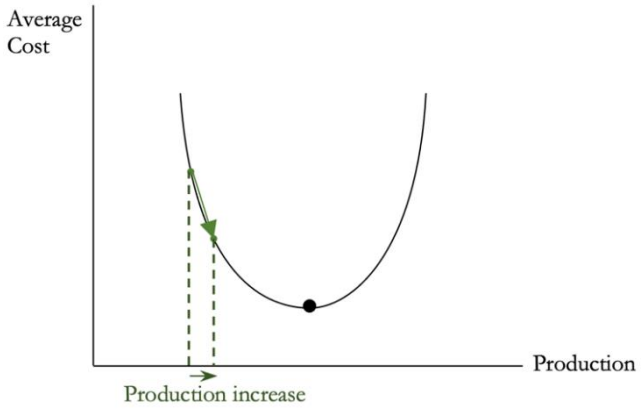
Figure 2: The organization reduces its average cost



Source: Economisch Bureau Amsterdam (2024)

To decrease these average costs, the organization must produce more, see Figure 3.

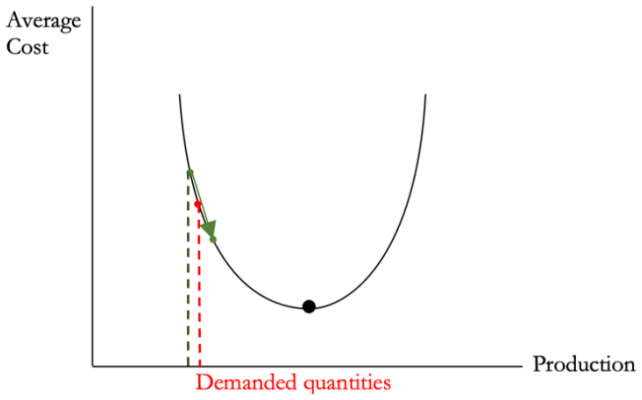
Figure 3: The organization increases its production



Source: Economisch Bureau Amsterdam (2024)

However, this increase in quantities produced is limited by the lower quantities demanded due to the small size of the population, see Figure 4.

Figure 4: A small demand constraints the supply to produce less



Source: Economisch Bureau Amsterdam (2024)

Therefore, realization of economies of scale is restricted by a small population. As a result, many organizations in SIDS may not realize economies of scale and small island societies may not benefit from them. In this study, this inability to realize economies of scale adds to the definition of diseconomies of scale and is now designated by the term 'loss of economies of scale'.

Several factors may contribute to create diseconomies of scale on small islands. An extensive overview of these determinants was made by Tisdell (2009).

Decreasing Population

According to Tisdell (2009), skilled labour on an island is prone to emigrate when wages are significantly lower than those in the emigration country. This migration reduces the size of the local population, resulting in further losses of economies of scale (Tisdell, 2009).

Transportation Cost

A significant distance between an island and major economies or international trade routes entails high transportation costs (Tisdell, 2009). In archipelagic configurations, the varying distances between islands constitute an additional source of costs for the supply of goods and services (Tisdell, 2009).

Identity

As per research by Fernandez-Abila et al. (2024), conflicts arise between the native inhabitants of islands, migrants, and organizations regarding the use of island lands. Long-standing residents may protest the loss of their lands for the creation or expansion of commercial infrastructure. This phenomenon is exacerbated in small islands because population growth worsens their unique environmental problems (Robinson et al., 2019). Disputes over land management incur costs for firms. They may be compelled to expend significant resources to meet the expectations of parties involved in the use of the island's lands. As a result, organizations may abstain from expanding their operations, which constitutes a loss of economies of scale.

Human Capital

The small population size of an island explains its dependence on skilled foreign workers. Indeed, a low number of people implies a low probability of mastering a wide range of skills. Consequently, a small population can be seen as a determining factor in reliance of island economies on foreign labour and leads to loss of economies of scale. The dependence of islands on foreign skilled labour can lead to the disappearance of training opportunities for locals (Tisdell, 2009). This is likely to exacerbate dependence on foreign workers (Tisdell, 2009), thus generating additional costs related to providing benefits to attract foreign personnel or paying salaries higher than the island's standards. For example, if the government or a company wants to increase a service for which expertise is not available on the island, it must rely on foreign labour. The stronger the demand for the service, the more the government or the company must hire foreign workers. Thus, the costs associated with attracting labour increase as the supply of the service increases, leading to diseconomies of scale.

Imperfect Competition

Due to the limited size of markets in islands, they suffer from a lack of competition in exchanged goods (Tisdell, 2009). More precisely, the number of firms operating in the industry is a function of the minimum efficient scale. Indeed, the number of companies producing at their minimum efficient scale at competitive equilibrium constitutes the maximum number of firms that can operate in the industry. However, minimum efficient scales are harder to reach due to the low population size on islands. As a result, the number of firms is reduced and a barrier to entry is created for businesses wishing to enter the market. This unfavourable economic condition is a major cause of imperfect competition in island economies. The absence of competition can remove the incentive for businesses to improve their technology. It creates inefficiency, which, accumulated over time, generates high costs and significant expenses to improve outdated technology. The industries concerned by imperfect competition in islands include international and inter-island transport, certain service sectors such as banking, and certain types of retailing and electricity distribution (Tisdell, 2009). Therefore, some of these industries may face diseconomies of scale. Additionally, diseconomies of scale should affect markets that produce heavy or bulky goods because their transportation is expensive. Also, costs increase in sectors that produce complex goods (products constructed from several other goods, for example) because they require advanced costly means of production and use various raw materials that are often imported which increases costs. Finally, markets that require expertise not existing on the island are affected.

Environmental Issues

Following Tisdell (2009), many islands face environmental problems due to their economic activities, such as pollution of natural resources due to excessive or intense consumption. Therefore, sectors relying on the exploitation of natural resources face diseconomies of scale, since their costs increase as they produce because

the raw materials they use become contaminated or scarce. According to research by Bodey et al. (2023), ecological disasters caused by invasive species are frequent on islands. The authors also mention that invasive species negatively impact local economies. For example, non-native species can destroy agricultural crops, decrease coastal productivity, and increase healthcare costs (Bodey et al., 2023). Bodey et al. (2023) indicate that methods to control and eradicate invasive species are relatively costly. The frequency of invasion of non-native species on islands and the associated costs is related to the growth of industries involving international exchange such as tourism. As a result, this specific type of biological issue is source of diseconomies of scale for the regulator.

