Phase 2:

Impact of Physical Separation from the UK Mainland on Isle of Wight Public Service Delivery

Prepared by the Economics and Finance Department, Portsmouth Business School, University of Portsmouth.

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Summary

Phase one reviewed existing literature, data and evidence and identified the key factors related to separation, and the impact on public and council services. This report explores these issues in more detail:

The cost of reduced spillover (Self-sufficiency)
Self-sufficiency refers to the lack of spillover of public goods and public service provision to and from neighbouring authorities and the potential for over provision. We estimate that the Isle of Wight council needs to spend an additional 3% on public service provision as a result of being an Island.

- 3% of the Isle of Wight council total services expenditure is over £6.4 million (Revenue Account Budget (RA): 2015-16 data).

- This is equivalent to two-thirds of the 2016-2017 Budget Gap resulting from the Finance Settlement (Isle of Wight Council Medium Term Financial Plan).

- Or equivalent to 4 times the amount of Rural Services Delivery Funding that North Yorkshire receives, or almost 4.5 times the amount received by Devon (Key Information for Local Authorities 2015-2016).

The cost of doing business on the Island (Island Premium)
Among businesses currently operating on the Island there appears to be a common perception of unavoidable limits to achieving economies of scale or scope thus leading to stable but slow growth. Companies engaged with the local market are limited by the size of it; those engaged with external markets are limited by constraints in the input of production (mainly human capital). Relocation remains an option as an alternative to closure but businesses have also shown an emotional attachment to the Island and its human and social ecosystem.

Among the businesses surveyed that are currently not operating on the Island, none have ever considered relocating on the Isle of Wight and only a few have considered expanding onto the Island. The size of the relevant market is not considered sufficient to justify a local office or indeed an operational facility. Furthermore, the infrastructure connectivity is a cause for concern if assessing a relocation or expansion on the Island. Whilst at very long distances the cost of shipping (monetary and time) to/from the Island represents a small component of the total shipping cost, at shorter distances it is seen as significant.

Within the broader issue of skilled labour shortage felt in many sectors, the businesses feel they have an acceptable supply from their local area. Their knowledge of the business sector suggests that there are no hidden or untapped sources of skilled personnel on the Island; indeed they employ people who commute from the Island on a daily basis.

The impact of industry changes (Dislocation)
A 75% increase in the income from business rates payable on the Island (NNDR) is required to meet the estimated funding gap.

Growing business rates by encouraging growth of low GVA sectors such as retail and tourism has a detrimental impact on the economy. We estimate that reducing the efficiency of firms by approximately 10% reduces domestic production of goods in (GDP) services and manufacturing industries by 3% and 2.4% respectively.

Introduction

The three overarching Island issues of Self-sufficiency, Island premium and Dislocation presented and discussed in Phase 1 of this project are analysed further in this report:

The cost of reduced spillover (Self-sufficiency)
Self-sufficiency refers to the (lack of) spillover of public goods and public service provision to and from neighbouring authorities and the potential for over provision. Self-sufficiency costs occur where there is an obligation that a sufficient and proportionate service is provided on the Island. In this case it is not possible, or too costly, to share or access mainland services or facilitate cross-boundary arrangements for the provision of services that may be available to other authorities. Examples include the operational delivery of Fire and Rescue Service and the operational delivery of a number of services for children's and adult social care. If a region like the Isle of Wight is detached from the mainland, its citizens cannot readily use public services provided by other local governments. As a consequence, the local government will either provide this service at a lower-than-efficient scale, or choose not to provide it. The magnitude of this issue to the Isle of Wight is calculated in the next section.

The cost of doing business on the Island (Island Premium)
The Island premium refers to the additional cost of conducting business on and with the Isle of Wight. For the provision of public services this may refer to the relatively higher prices that may be charged by contractors, or reflected in the price of goods and services delivered. This may reflect physical costs, such as additional transport costs, or the need to establish distribution infrastructures. Additionally, it will likely be influenced by the size of the market and the inherent potential for restricted competition. This is evidenced by surveying the advantages and disadvantages of operating a business on, or from, the Island. We discuss the issue with the business community to provide a comparison of firms on the Island and similar firms on the mainland.

The impact of industry changes (Dislocation)
Dislocation refers to the costs associated with the physical, and perceived, separation from the mainland. Dislocation has direct and indirect costs, and is closely tied to the underlying issues of the Island premium and Self-sufficiency. Often, driving up the growth of business rates collected by the local authorities is the simplest solution to suggest when an increase in public finance is required. The reality of this issue is often complicated by affecting other elements of the economy. We simulate an economy to model the different scenarios, such as variations in population size or business numbers, required to achieve the economies of scale, to raise council tax and business rate receipts to offset the island factor in the current funding formula.

The costs of reduced spillover

We estimate that the Isle of Wight council needs to spend an additional 3% on public service provision as a result of being an island.

- 3% of the Isle of Wight council total services expenditure is over £6.4 million (Revenue Account Budget (RA): 2015-16 data).

- This is equivalent to two-thirds of the 2016-2017 Budget Gap resulting from LG Finance Settlement (Isle of Wight Council Medium Term Financial Plan).

- Or equivalent to 4 times the amount of Rural Services Delivery Funding that North Yorkshire receives, or almost 4.5 times the amount received by Devon (Key Information for Local Authorities 2015-2016).

In this section, we summarise our analysis of the impact of being an island on public service provision. We develop a framework for quantifying the cost that a geographically separated municipality bears due to the lack of public goods spillovers from neighbouring municipalities. A full description of the analysis is appended to this report under the heading "*No Man Is an Island: Quantifying the Cost of Foregone Public Goods Spillovers".*

It is established in economic literature that there exists a relationship between public goods provision in neighbouring local governments. For instance, if local public goods are substitutes, then local governments benefit from their population being able to use public goods provided by neighbouring municipalities so that local expenditure for public goods will be lower when such expenditure is high in nearby municipalities. This has been shown empirically to be the case, for instance, by Solé-Ollé (2006) or Hanes (2002). This spillover of public goods provision is socially beneficial if each municipality by itself would be too small to provide these public goods at an efficient scale.

The immediate effect of a small region's separation from neighbouring regions is that its citizens cannot easily use public goods provided by other local authorities. As a consequence, the local government will either provide this good at a lower-than-efficient scale, or choose not to provide it. Hence, this physical separation will result in higher costs of public goods provision or social welfare loss caused by its under provision.

The empirical analysis proceeds in two steps: In the first step, we use data from 151 English municipalities to estimate the impact of the areas' own characteristics, its neighbours' characteristics and public expenditure, and the distance to these neighbours on a municipalities' own public expenditure. We find that municipalities spend less if public expenditure in neighbouring municipalities is high. However, our results also point at a cost of proximity to other municipalities: If neighbouring municipalities are more populous, public goods may become overcrowded, so that the local government will have to spend more on them.

The second step is to use the estimation results from the first step to predict how much more or less the Isle of Wight would spend if it were connected to the mainland by traditional road and rail connections. We estimate the annual cost of foregone public goods spillover for the Isle of Wight amounts to about three percent of the Island's annual public spending.

The cost of doing business on the Island

There appears a common perception of unavoidable limits to achieving economies of scale or scope thus leading to stable but slow growth on the Isle of Wight.

Within the wider scope of our investigation, it was thought to be advantageous to probe a number of businesses based on the Isle of Wight to explore, identify and possibly quantify (albeit roughly) the direct costs involved with doing business with or on the Isle of Wight.

Under terms of anonymity and confidentiality, telephone interviews were carried out with relevant Company Directors with the aim to address the following questions:
(1) What are the advantages and disadvantages of operating on, or from, the Island?
(2) Is it possible to clearly identify and quantify these, and
(3) what would make the business seek relocation elsewhere?

