

Dublin's Role in the Irish and Global Economy 2012

Report 2

Prepared for Dublin Regional Authority

SPATIAL ANALYTIC APPROACHES ASSESSING SOCIO-ECONOMIC DEVELOPMENT OF THE DUBLIN REGION COMPARED WITH OTHER REGIONS IN IRELAND

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Abbreviations

AIRO	All Island Research Observatory
ATM	Athlone, Tullamore and Mullingar
CLC	CORINE Land Cover
CORINE	Coordination of Information on the Environment
CSO	Central Statistics Office
DECLG	Department of the Environment, Community & Local Government
DES	Department of Education and Skills
ED	Electoral Division
EI	Enterprise Ireland
EPA	Environmental Protection Agency
ESRI	Economic and Social Research Institute
FDI	Foreign Direct Investment
GDA	Greater Dublin Area
GDR	Greater Dublin Region
GIS	Geographic Information System
HEA	Higher Education Authority
IDA	Industrial Development Agency
ISSDA	Irish Social Science Data Archive
LA	Local Authority
MOLAND	Monitoring Urban Land Cover Dynamics
NIRSA	National Institute of Regional and Spatial Analysis
NTA	National Transport Authority
NUI	National University of Ireland
NUTS	Nomenclature of Territorial Units for Statistics
OSi	Ordinance Survey Ireland
POWCAR	Place of Work Census of Anonymised Records
QNHS	Quarterly National Household Survey
RoI	Republic of Ireland
SAPS	Small Area Population Statistics
SME	Small and medium enterprises
UCD	University College Dublin
UEP	Urban Environment Project

EXECUTIVE SUMMARY

This report and the spatial analysis therein can provide new information and assessments of the suitability of locations nationwide for investment in services, infrastructure, business formation and social infrastructure.

A key aim of Report 2 is to provide evidence mapping the spatial distribution of businesses by sector and areas with economic development potential and address the following issues:

- 1) What are the best locations nationally and regionally to ensure best economic and social return for investment of scarce fiscal resources?
- 2) What geographic areas are exhibiting clustering effects which may assist viable business formation and the growth of a knowledge economy?
- 3) Where should future ancillary services such as in the areas of health, education and transport be located based on current patterns of development and opportunity?
- 4) What are the benefits that Dublin brings to other regions in Ireland and how can this be optimised?

Report 2 is methodological in nature and is designed to demonstrate the potential of applying the “big data” concept to evidence based policy formation.

Spatial patterns of selected socio-economic indicators were studied using Geographic Information System (GIS) and geo-spatial analysis. These include indicators such as population distribution, density and change, age dependency ratio, unemployment rate, spatial distribution of jobs, household vacancy rates, bus service coverage areas, etc.

Density mapping and Hot Spot analyses were carried out across broad economic sectors with a strong indication that Dublin is the dominant player in all key sectors except for Agriculture, Forestry and Fishing¹. Moreover, the dominance and importance of the main gateway settlements of Cork, Galway and Limerick is clearly evident across most sectors. This analysis indicates a general pattern of continuing urbanisation and the benefits of clustering effects and add to the strong evidence base supporting further investment in a small number of selected Gateways and Hubs. Additionally companies with Foreign Direct Investment were mapped based on the IDA Ireland database. This also confirmed international research findings that Dublin is the most attractive region in Ireland for foreign investment (OECD 2008). As Ireland’s only city region of recognised metropolitan scale Dublin is critical to the inflow of continued investment in Ireland and as a location for global and regional Multinational Enterprise headquarters.

The importance of Dublin as an investment location is supported by the Opportunity Mapping analysis carried out in this research. This is a new approach for presenting spatial distribution of economic, educational and neighbourhood opportunities in the country and thus the more appropriate locations for economic investment in a national context. These maps combine series of variables into a single measurement which indicates the level of opportunity for economic and social progression within neighbourhoods as summarised by ED level. It should be noted in that summarising results to ED level it is intended to provide a level of disaggregation which is appropriate to the specification of this research and more prescriptive research to small area may be required in location specific analysis. Opportunity Maps are in

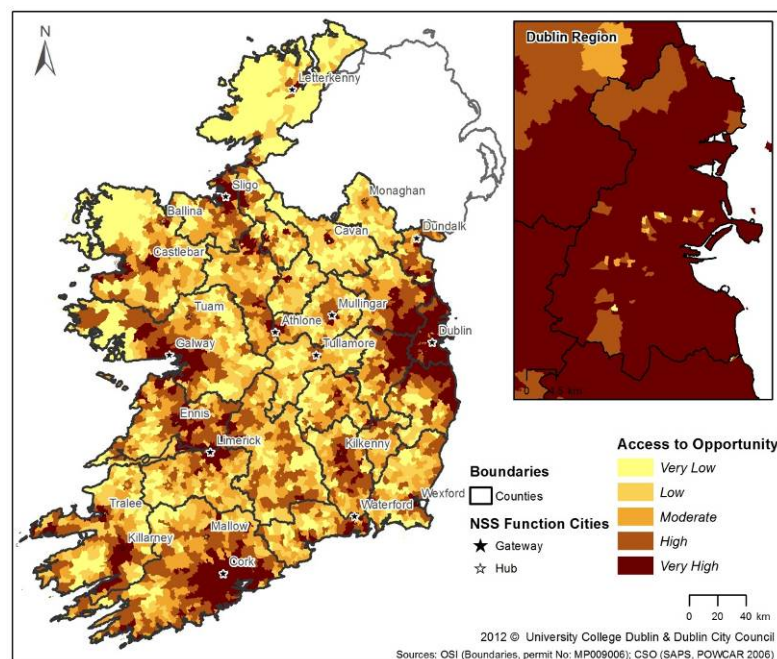
¹ According to AnPost GeoDirectory 2011 classification.

their infancy and as such are a relatively undeveloped policy instrument at present. New and emerging data opportunities and more joined up data have potential to develop opportunity maps for the city region in the future which will be a major support to current decision-making processes in planning and development. The Opportunity Mapping is described in detail in Appendix 2 and Appendix 3.

While the indicators used for this report are representative only, they do point up the potential of forming a strong evidence base in terms of making the case for best return on capital investment, best broad-base location for businesses and the need to service future population growth. The research team also identified a number of key datasets (see Appendix 5) which in combination with these opportunity maps would provide a clearer and more complete assessment of best location for investment and future critical services delivery.

Main Results

The results of the spatial mapping exercises show the statistically proven significance of the main Gateways and Hubs as key centres for the main sectors of business in Ireland. In the case of the Comprehensive Map of Opportunity (see below) a clear pattern emerged whereby Dublin and the other Gateways across the State were the centres which represent those broad geographic areas of greatest opportunity to maximise return for investment on enterprise development.



Comprehensive Opportunity (weighted)

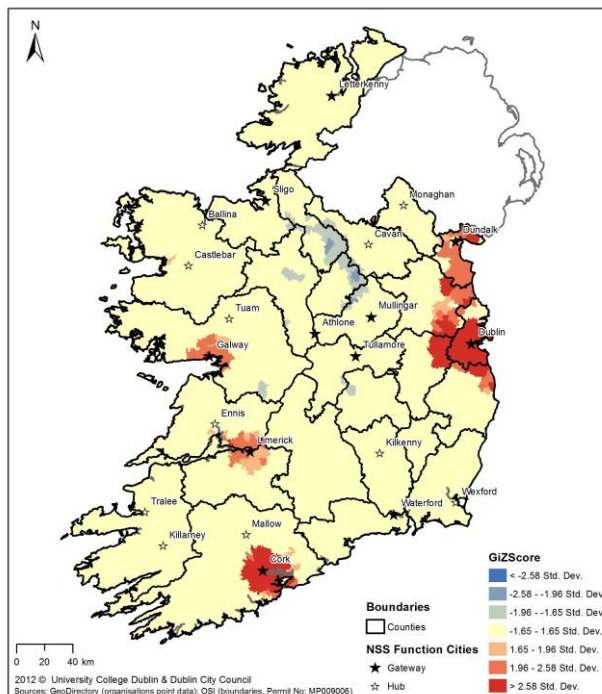
Hot spot analysis in particular reinforces the absolute importance of Dublin as a location with a critical mass of business across all sectors except agriculture and food. In the case of the latter there is an argument to investigate the potential to improve the quantum and distribution of specialist food products and services. The consequence of this result is to reinforce existing literature in this area regarding the importance of developing a few key growth centres across the State in which investment resources can be maximised to their fullest potential.

This analysis (as well as mapping the location of IDA supported companies) similarly points up the importance of the key Gateways and Hubs and in particular the GDA in terms of statistically significant clustering of key economic sectors: Financial Services; ICT; Professional, Scientific

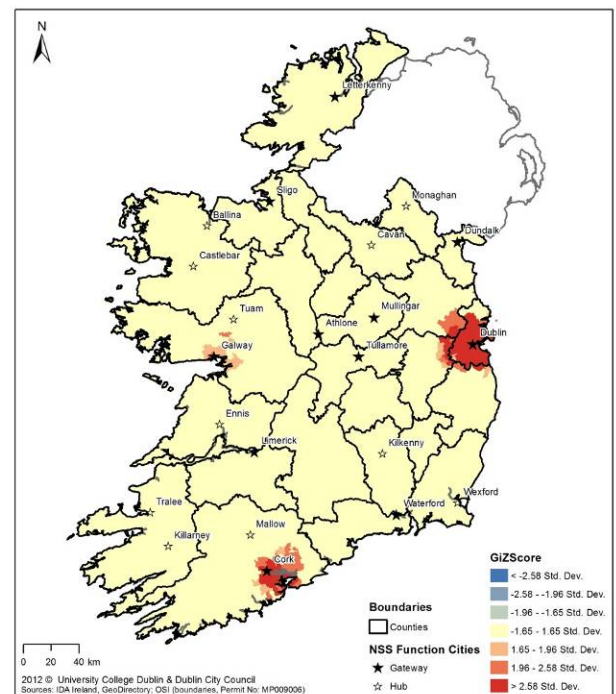
and Technical Services, Construction; Retail and Wholesale Trade; Food and Accommodation and Services..

The Hot Spot analysis map below on left is a representative example of the role of Dublin and the importance of the Gateways and Hubs in terms of being areas of statistical clustering effects. In addition it highlights the emerging important dynamic of the M1 economic corridor and the potential economic benefits of nurturing and servicing this corridor. In terms of policy formation this output and the other hot spot analysis are intended to place the role of Dublin firstly in the context of national economic functioning and secondly in the global context. It is evident from hot spot analysis that Dublin and its hinterland area have a quantum and distribution of business type which is much greater than any other area or city region nationally. It can be argued from the results of the hot spot analysis that the GDA is Ireland’s key global focal point and the most viable location for investment and indigenous business formation in many of the key growth sectors.

As presented in the map below on the right statistically significant clustering of IDA companies are noticed only in Dublin, Cork and Galway cities.



Clusters of Professional, Scientific & Technical Service Organisations in Rol in 2011



Clusters of IDA supported companies in Rol in 2012

While Dublin is both the global economic focal point for Ireland and the key component of a broader spatial distribution of Gateways and Hubs nationally the results can also be viewed in the context of Dublin and other key Gateways having a combined critical mass of business occurrence across key economic sectors which may be attractive to inward investment.

A key finding of this report is that as part of a “Joined up data, Joined up thinking” initiative there is potential to collaborate with the Dublinked and other relevant projects to provide guidance and directions to the main datasets, spatial outputs and information points held by various organisations which relate to the Dublin and National economy. Examples of such publicly available sites now include MyPlan, CSO and AIRO Interactive Census Mapping, Pobal Deprivation Mapping etc.

The integration of the findings and spatial patterns in such data sets represents a major support to policy action plans both at national and sub-national level. This analysis is also possible at an All-Ireland level. It would be possible to map and carry out hot spot analysis of all agency assisted data, working closely with Forfás, Enterprise Ireland and the IDA to realise this ambition.

Opportunity mapping is an excellent concept which has the potential to build in hard evidence on the viability of locations for investment and/or residential units according to a number of key indicators. At present, access to health infrastructure and other tertiary services are not included in this study due to a lack of data availability. However, these data have been generated by relevant organisations and can be analysed.

Other potential general uses would be to carry out a mapping exercise of under-utilised and/or derelict sites within the administrative area of Dublin city council and provide qualitative assessment of the potential of these sites based on comparison with opportunity mapping, future land use demand and patterns of demographic change. Further potential examples of this form of analysis linked to themes such as Transport and wider applications of Opportunity Mapping are detailed in recommendations in Section 4.

For more on recommendations see Section 4 Conclusion.

1. INTRODUCTION

Contextual Background

Report 2 forms part of a broader analysis of the economic health of both the Dublin city region and nationally. The methodologies presented here are designed to support existing research on the spatial distribution of economic activity in Ireland and to provide a renewed evidence base for decisions on location for investment.

The key aim, therefore, is to support the existing evidence base and provide answers to critical policy questions such as

1. Where are the best locations nationally and regionally to ensure best return for investment of scarce fiscal resources?
2. What geographic areas are exhibiting clustering effects which may assist further viable business formation and the growth of a knowledge economy?
3. Where should future ancillary services such as in the areas of health, education and transport be located based on current patterns of development and opportunity?
4. What are the benefits that Dublin brings to other regions in Ireland? .

The spatial mapping outputs developed in this research are intended to add to the existing evidence base for national to local development policy formation. They should be viewed in the context of the overall study which will examine a broad range of data and information including demographic patterns, transport policy and patterns, tax revenues at sub-national scale and associated expenditure and Dublin and Ireland's performance in international metrics.