Solutions exist to avoid diseconomies of scale. Among them are intangible services; tourism; population centralization; lightweight, non-bulky, and simple goods; as well as international and regional collaborations

Because these mechanisms increase average costs as production increases or are related to loss of economies of scale, they produce diseconomies of scale. However, some islands have shown ingenuity in overcoming these problems.

According to Azzopardi (2004), island economies have discovered strategies to generate income by focusing on unconventional services, such as niche markets in tourism activities and offshore banking. Being primarily immaterial, these activities minimize transportation costs (Azzopardi, 2004) and thus avoid inefficiencies associated with diseconomies of scale. Following Baldacchino (2002), several islands have overcome inherent obstacles such as diseconomies of scale by taking advantage of their identity. Baldacchino (2002) gives the example of a company in Prince Edward Island. This firm used the island's culinary and cultural traditions as a selling point for its products (Baldacchino, 2002).

Furthermore, tourism helps reduce the expenses associated with exporting goods from the Prince Edward Island company (Baldacchino, 2002). There are several mechanisms that use tourism to minimize transport costs and thus avoid diseconomies of scale. A company can internalize logistical costs by reflecting them in the prices of goods sold to tourists. Alternatively, it can capitalize on the air traffic generated by tourism to send its merchandise. This is less expensive than opting for a transport service using less frequented air routes. The diseconomies of scale due to transportation can also be reduced by grouping the sparse populations of archipelagos and islands into designated areas. These zones allow for the centralization of both public and private services, thereby limiting the distances traveled and their associated costs. An example of this organization is the housing policy implemented by the government of the Maldives that encourages residents to live on islands in the archipelago that are less vulnerable to natural disasters (Joint Needs Assessment, 2005). One of the many objectives of this policy is for the public and private sectors to achieve economies of scale when providing their services (Joint Needs Assessment, 2005).

Legarda (1984) advocates that small island economies engage in activities where economies of scale have a low impact. He gives the example of industries producing lightweight, low-volume goods with low complexity, such as certain types of nuts.

Bodey et al. (2023) suggest that the development of international cooperation is a solution to address threats common to many countries. Indeed, governments have an interest in collaborating to divide costs and therefore reduce diseconomies of scale. For small states, cooperation is also advocated at the regional level by the Report of the Commonwealth Secretariat (2000). The report indicates that this collaboration involves sharing regional public goods and services, which reduces costs on an individual scale.

In islands, governments often face diseconomies of scale. Local governments should experience a U-shaped relationship between population density and public expenditure. The optimal municipality size for the provision of public goods would be around 10,000 residents

This literature review concludes with an overview of the link between diseconomies of scale and municipalities in large countries, together with results relating to public spending. The purpose of this section is to provide an understanding of the diseconomies of scale specifically experienced by governments in islands.

Using a robust conditional Data Envelopment Analysis, D'Inverno et al. (2022) investigate the existence of diseconomies of scale in 307 municipalities in the Flemish region of Belgium between 2006 and 2011. The authors conclude that diseconomies of scale manifest in almost all sizes of municipalities. D'Inverno et al. (2022) also find weak evidence that around 10,000 residents is the optimal size for a municipality for the provision of public goods. As indicated by the authors, this optimal size has also been observed in Italy and Spain.

Ladd (1992) used the piecewise linear regression technique on expenditure data from all local governments in 247 large U.S. counties in 1985 to demonstrate a U-shaped relationship between population density and public expenditure. Specifically, the author shows that among counties with very low population density, those with the highest density record the lowest public costs. Conversely, for the remaining counties, the greater the demographic concentration, the higher the public expenditures (Ladd, 1992).

However, in small islands, the public sector tends to occupy a significant role. Indeed, it is not profitable for the private sector to operate in certain areas due to the absence of economies of scale (Azzopardi, 2004). This comment suggests that potential differences may be observed in practice regarding the results of this section.

In the public sector, smaller economies often experience diseconomies of scale (Lederman and Lesniak, 2018). Indeed, countries such as islands must provide public goods in small quantities due to their low population size. This characteristic hinders governments from capitalizing on economies of scale. Furthermore, the utilization of public goods is hardly profitable due to the low population. Consequently, governments from smaller economies face loss of economies of scale.

3. Methodology

Using regression analysis, the empirical study verifies whether the determinants and solutions to diseconomies of scale described in the literature review, are observed in practice for SIDS governments. Governments are studied based on their consumption expenditures or on public investment plus consumption expenditures.

A cross-section is analyzed using data from the World Bank Group, International Monetary Fund and the Centre d'Études Prospectives et d'Informations Internationales

The data for this analysis are from the World Bank Group and International Monetary Fund (IMF). Additionally, geographical data are obtained from the Centre d'Études Prospectives et d'Informations Internationales (CEPII). CEPII is a French research and expertise center on the global economy.

The databases from the World Bank consist of panel data covering over 200 countries from 1960 to 2022. These panels include real GDP per capita in purchasing power parity (PPP), public consumption expenditure, and other economic and financial indicators. The IMF provides a panel data on public investment for approximately 160 countries between 2013 and 2019. The geographical information from CEPII consists of bilateral distances between states, grouped in a cross-section format. A single panel dataset is created to compile and organize these data.

Analyzing these data as a panel is not desirable due to a large number of missing values. Therefore, a cross-section is constructed from the panel data. This new dataset consists of the most recent available observation between 2018 and 2022 for each variable. Additionally, the country of Kiribati is excluded from the cross-section because it exhibits outlier values that significantly distort the empirical analyses. Kiribati displays an incredibly high public consumption expenditure, equivalent to 70 percent of its GDP in 2021. In comparison, the other analyzed countries have an average public consumption expenditure of 17 percent of GDP. A potential explanation for this economic situation could be the significant isolation of the country, which is located in the central Pacific Ocean.

Ordinary Least Squares (OLS) is used to examine relationships

Two dependent variables expressed in percentage of GDP are examined: government final consumption expenditure and government final consumption expenditure plus public investment.

Government final consumption expenditure is preferred over total public administration expenditure because it excludes direct monetary transfers to households. These transfers are less affected by diseconomies of scale since they do not involve production.

Ordinary Least Squares (OLS) is employed to explore the relationship between small island economies and the two dependent variables. Results from that analysis offer insights into diseconomies of scale. Indeed, government consumption expenditure expressed as a percentage of GDP is a proxy for average public costs since it accounts for the size of the economy and therefore reflects the economic scale.