Most businesses are the result of long established operations which, perhaps after several changes of the shareholding and operational structure, developed into what they are today; to some extent a development by chance rather than by design. In some cases, the main benefit was reported to be the lower rent and land prices on the Island compared to the mainland. In all cases the availability of relatively stable personnel, with skillsets deemed to be suitable to support the re-purposing of the operations, was considered an advantage.

The positive factor of counting on a stable and loyal workforce can also be interpreted as the result of a general lack of alternatives for personnel with sector specific skills. A relatively low level of the cost of labour was also seen as a positive factor in comparison to similar businesses operating in more competitive locations on the mainland. This, in turn, does not create opportunities of cross pollination between sectors, thus hampering further skills development and creation.

Businesses on the Island are also aware that while high tech manufacturing, like the marine and aerospace sectors, undoubtedly enjoys the benefits of clustering, sector specific trends are global in nature and small/medium businesses in these sectors are trend takers rather than setters; still capable of producing growth but due to exogenous factors and at organic rather than nonlinear or disruptive rate. Some businesses lamented the lack of sectoral clustering but recognised that critical masses are missing and that investors would most probably look at more promising, less constrained and better connected areas.

With regards to personnel, the lack of a suitable pool of potential workforce was highlighted: both in quantity and in quality; the lack of extended sectoral clusters limits the opportunities of career development and skills enrichment and development on the Island; this becomes a more critical issue for some managerial positions. Some smaller firms with less specific skills demands were happy to recruit from the local community and simply provide their own training. The alternative option is to recruit from outside the Island. A small number of medium size recruitment companies were interviewed to assess the difficulties in researching, recruiting and selecting personnel for a job post on the Island. Quite interestingly, none of the firms would accept ‘success fee’ projects; this is symptomatic of underlying difficulties in successfully completing such recruitment projects. Often, the hope for these firms is to attract a candidate who is originally from the Island and with a desire to return back there after a few years on the mainland. For some positions (often sale and field representatives) the Island’s companies are amenable to recruit personnel from the mainland offering the opportunity to work from home or from dedicated offices in the Southampton/Portsmouth area.

Salaries are in general lower on the Island when compared to similar positions in England and this creates an additional problem in attracting talent. Furthermore, wage trends on the mainland follow different and more competitive dynamics, hence raising the opportunity cost of relocating to the Island.

In general, all respondents indicated the generic additional costs of travel for members of staff and visitors, and shipping of raw materials and goods to and from other destinations. The issues raised by previous reports were all confirmed and it might be worth updating those findings with current figures. Although these costs are well tracked for accounting purposes and represent a sizeable component of the business operating costs, they did not appear to be cause for special concern; a sense of resignation was perceived as a consequence of the unavoidable geography. It could be interesting to investigate to what extent isolation costs (higher movement costs) are compensated by isolation benefits (lower wages) so as to maintain the total cost to market level.

None of the respondents have been able to monetise the cost and benefit of isolation; perhaps an additional symptom of resignation towards geography and demographics.

When prompted to discuss the option of relocation elsewhere, the prevailing perception confirmed the feeling that current operational configurations are the result of chance rather than design and that relocation away from the Island constitutes often an item for anecdotal discussion rather than strategic analysis. A few respondents reported that relocation is always an agenda item at any periodic strategic review but the opportunity costs of it are thought to be too high and uncertain; a total replacement of the workforce, discontinuity of the operations and relocation costs would require the justification of a radical repurposing of the entire business and not simply of a more convenient postcode; the shareholders might even consider the closure of the operations as the option next to their relocation. Political and economic uncertainty might have the effect of squeezing margins and might prompt shareholders to consider radical options, as consequence of general and pressing market conditions rather than of underlying geographical factors.

In summary, there is a common perception of unavoidable limits to achieving economies of scale or scope thus leading to stable but slow growth. Companies engaged with the local market are limited by the size of it; those engaged with external markets are limited by constraints in the input of production (mainly human capital). Relocation remains an option as an alternative to closure but businesses have also shown an emotional attachment to the Island and its human and social ecosystem.

Outside the scope of the project, the team was asked to run a short unstructured survey among a selection of businesses currently not operating on the IoW.

The surveyed businesses cannot be considered a representative sample of the business community based on the mainland.

The 11 surveyed businesses are: a major car dealer, a food and drinks distributor, a maker of cabinets for industrial purposes, a digital marketing agency, a recruitment agency, a maker of structures in composite material, a private school, a manufacturer of electrical components, a stockist of mechanical components, a distributor or marine equipment, a provider of language courses to non-English speaking students.

What follows are key issues identified during the brief survey.

1. None of the above businesses have ever considered relocating on the IoW and only few have considered to expand on the IoW, beyond the current customer base (for those who have one there).
2. Marketing activities are carried out online, at trade events and through visits to current and potential customers. The IoW is perceived to be simply too far to allow impromptu decisions to visit a site or a customer.
3. The size of the relevant market on the IoW is not considered sufficient to justify a local office or indeed an operational facility.
4. Within the broader issue of skills' shortage felt in many sectors, they feel to have acceptable supply from their local area. Their knowledge of the business sector suggests that there are no hidden or untapped sources of skilled personnel on the IoW; indeed they employ people who commute from the IoW on a daily basis.
5. Within one and a half hour commuting time (75 miles) from Southampton/Portsmouth, there are about 15.3 million people and tens of thousands of businesses, which could play their part as suppliers or customers. Within the same commuting time (20 miles) from Cowes, there are 1.2 million people. As such, living just across the Solent would roughly multiply the market reach by a factor of 13.
6. Infrastructure connectivity was mentioned as a cause for concern when assessing a relocation or expansion onto the IoW; whilst at very long distances the cost of shipping (monetary and time) to/from the island represents a small component of the total shipping cost, at shorter distances it is seen as significant.
7. The language school never thought of opening an office on the IoW but had tried to organise language study holidays on the Island; their feedback is that their counterparts (other language schools, hotels and even the local tourist office) were not interested.

The impact of industry changes.

Aiming to plug the funding gap solely with an increased level of expansion – via a larger council tax and/or business rate base - is simply not a viable option.

At least 3,800 small business enterprise or 7,000 additional council tax band C properties would be required to fill the funding gap.

This section investigates the impact on the economy of changes in industry type and labour size. Stage one focusses on the tax revenues collected locally by the Isle of Wight Council. Stage two takes a detailed view of how certain changes might impact the wider economy.

Stage One:
Calculation of the optimal number of businesses required and/or additional council taxpaying properties required to 'balance the Council budget'.

The Isle of Wight Council has an estimated funding gap of £35.13 million over the four years from 2016/17 to 2019/20. To put this in context, the Council has a budget of £126.8m (£122.8m funding) for 2016/17.

It has previously been estimated (The Isle of Wight Council Case for Fairer Funding, 2016) that to close the estimated funding gap (£35 million) through an increase in National Non Domestic Rates (NNDR) alone would require the income from business rates payable on the Island to increase by 75%. There are close to 6,600 business properties with a rateable value currently on the Island. If the make-up of the economy was to remain as it is, this equates to an additional 5,000 business properties.

Given the average rateable value of a business property on the Isle of Wight is £4,800, the Island would require receipts from an additional 3,800 business enterprise to fill the funding gap. However, even just focusing on the upper-end of the NNDR receipts, this would require the equivalent to an additional 17 superstores of a similar size as B&Q, Morrisons and Marks and Spencer in Newport. Alternatively, this would also be comparable to an additional 35 factory and premises equivalent to each of Vestas', GKN's and Gurit's sites on the Island.