To date, the extent of analysis possible for location preferences of specific economic sectors has been limited. Morgenroth (2008) using Place of Work Anonymised Records (POWCAR) data considered these locational preferences in the paper "Exploring the Economic Geography of Ireland." The degree to which sectors agglomerate or co-agglomerate was examined in detail. The analysis showed variances in the spatial distribution of employment by sector down to a detailed level of disaggregation using the aforementioned POWCAR. Morgenroth (2008) pointed out the lack of attention that mapping of the spatial distribution of economic activity has received in Ireland to date, with some previous studies examining the sectoral distribution and specialisation of indigenous and multinational enterprises (MNE's).

It should be noted that the work presented here is largely intended to add to a broader evidence base with an initial appraisal of spatial output appearing to reinforce the importance of the main Gateway and hub settlements (Map 1-1) both in terms of the spatial concentration of economic activity within a few key locations and access to economic and social capital (opportunity).

While An Post Geodirectory¹ dataset used in this part of the research is limited in that it maps addresses of buildings by sector only and does not contain any other attributes (e.g. number of employees, annual turnover, etc.) that are of use to this study, it is regularly updated and relatively reliable.

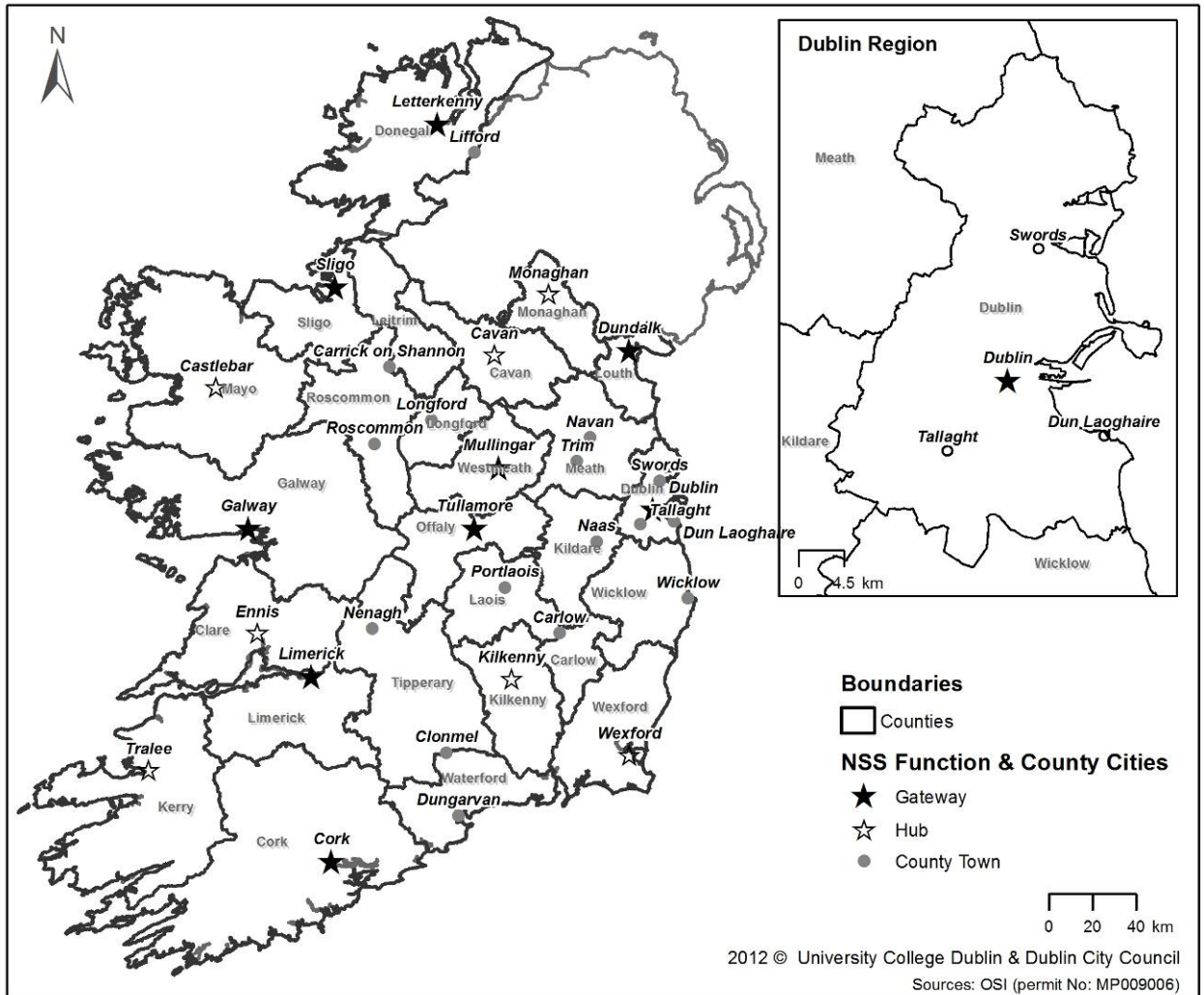
FAME² or Data Ireland³ datasets were also considered due to the potential, with appropriate geo-coding, to align sector, location and employment levels. The reliability and/or cost of these

¹ <http://www.geodirectory.ie>

² <http://www.bvdinfo.com>

³ <http://www.dataireland.ie>

data make them a more restricted resource, however. IDA Ireland¹ assisted business also have been mapped and a special section is incorporated in the report which maps the location and clusters of IDA businesses nationally and in the city region (Map 3-22).



Map 1-1: NSS function cities and county towns in RoI.

It was decided therefore to concentrate resources on developing a strong methodological approach which can be both incorporated into the much wider study and complement existing research.

Indicators and Opportunity Mapping

It is incumbent on policy makers to better understand socio-economic and environmental spatial patterns. These can be utilised to inform planning decisions and to allocate resources within areas which best maximise return for investment. The research carried out here presents an initial set of spatial analysis with an associated methodology and commentary on key areas for access to economic opportunities, education opportunities and neighbourhoods with robust social and tertiary services structures. It points up where clustering of opportunity has occurred and areas where there are more intense concentrations of high skill employment and education, transport accessibility as well as neighbourhoods with strong social capital.

¹ <http://www.idaireland.com>

This methodological approach adopted for indicators evaluation and opportunity mapping will require update in the near future when CSO POWCAR data from the 2011 census are released later in the year.

In addition, it is intended to match opportunity analysis with areas of underdevelopment, dereliction and/or brownfield sites as a demonstrator project across the DCC administrative area. This will show where areas of enterprise investment opportunity and areas for future development are aligned. While high opportunity areas are likely to be found in most inner city urban areas, the Opportunity mapping is part of building a case to realise development in derelict or under used areas. By building an attributes table on all derelict or under used sites in GIS Dublin City Council will be able to effectively map and plan these areas for appropriate future development.

Hot Spot Analysis

Areas of hot spot activity for broad industry types are also presented here, showing where sectors tend to significantly cluster most within the Dublin city region and State. Importantly, the hot or cold spots are identified through comparison with the national average for each sector and so hot or cold spots provide relative comparisons.

This spatial analysis can be utilised to show what areas, (summarised by ED level) of the State have a statistically significant concentration of businesses operating within the same broad economic sector. In combination with existing research this spatial analysis can be utilised to identify natural economic areas and the strength of key urban areas in terms of the development of knowledge economy activities (including appraisal of localisation versus urbanisation economies).

Research Justification

Dynamics of Economy

It is necessary to contextualise the requirement for this study against the background of the current economic climate (see Appendix 4). The respective economic profiles of the Dublin city region and the State have changed considerably in the period 2007 to the present. At the same time the world is urbanising and the importance of cities as trading points and centres of innovation are arguably increasing. It has been claimed that just 600 urban centres worldwide generate about 60 percent of global GDP (Dobbs et al, 2011) and the United Nations estimate that currently half of the world's population is urban and that by 2050 this will rise to 70%. Despite the recent economic downturn Dublin is a thriving international city region, hub of globalisation and the engine of growth for the national economy. County Incomes and Regional GDP show that the Dublin region is the most productive region nationally (CSO, 2012a). From 2000 to 2009 the Dublin Region had the highest levels of disposable income and was the only region above the State average, demonstrating the overwhelming influence Dublin has on State averages. The Dublin Region and its wider functional area of the Greater Dublin Area (GDA) also has the highest GVA per person at basic prices during the recording period 2000-2009. Only in 2002 and 2003 did the South West region which contains the second city of Cork outperform Dublin and the Mid East in terms of per capita GVA. The economic wellbeing of the Dublin city region as home to 1.27m people, accounting for almost 28% of the national population (population of Ireland was 4.58 million in 2011 (CSO, 2011) is evidently central to national economic recovery. At State level average disposable income per capita fell from €23,239 in 2008 to €21,356 in 2009, representing a decline of €1,883 or 8.1% (CSO, 2012). Of

the eight regional authority areas, the Dublin region had the highest average disposable income per capita in 2009. At €24,316 the average disposable income per capita in Dublin was 13.9% higher than the State figure of €21,356.

With regard to income contribution and the distribution of resources Morgenroth (2009) demonstrated that the Dublin and South-West Regions are substantial net contributors in terms of resource generation, tax take and subsequent re-distribution. He argues that the Irish fiscal system acts to equalise regional disparities transferring resources from richer regions to poorer ones, though this is not explicit in policy. This research found that Dublin and the South-West contributed just over €2000 per person while the Midlands received €3,000. In 2004 just over €3 billion were transferred from the 'net surplus regions' Dublin, South-West and Mid-West to the other regions. Overall the tax burden (including social contributions) averages at €11,000 per person in 2004 with a high for Dublin of almost €14,000 per person and a low of €8,500 per person in the Midlands. While Dublin and the South-West regions have a higher per capita expenditure than other regions, they have an even larger per capita revenue. For example, over the period 1995 to 2004 Dublin accounted for 28.9 per cent of the population, 35 per cent of revenue and 31.4 per cent of expenditure. The Midlands, which accounted for just 5.7 per cent of the population and 4.6 per cent of revenue accounted for 5.5 per cent of public expenditure. Thus while being redistributive the fiscal system does not appear to unduly disadvantage the better off regions (Morgenroth, 2009).

Since 2007 Ireland has witnessed a major decline in its economic performance and a resulting contraction in the numbers in employment. This was largely linked to a collapse in the housing and construction sectors. In 2008 output fell for the first time since 1983. House prices increased by over 400% in the late 1990's up to 2007, and investment in housing as a percentage of GNP rose from around 6% in 1996 to almost 15% in 2006. The construction industry in Ireland at its peak in 2006 represented 24% of national GDP employing 1 in 7 people. This compares to just 4.9% of GDP in the US for the same year and less than 1 in 17 people in employment¹. A number of indicators relating to property and construction have displayed falls of over 90% in activity since 2007 (including building commencements, planning permissions, housing completions).

The national unemployment rate has more than tripled to over 14% from 4% in 2007, with almost half of those unemployed for over a year. Unemployment in Dublin is currently around 12.7% and is back to levels not seen since the 1980's. Unemployment levels at peak Q2 2007 stood at 4.8% in the Dublin Region².

The collapse in house prices in Dublin by over 55% (45% nationally) from their peak in 2007 (CSO, 2012a) has placed many households in negative equity. Over 10% of all residential mortgages are currently in arrears of over 90 days.³ CSO house prices figures show that in Dublin the house price index stood at 58 index points compared to the base year January 2005 (100) and a high of 131.2 points in Q2 2007 (CSO, 2012a). A report by the Central Bank of Ireland in April 2012 suggested that house prices have over-corrected by 12-26% (Kennedy and McQuinn, 2012).

The economic difficulties caused by a collapse in the domestic economy (due in part to a construction boom and bust) and coupled with the global downturn and credit crunch meant that Ireland was no longer able to finance its borrowing from the global markets. This resulted in

¹ Bureau of Labour Statistics, 2011.

² Special CSO tables for NUTS III based on Quarterly National Household Survey, 2012

³ <http://www.reuters.com/article/2011/08/29/ireland-arrears-idUSL5E7JT0PX20110829>

Ireland being rescued from bankruptcy through an €85 billion joint EU/IMF financial support package in 2010. As of Q4 2011, the debt ratio as percentage of GDP was 105% compared to 85% in Q3 2010 (Central Bank, 2012).

Exports do, nonetheless, continue to keep the Irish economy afloat. While a recent report by Ulster Bank in March 2012 stated that exports would now increase by 2% year on year in 2012 compared to earlier expectations of 2.8%, the export sector remains the key component of recovery. Challenges do lie ahead such as maximising the Asian market, continuing to exploit exports in niche sectors, growing SME exports and the adjustment to some *Chemicals and related products* coming off patent. The latter challenge was responsible for the 9% decrease in exports (seasonally adjusted) for December 2011 (CSO, 2012). The trade surplus for the year is provisionally set at about €44.3 billion which is very strong given the global economic slowdown.

Increasing the evidence base for appropriately located and formed planning and investment in Ireland has therefore never been more important to ensure that return for capital investment is maximised and that resources are directed to most appropriate locations, services and sectors.

Dynamics of Population

While the economic outlook is moderate one area which provides Ireland with some challenge and much opportunity is its relatively youthful age profile. The median age of the national population is 35 years and the lowest in the EU and is a composite indicator of opportunity mapping described in Section 4. It is given special mention here as a relatively young population is very positive in terms of availability of a well-educated workforce for prospective Foreign Direct Investment (FDI) and adaptation to a smarter economy. It also provides a relative allowance of additional time to put in place necessary fiscal and regulatory provisions and a long term strategy for a population that will have an older age profile within the next 20-30 years. Presently, while Europe has an ageing population, in comparative terms, Ireland does not. In 2008, for example, 11% of our population was over 65 years while in Germany the figure was 20%. Conversely, 20% of the Irish population was under 14 years while in Germany the figure was 13.7%. As a result, Ireland has one of the lowest old-age dependency ratios in Europe and the highest young-age dependency ratio. The Greater Dublin Area has seen some of the highest growth and while Dublin City experienced an increase of 9.8% population in the twenty years to 2011 the majority of this growth was in the inner city reflecting a high level of apartment building there. This part of the city grew by 62% between 1991 and 2011. In the medium term, a relatively young and well-educated workforce can be expected to help realise competitive advantage (DCC, 2011).