Models studied and their usefulness

Four models are studied:

Model 1

$$\textit{General government final consumption expenditure}_i = \textit{Import}_i + \textit{Export}_i + \textit{Population density}_i + \textit{Real GDP per capita PPP}_i + \textit{Natural resources}_i + \textit{Inflation}_i + \textit{Tax revenue}_i + \textit{Government effectiveness}_i + \textit{Distance to nearest landmass}_i + \textit{Island}_i + \textit{Island}\times\textit{import}_i + \textit{Island}\times\textit{export}_i + \textit{Island}\times\textit{distance to nearest landmass}_i + \textit{Island}\times\textit{natural resources}_i$$

The subscript "i" represents the countries in the database.

Model 2

$$\textit{General government final consumption expenditure}_i = \textit{Import}_i + \textit{Export}_i + \textit{Population density}_i + \textit{Real GDP per capita PPP}_i + \textit{Natural resources}_i + \textit{Inflation}_i + \textit{Government effectiveness}_i + \textit{Distance to nearest landmass}_i + \textit{Island}_i + \textit{Island}\times\textit{import}_i + \textit{Island}\times\textit{export}_i + \textit{Island}\times\textit{distance to nearest landmass}_i + \textit{Island}\times\textit{natural resources}_i$$

Model 2 is a replication of model 1 without tax revenues as this factor has a significant number of missing values. Removing tax revenues allows model 2 to analyze 148 countries, including 16 islands, compared to 114 countries and 10 islands for model 1.

Model 3.1

$$(\text{General government final consumption expenditure} + \text{General government investment})_i = \text{Import}_i + \text{Export}_i + \text{Population density}_i + \text{Real GDP per capita PPP}_i + \text{Natural resources}_i + \text{Inflation}_i + \text{Tax revenue}_i + \text{Government effectiveness}_i + \text{Distance to nearest landmass}_i + \text{Island}_i + \text{Island} \times \text{import}_i + \text{Island} \times \text{export}_i + \text{Island} \times \text{distance to nearest landmass}_i + \text{Island} \times \text{natural resources}_i$$

Model 3.1 is a reproduction of model 1 with the dependent variable being the sum of final consumption expenditures of governments and public investments.

Model 3.2

$$(\text{General government final consumption expenditure} + \text{General government investment})_i = \text{Import}_i + \text{Export}_i + \text{Population density}_i + \text{Real GDP per capita PPP}_i + \text{Natural resources}_i + \text{Inflation}_i + \text{Government effectiveness}_i + \text{Distance to nearest landmass}_i + \text{Island}_i + \text{Island} \times \text{import}_i + \text{Island} \times \text{export}_i + \text{Island} \times \text{distance to nearest landmass}_i + \text{Island} \times \text{natural resources}_i$$

Model 3.2 is a modified version of Model 2. It uses the sum of final consumption expenditures of governments and public investments as the dependent variable.

Models 3.1 and 3.2 expand the study of diseconomies of scale by analyzing public expenditures on infrastructure and equipment. Model 3.2 increases the number of observations compared to model 3.1.

Several robustness tests indicate that the models are robust

To ensure the robustness of the models (to avoid overfitting and test the relevance of certain factors), several steps are taken. Two specifications are added to each of the four models. The first specification eliminates the variable that has the least impact on changing the model's estimates when it is removed. The choice of this variable is typically confirmed by the Bayesian Information Criterion (BIC). The second specification builds on the model from the first specification and repeats the same process of variable removal. The results of all these specifications are in the appendix. They indicate that all models are robust. To ensure that the import and export factors are not subject to multicollinearity, a copy-paste of the four models and their specifications is analyzed with the trade balance instead of import and export. The results associated with these models are in the appendix. They confirm the robustness of the models. Each model and specification is analyzed without interaction terms. These examinations are in the appendix. They indicate that including interaction terms in the models does not lead to multicollinearity issues. Finally, the model estimates converge despite different numbers of observations and distinct countries analyzed.

The models have two dependent variables: government consumption expenditure and government consumption expenditure plus government investment. The set of independent variables includes imports, exports, population density, real GDP per capita (PPP), natural resource rent, inflation, tax revenue, government effectiveness, distance to the nearest landmass, and a dummy variable indicating island status

Many of the following economic, financial, and geographical factors are selected because the literature review identifies them as determinants of diseconomies of scale.

Government final consumption expenditure is expressed as a percentage of GDP. It includes all current government expenditures on goods and services used to provide public services. However, it excludes military expenditures which are considered part of government capital formation.

General government investment is expressed as a percentage of GDP. It corresponds to spending on infrastructure and capital assets.

Import is expressed as a percentage of GDP. It represents the value of all goods and services received from the rest of the world, excluding transfer payments, income from investments, and compensation of employees.

As a result, imports quantify the dependence and associated costs of goods and services from the rest of the world.

Export is measured as a percentage of GDP. This represents the value of all goods and services provided to the rest of the world, excluding transfer payments, income from investments, and compensation of employees.

This factor is included as it determines whether exporting production that is not sold domestically can lead to economies of scale.

Population density is the number of inhabitants per square kilometer of land area, calculated as the mid-year population. The population count doesn't include temporary refugees. Land area excludes exclusive economic zones, national claims, and inland water bodies.

The scientific literature (Ladd, 1992) indicates a U-shaped relationship between population density and public administration expenditures. Population density is preferred over population size because archipelagos can have a large population but few inhabitants on each island. Therefore, population size reflects the economic scale less effectively than population density.

Real GDP per capita PPP refers to GDP per capita based on purchasing power parity (PPP) and expressed in 2017 US dollars.

Countries with high real GDP per capita PPP may have more resources available to allocate towards public services and infrastructure.

Natural resources are expressed as a percentage of GDP. This factor represents the sum of rents from oil, natural gas, coal, minerals, and forests.

Countries rich in natural resources may be more self-sufficient vis-à-vis the rest of the world. This is especially important for isolated states to avoid additional costs due to distance.

Inflation is an annual percentage and increases the prices of goods and services purchased by the government. For example, the rise in prices can limit the number of projects the government can fund within the same budget. As a result, government consumption decreases.

Tax revenue corresponds to compulsory transfers to the government. This factor is expressed as a percentage of GDP. It excludes most social security contributions, penalties, and fines.

An increase in tax revenue provides governments with more financial resources to invest in public services.

Government effectiveness is an indicator created by Kaufmann et al. (2010). This index assesses the quality of various aspects of government, including policy implementation, public services, and more.

The consumption expenditure of an efficient government can be lower than that of less effective states due to economies of scale, for example.