Given the physical limitations of the geography, the restricted market size and the constrained pool of labour, such an increase is unlikely to be achievable by an influx of business relocations. Neither is this likely to be met by expansion of the current cohort of enterprises on the Island. This is supported by the findings discussed in section 2 of this report.

Similarly, an increase in council tax receipts alone would require receipts from the number of band C (the median) equivalent properties on the Island to increase by approximately 28,000 units over the four years (7,000 units paying for four years). To put this in context, the Isle of Wight has only experienced an average increase of 430 houses per annum over the last five years. Furthermore, the Island only has a dwelling stock of 68,000 (ONS, 2011) so this would equate to more than an additional 10% of properties. Even if all new properties were at the highest council tax band (H) then this would still require some additional 3,250 properties.

Furthermore, these are likely to be an under-estimation of the true increase in NNDR and/or additional properties actually required to plug the funding gap. First it assumes a 100% collection rate (currently around 98%), and does not take into consideration the actual cost of collection. Furthermore, it does

not take account of the potential change in costs likely to be incurred by the Council. While spare capacity would result in low or zero marginal cost and therefore a reduction in the average cost (economies of scale), if the Council is pushed beyond their current operational capacity then the average cost of provision will actually rise. Given the proportionally large increases of businesses and properties required then the latter is more likely.

In other words, aiming to plug the funding gap solely with an increased level of expansion – via a larger council tax and/or business rate base - is simply not a viable option on such a geographically restrained island with the current levels of human capital. The next stage considers some scenarios where the number of businesses remains stable but their productivity is increased.

Stage Two:
This section assesses the impact of three scenarios on the economy using computable General Equilibrium (CGE) modelling. A CGE model of the economy is designed to establish a numerical framework for empirical analysis and evaluation of economic policies (Hosoe, Gasawa& Hashimoto, 2010).
The three scenarios are as follows:

1. Business demography changes to one with a larger proportion of high Gross Value Added (GVA) businesses (e.g. finance industry).
2. Business demography changes to one with a larger proportion of low GVA businesses (e.g. tourism industry).
3. Population continues to age, following current population projections.

Results follow a brief description of the model framework. Modelling the economy is based on the allocation of resources and the trade-offs caused by scarcity. For example, this includes the decision by firms to export goods or sell them to the domestic consumers. Exports can earn currency which will support the desire to purchase imported goods. Imported and domestically supplied goods can be consumed by households or used as intermediate inputs by firms, where intermediate inputs contribute to further increase in output. Ultimately, the level (or changes in) household consumption determines society's economic welfare.

The main agents in an economy are the households, firms, and the Government. The information that allows interaction between these agents is price. The price mechanism solves the trade-off problem to find an efficient allocation of resources given constraints. Agents make decisions in order to optimise their private benefit based on prevailing price information taken from a market and a resource or budget constraint.

Households maximise utility derived from consumption based on their budget constraint. The demand for goods are derived from the prices of goods and the household income. The demand for a good will increase if the price of the good falls or if the income rises.

Firms maximise profits subject to technology constraints. The demand for labour, capital, and intermediate goods are derived from the prices for these factors and the revenue from selling the goods. The demand for factors will increase if the price of factors falls or if production of the goods increases.

The Government collects taxes and consumer goods. Collecting household income tax, production tax, and tariffs from imports. Expenditure is on goods and services.

Households save some of their income, this contributes to the investment demand in the economy. Government savings and current account balance make up the rest of investment demand.
Goods are imported into the economy from a foreign sector. Similarly, domestically produced goods are exported to the rest of the world. Imports are subject to tariffs, collected by the Government and are purchased at a world price based on an exchange rate between the domestic and world currency.

Markets equilibrate by adjusting prices. Prices rise when demand exceeds supply and vice versa. The market clears if all produced goods by the firm are purchased by the household, the factor demand is equivalent to the endowment, and there is no gap between the supply and demand prices.

The system of equations representing the above statements are solved simultaneously to obtain a general equilibrium of the economy. National Input - Output data and Income Expenditure data, collected from the Office for National Statistics, are used to provide the detailed information for the above framework. These data represent an island economy in a single year, a snapshot of the economy from 2013 (the latest available data tables). Together, this data and the mathematical framework provide a numerical value of the economy wide impact of reforms that influence individuals sectors or agents.

Based on projected changes in NNDR, council tax and costs to the Council, the impact of each of the scenarios on the Council budget are described below and represented in Table 1:

1) An **increase in the efficiency of firms** by approximately 10%, leading to higher GVA typical of the finance sector, has the following effects on the economy:

There is an increase in social welfare, measured by household utility, by 2.5%. Domestic production of goods (GDP) in services and manufacturing industries rises by 3% and 2.4% respectively. Household income rises by 0.65%.

2) A **reduction in the efficiency of firms** by approximately 10%, leading to lower GVA typical of the retail and tourism sector, has the following effects on the economy:

There is a reduction in social welfare by 2.4%. Domestic production of goods (GDP) in services and manufacturing industries reduces by 3% and 2.4% respectively. Household income falls by 0.64%.

3) An **ageing population** is equivalent to a reduction in the proportion of the population in the labour force. Therefore, a reduction in the working age population of 10% has the following impacts on the economy:

Firstly, and most importantly, this reduces society welfare, measured by household utility, by 6.5%. Domestic production of goods (GDP) in services and manufacturing industries falls by 6.2% and 5.5% respectively. Household income falls by 7.8%. However, those in the labour force that are unemployed (seeking work) are more likely to find a work opportunity given the reduction in the labour supply. This will reduce the unemployment rate and thus some government expenditures on unemployment benefits.

Table 1: Descriptive results of shocks to Isle of Wight - CGE model

	Shocks		
Effect:	**High GVA industry**	**Low GVA industry**	**Ageing population**
Population	↑ in long run	Stable / ↓ in long run	Demography change
Labour force	If IoW labour force was upskilled. However, short-term, demand for labour met by in-migration. Supporting industries and services may employ current IoW labour force.	Stable, but low paid employment of low-skilled IoW workforce. However, would further lead to a 'brain drain' of high-skilled workforce. This type of work may suffer from seasonality – further reducing income.	Reduced working age population, but reduced unemployment.
Business demography	High GVA industries. These have the potential to sustain low GVA support services & industry, subject to capacity.	Low GVA industries employing low paid/skilled workforce.	Change in local market and consumer spending decisions due to ageing households.
Island GDP	↑	↓	↓
Council tax receipts	↑, potential increase in value and reduction in Local Council Tax Support.	Stable / ↓ in long run if population decreases	↓ if more Local Council Tax Support
NNDR receipts	↑ potential	↓	Stable / ↓ in long run
Council expenditure	Increased expectation of provision of services e.g. education, leisure.	Increased volume of support for low income households	Increased volume of support for low income households, increased provision of adult social care likely.
Other	Potential overcrowding / encroachment of environmental areas. Likely increase in cost of living & housing for all Island residents.		Household expenditure – quantity and types of products – varies with age. This is likely to change in the market provision of certain goods.

These results depend on various limiting factors:

- The ability of the current Island resident workforce to meet the demand for labour.
- The ability of the Island to accommodate an increase in population.
- The ability of the Island to accommodate an increase in the number/size of enterprise.

As a sensitivity analysis Table 2 shows the impact of a 10% reduction of working age population under normal circumstances and under high and low GVA industry make up, as modelled above..