At the same time a population which is expanding at either side of the population profile spectrum means that the provision and effective delivery of critical services will come under increasing pressure. It is critical therefore that the most appropriate locations down to micro level are identified in terms of the quantum and distribution of population growth in order to maximise return for future investment and to meet the urban challenges associated with young and old age dependencies.

2. MAPPING SPATIAL PATTERNS

Mapping socio-economic data can be very useful in discovering spatial distribution and hidden socio-economic patterns across the country. There are number of recent interesting and informative studies exploring economic geography in Ireland (Morgenroth 2001, 2008; Curran & van Egeraat, 2010, CSO 2009, Bullock et al., 2008, Tol et al. 2009, etc.). In this section we present the spatial distribution of a number of select indicators aiming to map the current challenges in Irish economy. These include (un)employment by education and skills level, home ownership rates and so forth. The following maps show key baseline patterns for selected variables across the country with a specific focus on the Dublin Region.

At the moment of preparation of this report only the preliminary results from Census 2011 were publicly available, covering only the main statistics such as population by electoral divisions (Map 2-1). Therefore, some of the maps presented below are developed based on 2006 Census data and require update using 2011 Census when the tables at ED level are released later in 2012 (late Q3, 2012).

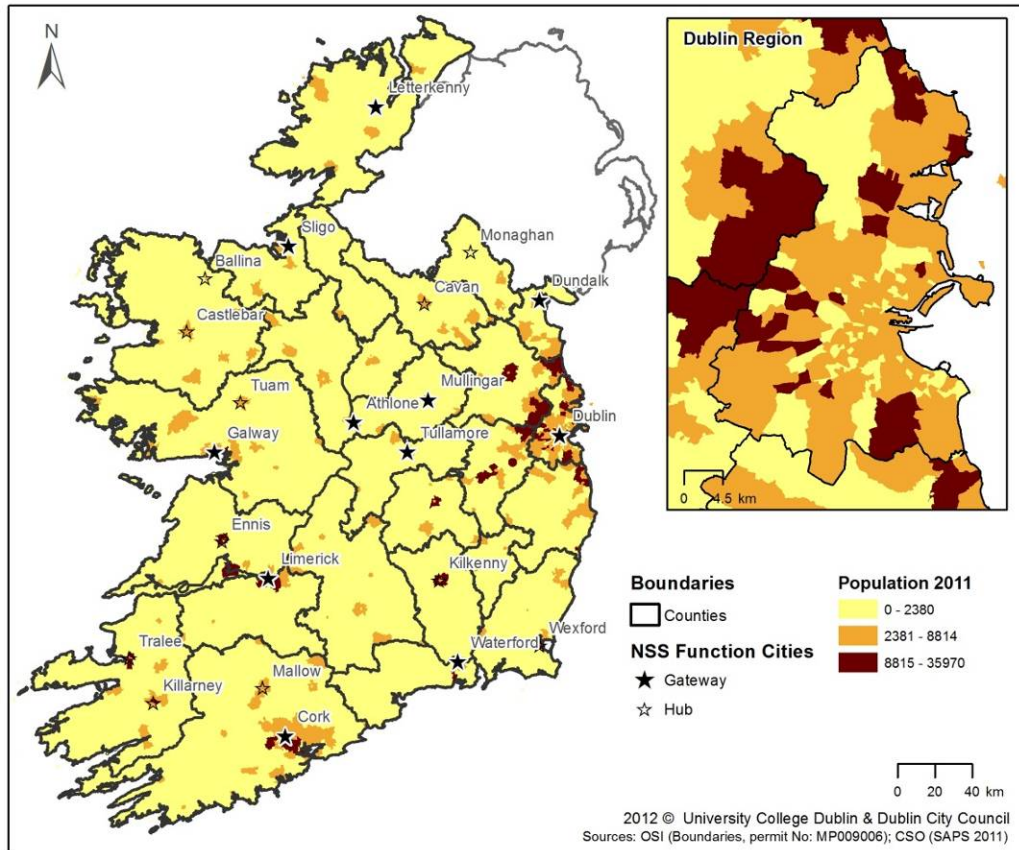
In the most of the maps in this section the classes are based on natural groupings inherent in the data using ArcGIS Natural breaks (Jenks) classification method (if no other method is mentioned). Thus, ArcMap identifies break points by picking the class breaks that best group similar values and maximize the differences between classes. In other words the boundaries for rates are divided into classes according to relatively big jumps in the data values.

Map 2-1 shows absolute population at census 2011 night by electoral divisions. The patterns are quite different if we present population per square kilometre (Map 2-2). It shows the dominance of Dublin city as a population centre in Ireland. Even the second city of the country Cork is not comparable with the capital city in terms of population density.

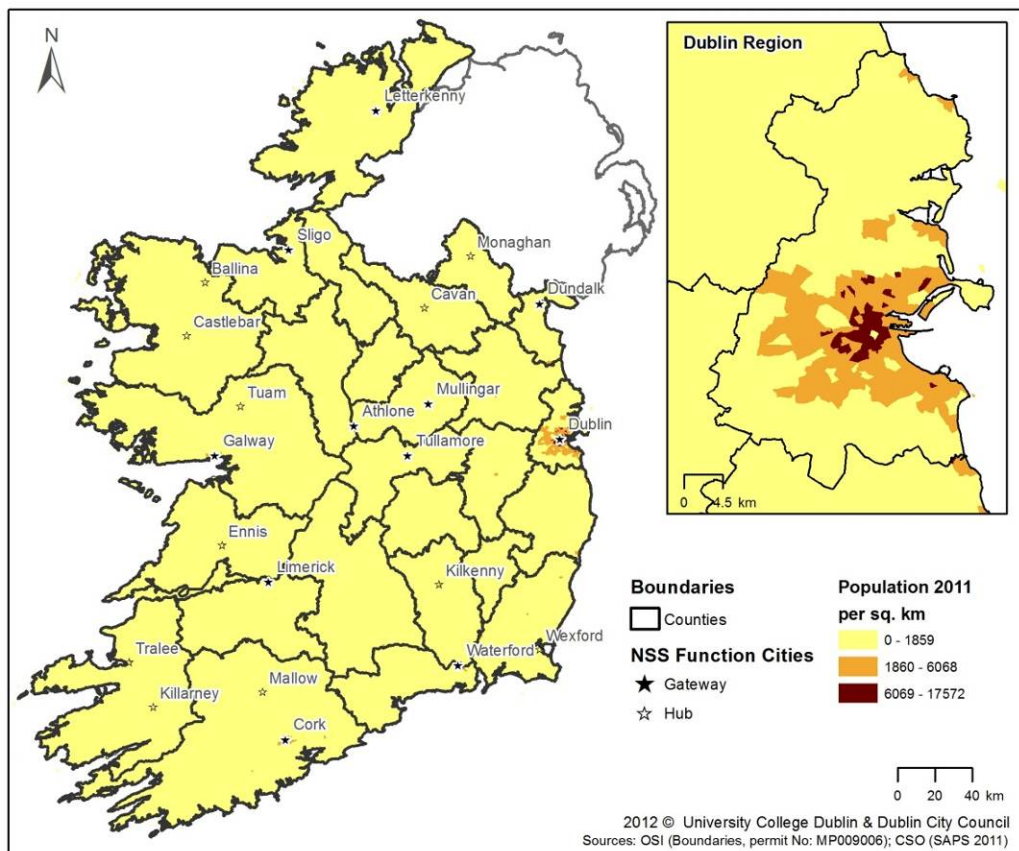
Census 2011 results show that Ireland's population has continued to grow strongly since Census 2006, increasing by 348,404 persons to 4,588,252 persons (CSO, 2012c). This represents an increase of 8.2% over the 5 year intercensal period, an annual average increase of 1.6%. However, mapping the population change between 2006 and 2011 shows that the population in the Dublin city has decreased in some areas (Map 2-3). In contrary population have increased in various other locations, often in sub-optimal locations outside of key urban centres. CSO statistics ascertains that Dublin city has lost population share of the total urban population at the expense of other urban areas over the past fifty years (CSO, 2012c).

Map 2-4 presents the ratio of dependents (people younger than 15 or older than 64) to the working-age population (aged 15-64) in the Republic. It is notable that working age population is relatively higher in the urban areas in general and in the Greater Dublin Area in particular. Dublin city centre has very low age dependency ratio, showing that the proportion of working age people there is much higher than the numbers of children or elderly people living there. In contrary, there is high pressure on working age people in some counties such as Roscommon, Cavan, Donegal, Mayo, Clare and Cork.

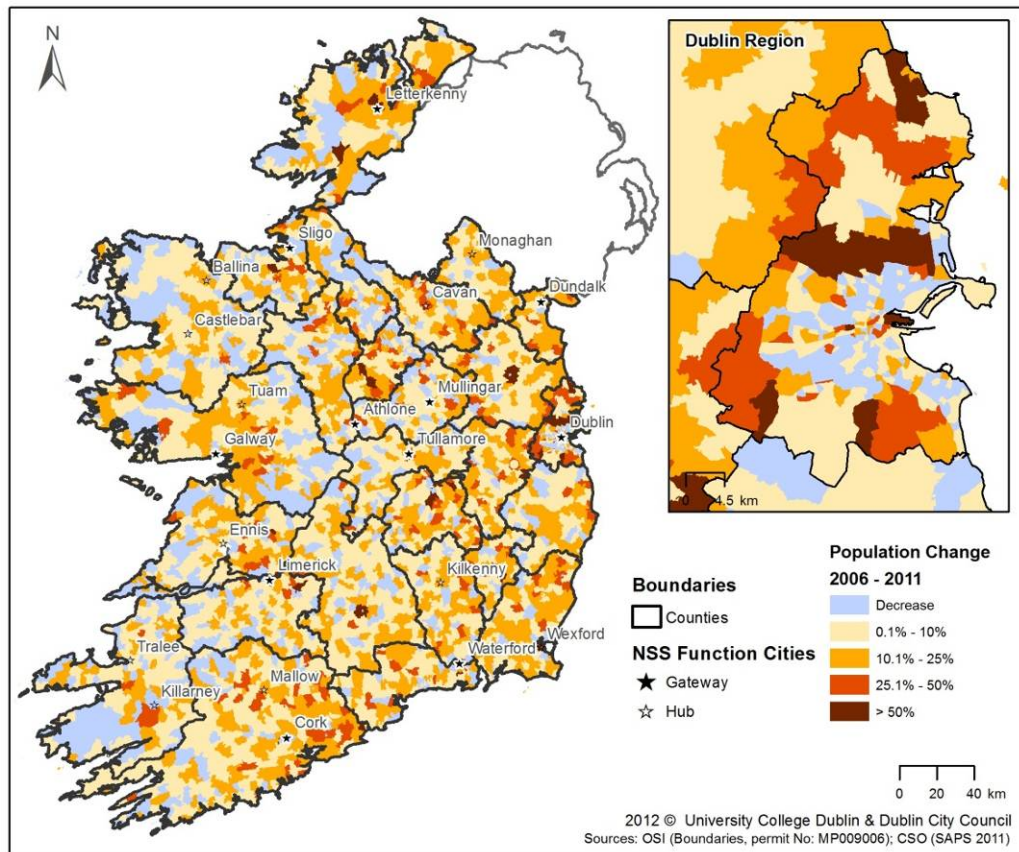
Map 2-5 shows the areas nationally and within the Dublin region where unemployed people are most concentrated. The spatial pattern shows a notable high unemployment rate in the North-West cost of the country. Unemployment is mostly lower in the cities and towns. However there are some exceptions such as Dundalk, Drogheda and Longford. As for Dublin city, the unemployment is very low in the South-East of the city region, comparably higher in the North with some dense clusters of unemployed people living in the centre and the West of the city.



Map 2-1: Census 2011 population by electoral divisions.



Map 2-2: Census 2011 population per square kilometre.