Distance to nearest landmass is measured in kilometers. It represents the bilateral distances between the largest cities of either the nearest mainland country for SIDS or the nearest country for continental countries. These distances are weighted by the proportion of each city's population relative to the total population of the country.

The isolation of a territory leads to high transportation costs for goods and services purchased by governments, which in turn increases public consumption expenditure. This economic mechanism is captured by distance to the nearest mainland.

Island consists of Small Island Developing States (SIDS). SIDS are 57 islands across the globe that share unique social, economic, and environmental vulnerabilities. Studying them allows for designing policies that specifically address the exceptional challenges encountered by small island economies. This group of islands was defined in 1992.

Table 1: Average, standard deviation, minimum and maximum values for each variable and model

	Average				Minimum				Maximum			
(Model)	(1)	(2)	(3.1)	(3.2)	(1)	(2)	(3.1)	(3.2)	(1)	(2)	(3.1)	(3.2)
Import	51 (29)	51 (31)	50 (28)	51 (31)	16	1	16	16	177	190	177	190
Export	48 (34)	48 (36)	48 (33)	48 (35)	7	2	7	5	211	211	211	211
Population density	211 (732)	258 (868)	206 (756)	261 (913)	2	2	2	2	7,595	7,595	7,595	7,595
Real GDP per capita PPP	25,270 (23,995)	23,645 (23,781)	25,998 (24,444)	23,768 (23,675)	824	708	824	708	117,747	117,747	117,747	117,747
Natural resources	6 (9)	7 (11)	6 (10)	7 (10)	0	0	0	0	43	61	43	43
Inflation	13 (20)	13 (21)	12 (18)	11 (17)	2	-1	2	-1	171	171	171	171
Tax revenue	17 (7)	-	17 (7)	-	1	-	1	-	35	-	35	-
Government effectiveness	0.2 (0.9)	0.1 (1)	0.2 (0.9)	0.1 (1)	-1.7	-2.2	-1.7	-2.2	2.1	2.1	2.1	2
Distance to nearest landmass	607 (615)	592 (576)	556 (503)	542 (468)	106	106	106	106	3127	3127	2556	2556
Government consumption	17 (6)	17 (6)	-	-	2	2	-	-	38	38	-	-
Government consumption + investment	-	-	21 (7)	21 (7)	-	-	4	4	-	-	46	46
Observations	114	148	103	131	114	148	103	131	114	148	103	131
Number of islands	10	16	6	10	10	16	6	10	10	16	6	10
Number of countries	104	132	97	121	104	132	97	121	104	132	97	121

Standard deviations for each variable and model are in parentheses in the Average column.
Source: Economisch Bureau Amsterdam (2024) based on World Bank (2022), International Monetary Fund (2019) and CEPII (2011).

Except for Government effectiveness, the results in Table 1 are rounded to the nearest whole number. Government effectiveness statistics are rounded to one decimal place because the scale of this determinant is small (ranging between -2.5 and 2.5).

- Average: Each variable exhibits similar averages across the different models, except for Population density, Real GDP per capita PPP and Distance to nearest landmass.
- Minimum: The minimum values of the determinants remain stable across models aside Import, Export, and Government Effectiveness.
- Maximum: In general, parameters in each model exhibit similar maximum values.
- The factors vary significantly in each model and are incrementally heterogenous:
    - Import, Export, Tax revenue, Government consumption and Government consumption + investment: Countries differ from each other regarding these factors.
    - Real GDP per capita PPP and Distance to nearest landmass: Nations have very diverse levels of wealth and isolation.
    - Population density, Natural resources, Inflation and Government effectiveness: Countries are extremely heterogeneous regarding these factors.

4. Results

Table 2: Regression results of the four models

Dependent variable	Government consumption		Government consumption + investment	
(Model)	(1)	(2)	(3.1)	(3.2)
Import	0.155***	0.231***	0.236***	0.309***
Export	−0.147***	−0.198***	−0.213***	−0.270***
Population density	−0.002***	−0.002***	−0.003	−0.002***
Real GDP per capita PPP	0.0001	0.0001*	0.00005	0.0001*
Natural resources	0.162**	0.182***	0.276***	0.316***
Inflation	−0.042	−0.034	−0.081***	−0.110***
Tax revenue	0.323***	-	0.196	-
Government effectiveness	0.882	1.666*	2.516*	2.240*
Distance to nearest landmass	−0.001	−0.0002	−0.001	−0.001
Island	−11.597***	−10.338***	−12.243***	−11.568***
Island×Import	0.055	0.153**	0.056	0.371***
Island×Export	0.052	−0.050	0.082	−0.229***
Island×Distance to nearest land mass	0.004*	0.002	0.002	−0.001
Island×Natural resources	0.389	0.367**	0.327	−0.161
Constant	8.708***	11.928***	14.295***	15.543***
Average Total Island Effect	-	0.959**	-	-0.768***
Island import	-	0.384**	-	0.680***
Island export	-	-	-	-0.499***
Island natural resources	-	0.549**	-	-
Observations	114	148	103	131
Number of islands	10	16	6	10
R^2	0.460	0.358	0.427	0.417
Adjusted R^2	0.384	0.296	0.335	0.352
F Statistic	73.38*** (df = 14; 99)	14.34*** (df = 13; 134)	70.48*** (df = 14; 88)	282.2*** (df = 13; 117)

Note: *p<0.1; **p<0.05; ***p<0.001
Source: Economisch Bureau Amsterdam (2024)

Choice of models studied: model 2 is the most suitable

Model 1 versus Model 2: The significant coefficients of model 2 are larger than those of model 1. There are several hypotheses for these differences. First, for each model, Tax revenue is an important explanatory variable because the inclusion of this variable alters the coefficients of the other variables. Second, the number of observations increase when the Tax revenue variable is removed. The increased number of observations might make the estimates more consistent or introduce countries fundamentally different from those already studied. Between the two models, model 2 is preferred because it analyzes six more islands than model 1. This is significant because model 1 includes only a small sample of 10 islands. This choice is reinforced by the small estimation gap between the two models, except for Import and Export.

Model 3.1 versus model 3.2: The significant coefficients of the models 3.1 and 3.2 are remarkably different from one model to another. The explanations are the same as those for the differences between models 1 and 2. The increase in observations in model 2 is mainly due to the inclusion of additional continental countries, as the number of islands only increases from 6 to 10. It is difficult to know if the two models are equally strong or if one is better than the other. Indeed, model 3.1 includes the variable Tax revenue, which reduces endogeneity. Model 3.2 does not include this variable, allowing it to have a larger number of observations, thereby increasing consistency.