Table 2: The impact of a 10% reduction in working age population

Impact on	Low GVA industry	Normal	High GVA industry
Domestic output (GDP) Services	-9.0%	-6.2%	-3.4%
Domestic output (GDP) Manufacturing	-7.8%	-5.5%	-3.1%
Household income	-8.4%	-7.8%	-7.2%
Welfare	-8.9%	-6.5%	-4.2%

In summary, an ageing population is more likely to be more detrimental to the Island residents and Council than a low productivity industry base.

Furthermore, it is clear that increasing the productivity of the firms on the Island will result in the most positive outcomes for the Council and mitigate against some of the shock of an ageing population. Wealthier residents and more profitable industries would be better able to absorb a potential increase in council tax/NNDR. However, sustainable success of such a shock would depend on the available human capital of the resident labour force. If the demand for higher skills was not met by the local population then many of the proposed benefits would simply leave the Island. This course of action would also not be without potential externalities, such as the likely increase in cost of living and housing for all Island residents, regardless of whether they benefit from higher incomes from these productive industries.

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No Man Is an Island: Quantifying the Cost of Foregone Public Goods Spillovers*

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Abstract

We develop a framework for quantifying the cost that a geographically separated municipality bears due to the lack of public goods spillovers from neighbouring municipalities. Our approach uses parameter estimates from a countrywide estimation of the determinants of local public expenditure to identify the extra local public budget that a remote municipality would require in order to implement the same level of public goods that it would exhibit if it was connected with its next neighbours, *ceteris paribus*. We illustrate our approach by applying it to the case of the Isle of Wight, which is located 5 miles off the south coast of England. We estimate that the annual cost of foregone public goods spillover for the Isle of Wight amount to about six percent of the island's actual annual local public spending.

1 Introduction

Spillovers of locally provided public goods to neighbouring municipalities are prominently assumed in many theories of public goods provision (Brainard and Dolbear (1967), Boskin (1973), Etro (2006)). If local public goods are substitutes, then these spillovers imply that local expenditure for public goods will be lower when such expenditure is high in nearby municipalities. This has been shown empirically to be the case, for instance, by Solé-Ollé (2006) or Hanes (2002). In other words, local governments benefit from their population being able to use public goods provided by neighbouring municipalities. This

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spillover of public goods provision is socially beneficial if each municipality by itself would be too small as to provide these public goods at an efficient scale.

However, opportunities for spillover of public goods do not always exist: Neighbouring municipalities may be separated from each other geographically by water or mountains or politically by country borders on which trade barriers are imposed. In such a case, the costs imposed on the local community by the lack of public goods spillover is an important piece of information for political decisions such as the construction of bridges or tunnels, or the establishments of regional economic hubs that span both sides of a country border. The immediate effect of a small region's separation from neighbouring regions is that its citizens cannot use public goods provided by other local authorities, or only at a significant cost. As a consequence, the local government will either provide this good at a lower-than-efficient scale, or choose not to provide it. Hence, this physical separation will result in higher costs of public goods provision or social welfare loss caused by its underprovision. The aim of this paper is to develop a framework to quantify the loss to such an isolated region resulting from the foregone public goods spillovers.

The empirical analysis proceeds in three steps: In the first step, we use data from 151 English municipalities to estimate the impact of the municipalities own characteristics, its neighbouring municipalities characteristics and public expenditure, and the distance to these neighbouring municipalities on municipalities public expenditure. Consistent with the above argument of substitutability of local public goods, municipalities spend less if public expenditure in neighbouring municipalities is high. However, our results also point at a cost of proximity to other municipalities: If neighbouring municipalities are more populous, public goods may become overcrowded, so that the local government will have to spend more on them. Hence, it is not a priori clear which of these effects will dominate, i.e. whether being part of a contiguous area would make the geographically separated municipality spend more or less than it actually does.

The second step is, therefore, to use the estimation results from the first step to predict how much more or less such a geographically separated municipality would spend if it wasn't separated. We use the Isle of Wight as a particular example for such a geographically separated municipality and predict how much it would spend on public goods were it attached to the mainland by normal road and rail connections. Making plausible assumptions on the perceived distance to its next neighbours, we find that optimal expenditure of the Isle of Wight would be about three percent less if it was connected with the neighbouring municipalities by normal road and rail connections compared to the actual geographical situation.

Finally, we will quantify the overall social loss for the Isle of Wight resulting from being detached from the mainland. As noted above, a remote municipality may decide

not to provide a certain goods or services at all rather than providing it at an inefficient scale. As our analysis in the second step is only concerned with expenditure, it would not capture such an effect, so that we would underestimate the impact on the Isle of Wight when confining our analysis on that part only. Hence, we use a simple theoretical model of decision making by local governments in order to show how the parameter estimate of grants can be used to quantify the income effect on a municipality's optimal public goods provision. Using this effect and the previously obtained prediction of the impact of remoteness on expenditure, we can then quantify how much more budget the Isle of Wight would need such that its citizens can consume the same amount of private and public goods as if it was part of the mainland.

Public expenditure spillovers have been analysed extensively in the literature, with different results depending on the level of observations, the nature of local public expenditure and the definition of neighbourliness. For instance, state governors have theoretically been argued to be concerned about migration of the tax base and benefit claimants as well as yardstick competition between state governments, all of which predict a positive correlation between public expenditure in similar, not necessarily adjacent states, which is confirmed by Case, Rosen, and Hines (1993) and Baicker (2005).

Alternatively, expenditure spillovers may reflect public goods spillovers. Due to the importance of geographical distance, studies that are concerned with this issue use municipality-level data and spatial weights based on geographical distance. However, whether the goods and services paid for with these expenditures are substitutes or complements is an empirical question: For instance, Hanes (2002) for rescue services in Sweden and Solé-Ollé (2006) for total spending in Spain have obtained results that are consistent with local public goods being substitutes, whereas Murdoch, Rahmatian, and Thayer (1993) for recreation expenditures in the Los Angeles region and Costa, Veiga, and Portela (2015) for total spending in Portugal find a positive coefficient for spatially lagged expenditure, which is in line with complementarity between local public goods. We focus on local public goods spillovers and, therefore, use municipality-level data, and find support for substitutability of local public goods. It will turn out that this substitutability simplifies the theoretical model and, therefore, identifying the effect that we are interested in.

As another line of related literature there is a number of policy papers on Pacific Island Countries and the impact of their small scale and isolation on issues such as public financial management (Haque, Knight, and Jayasuriya (2015)) or growth and vulnerability to shocks (Becker (2012) and Tumbarello, Cabezon, and Wu (2013)). None of these papers analyse the costs of forgone public goods spillover.

The paper proceeds as follows: In Section 2 we use a well-known model of public

expenditure spillovers to motivate the regression analysis and extend this model to derive the impact of remoteness on public goods provision as a function of the parameter estimates that are going to be obtained in the regression. Section 3 discusses the variables used in the regression and explains the construction of the spatial weight matrices. Section 4 presents the empirical analysis, and Section 5 concludes.

2 A Simple Theory of Public Expenditure Spillovers

Determinants of Regional Public Expenditure We will consider a slightly simplified version of the model in Solé-Ollé (2006) to analyse the impact of a municipality's characteristics on optimal local public expenditure. Let us suppose that social welfare $V_i(x_i, z_i)$ in municipality i is a quasi-concave function of per-capita public goods provision z_i and per-capita spending x_i for a composite private good. Furthermore, the amount of public goods z_i that each citizen of municipality i has at her disposal is a function of several characteristics of municipality i, including a linear, positive relationship with municipality i's per capita public goods expenditure e_i. More specifically, let $z_i = Z_i + \varepsilon e_i$, where Z_i denotes that part of z_i that is invariant to e_i (because it depends on other characteristics of i).