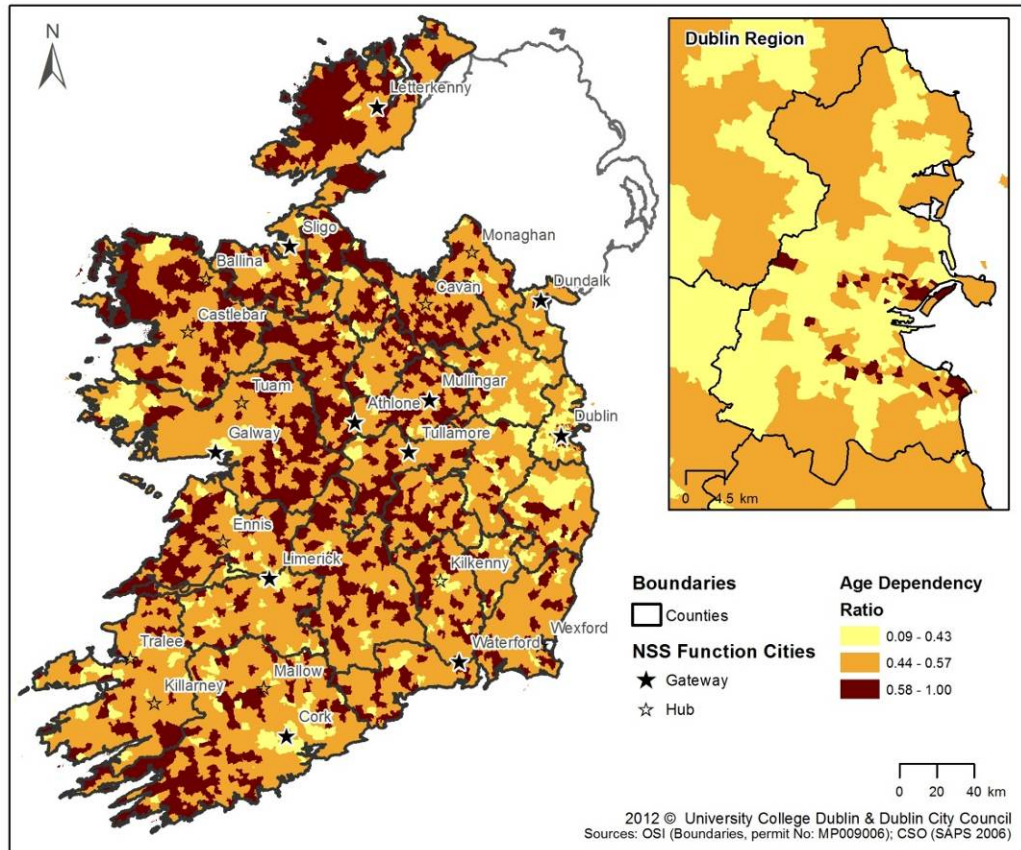
Map 2-3: Percentage change in the population of Electoral Divisions 2006-2011¹.

Map 2-6 shows number of working people per number of residents in an ED. A few settlements such as Shannon, Naas, Waterford, etc. have relatively large concentration of jobs compared with their population. In the Dublin region, not surprisingly the city centre has the highest rate of jobs compared residents, followed by Rathcole, Rosemount, Dublin Airport, amongst others. However, it should be mentioned that this map shows the rate of jobs relative to the resident people in the same ED. So if a particular ED has no or very low population then even in case of small amount of jobs there, the rate can be very high (i.e. Phoenix Park or Airport areas in the map). This map shows also the polycentric nature of development across the Dublin Region.

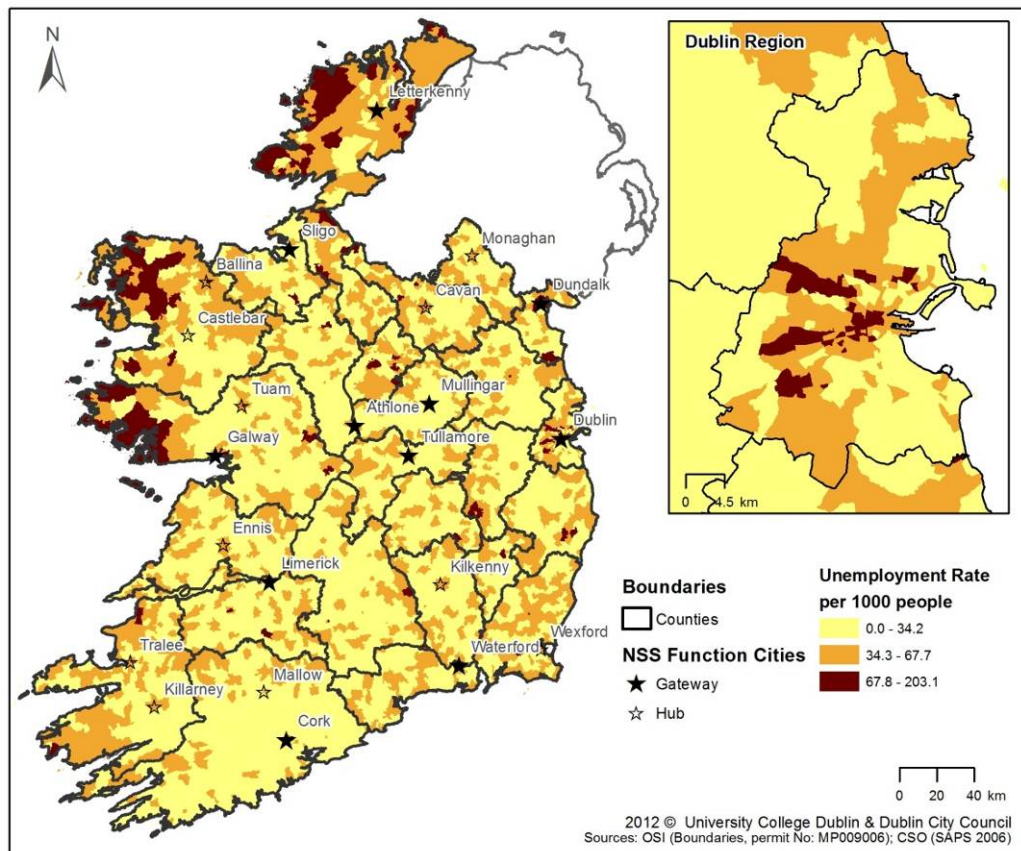
Map 2-7 shows the areas nationally and within the Dublin region where people with third level qualifications are most concentrated. While those with higher levels of education tend to be more mobile there is merit in examining over time, areas which are more attractive to higher educated both in terms of choice of business location, the formation of more sustainable travel patterns and arguably in terms of neighbourhood formation. These patterns may be particularly useful within the high employment density area of the Dublin city region to show where education and innovation cluster.

The pattern of density nationally is not surprising with a notable concentration of third level qualifications in the main cities and towns. Gateway cities have the highest concentrations – Dublin, Cork, Galway and Limerick. This map should be examined in context with other data (pointing out graduate retention for the University and Institutes cities and towns).

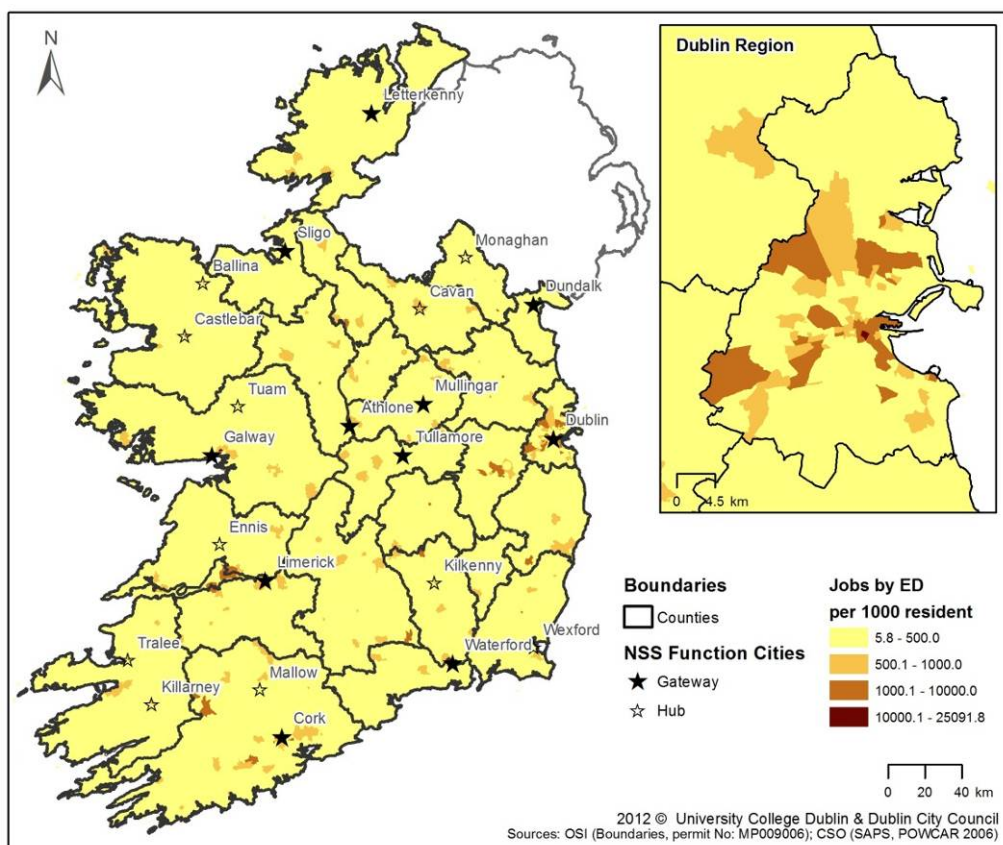
¹ Taking into consideration the distribution of the population change in EDs, the map was developed using manual classification method in ArcGIS.



Map 2-4: Age dependency ratio in 2006



Map 2-5: Unemployment rate per 1000 population in 2006.



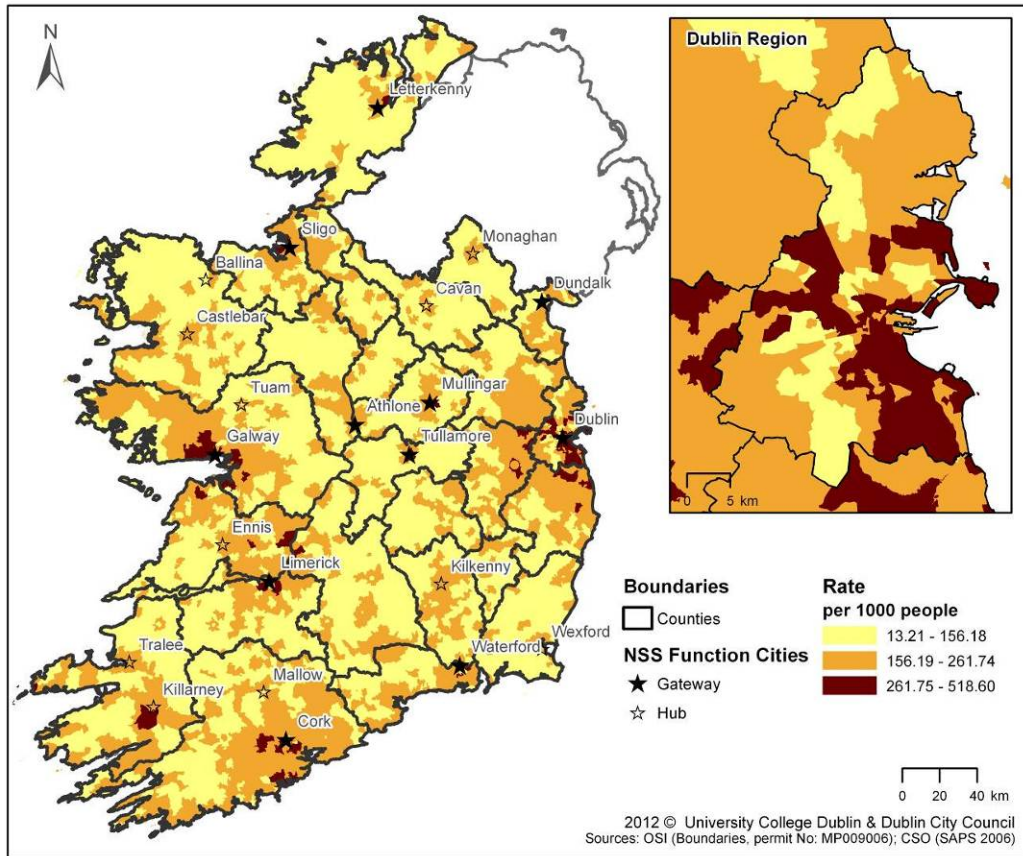
Map 2-6: Number of jobs (place of work) per 1000 residents in 2006¹.

Map 2-8 shows the numbers of persons per 1000 with a doctoral degree. The effectiveness of this map as indicator of spatial distribution of talent is questionable due to the low numbers overall with this degree and the inherent mobility of these workers and the concentration of employment opportunities in larger urban centres. However, as the country seeks to move to a smart economy it is useful to note the concentration in Dublin and the other Gateway settlements.

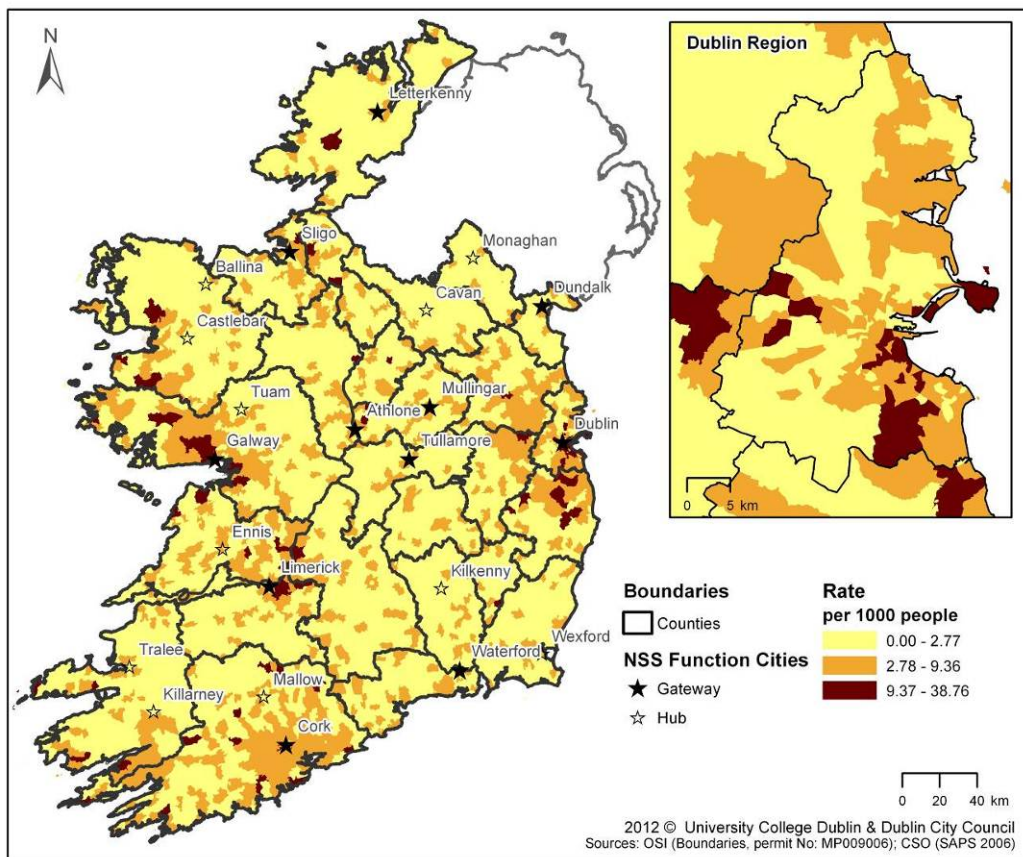
Map 2-9 shows a very interesting spatial pattern whereby in 2006 the majority of owner occupied households not saddled by a mortgage were located outside of the main Gateways and county towns. The Dublin region and large parts of the commuter belt within the GDA show a much reduced level of ownership with no mortgage. In consideration of falling house prices and the numbers of household who have fallen into negative equity since peak (Q3/Q4 2007) this map is a key indicator of areas of social and economic stress.