Model 2 versus model 3.1: model 2 has many more islands observations than model 3.1, which has only 6 islands. Therefore, model 2 is preferred over model 3.1.

Model 2 versus model 3.2: The models contradict each other on the sign of the Average Total Effect of Island. To understand where this divergence comes from and to choose the most suitable model, here is an analysis of the Average Total Island Effect:

Table 3: In general, Total Island Effects are of the same sign

	Total Island Effects		Same sign
(Model)	(2)	(3.2)	
Aruba	-1.910381	-	-
The Bahamas	-2.744631	-5.7573611	Yes
Barbados	-3.836958	-4.3759940	Yes
Cabo Verde	4.331772	-3.5226413	No
Dominica	1.952588	9.6895579	Yes
Dominican Republic	-3.668159	-6.0326242	Yes
Fiji	3.575890	0.3540922	Yes
Haiti	-3.861808	-3.4917055	Yes
Jamaica	-1.902109	-	-
Mauritius	-1.375199	-2.3254014	Yes
Samoa	3.639667	-	-
Seychelles	5.771806	6.5125041	Yes
Singapore	3.645196	1.2693334	Yes
Solomon Islands	6.151171	-	-
Tonga	3.004021	-	-
Vanuatu	2.564633	-	-
Average Total Island Effect	0.959	-0.768	

Source: Economisch Bureau Amsterdam (2024)

These coefficients indicate whether the consumption expenditure of island governments is higher (positive sign) or lower (negative sign) compared to public consumption expenditure in other countries. The coefficients are equal to the sum $\beta_{\text{Island}} + \sum_i \beta_i X_i$. Here, β_{Island} is the coefficient of the island dummy, β_i refers to the coefficients of the interaction terms with the island dummy, and X_i is the value that the interacting variable

takes. This sum represents the total effect of insularity on the dependent variable and gives insights into the diseconomies of scale experienced by small island economies. The average of these Total Island Effects is positive for model 2 and negative for model 3.2. It is, however, plausible that this difference is explained by the omission of countries in model 3.2.

With more observations, model 3.2 would likely show a positive Average Total Island Effect. The reason for this is that the islands common to both models have a total island effect of the same sign, except for Cabo Verde. Among the 6 islands that model 3.2 does not analyze, 4 have a positive Average Total Island Effect in model 2. It can be assumed that at least 4 of these islands would have a positive effect in model 3.2. This is in line with the intuition that SIDS, which are known to be economically vulnerable, face more expensive public expenditure than other states.

Furthermore, the sources of the dependent variables are different. It is possible that the World Bank and IMF do not use the same GDP values to calculate the two variables, causing measurement error in model 3.2.

In conclusion, model 2 is preferred over model 3.2 because it examines more observations (both continental countries and islands), and the data it analyzes are consistent with their respective sources.

The main take-away of model 2 are presented.

Import For continental countries, for every one percentage point increase in imports (as a percentage of GDP), public consumption expenditure (as a percentage of GDP) increases on average by 0.231 percentage points, holding all else constant. Transportation costs, in addition to the purchase of goods and services, can explain the increase in government consumption expenditure induced by imports. Moreover, high public consumption may lead to increased imports to meet government demand, resulting in additional public costs.

For Small Island Developing States (SIDS), a one percentage point increase in imports (as a percentage of GDP) leads to an average increase in public consumption expenditure (as a percentage of GDP) by 0.384 percentage points, with all other factors constant. The island status amplifies the effect of imports on public consumption expenditure by an additional 0.153 percentage points per percentage point increase in imports. This result is likely due to the high transportation costs associated with geographical isolation, which is a specific characteristic of islands.

Export For each one percentage point increase in exports as a percentage of GDP, public consumption expenditure (as a percentage of GDP) decreases on average by 0.198 percentage points, whether the country is an island or not, ceteris paribus. Exports may facilitate economies of scale, by allowing industries to produce beyond domestic demand and export surplus production, leading to higher economic output. As a result, this gain in efficiency through economies of scale would allow the government to reduce its support.

Population density If population density increases by one inhabitant per squared kilometer, public consumption expenditure (as a percentage of GDP) decreases on average by 0.002 percentage points, regardless of the country's status, provided all other variables remain stable. A clustered population may reduce logistical costs, which would allow the government to decrease their consumption expenditure on public transportation, for example. This result encourages archipelagos to concentrate their population in the same location to avoid transportation costs, which the Maldivian government did with its housing policy (Joint Assessment, 2005).

Natural resources For continental countries, all else being equal, public consumption expenditure (as a percentage of GDP) increases on average by 0.182 percentage points for each one percentage point increase in natural resource rent (as a percentage of GDP). Governments of resource-rich countries may benefit from significant tax revenues due to resource rents from their territories. This source of income increases the public budget, enabling governments to spend more. In addition, this fiscal gain can help the government to offset the loss of income during economic shocks such as the COVID-19 crisis, which is included in the period analyzed.

For Small Island Developing States (SIDS), a one percentage point increase in natural resource rent (as a percentage of GDP) leads to an average increase of 0.549 percentage points in public consumption expenditure (as a percentage of GDP), after controlling for other variables. Being a small island economy intensifies the effect of natural resources on public consumption expenditure by an additional 0.367 percentage points per percentage point increase in natural resource rent. The income from natural resources in islands is a major source of financial revenue. These revenues can allow the governments of small island economies to increase their spending.

Island In sum, the total effect of being a small island economy is that it is associated with an increase in public consumption expenditure by 1 percentage point[1] of GDP compared to other countries, all else being equal. This result quantifies the cumulative disadvantages observed due to the variables included in the model or due to other (omitted) variables that are not observed, in Small Island Developing States (SIDS).

The model 2 provides information on the sign and magnitudes of the associations between the dependent variable and the regressors.

In model 2, the coefficients and their standard errors are likely biased. Indeed, the omitted variable, Tax revenue, is not orthogonal to some factors in the model. Robustness tests in the appendix indicate that this bias is only slight. Government debt, which is omitted due to many missing values, is likely to cause endogeneity. Additionally, there may be a reverse causality between government consumption expenditure and imports. Besides this, the data are independent because the countries have economic and geographical situations that provide no information about other nations with respect to the factors analyzed. The data are considered identically distributed because the means and standard deviations are mostly similar for each factor across the four models described in the methodology. Heteroscedasticity is corrected by adjusting the standard errors of coefficients using the HC1 estimator from the sandwich package in R software. There is no perfect collinearity, and the fourth-order moments of the explanatory variables are bounded. Asymptotic normality is not guaranteed by the sample size (148 observations) and the Shapiro-Wilk test rejects the normality of errors. Therefore, statistical inferences may be slightly biased. Finally, model 2 studies less than half of the number of islands in the SIDS, making the coefficient of the Average Total Island Effect uncertain.