Furthermore, assume that the per-capita income after central taxes, and including grants from the central government, in municipality i is y_i. Hence, i will choose e_i so as to maximize $V_i(y_i - e_i, z_i(e_i))$. Assuming that $\frac{dV(y_i,Z_i)}{de_i} > 0$, the optimal choice e_i^* satisfies the first-order condition

$$-\frac{\partial V_i(y_i - e_i^*, z_i(e_i^*))}{\partial x_i} + \varepsilon \frac{\partial V_i(y_i - e_i^*, z_i(e_i^*))}{\partial z_i} = 0. \tag{1}$$

Hence, the impact of a determinant a_i of i's public goods provision on the optimal choice of e_i is given by the comparative statics of (1),

$$\frac{\partial e_i}{\partial a_i} = -\frac{\varepsilon \frac{\partial^2 V_i(y_i - e_i^*, z_i(e_i^*))}{\partial z^2} - \frac{\partial^2 V_i(y_i - e_i^*, z_i(e_i^*))}{\partial x \partial z}}{\Omega} \frac{\partial z_i}{\partial a_i}, \tag{2}$$

where Ω is the term that the second-order condition for a local maximum requires to be negative. Hence,

$$sgn\left(\frac{\partial e_i}{\partial a_i}\right) = -sgn\left(\frac{\partial z_i}{\partial a_i}\right). \tag{3}$$

as long as the composite private good is a normal good.

Following Solé-Ollé (2006), we shall also argue that z_i depends on the municipality's characteristics in the following ways: Ceteris paribus, more public goods provision in a neighbouring municipality and lower costs of the own and the neighbouring municipalities' public goods provisions will increase the public goods z_i at municipality i's citizens'

disposal for given per capita expenditure e_i by i and its neighbours. However, a larger population in municipality i and a larger ratio of neighbouring municipalities' to the own municipality's populations will overcrowd the public good and, thus, reduce a representative citizen's consumption of it. For all of these characteristics, (3) implies that the effect on e_i will have the opposite sign than what we have just argued for z_i.

It is important to note that the aforementioned assumption on how i's expenditure depends on public goods provision in neighbouring municipalities is implicitly based on an assumption that public goods provided by i and its neighbours are substitutes, for which the regressions in Section 4 will lend empirical support. Intuitively, we assume that public goods spillovers just impact on the amount of public goods available for municipality i's citizens. However, complementarity between own and neighbours' public goods would require that public goods spillover increases the marginal benefit of own public goods provision for a given level of own public goods provision. Hence, our approach cannot be used for complementary public goods spillovers since we would erroneously interpret the positive correlation between neighbouring municipalities' expenditures that we would observe in this case as negative externalities.

In addition to these characteristics that affect public goods consumption for given local public expenditures, but not social welfare directly, there may also be characteristics b_i that directly impact on V_i. In this case, the comparative statics analysis yields

$$\frac{\partial e_i}{\partial b_i} = -\frac{\varepsilon \frac{\partial^2 V_i(y_i - e_i^*, z_i(e_i^*))}{\partial z \partial b} - \frac{\partial^2 V_i(y_i - e_i^*, z_i(e_i^*))}{\partial x \partial b}}{\Omega}. \tag{4}$$

For instance, if b_i represents a preference parameter that expresses the representative citizen's taste for consumption of public rather than private goods, then a higher b_i will increase $\frac{\partial V_i}{\partial z}$ relative to $\frac{\partial V_i}{\partial x}$, so that we expect this parameter's impact on i's equilibrium expenditure to be positive. Alternatively, b_i may represent the public budget of municipality i. If both the public and the composite private good are normal, i will spend more on both goods, which means that e_i will increase.

To sum up, the theoretical analysis presented above suggests that several characteristics of a municipality and spatial lags of some characteristics determine this municipality's choice of per capita expenditure. In Section 4, we will, therefore, estimate the following equation

$$\begin{aligned} e_i =& \alpha_0 + \alpha_1 \sum_j w_{ij} e_j + \alpha_2 N_i + \alpha_3 N_i^2 + \alpha_4 \frac{\sum_j k_{ij} N_j}{N_i} \\ &+ \alpha_5 u_i + \alpha_6 m_i + \alpha_7 r_i + \alpha_8 t_i + \alpha_9 g_i + \alpha_{10} wage_i \\ &+ \alpha_{11} \sum_j w_{ij} u_j + \alpha_{12} \sum_j w_{ij} m_j + \alpha_{13} \sum_j w_{ij} r_j, \end{aligned} \tag{5}$$

where N_i is municipality i's population size, $K = (k_{ij})$ is a spatial weights matrix in which $k_{ij} = 0$ if the distance d_{ij} between i and j is at least 50 miles, and $k_{ij} = d_{ij}^{-1/2}$ otherwise, and $W = (w_{ij})$ is the row standardised version of K. The shares u_i of unemployed, m_i of non-EU migrants and r_i of residents of rural areas in the population collectively serve as proxies for cost of public goods provision. Furthermore, we will control for local tax t_i, per capita grants g_i and wage income $wage_i$ to account for the municipality's budget constraint. Last, we include the spatial lags of the aforementioned proxies for costs of public goods provision, unemployment, migration and urbanisation. This specification follows Solé-Ollé (2006) to a large extent.

Quantifying Costs of Foregone Spillover We will now explore a way of identifying the costs that an isolated municipality bears compared to a hypothetical case in which it is connected with its next neighbours. Let d'_{ij} denote the distance between i and j in the hypothetical situation of contiguity that we are interested in. In our empirical application, in which i is an island, even the 'actual' distance d_{ij} is not straightforward to determine: Unless there are road or railway bridges, a given distance to the mainland will be significantly more costly and time consuming to travel than the same distance on land. Furthermore, the spatial lags of per-capita variables in (5) are computed using a row-standardaised spatial weights matrix, which is appropriate for the case of contiguous regions but cannot account for remoteness.

We will tackle this issue by defining the i-th rows of K and W based on the hypothetical distances d'_{ij} and discounting them by a factor λ that accounts for the time and costs that it takes to get from i to the mainland. Hence, our notion of remoteness is similar to iceberg transportation costs known from the trade literature. If travelling from the island i to the mainland costs more time and money than travelling 50 miles on the mainland, the appropriate value for λ would be zero.

Hence, if A_i is the vector of spatial lags used in the estimation (5), based on the hypothetical spatial weight matrices, and α the vector of estimated coefficients for these spatial lags, the estimation of (5) predicts the impact of these spatial lags on i's actual local public expenditure to be $\lambda\alpha A_i$. We will write $e_i^o(\cdot)$ to denote i's optimal expenditure choice as a function of this impact of the spatial lags. For instance, the actually observed level of expenditure in i is equal to $e_i^o(\lambda A_i)$.