The Dublin Region with largely lower rates of ownership without mortgage did have a distinct line of higher ownership without mortgage around its core extending from Dun Laoghaire towards Stillorglin and Terenure on the southside with pockets on the north side around Dromcondra and Glasnevin and along the coast. This indicator was used as part of Opportunity mapping described in Appendix 2 and Appendix 3 and appears to be a key component of outputs shown for the Neighbourhood Index. This map can be more useful if combined with further analysis of house prices and housing affordability nationally. Mapping of mortgage age or using house age as a proxy would potentially strengthen the robustness of this measure.

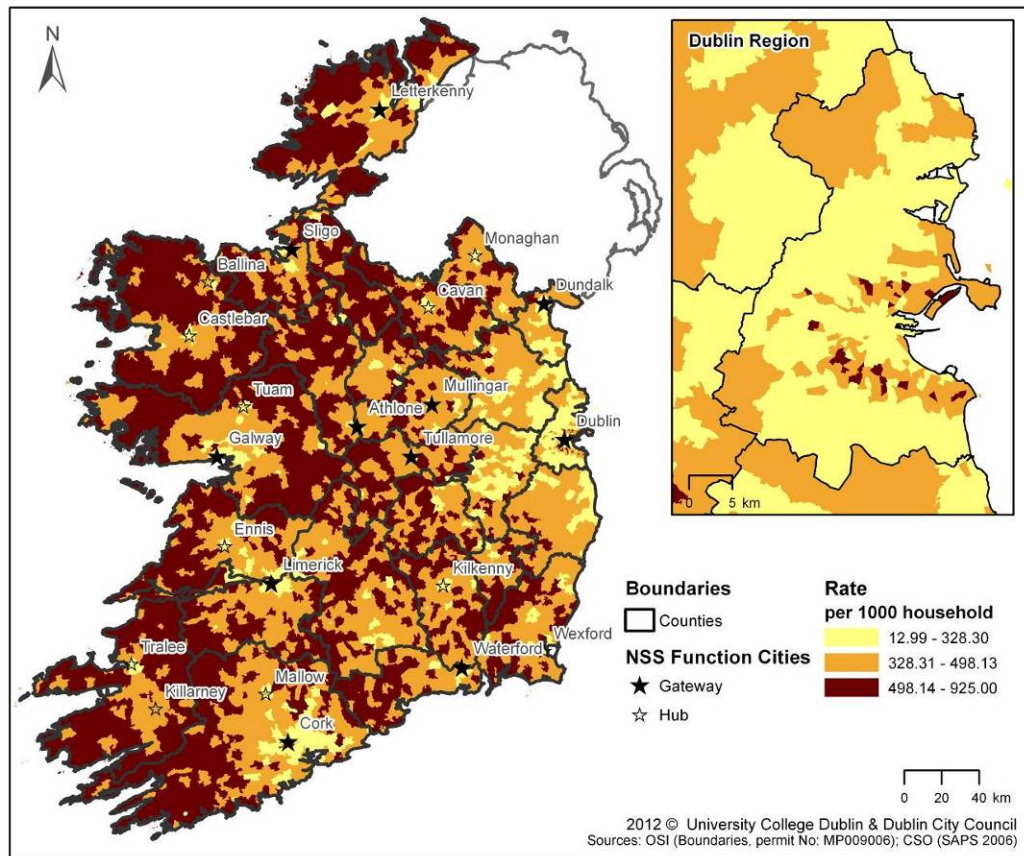
¹ Taking into consideration the specific distribution of the rates in EDs, the map was developed using manual classification method in ArcGIS.



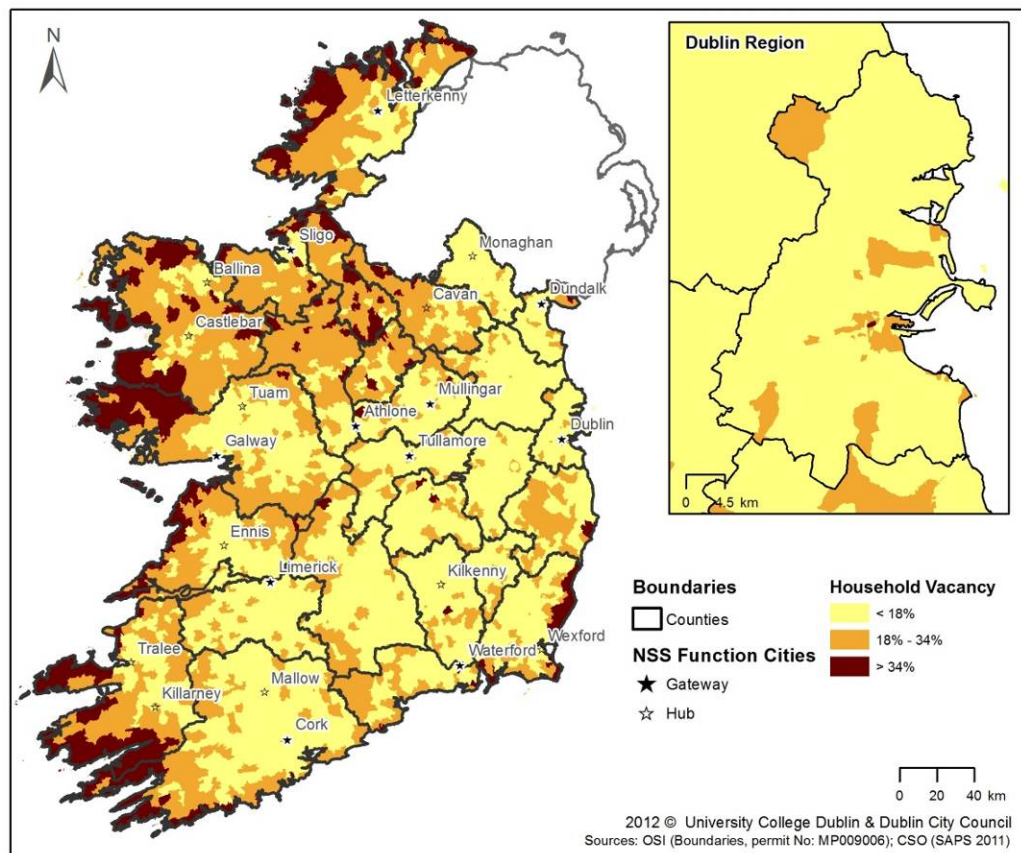
Map 2-7: People with 3rd level of education per 1000 population in 2006



Map 2-8: People with doctoral degree per 1000 population in 2006



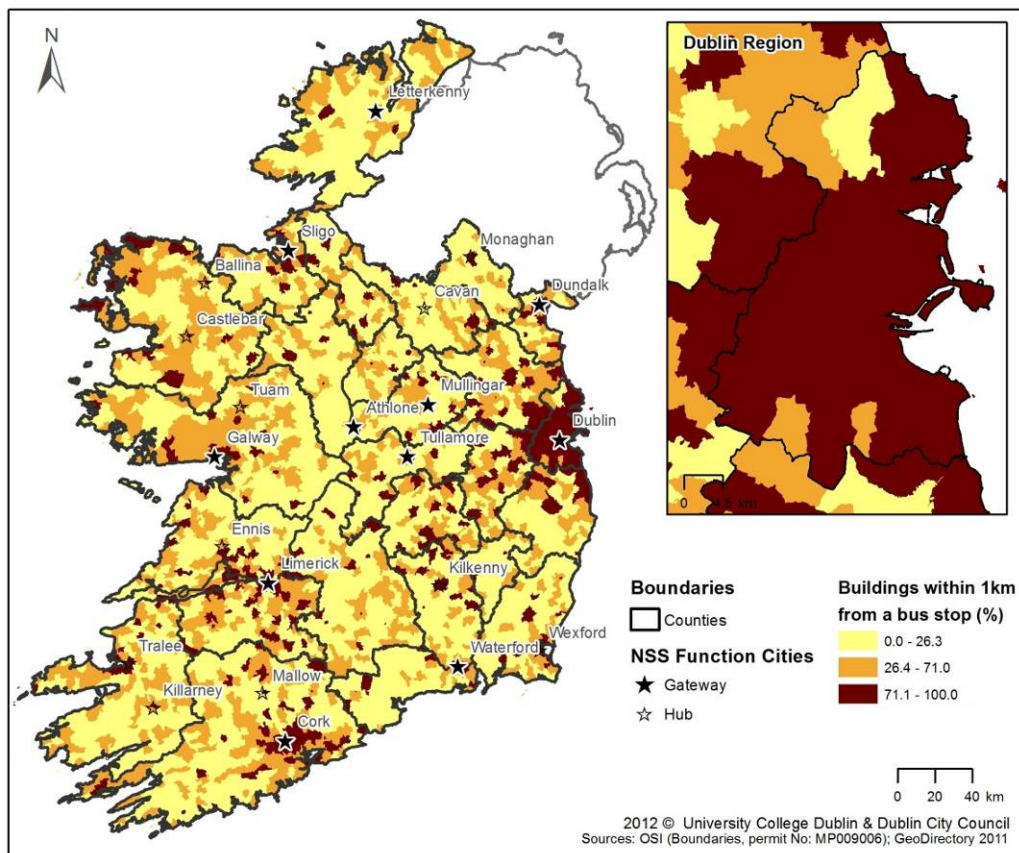
Map 2-9: Households by owner occupied with no mortgage per 1000 households in 2006



Map 2-10: Percentage household vacancy by EDs in 2006.

Map 2-10 shows household vacancy rate in EDs in 2006. It is calculated as a percentage of number of vacant households to the total number of housing units. Not surprisingly the Greater Dublin Region has low vacancy rate except the Wicklow mountain areas; whereas coastal areas in West and in South-East have considerable number of vacant households. Such patterns in the coastal or peripheral regions may be explained by a more significant number of vacation houses and older age cohorts in those areas and migration patterns to urban areas.

Map 2-11 presents the percentage of the buildings (from GeoDirectory 2011) in the EDs within one kilometre distance from a bus stop (Dublin bus, Eireann Bus, Private bus operators). Data taken from the NTA are used in conjunction with An Post GeoDirectory to create this particular map. The one km distance is taken as a maximum walking distance to a public transport access point. This map has limitations and does not account for frequency of service. It does demonstrate a general pattern of bus stops in the GDA and around the gateways of Cork and Limerick in particular.



Map 2-11: Buildings within 1 km from a bus stop in 2011 (GeoDirectory)

3. STUDY OF BUSINESS CLUSTERS IN IRELAND

The project's previous report (Report 1) on Socio-Economic data availability (Shahumyan et al, 2012) describes main datasets available for this project. As many of these datasets have limitations, the team attempted to fill the gaps with complementary use of different datasets. Thus, GeoDirectory provides coordinates and NACE codes of organisations, but it does not provide any information about the number of employees or income of these organisations. To this effect density maps created based on the GeoDirectory information only may be misleading, as a small company with one or two employees will be weighted as equally as a large Multi-National Enterprise with thousands of employees. Data integration and their combined analysis offer potential to overcome limitations of singular datasets. For example the team have used, for business spatial clusters analysis the GeoDirectory for locating the organisations and Place of Work Census of Anonymised Records (POWCAR) for locating the jobs.

There were about 300,000 organisations registered in the GeoDirectory by the end of 2011. These are classified based on NACE Rev2 classes including 19 broad sections (Table 3-1) and more than 1300 individual classes.

Table 3-1: Organisations distribution in GeoDirectory 2011 by their NACE Rev2 Broad Sections

Sector	RoI		GDR	
	Count	%	Count	%
A Agriculture, forestry and fishing	98843	33.35	8279	10.67
B Mining and quarrying	574	0.19	133	0.17
C Manufacturing	5802	1.96	1868	2.41
D Electricity, gas, steam and air conditioning supply	246	0.08	83	0.11
E Water supply; sewerage, waste management and remediation activities	780	0.26	230	0.30
F Construction	12935	4.36	3433	4.42
G Wholesale and retail trade; repair of motor vehicles and motorcycles	39916	13.47	13283	17.11
H Transportation and storage	6575	2.22	2141	2.76
I Accommodation and food service activities	21439	7.23	5455	7.03
J Information and communication	2703	0.91	1280	1.65
K Financial and insurance activities	3864	1.30	1750	2.25
L Real estate activities	2132	0.72	849	1.09
M Professional, scientific and technical activities	12681	4.28	5128	6.61
N Administrative and support service activities	6329	2.14	2080	2.68
O Public administration and defence; compulsory social security	2858	0.96	701	0.90
P Education	7818	2.64	2301	2.96
Q Human health and social work activities	13518	4.56	4793	6.18
R Arts, entertainment and recreation	7687	2.59	2558	3.30
S Other service activities	17091	5.77	5206	6.71
Missing	32586	10.99	16065	20.70
Total	296377	100%	77616	100%

This study aims to better understand the distribution of organisations in the Republic of Ireland (RoI), to identify its spatial patterns and trends for more effective decision making and planning. The density mapping and hot spot analysis was applied using ArcGIS software package to find the clusters of companies by their activity sector.