In conclusion, model 2 establishes correlations between the dependent variable and the regressors rather than causal relationships. Therefore, this model is useful because it provides information on the sign and magnitudes of these relationships.

[1] This result is rounded to two decimal places.

5. Discussion

The results support the literature review and enrich it through the analysis of exports

Tisdell (2009) explains that a great distance between islands and economic hubs results in high transportation costs. This disadvantage can lead to a significant increase in government spending. The empirical study corroborates this mechanism by suggesting that the effect of imports on public consumption expenditure is amplified in small island economies compared to the rest of the world.

Tisdell (2009) also indicates that the spacing between the islands of an archipelago is an additional source of costs. The econometric analysis supports this argument, suggesting that public consumption expenditure is lower when population density is higher.

The income from natural resources in islands is one of the few activities that generates significant financial revenue, thanks to the abundance of energy sources like the sun and water, for example. These financial means may enable governments to consume more. This is likely the case due to the private sector's limited interest in certain industries, attributed to the absence of economies of scale (Azzopardi, 2004). The regression supports this by indicating that natural resource rent on the islands leads to much higher public consumption expenditure than in the rest of the world.

The empirical results also suggest that exports reduce government consumption expenditure. This novelty vis-à-vis the literature can be explained by the resolution of the problem of low domestic demand on the islands, caused by the small population size. Indeed, exporting the surplus of national production would allow businesses to reach their minimum efficient scale or achieve economies of scale. The efficiency gained would favor the economic development of the islands, allowing the government to reduce its consumption expenditure.

Finally, the economic vulnerability of Small Island Developing States is confirmed by a significant difference in public consumption expenditure (as percentage of GDP) of 1 percentage point between SIDS and the rest of the world.

To go further, new data, instrumental variable regression and a study of the private sector are necessary

To improve this study, the use of more comprehensive data is desirable to enhance the analysis with fiscal revenues, government debt, and the determinants listed in the literature review that are not analyzed: small population size, conflicts between natives and foreigners, human capital, and imperfect competition. The colonial history of the countries can explain economic differences between certain islands, justifying the introduction of this factor in the study. Moreover, an instrumental variable regression is necessary to address the reverse causality between government consumption expenditure and imports. Finally, examining the private sector in the same way as this analysis of the public sector would provide a comprehensive view of the diseconomies of scale experienced by small island economies.

Policies such as technological progress, international collaboration, exports, and population concentration are proposed as solutions to diseconomies of scale

To reduce the impact of imports, it is essential to invest in research and development of technologies that enable economic independence. Several effective approaches are possible: stimulating corporate technology hubs, investing in advanced skills development (education), and boosting intangible services such as tourism. International collaborations can mitigate the financial impact of these investments through knowledge sharing. Collaborations can also increase economic scale by engaging in joint purchasing, for example.

Furthermore, exports may facilitate economies of scale. Therefore, it is necessary to develop export-oriented sectors and encourage companies to produce beyond domestic demand to export surplus production. These exports can be encouraged and facilitated through the establishment of trade partnerships.

Finally, like the housing policy in the Maldives (Joint Assessment, 2005), island populations have an interest in clustering together to reduce logistical costs.

6. Conclusion

This study contributes to enriching the literature on diseconomies of scale in islands and suggests solutions that can be applied by economic development policies.

The literature review lists and details the following determinants of diseconomies of scale in island economies: small population size leading to low domestic demand, geographical isolation resulting in high transportation costs, conflicts between natives and foreigners, dependence on skilled foreign workers, imperfect competition, and environmental problems.

The literature proposes various solutions to avoid diseconomies of scale, which include intangible activities based on the island's identity such as tourism, population concentration in a single location, establishing international collaborations, and the manufacture of goods that are light, non-bulky, and simple to produce.

The empirical analysis is an ordinary least squares regression on 215 countries between 2018 and 2022. The results corroborate the literature review by suggesting that imports and the use of natural resources increase public consumption expenditure, reflecting diseconomies of scale. The results also indicate that exports can create economies of scale and that the geographical concentration of the population reduces public consumption expenditure. Furthermore, the study suggests that being a small island economy is associated with an increase in public consumption expenditure of 1 percentage point of GDP compared to other countries, ceteris paribus.

In view of future economic policies, it is advised to invest in research and development to overcome diseconomies of scale related to imports. Additionally, it is recommended to create international collaborations to share technical progress at lower costs, develop export-oriented sectors, and design population and migration policies.

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Appendix

Table 4: Model 1 without interaction terms

	Dependent variable: Government final consumption expenditure (percentage of GDP)					
	Model	1st specification	2nd specification	Model	1st specification	2nd specification
Import	0.160***	0.155***	0.155***			
Export	−0.140***	−0.139***	−0.147***			
Trade balance				−0.149***	−0.147***	−0.151***
Population density	−0.001***	−0.001***		−0.001**	−0.001**	
Real GDP per capita PPP	0.0001	0.0001***	0.0001***	0.0001*	0.0001***	0.0001***
Natural resources	0.178**	0.162**	0.170**	0.176***	0.164**	0.171**
Inflation	−0.042	−0.047*	−0.047*	−0.042	−0.046*	−0.047*
Tax revenue	0.343***	0.367***	0.402***	0.372***	0.386***	0.410***
Gov. effectiveness	0.838			0.609		
Distance	0.0001	0.0001	0.0005	−0.0002	−0.0001	0.0003
Island	0.115	0.236	−1.177	0.580	0.601	−0.904
Constant	7.256***	6.709***	6.275***	7.482***	7.026***	6.469***
Observations	114	114	114	114	114	114
R^2	0.422	0.419	0.402	0.417	0.415	0.401
Adjusted R^2	0.366	0.368	0.357	0.367	0.371	0.362
F Statistic	10.61*** (df = 10; 103)	12.03*** (df = 9; 104)	8.933*** (df = 8; 105)	12.12*** (df = 9; 104)	13.61*** (df = 8; 105)	10.08*** (df = 7; 106)