We seek to identify the extra budget that i would need to provide the same level of public goods that its residents would have at their disposal if i was connected with its neighbours without compromising private goods consumption, i.e. the difference $\tilde{e} - e_i^o(\lambda A_i)$, where $\tilde{e}$ is defined formally by

$$z_i(\tilde{e}, \lambda A_i) = z_i(e_i^o(A_i), A_i). \tag{6}$$

The first step is to use the regression results to predict $e_i^o(A_i)$, i.e. the per capita expenditure that i would spend if it was connected to the mainland. Furthermore, we can rewrite (6) so as to be able to use the parameters that we are going to estimate in the empirical exercise: (6) is equivalent to

$$z_i(\tilde{e}, \lambda A_i) - z_i(e_i^o(\lambda A_i), \lambda A_i) = z_i(e_i^o(A_i), A_i) - z_i(e_i^o(\lambda A_i), \lambda A_i). \tag{7}$$

which, due to the fact that z_i is linear in e_i, is equivalent to

$$\begin{aligned} \tilde{e} - e_i^o(\lambda A_i) &= \frac{1}{\varepsilon} \int_{\lambda A_i}^{A_i} \left(\frac{\partial z_i(e_i^o(\tilde{A}), \tilde{A})}{\partial e} \frac{\partial e_i^o(\tilde{A})}{\partial \tilde{A}} + \frac{\partial z_i(e_i^o(\tilde{A}), \tilde{A})}{\partial \tilde{A}} \right) d\tilde{A} && (8) \\ &= \alpha A_i(1-\lambda) + \frac{1}{\varepsilon} \int_{\lambda A_i}^{A_i} \frac{\partial z_i(e_i^o(\tilde{A}), \tilde{A})}{\partial \tilde{A}} d\tilde{A} && (9) \end{aligned}$$

The first summand on the right-hand side of (9) is the difference $e_i^o(A_i) - e_i^o(\lambda A_i) = \alpha A_i(1-\lambda)$ between predicted optimal local public expenditure in the hypothetical situation that i is connected to its neighbours, and the actually observed local public expenditure. This takes account of the 'indirect' effect of connectedness on public goods consumption via the change in optimal local public expenditure. Note that we expect this to be negative since typically the benefit from neighbouring municipalities using each others' public goods outweighs potential costs of congestion due to scale effects. Hence, the availability of more public goods spillover will induce i to spend less than it actually does.

As we observe $e_i^o(\lambda A_i)$ and have just argued that we can predict $e_i^o(A_i)$ using our regression results, it remains to identify the second summand on the right-hand side of (9), which measures how connectedness directly impacts on public goods consumption for given local public expenditure. This is potentially problematic since our estimation will neither deliver the impact ε of local public expenditure nor that of the spatial lags A_i on local public goods consumption directly. However, the following proposition shows how these impacts can be obtained in a simple way from parameters that our estimation does deliver.

Proposition 1 *Define* $\gamma := \frac{\partial e_i^o}{\partial y_i}$. *Then,*

$$\frac{1}{\varepsilon} \frac{\partial z_i(e_i^o(A), A)}{\partial A} = \left(-1 - \frac{\gamma}{1-\gamma} \right) \frac{\partial e_i^o(A)}{\partial A} \tag{10}$$

Proof. See the Appendix. ■

Intuitively, removing municipality i's physical separation is like reducing the price for public goods, as i's citizens can consume more public goods for given local public expenditure. In this sense, Proposition 1 yields the total effect of this 'price reduction'

on public goods consumption by disentangling it into a substitution effect and an income effect: The cheaper availability of public goods due to the intensified spillover after the removal of physical separation causes the municipality to substitute some private goods consumption with more public goods consumption. However, its citizens will also feel richer due to the cheaper availability of public goods. This income effect can be obtained using the parameter for an exogenous change in i's budget in the estimation of (5). In the empirical exercise carried out in Section 4, we will use the parameter of government grants in order to obtain the effect γ of such an exogenous budget change on optimal local public expenditure.

With Proposition 1, (9) becomes

$$\tilde{e} - e_i^o(\lambda A_i) = -\alpha A_i(1-\lambda)\frac{\gamma}{1-\gamma}. \tag{11}$$

Recall that we have argued above that we expect αA_i to be negative, so that the extra amount of local budget that i would need to achieve the same levels of consumption as in the hypothetical case where it is connected with the mainland is expected to be positive.

3 Data

Observations Our dataset is comprised of 151 English municipalities, each with an own local public expenditure budget at its disposal. More specifically, these are all Unitary Authorities,[1] Shire Counties, London Boroughs and Metropolitan Districts in England.

Variables Table 1 presents an overview of all variables used in the empirical analysis and their summary statistics. The dependent variable, Expenditure, is defined as the difference between total local public expenditure and expenditure for fire and rescue and police, since these areas are often provided in cooperation between two municipalities. The source for these variables is 2015-16 Revenue Account Budget data provided by the Department for Communities and Local Government.

Among the independent variables, there is a set of population-related variables, all of which have been obtained from 2011 census of the Office for National Statistics: In addition to the total population count this set includes the shares of non-EU migrants and the rural population in total population, and a proxy for the local unemployment rate which is calculated as the share of claimants for unemployment benefits in the total population. Furthermore, wage income is defined as mean annual gross pay and obtained

[1] with the exception of the Isles of Scilly, which we excluded due to their extraordinarily small population and, as a consequence, the fact that the claimant count data was not reported for confidentiality reasons.

Table 1: Summary Statistics.

Variable	Mean	Std. Dev.	Min	Max
Per Capita Expenditure (£1,000)	1.4683	0.7396	0.9705	10.0386
Population	362,808.0	273,096.5	8,760	1,524,719
Wage income	34,329.70	8,936.63	24,186	94,416
Unemployment	1.9225	0.8903	0.5	4.3
Non-EU migrants	0.0297	0.0383	0.0022	0.1411
Share of Rural in Total Population	17.3927	24.5068	0	100
Household Council Tax	1,193.92	166.93	379.16	1,502.79
Per Capita Grants	1.3620	0.5056	0.5965	5.3533

from the Annual Survey of Hours and Earnings. Last, the average Band D equivalent council tax per household and the total specific and special revenue grants and revenue support figures used to calculate grants per capita are obtained from the Department for Communities and Local Government.

Spatial Weights The spatial weights matrices are based on simple beeline distances between the post codes of the municipalities' townhalls. We use these distances d_{ij} to create the spatial weight matrix $K = (k_{ij})$ where

$$k_{ij} = \begin{cases} d_{ij}^{-\frac{1}{2}}, & \text{if } 0 < d_{ij} \leq 50; \\ 0, & \text{otherwise.} \end{cases} \tag{12}$$

and the row standardised matrix $W = (w_{ij})$ where

$$w_{ij} = \frac{k_{ij}}{\sum_j kij}. \tag{13}$$

For the municipalities in our dataset that are located on the English mainland, we simply use these spatial weights. However, we have also an island municipality in our dataset, the Isle of Wight. As discussed in the theoretical analysis, the beeline distance from an island is usually much more costly and time consuming to travel than the same distance on the mainland. Hence, it is important to create a realistic set of weights for the Isle of Wight.

For the hypothetical case that the Isle of Wight was not separated from the mainland, we will use the i-th rows of K and W as defined above using the beeline distances. In order to account for the physical separation, we first calculate the 'perceived' distance from the Isle of Wight to the mainland, taking into account the higher costs of transport, the lower speed of travel over water and the additional time required for boarding: For

instance, the car ferry requires arrival at least 30 minutes before the scheduled sailing time, whereas the means of transport has to be changed twice when travelling from some train station on the Isle of Wight to another train station on the mainland. We define the perceived distance as the distance that costs the same amount of money and time to travel on land as it costs to travel from the Isle of Wight to the mainland, taking the average of the time-based and the cost-based calculations. In Appendix B we compare the time and money required for the cross-Solent travel to travelling on the mainland and propose a perceived distance of 31.5 miles for a train journey and more than 69.6 miles for a car journey.

In a next step, we use the actual width of the Solent (5 miles) to calculate the difference $\tilde{d}$ between the perceived and the beeline distance between the Isle of Wight and the mainland. When accounting for this difference in the weight matrices, the problem arises that it would have little impact on the row standardised matrix W. Hence, we will discount the Isle of Wight's weights by a factor λ which is decreasing in the difference between the perceived and the actual distance, does not change the weight matrices if this distance is zero (i.e., $\lambda = 1$ in this case) and removes all spillovers from neighbours if this difference is above 50 miles. A factor that satisfies all these requirements is $\lambda = \max\left\{1 - \frac{\tilde{d}}{50}, 0\right\}$. We will use the factor $\lambda = 1 - \frac{26.5}{50} = 0.47$ based on the train journey in the regression analysis and the quantification of the costs of foregone spillovers proposed in equation (11). Furthermore, we will provide the same regressions and calculations for the factor $\lambda = 0$, which is appropriate for a car journey, in Appendix C, and show that our qualitative results are robust to the way in which the spatial weights matrix is adjusted for the Isle of Wight.