Figure 3-1 shows the distribution of the top seven sectors in the RoI. These are sectors having more than 4% share in the overall number of organisations in the RoI (A, F, G, I, M, Q, S). In the spatial analysis described below we have focused more on these sectors as well as on “Information and communication” (J) sector and the “Financial and Insurance Activities” (K) sector which altogether covers about 85% of all organisations in the country (organisations with missing sector values were not counted). Though the Information and Communication sector covers only about 1% and the Financial and Insurance Activities sectors covers 1.35% of all organisations in the State, they are of particular interest as they respectively include multinational giants such as IBM, Microsoft, Google, Ebay, Yahoo, and others in the former (J) and the activities of the IFSC in the case of the latter sector (K).

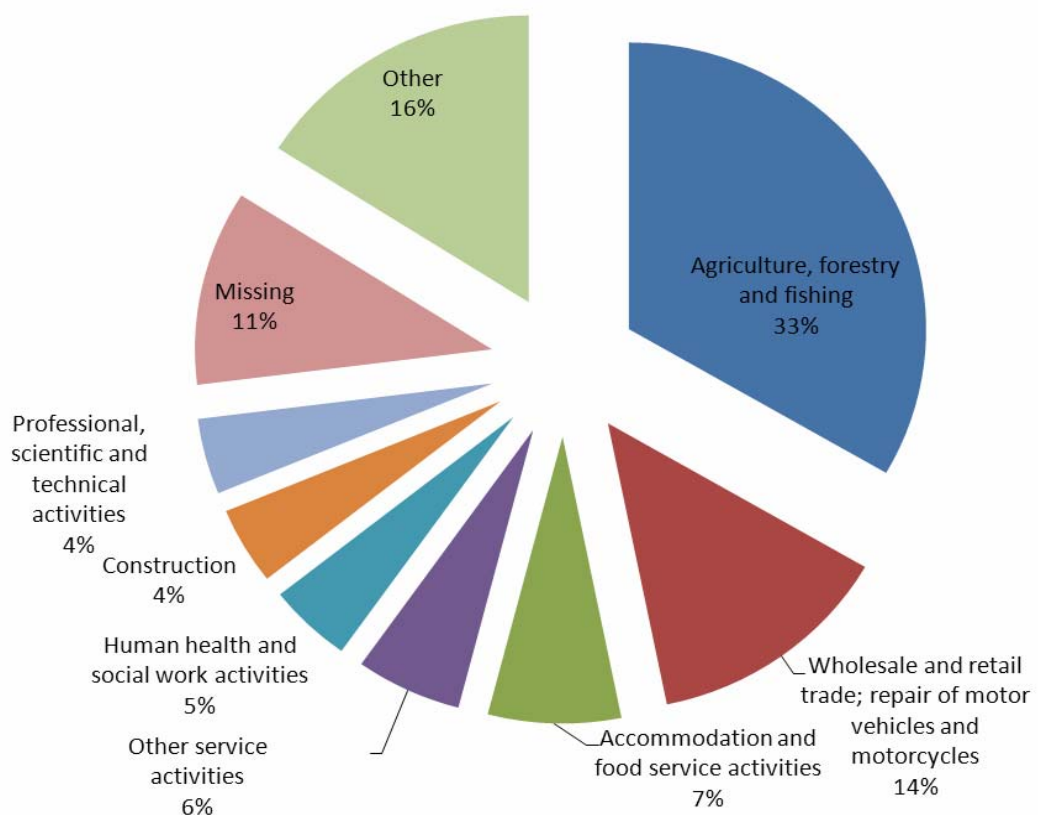


Figure 3-1: Top activity sections nationally according to GeoDirectory 2011

The sectoral distribution of the companies in the Greater Dublin Region (GDR)¹ has similar patterns (Figure 3-2). The top seven sectors are the same in the GDR. However, there are some changes in the ranking. Thus the most companies in the GDR are from “Wholesale and Retail Trade” (18%), compared with “Agriculture, Forestry and Fishery” (11%) which was ranked first on national scale (33%). “Professional Services” share more than 7% compared with national share of 4%. The missing sector information is significantly higher in the GDR

¹ GDR is of similar, though not identical extent to the Greater Dublin Area (GDA): the GDA consists of the Dublin, Meath, Kildare, and Wicklow counties; while in addition to these the GDR includes also Louth County. The GDR geographical delimitation is used as it ties into MOLAND land use modelling and scenario planning application.

composing 21% while it is about 11% on national scale. The remaining top sectors have similar distribution with 1% differences in most of the cases.

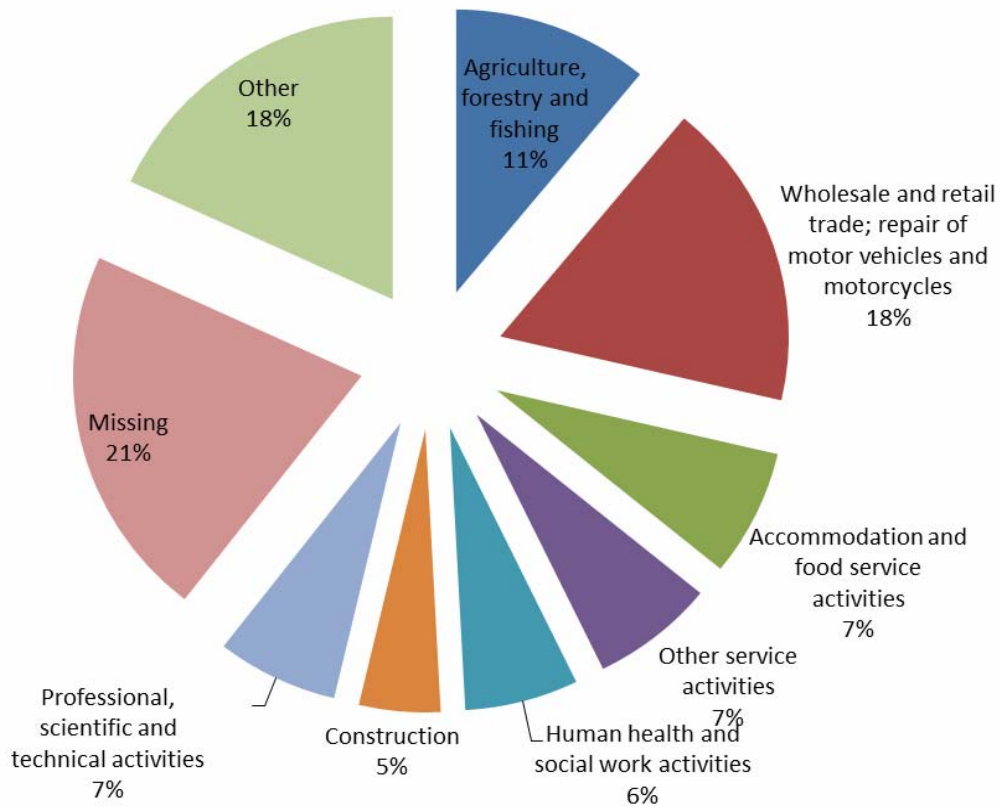


Figure 3-2: Top activity sections in GDR according to GeoDirectory 2011

As indicated above, the main limitation of GeoDirectory for this study is that it has no information about the size of organisations, number of employees and income, which permit appropriate weighting to be carried out (see the project Report 1 by Shahumyan et al. (2012) for more details). The number of employees by industrial section provided by POWCAR has been utilised. At present only POWCAR for 2006 is available, and it was used for the analysis described below. However, the results of 2011 census will be published later this year and may be used to adjust the findings of this study. In the interim the following outlines the methodological approach required to carry out the analyses.

While POWCAR industrial groups are not exactly the same as NACE broad sectors some of them fit well as “Construction” or “Agriculture, Forestry, Fishing.” However, other sectors required regrouping as shown in Taking into consideration that GeoDirectory and POWCAR are not available for the same year, such combined analysis are not reliable and are provided here as a methodological example. However, the methodology can be much more accurately applied once POWCAR is made available from Census 2011.

Table 3-2.

It is interesting and noteworthy that according to GeoDirectory, organisations in Agriculture, Forestry and Fishing have the biggest share (more than 33%) of overall number of organisations in Rol in 2011 (Figure 3-3). However, the same industrial group provided less than 5% of jobs in 2006 according to POWCAR 2006. The picture is different in case of Commerce: where the number of organisations was around 15% in 2011, while jobs were approximately 27% in 2006. Such patterns are caused by the variations in average number of

employees in different industrial groups as evidenced by the examples of Agriculture, Forestry and Fishing and Commerce.

Taking into consideration that GeoDirectory and POWCAR are not available for the same year, such combined analysis are not reliable and are provided here as a methodological example. However, the methodology can be much more accurately applied once POWCAR is made available from Census 2011.

Table 3-2: Industrial groups and distribution of employees from POWCAR 2006 and distribution of organisations from GeoDirectory 2011¹.

	POWCAR Industry Group	Employees		Corresponding GeoDirectory NACE Sector	Organisations	
		<i>number</i>	%		<i>number</i>	%
1.	Agriculture, Forestry, Fishing	87384	4.8	A	98843	33.4
2.	Manufacturing, Mining, Quarrying	251736	13.7	B, C	6376	2.2
3.	Construction	205542	11.2	F	12935	4.4
4.	Commerce	501554	27.3	G, K, L	45912	15.5
5.	Transport, Storage, Communic.	101694	5.5	H, J	9278	3.1
6.	Public Administration and Defence	96100	5.2	O	2858	1.0
7.	Education, Health and Social Work	304788	16.6	P, Q	21336	7.2
8.	Other	170583	9.3	D,E,I,M,N,R,S	66253	22.4
9.	Not stated	115091	6.3		32586	11.0
	Total	1834472	100		296377	100

¹ GeoDirectory began registering organisations by their NACE codes from 2008, while POWCAR at the time of this study was available only for 2006. Therefore, this table should be updated as soon POWCAR from Census 2011 data become available.

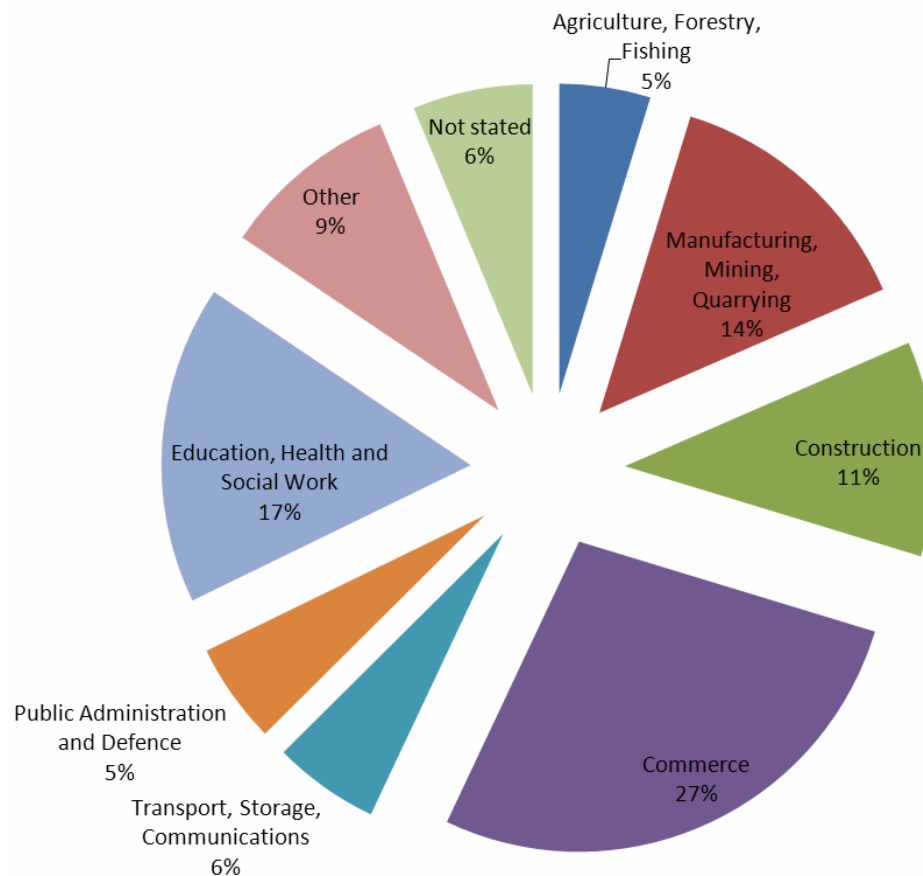


Figure 3-3: POWCAR 2006 employees' distribution by Industrial groups.

In the section 3.2 selected eight sectors from GeoDirectory and seven groups from POWCAR are analysed to discover specific spatial patterns and trends. The location of the companies with foreign investment were also analysed based on the address database provided by IDA Ireland.