Note: *p<0.1; **p<0.05; ***p<0.01;
Source: Economisch Bureau Amsterdam (2024)

Table 5: Model 1 with interaction terms

	Dependent variable: Government final consumption expenditure (percentage of GDP)					
	Model	1st specification	2nd specification	Model	1st specification	2nd specification
Import	0.155***	0.149***	0.143***			
Export	−0.147***	−0.146***	−0.144***			
Trade balance				−0.147***	−0.144***	-0.142***
Population density	−0.002***	−0.002***		−0.001	−0.002	
Real GDP per capita PPP	0.0001	0.0001***	0.0001***	0.0001*	0.0001***	0.0001***
Natural resources	0.162**	0.146**	0.158**	0.168**	0.152**	0.160**
Inflation	−0.042	−0.047*	−0.048	−0.041	−0.046	−0.047
Tax revenue	0.323***	0.349***	0.378***	0.357***	0.376***	0.391***
Gov. effectiveness	0.882			0.806		
Distance	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
Island	−11.597***	−11.683***	−10.531***	−7.006***	−6.863***	−6.848**
Island*Import	0.055	0.071	0.280*			
Island*Export	0.052	0.040	−0.196			
Island*Trade balance				0.251	0.246	0.017
Island*Distance	0.004*	0.003*	0.001	0.007**	0.007**	0.004
Island*Natural resources	0.389	0.390*	0.718**	−0.199	−0.211	0.174
Constant	8.708***	8.141***	7.568***	8.395***	7.771***	7.325***
Average total effect of island	-	-	-	-	-	-
Observations	114	114	114	114	114	114
R^2	0.460	0.456	0.441	0.445	0.442	0.433
Adjusted R^2	0.384	0.385	0.375	0.379	0.381	0.378
F Statistic	73.38*** (df = 14; 99)	69.45*** (df = 13; 100)	27.73*** (df = 12; 101)	50.44*** (df = 12; 101)	52.85*** (df = 11; 102)	31.56*** (df = 10; 103)

Note: *p<0.1; **p<0.05; ***p<0.01;
Source: Economisch Bureau Amsterdam (2024)

Table 6: Model 2 without interaction terms

	Dependent variable: Government final consumption expenditure (percentage of GDP)					
	Model	1st specification	2nd specification	Model	1st specification	2nd specification
Import	0.250***	0.249***	0.248***			
Export	−0.207***	−0.203***	−0.221***			
Trade balance				−0.226***	−0.223***	−0.230***
Population density	−0.002***	−0.002***		−0.001***	−0.001***	
Real GDP per capita PPP	0.0001*	0.0001	0.0001	0.0001**	0.0001**	0.0001*
Natural resources	0.208***	0.221***	0.230***	0.189***	0.203***	0.216***
Inflation	−0.033			−0.040		
Gov. effectiveness	1.873*	2.335**	2.472**	1.729*	2.275**	2.402**
Distance	0.001	0.001	0.001	0.0001	0.0001	0.0003
Island	−0.035	0.119	−0.787	0.428	0.653	−0.230
Constant	10.938***	10.571***	11.212***	12.735***	12.446***	12.331***
Observations	148	148	148	148	148	148
R^2	0.328	0.316	0.271	0.298	0.282	0.258
Adjusted R^2	0.284	0.277	0.235	0.257	0.246	0.226
F Statistic	10.66*** (df = 9; 138)	11.49*** (df = 8; 139)	7.076*** (df = 7; 140)	8.797*** (df = 8; 139)	9.778*** (df = 7; 140)	8.103*** (df = 6; 141)

Note: *p<0.1; **p<0.05; ***p<0.01;
Source: Economisch Bureau Amsterdam (2024)

Table 7: Model 2 with interaction terms

	Dependent variable: Government final consumption expenditure (percentage of GDP)					
	Model	1st specification	2nd specification	Model	1st specification	2nd specification
Import	0.231***	0.229***	0.213***			
Export	−0.198***	−0.193***	−0.194***			
Trade balance				−0.218***	−0.214***	−0.209***
Population density	−0.002***	−0.002***		−0.001***	−0.001***	
Real GDP per capita PPP	0.0001*	0.0001	0.0001	0.0001**	0.0001**	0.0001*
Natural resources	0.182***	0.196***	0.198***	0.180***	0.193***	0.196***
Inflation	−0.034			−0.039		
Gov. effectiveness	1.666*	2.143**	2.279**	1.720*	2.251**	2.319**
Distance	−0.0002	−0.0003	−0.001	−0.001	−0.001	−0.001
Island	−10.338***	−10.113***	−10.119***	−3.207	−3.127	−4.509**
Island*Import	0.153**	0.155*	0.193**			
Island*Export	−0.050	−0.054	−0.125*			
Island*Trade balance				−0.015	−0.021	−0.071
Island*Distance	0.002	0.002	0.002	0.002*	0.003*	0.003*
Island*Natural resources	0.367**	0.363**	0.398**	0.245*	0.245*	0.289**
Constant	11.928***	11.561***	12.403***	13.220***	12.967***	13.056***
Average total effect of island	0.959**	1.129**	-	-	-	-
Observations	148	148	148	148	148	148
R^2	0.358	0.346	0.309	0.315	0.300	0.288
Adjusted R^2	0.296	0.288	0.253	0.260	0.249	0.242
F Statistic	14.34*** (df = 13; 134)	16.47*** (df = 12; 135)	8.438*** (df = 11; 136)	9.236*** (df = 11; 136)	9.498*** (df = 10; 137)	7.796*** (df = 9; 138)

Note: *p<0.1; **p<0.05; ***p<0.01;
Source: Economisch Bureau Amsterdam (2024)

Table 8: Model 3.1 without interaction terms

	Dependent variable: Government final consumption expenditure + Government investment (pertcentage of GDP)					
	Model	1st specification	2nd specification	Model	1st specification	2nd specification
Import	0.243***	0.243***	0.235***			
Export	−0.202***	−0.207***	−0.193***			
Trade balance				−0.219***	−0.222***	−0.189***
Population density	−0.001**			−0.001		
Real GDP per capita PPP	0.00003	0.00002		0.0001	0.0001	
Natural resources	0.290***	0.296***	0.292***	0.290***	0.296***	0.282***
Inflation	−0.082***	−0.082***	−0.080***	−0.081***	−0.081***	−0.073***
Tax revenue	0.216*	0.241**	0.237**	0.266**	0.282**	0.287**
Gov. effectiveness	2.695**	2.746**	3.146***	2.336*	2.412*	3.399***
Distance	−0.0005	−0.0002	−0.0002	−0.001	−0.001	−0.001
Island	−1.566	−2.917	−3.059*	−0.354	−1.575	−1.385
Constant	12.990***	12.653***	13.022***	13.558***	13.229***	14.532***
Observations	103	103	103	103	103	103
R^2	0.407	0.398	0.397	0.392	0.387	0.378
Adjusted R^2	0.342	0.340	0.346	0.334	0.335	0.332
F Statistic	19.84*** (df = 10; 92)	17.51*** (df = 9; 93)	18.18*** (df = 8; 94)	22.68*** (df = 9; 93)	21.16*** (df = 8; 94)	20.78*** (df = 7; 95)