4 Empirical Analysis

Table 2 presents the regressions that estimate municipalities' expenditures. Following Solé-Ollé (2006), we use the weight matrix K for the spatial lags of the population and its square and the row standardized weight matrix W for all spatial lags of per capita variables (and the spatially autocorrelated error term). Note that the Isle of Wight is included in the regressions, but we have set all weights to λK_i and λW_i as explained in Section 3.

The simple OLS estimation reported in Panel (1) suggests that higher public expenditure in neighbouring municipalities induce a municipality to reduce its expenditure. This is consistent with the aforementioned argument that some of the public goods provided in the near proximity will spill over to citizens of a given municipality, so that this municipality will reduce its own public expenditure in order to achieve the optimal mix of

consumption of private and public goods. Similarly, a larger population in neighbouring municipalities will make a municipality's own public goods more congested and, thus, induce it to spend more. Increases in council tax income or grants increase the budget and, thus, imply an increase in public spending. In addition to that, Solé-Ollé (2006) controls for personal income in order to close the budget constraint on the individual level. For our units of observation, the Annual Survey of Hours and Earnings provides the wage income, the coefficient of which, however, turns out to be insignificant in our estimation.

Last, the variables unemployment, non-EU migrants and share of rural population are supposed to proxy for costs of public goods provision. Intuitively, larger costs force the municipality to increase public goods expenditure for a given amount of public goods provided. However, there is a countervailing effect that optimal public goods provision will go down as a result of the cost increase. In this sense, our positive parameter of the share of non-EU migrants indicates that the first effect may dominate, whereas the effects seem to balance out for unemployment and the share of the rural population.

However, the OLS regression does not take into account that neighbouring municipalities' optimal expenditure choices will depend on the municipality's own expenditure, so that the spatial lags of the dependent variable are endogenous. Furthermore, the error term of such a regression may be spatially autocorrelated. In order to account for these problems, we use the generalised spatial two-stage least squares estimator developed by Kelejian and Prucha (1998) in the remaining Panels of Table 2.

Panel (2) shows that the coefficient of the spatial lag of the dependent variable is slightly lower than in the OLS regression. By and large, however, the effects are very similar to the parameters obtained by OLS. For the regression displayed in Panel (3), we added spatial lags of the cost-related variables. The idea is that higher costs for neighbours to provide public goods will reduce their public goods provision, and thus the spillover to a given municipality, for given public expenditure by neighbouring municipalities. Our significantly positive coefficients of the spatial lags of unemployment, and the share of the rural population support this argument. Furthermore, observe that the inclusion of these variables seems to remove the spatial autocorrelation of the error terms. The other coefficients are, with the exception of the now significantly negative coefficient of unemployment, almost identical to those in Panel (2).

Given our analysis in Section 2, it is straightforward to use these parameter estimates to calculate the costs of geographical separation for a municipality. First, we predict the impact of increasing the Isle of Wight's spatial weights λK_i and λW_i to K_i and W_i, respectively, which yields $e_i^o(A_i) - e_i^o(\lambda A_i) = \alpha A_i(1-\lambda) = 45.41$ per capita in equation (9). In other words, the Isle of Wight would spend £45.41 less per capita on public goods

Table 2: Local Public Expenditure in England.

	OLS	GS2SLS	GS2SLS
Expenditure (spatial lag)	-0.1484***	-0.1363**	-0.1365**
	(0.0539)	(0.0631)	(0.0574)
Population	0.0928	0.0840	0.0388
	(0.1029)	(0.0992)	(0.0899)
Population^2	0.0130	0.0242	0.0564
	(0.0626)	(0.0586)	(0.0559)
Population (spatial lag)	0.0111***	0.0110***	0.0107***
	(0.0004)	(0.0003)	(0.0003)
Unemployment rate	0.0115	-0.0020	-0.0303**
	(0.0116)	(0.0127)	(0.0127)
Non-EU migrants	0.6417**	0.6172**	0.6010**
	(0.3145)	(0.3086)	(0.2904)
Rural	0.0010**	0.0008*	0.0007
	(0.0005)	(0.0005)	(0.0005)
Grants	0.6098***	0.6231***	0.6665***
	(0.0473)	(0.0446)	(0.0422)
Wage Income	-0.0019	-0.0018	-0.0012
	(0.0013)	(0.0012)	(0.0013)
Household Council Tax	0.0003***	0.0003***	0.0003***
	(0.0001)	(0.0001)	(0.0001)
Unemployment (spatial lag)			0.0725***
			(0.0197)
Migrants (spatial lag)			-0.8639
			(0.6130)
Rural (spatial lag)			0.0029***
			(0.0009)
Constant	0.3702***	0.3839**	0.1990
	(0.1317)	(0.1495)	(0.1345)
Spatially autocorrelated part of error term		0.5470***	0.2904
		(0.1993)	(0.4409)
N	151	151	151

Robust standard errors in parentheses. *, ** and *** denote significance at 10-percent, 5-percent and 1-percent levels, respectively. The population variable has been divided by one million for expositional reasons.

if it was connected to the mainland, which is about 3.1% of its actual expenditure of £1,484.87 per capita.

As argued earlier, this difference is just the optimal reaction of the local government to gepgraphical separation but does not take into account the social costs of lower consumption over all due to the 'income effect'. Hence, in line with the analysis in Section 2, we multiply this difference by the factor $\frac{\gamma}{1-\gamma} = \frac{0.6665}{0.3335}$ to obtain the full effect of geographical separation, which is £90.75 per capita. Hence, we conclude that, according to our measure of social costs, the Isle of Wight's costs of geographical separation from the mainland and, thus, lack of public goods spillover, is amounts to about 6.1% of its actual public expenditure.

5 Conclusion

We have estimated a model of public expenditure spillovers using data from 151 English municipalities and obtained parameter estimates that are consistent with spillovers of local public goods that are substitutes for each other. Within a simple theoretical model of spillover of substitutable public goods, we showed that the extra budget that a geographically separated municipality would need to provide the same level of public goods as it would if it was not separated can be quantified using our parameter estimates. As an illustration, we performed this exercise for the case of the Isle of Wight and found that it would cost the Isle of Wight about six percent of its actual current public expenditure to fund the level of public goods at its citizens' disposal if public goods spillovers were available.

Our proposed approach can yield valuable information for political decisions in a number of scenarios beyond the case of the Isle of Wight used for illustrative purposes in this paper: For instance, Norway has an abundance of islands separated from the mainland, opposite banks of fjords separated from each other, or municipalities on both sides of a steep mountain range, the *Nordryggen*. Similarly, some country borders form, to some extent, barriers to economic interactions between municipalities on both sides of these borders, the most extreme cases being borders that separate countries with radically different political systems such as that between South and North Korea. In these scenarios, the quantification of social costs of the lack of public goods spillover as obtained by our approach can deliver two sets of insights: First, saving these costs of separation would be an important benefit of investing in overcoming this separation by building bridges or tunnels or by establishing free movement between countries. Second, if such an investment is infeasible or impossible, this figure hints at what amount of support a municipality needs from central government to guarantee fair funding across

regions.