3.1 Methodology

Density Analysis

Density maps are good for showing where point or line features are concentrated. For example, GeoDirectory provides point coordinates of all buildings in the RoI. This includes organisations by their NACE classification. So, it is possible to use density mapping to learn more about the spread of organisations over the region by their activity sector type. Alternatively, using place of work data from POWCAR it is possible to study the spatial distribution of jobs by their industrial group. There are two basic approaches to exploring the density of values in GIS:

- 1) mapping simple calculations of the value of a given attribute by area (e.g. using number of employees in particular industrial groups from POWCAR by ED area);
- 2) creating density surfaces for points or line vector data using the Spatial Analyst extension (that is, using organisation coordinates from GeoDirectory).

With the help of the Kernel Density function in ArcGIS Spatial Analyst extension we have created continuous density surfaces, giving a better indication as to organisations' and employment distribution over Ireland. The main outcomes are provided in the section 3.2.

Resulting density maps present high or low concentrations of the organisations/jobs in Ireland per square km. However, they do not indicate whether such differences in the level of clustering are statistically significant, or not. Therefore, the research was continued using Hot Spot analysis described next.

Hot Spot Analysis

Hot spot analysis is used to compare the distribution of values associated with the geographic features to a hypothetical random distribution in order to discover statistically significant clustering. It can be used to answer questions like: Where are the crime or disease hot spots? Where are unexpectedly high cancer or diabetes rates? Where is unexpectedly low public transportation usage (cold spots)?

The hot spot analysis tool in ArcGIS package conceptually works by looking at each feature within the context of neighbouring features. Where the value for a feature is high it may be interesting but not necessarily significant. However, if the value for a feature is high, and the values for neighbouring features are also high, there is a hot spot. The ArcGIS Hot Spot Analysis tool finds statistically significant clusters of high or low values.

The concepts, the hot spot analysis and applied formulas are described in the Appendix 1 in more detail.

Figure 3-4 presents the model we have developed in ArcGIS to implement the hot spot analysis using GeoDirectory and its organisations' classification.

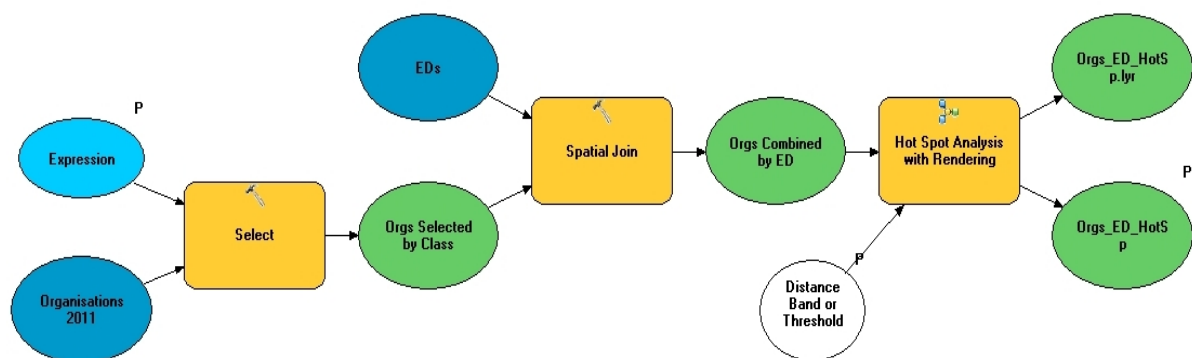


Figure 3-4: ArcGIS Model structure for Hot Spot analysis

The following steps were realised in the model:

1. Selection of the organisations from GeoDirectory based on their NACE broad class (Table 3-1). A separate GIS layer is being developed for each of the selected broad classes (“Orgs Selected by Class” in the model of Figure 3-4).
2. Spatially joining the selected organisations with the corresponding ED layer. As a result a new ED layer is being created which includes a count of organisations of the specific class in each ED (“Orgs Combined by ED”).
3. Running Spatial Statistics Hot Spot Analysis with rendering (colour coding) function. This generated organisations hot and cold spots maps for Ireland (“Orgs_ED_HotSp”)

Before applying the model, the main parameters of the Hot Spot Analysis tool were defined taking into consideration the characteristics of the study region and data layers:

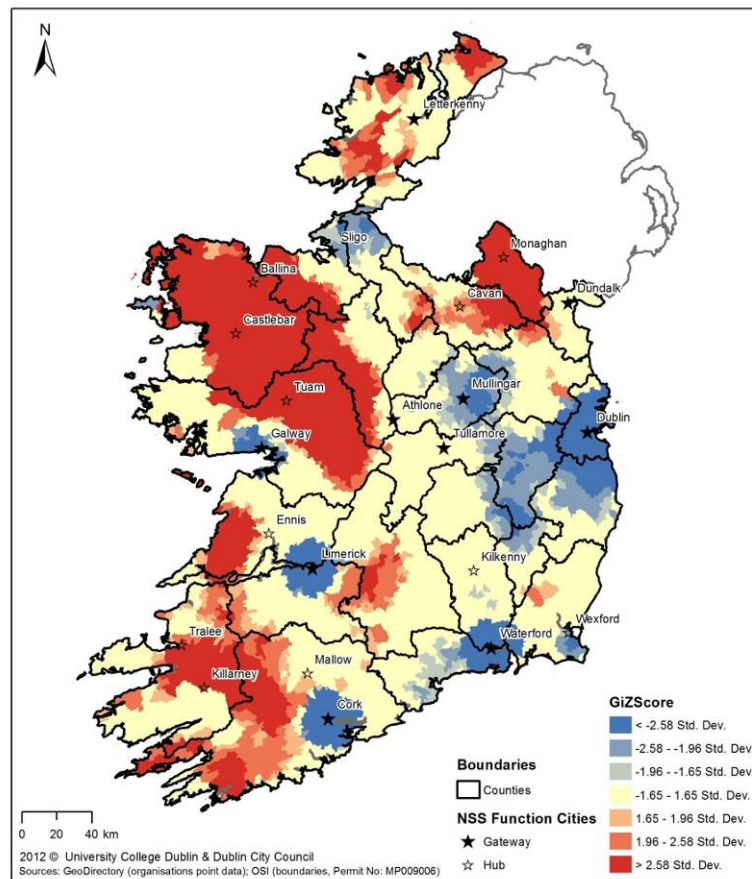
- Particularly, the ED areas vary greatly between different parts of the country. They are much wider in rural areas and much smaller in urban areas, with very small EDs in Dublin city centre. Therefore, the “Fixed distance” method was used in ArcGIS Hot Spot Analysis tool, as it works well for polygon data where there is a large variation in polygon size. The “fixed distance” method is also the recommended conceptualization of spatial relationships for the Hot Spot Analysis tool in ArcGIS.
- It is recommended that the distance band for “Fixed distance” method should reflect maximum spatial autocorrelation of the features. Indeed, clustering is evidence that some underlying spatial process is at work. The distance band that exhibits maximum clustering is the distance where that spatial process is most "active" or pronounced. The ArcGIS Global Moran's I Spatial Autocorrelation Tool was applied for each sector of organisations at multiple distances (7, 10, 15, 20, 25 km) to find the distance band for each sector when z-score reaches to its peak. These specific distances were then used in the hot spot analysis model and the results are presented in the following section.

3.2 Sectoral Analysis

The Hot Spot maps of different business sectors described below add to the overall body of evidence on business intensive regions such as Dublin and Cork. The significant clustering and critical mass of business located within the key Gateways of Dublin, Cork, Galway and Limerick point to a need to build on the comparative advantages of these areas through investment in their infrastructure. There is a need to build on inherent local synergies which may occur within and between these sectors.

Sector A: Agriculture, forestry, fishing

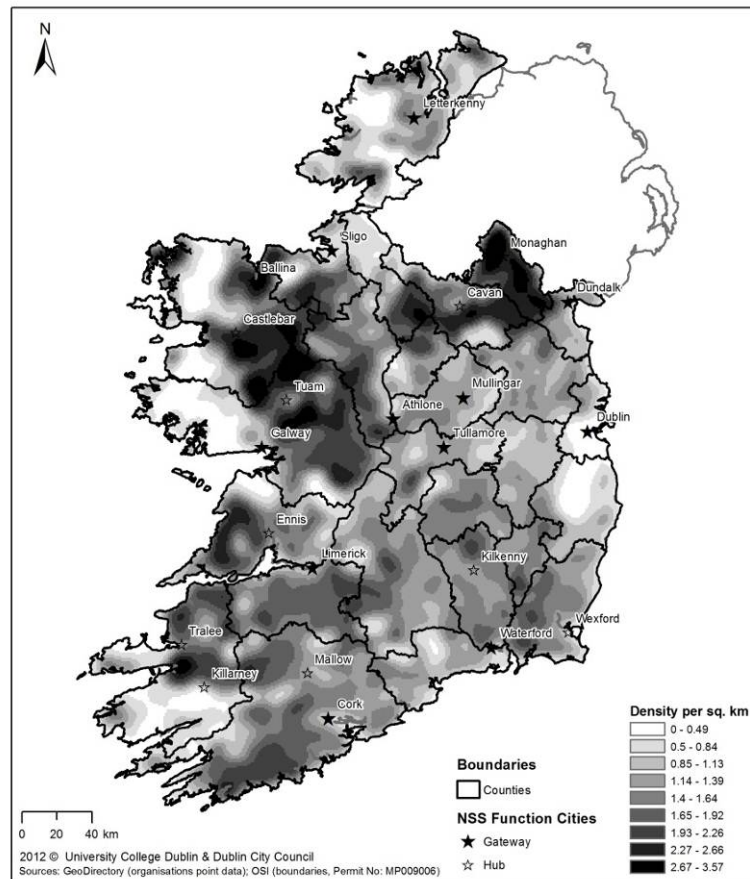
There are statistically significant clustering's of hot spots along peripheral and coastal areas (Map 3-1). Notably there is statistically significant lack of clustering of sectoral type A around the major cities, Galway, Limerick, Waterford, Cork and Sligo. For Dublin and the GDA the cold spot area extends from the city core into central Fingal, Wicklow and most of Kildare. This would broadly reflect the distinctly urban character of these areas and in the case of central Wicklow the urbanised north of the county and mountainous central area.



Map 3-1: Clusters (Hot Spots) of organisations of Sector A in Rol in 2011.

Analysis carried out for this broad NACE Rev 2 category is indicative of statistical trends; further disaggregation may be required in some instances. For example, Meath may have strong tillage activity and North Fingal may be a hot spot for horticultural specialism nationally. Broad categorisation can mask more specific spatial and sectoral activities.

The Density map (Map 3-2) in large extent mirrors hot spot clustering. In particular, the cold spot identified within the city core of Dublin reflects a density of Sector A business type of between 0-0.49 businesses per sq.km. This would be largely expected spatial pattern in an urban agglomeration for agricultural activity.



Map 3-2: Density of organisations of Sector A in ROI in 2011.

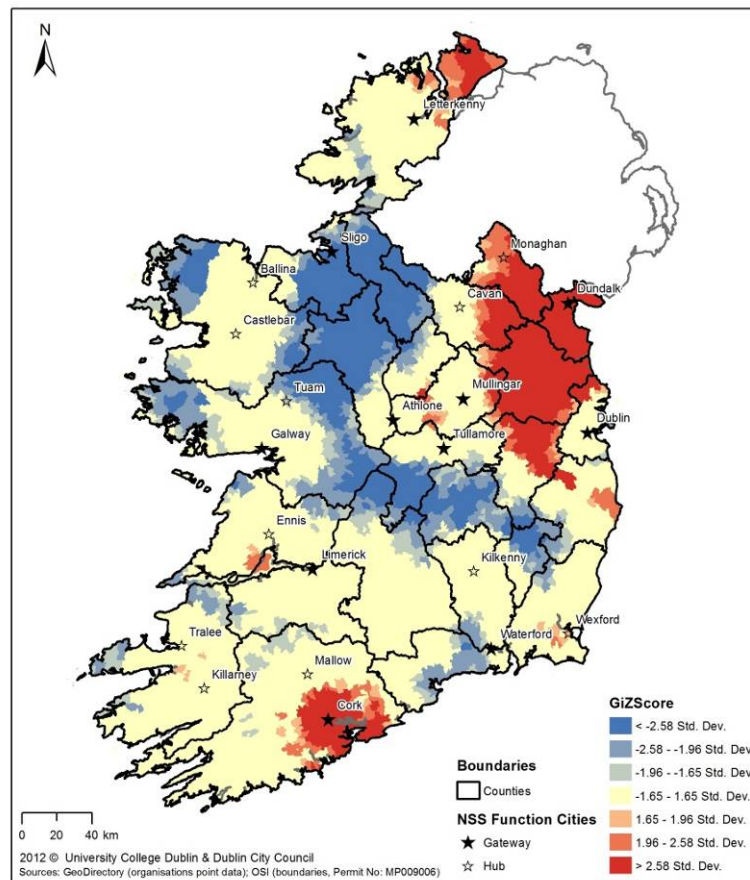
However, there are spatial exceptions. Take County Mayo and the area West of Castelbar as an example - this area is strongly involved in Sector A activities. The parameters developed to measure hot spot activity reflect this.

Nevertheless a map of density indicates the sparsity of business activity in West Mayo for this sector. This sparsity is reflective of the concentration of registered Geo-Directory businesses in the area. However, examination of the hotspot map shows that relative to the national average this area has statistically significant levels of business clustering. Density mapping shown here indicates spatial concentration of a business type within given areas and is a useful and informative measure. In combination with the hot spot maps these maps can be used to create an evidence base related to business type activity.

Sector F: Construction

The hot spot map of construction companies firstly points up a statistically significant relationship in terms of proximity to sectoral neighbours in Counties Meath, Louth Monaghan and Kildare (Map 3-3). These commuter counties experienced some of the country’s highest levels of construction during the Celtic Tiger era. In addition, they are located around the central urban core of the GDA and may be locations not only for construction oriented

businesses but also sources for “aggregates” for road construction etc. Cork and Letterkenny are the other extensive hot spot locations.