Note: *p<0.1; **p<0.05; ***p<0.01;
Source: Economisch Bureau Amsterdam (2024)

Table 9: Model 3.1 with interaction terms

	Dependent variable: Government final consumption expenditure + Government investment (percentage of GDP)					
	Model	1st specification	2nd specification	Model	1st specification	2nd specification
Import	0.236***	0.236***	0.221***			
Export	−0.213***	−0.212***	−0.185***			
Trade balance				−0.219***	−0.219***	−0.182***
Population density	−0.003			−0.0003		
Real GDP per capita PPP	0.00005	0.0001		0.0001	0.0001	
Natural resources	0.276***	0.290***	0.282***	0.291***	0.293***	0.278***
Inflation	−0.081***	−0.086***	−0.080***	−0.082***	−0.083***	−0.072***
Tax revenue	0.196	0.214*	0.209*	0.262**	0.264**	0.274**
Gov. effectiveness	2.516*	2.421*	3.247***	2.252*	2.239*	3.407***
Distance	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001
Island	−12.243***	−11.325***	−10.539***	−8.404***	−8.420***	−8.544***
Island*Import	0.056	0.453***	0.386***			
Island*Export	0.082	−0.346***	−0.294**			
Island*Trade balance				0.082	0.016	0.072
Island*Distance	0.002	0.0005	0.001	0.007*	0.007***	0.007***
Island*Natural resources	0.327	−1.247***	−1.162***	−2.048	−2.218	−1.988
Constant	14.295***	13.479***	14.096***	13.656***	13.564***	15.006***
Average total effect of island	-	-2.137***	-2.516***	-	-	-
Observations	103	103	103	103	103	103
R^2	0.427	0.422	0.416	0.403	0.403	0.390
Adjusted R^2	0.335	0.338	0.339	0.324	0.331	0.324
F Statistic	70.48*** (df = 14; 88)	855.1*** (df = 13; 89)	2.25e6*** (df = 12; 90)	35.74*** (df = 12; 90)	44.62*** (df = 11; 91)	64.71*** (df = 10; 92)

Note: *p<0.1; **p<0.05; ***p<0.01;
Source: Economisch Bureau Amsterdam (2024)

Table 10: Model 3.2 without interaction terms

	Dependent variable: Government final consumption expenditure + Government investment (percentage of GDP)					
	Model	1st specification	2nd specification	Model	1st specification	2nd specification
Import	0.343***	0.343***	0.340***			
Export	−0.292***	−0.290***	−0.292***			
Trade balance				−0.312***	−0.310***	−0.309***
Population density	−0.002***	−0.002***	−0.002***	−0.001***	−0.001***	−0.001***
Real GDP per capita PPP	0.0001*	0.0001*	0.0002***	0.0001**	0.0001**	0.0002***
Natural resources	0.339***	0.336***	0.287***	0.321***	0.313***	0.270***
Inflation	−0.115***	−0.115***	−0.136***	−0.119***	−0.120***	−0.138***
Gov. effectiveness	2.402**	2.346**		2.261**	2.100*	
Distance	−0.0004			−0.001		
Island	−1.228	−1.474	−1.385	−0.664	−1.291	−1.224
Constant	14.713***	14.476***	13.627***	16.777***	16.278***	15.377***
Observations	131	131	131	131	131	131
R^2	0.382	0.381	0.356	0.352	0.349	0.329
Adjusted R^2	0.336	0.341	0.319	0.310	0.312	0.296
F Statistic	13.49*** (df = 9; 121)	14.71*** (df = 8; 122)	13.56*** (df = 7; 123)	14.34*** (df = 8; 122)	15.88*** (df = 7; 123)	13.83*** (df = 6; 124)

Note: *p<0.1; **p<0.05; ***p<0.01;
Source: Economisch Bureau Amsterdam (2024)

Table 11: Model 3.2 with interaction terms

	Dependent variable: Government final consumption expenditure + Government investment (percentage of GDP)					
	Model	1st specification	2nd specification	Model	1st specification	2nd specification
Import	0.309***	0.309***	0.302***			
Export	−0.270***	−0.269***	−0.267***			
Trade balance				−0.295***	−0.293***	−0.290***
Population density	−0.002***	−0.002***	−0.002***	−0.0005	−0.001	−0.001
Real GDP per capita PPP	0.0001*	0.0001*	0.0002***	0.0001**	0.0001**	0.0002***
Natural resources	0.316***	0.311***	0.262***	0.320***	0.308***	0.263***
Inflation	−0.110***	−0.111***	−0.129***	−0.117***	−0.117***	−0.135***
Gov. effectiveness	2.240*	2.114*		2.300*	2.118*	
Distance	−0.001			−0.001		
Island	−11.568***	−12.955***	−14.240***	−2.977	−2.725	−2.980
Island*Import	0.371***	0.357***	0.391***			
Island*Export	−0.229***	−0.216***	−0.236***			
Island*Trade balance				−0.153	−0.150	−0.158
Island*Distance	−0.001			0.001		
Island*Natural resources	−0.161	−0.126	−0.025	−0.213	−0.193	−0.104
Constant	15.543***	15.185***	14.535***	16.927***	16.310***	15.430***
Average total effect of island	-0.768***	-1.151***	-1.058***	-	-	-
Observations	131	131	131	131	131	131
R^2	0.417	0.415	0.395	0.364	0.359	0.338
Adjusted R^2	0.352	0.361	0.345	0.305	0.311	0.295
F Statistic	282.2*** (df = 13; 117)	125.6*** (df = 11; 119)	313.8*** (df = 10; 120)	11.69*** (df = 11; 119)	12.83*** (df = 9; 121)	12.84*** (df = 8; 122)

Note: *p<0.1; **p<0.05; ***p<0.01;
Source: Economisch Bureau Amsterdam (2024)