In line with the estimation results, our approach to quantify the cost of geographical separation is based on the assumption that public goods provided in neighbouring municipalities are substitutes to each other. This simplifies identification because we can disregard the way in which public goods spillovers impact on marginal benefits of own public goods provision. However, since this latter effect is crucial when public goods provided by neighbouring municipalities are complements, our approach cannot be readily used for the case of complementarity. Furthermore, if the mix of public goods financed by municipalities in our dataset include substitutes and complements, we are likely to underestimate the cost of lack of public goods spillover. In this sense, we would see our quantification as a conservative estimate for these costs.

Last, it needs to be emphasised that our analysis focuses on the social costs of a lack of local public goods spillovers due to physical separation. However, physical separation is likely to have an effect on many other relevant economic activities such as the consumption of private goods or the flow of production factors between regions. These issues are beyond the scope of this paper and need to be addressed within suitable frameworks such as a computable general equilibrium model.

Appendix

A Proof of Proposition 1

The second total differential of $V_i(\cdot)$ is

$$\Omega = \varepsilon^2 \frac{\partial^2 V_i(y_i - e_i^*, z_i(e_i^*))}{\partial z^2} - 2\varepsilon \frac{\partial^2 V_i(y_i - e_i^*, z_i(e_i^*))}{\partial x \partial z} + \frac{\partial^2 V_i(y_i - e_i^*, z_i(e_i^*))}{\partial x^2} \tag{14}$$

Using (2), we have

$$\begin{aligned} \frac{1}{\varepsilon}\frac{\partial z_i(e_i^o(A), A)}{\partial A} &= -\frac{1}{\varepsilon}\frac{\varepsilon^2 \frac{\partial^2 V_i}{\partial z^2} - 2\varepsilon \frac{\partial^2 V_i}{\partial x \partial z} + \frac{\partial^2 V_i}{\partial x^2}}{\varepsilon \frac{\partial^2 V_i}{\partial z^2} - \frac{\partial^2 V_i}{\partial x \partial z}} \frac{\partial e_i^o(A)}{\partial A} \\ &= \left(-1 - \frac{\gamma}{1-\gamma}\right) \frac{\partial e_i^o(A)}{\partial A}, \end{aligned}$$

where the last equality is obtained using the comparative statics with respect to y_i:

$$\gamma = \frac{\partial e}{\partial y_i} = \frac{\frac{\partial^2 V_i}{\partial x^2} - \varepsilon \frac{\partial^2 V_i}{\partial x \partial z}}{\varepsilon^2 \frac{\partial^2 V_i}{\partial z^2} - 2\varepsilon \frac{\partial^2 V_i}{\partial x \partial z} + \frac{\partial^2 V_i}{\partial x^2}} \tag{15}$$

$$= 1 - \varepsilon \frac{\varepsilon \frac{\partial^2 V_i}{\partial z^2} - \frac{\partial^2 V_i}{\partial x \partial z}}{\varepsilon^2 \frac{\partial^2 V_i}{\partial z^2} - 2\varepsilon \frac{\partial^2 V_i}{\partial x \partial z} + \frac{\partial^2 V_i}{\partial x^2}}. \tag{16}$$

■

B Calculation of the Isle of Wight's Perceived Distance

In this Appendix, we calculate the 'perceived' distance of the Isle of Wight from the mainland.

For the case of a train journey, we compare the time and costs that it takes to get to London from a train station on the Isle of Wight that is located in close proximity to the shore ('Ryde Esplanade'), using the fast catamaran to cross the Solent, and the time and costs that the same journey would take if it started at the first station in Portsmouth ('Portsmouth Harbour'). The beeline distance between these stations is 5 miles. On a typical working day, the first journey is scheduled to take 144 minutes, whereas the latter only takes 94 minutes. Since the beeline distance between Portsmouth Harbour and London Waterloo Station is about 65 miles, our measure for the "perceived" distance from the Isle of Wight to the mainland based on the travel time is about $65 * 50/94 = 34.6$ miles.

Where the extra cost are concerned, the first trip costs £47.20 one-way, whereas exactly the same train from Portsmouth Harbour would cost £33.40. Based on this measure, the perceived distance is $65 * 13.8/33.4 = 26.9$ miles. Taking the average of the time-based and the cost-based measure yields a perceived distance equal to 31.5 miles.

For a car journey, we compare a journey from Ryde to Portsmouth and an equally long and costly onward journey on the mainland. It takes about 10 minutes to get to the Ferry terminal in Fishbourne, drivers are required to be there 30 minutes ahead of the booked sailing, and the crossing itself takes about 40 minutes. 110 minutes by car will take a traveller from Portsmouth, for instance, to Eastbourne (beeline = 61.5 miles) or Poole (beeline = 39.1 miles). As for costs, a typical car ferry ticket for a normal passenger car costs about £45. Using the HMRC approved mileage rate of £0.45, this amount of money would get a traveller 100 miles on land by car. Hence, even the most conservative estimate of the perceived distance as the average of the time-based and the cost-based calculations would be $(39.1 + 100)/2 = 69.6$ miles.

C Empirical Analysis for $\lambda = 0$

Table 3 presents the estimation results if the spatial weights for the Isle of Wight are multiplied by $\lambda = 0$ (instead of $\lambda = 0.47$ in the main regressions). The results are qualitatively identical than in the main regression but the size of the negative public expenditure spillover is smaller.

Just like in the main part of the paper, we use this estimation to predict how much less

Table 3: Local Public Expenditure in England for $\lambda = 0$.

	OLS	GS2SLS	GS2SLS
Expenditure (spatial lag)	-0.1295**	-0.1169**	-0.1349***
	(0.0534)	(0.0585)	(0.0519)
Population	0.0988	0.0883	0.0396
	(0.1032)	(0.0997)	(0.0902)
Population^2	0.0083	0.0207	0.0560
	(0.0627)	(0.0588)	(0.0561)
Population (spatial lag)	0.0112***	0.0111***	0.0107***
	(0.0004)	(0.0003)	(0.0003)
Unemployment rate	0.0119	-0.0014	-0.0304**
	(0.0116)	(0.0127)	(0.0127)
Non-EU migrants	0.6451**	0.6216**	0.5997**
	(0.3120)	(0.3066)	(0.2910)
Rural	0.0010**	0.0008*	0.0007
	(0.0005)	(0.0005)	(0.0005)
Grants	0.6054***	0.6198***	0.6664***
	(0.0472)	(0.0448)	(0.0423)
Wage Income	-0.0021	-0.0019	-0.0012
	(0.0013)	(0.0012)	(0.0013)
Household Council Tax	0.0003***	0.0003***	0.0003***
	(0.0001)	(0.0001)	(0.0001)
Unemployment (spatial lag)			0.0728***
			(0.0199)
Migrants (spatial lag)			-0.8632
			(0.6161)
Rural (spatial lag)			0.0029***
			(0.0008)
Constant	0.3505***	0.3603**	0.1961
	(0.1310)	(0.1450)	(0.1279)
Spatially autocorrelated part of error term		0.5357***	0.2913
		(0.1939)	(0.4418)
N	151	151	151

Robust standard errors in parentheses. *, ** and *** denote significance at 10-percent, 5-percent and 1-percent levels, respectively.

public expenditure the Isle of Wight would spend if it was connected with the mainland (instead of total separation, which we assume in this Appendix to be the status quo) and obtain a reduction by £47.85 per capita. Multiplying this figure by factor $\frac{\gamma}{1-\gamma} = \frac{0.6664}{0.3336}$ yields the result that the Isle of Wight would need an additional budget of £95.59 per capita or 6.4% of its actual public expenditure for its citizens to dispose of the same amount of public goods as in the hypothetical case that the Isle of Wight was connected with the mainland.

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