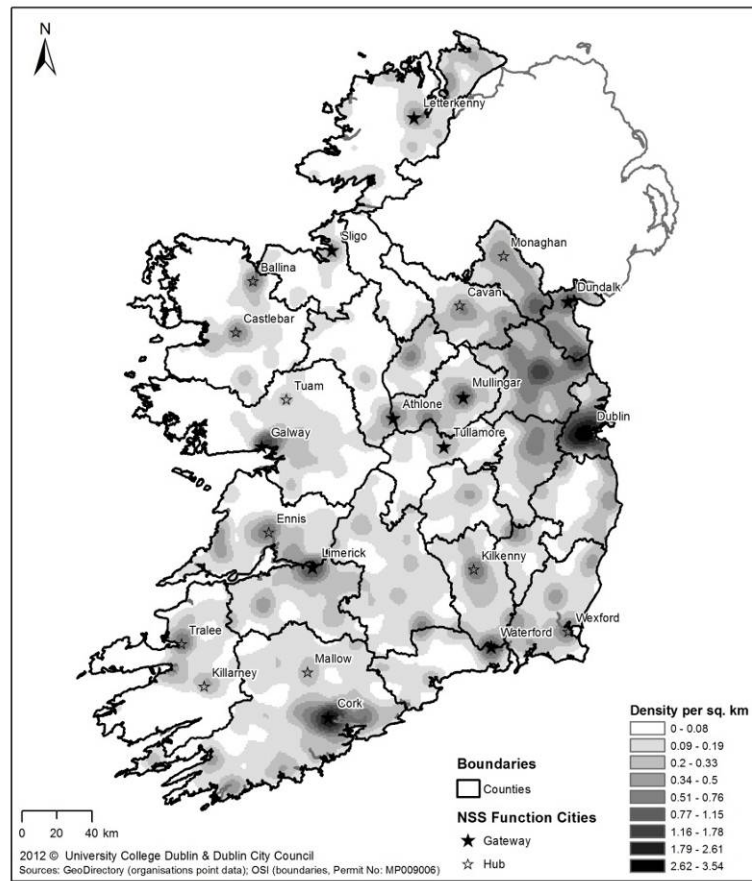
Map 3-3: Clusters (Hot Spots) of organisations of Sector F in RoI in 2011.

The extensive sectoral significance of hot spots in the hinterland of the GDA could probably be related to significant employment losses in this sector in the Mid-East region.

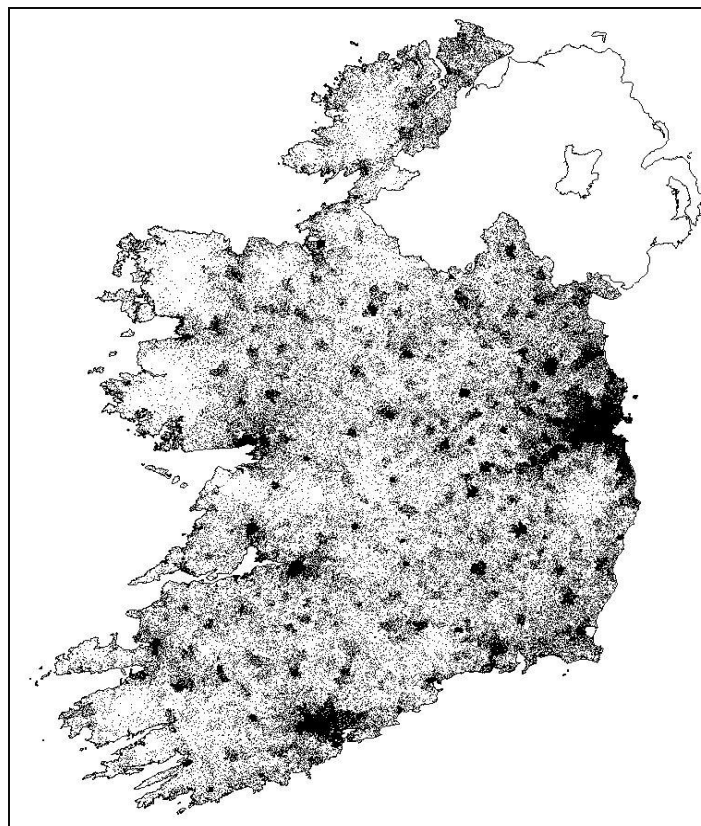
The density map (Map 3-4) points up a different trend. Here denser (darker) locations are concentrated within major urban conurbations.

Statistically the concentration of these construction businesses is not necessarily significant in relation to overall national concentration of construction businesses. However, this does indicate that construction companies do cluster to a certain extent within the primary areas of construction, that is, urban areas.

Job Density in the construction sector (Map 3-5) is used as a comparator to demonstrate potential for overlaying various data sets and types within a given sector. In this example, despite the time lag of 5 years and the disparities between data types (job density versus business location density) the visual similarities between maps are striking with a strong concentration of jobs and businesses in this sector within and around the main national gateways and county towns. In addition, Map 3-5 on job density points up the strong concentration in Dublin more forcefully and appears to show concentration along radial routes into the functional area. It is also possible by comparing Map 3-4 and 3-5 to visually approximate where job losses have occurred spatially. Broader regional employment changes available from Quarterly National Household Data can be used to partially confirm these losses.



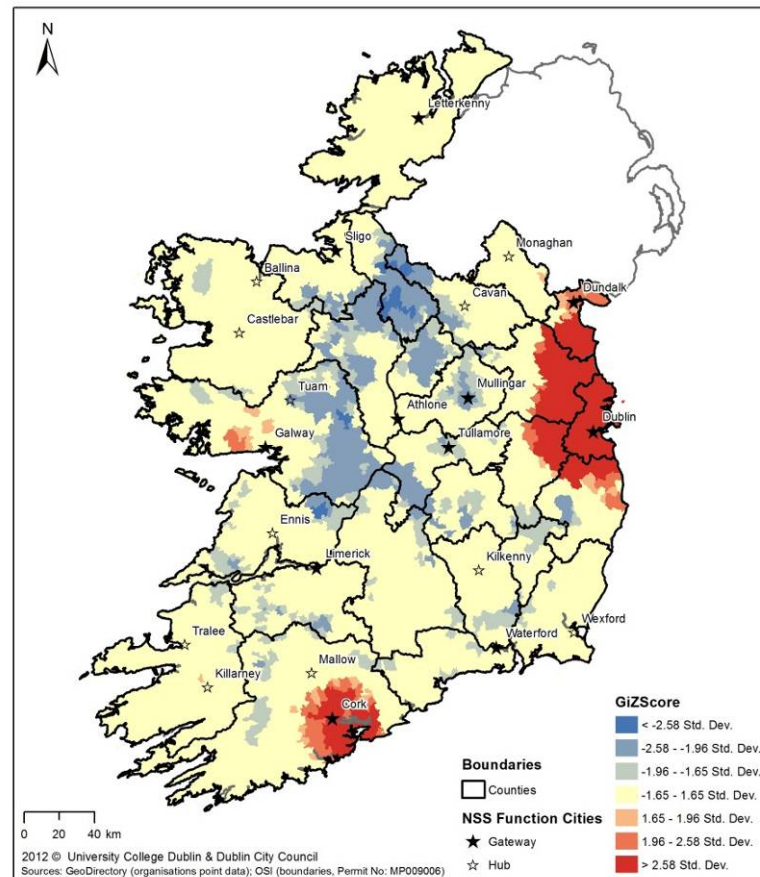
Map 3-4: Density of organisations of Sector F in RoI in 2011.



Map 3-5: Job Density Construction (persons per sq. km) in 2006 (Morgenroth 2008)

Sector G: Wholesale / retail trade; repair of motor vehicles & motorcycles

Hot spot analysis for the wholesale and retail sectors shows statistically significant hot spots within Dublin and Cork cities and their wider hinterlands (Map 3-6). In the case of Dublin a statistically significant clustering is evident across the entire Dublin Region extending as far north as Dundalk in County Louth, beyond the metropolitan boundary of the city region into east Meath and north Kildare and north Wicklow. This pattern could be expected in many regards reflecting the natural and extending retail catchment area of the Dublin region.

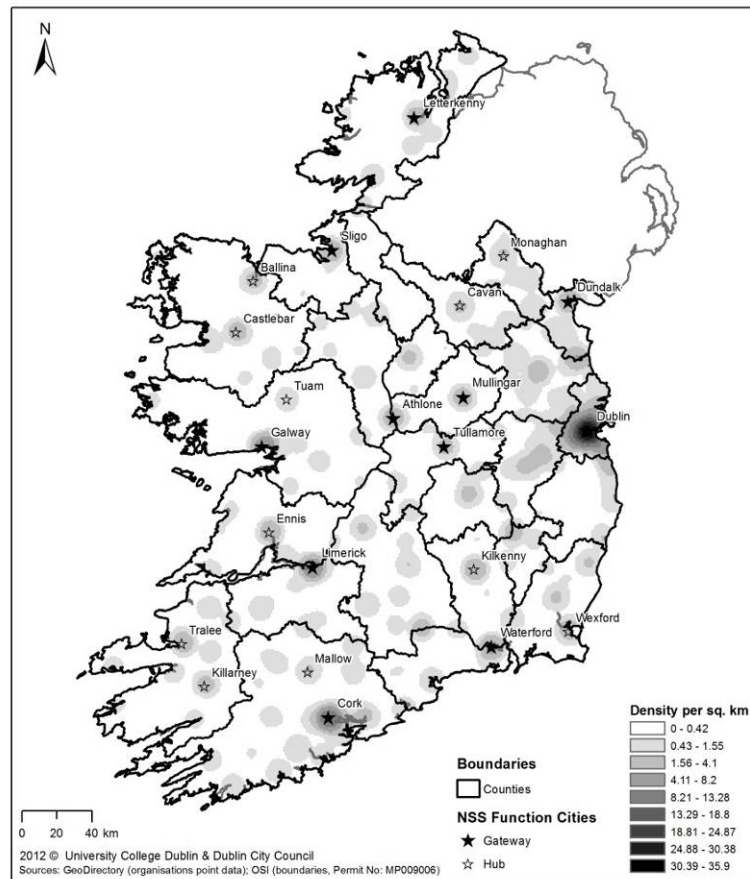


Map 3-6: Clusters (Hot Spots) of organisations of Sector G in ROI in 2011.

Statistically significant cold spots are present throughout the State. An area extending from south Offaly through east Galway, north Roscommon and Leitrim appears to have a particularly noticeable absence of activity in this sector. Density maps confirm this pattern.

Density maps for wholesale and retail show a concentration of activity in the national gateways, hubs and main county towns (Map 3-7). Dublin has the highest density per square kilometre.

Notably of the Athlone-Tullamore-Mullingar (ATM) Gateway towns Mullingar and Tullamore while exhibiting a density of retail and wholesale higher than their hinterlands are situated within statistical cold spots. This would indicate that the density of retail and wholesale is concentrated only within the urban ED(s) of these towns with a significant absence of clustering across neighbouring EDs in the surrounding hinterland.



Map 3-7: Density of organisations of Sector G in Rol in 2011.

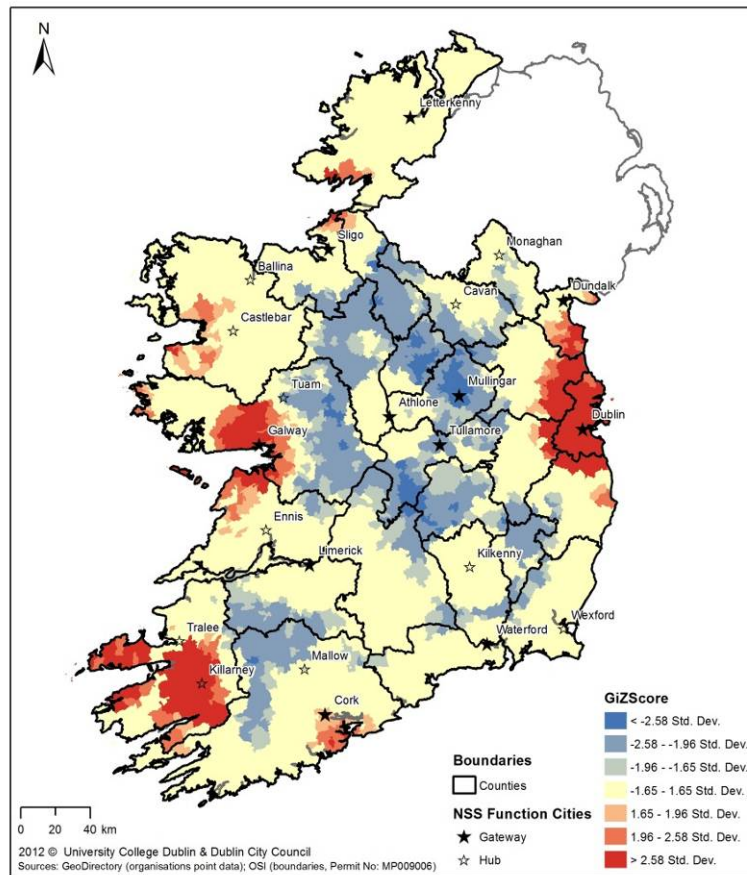
Sector I: Accommodation and Food Services

The hot spot analysis for this sector strongly relates to the tourism industry. From a policy perspective a strong clustering effect in around Dublin, Galway, Kerry, parts of Mayo and Cork indicate that these tourism nodes are responsive and active in terms of supply of services and concentration of business in this sector (Map 3-8).

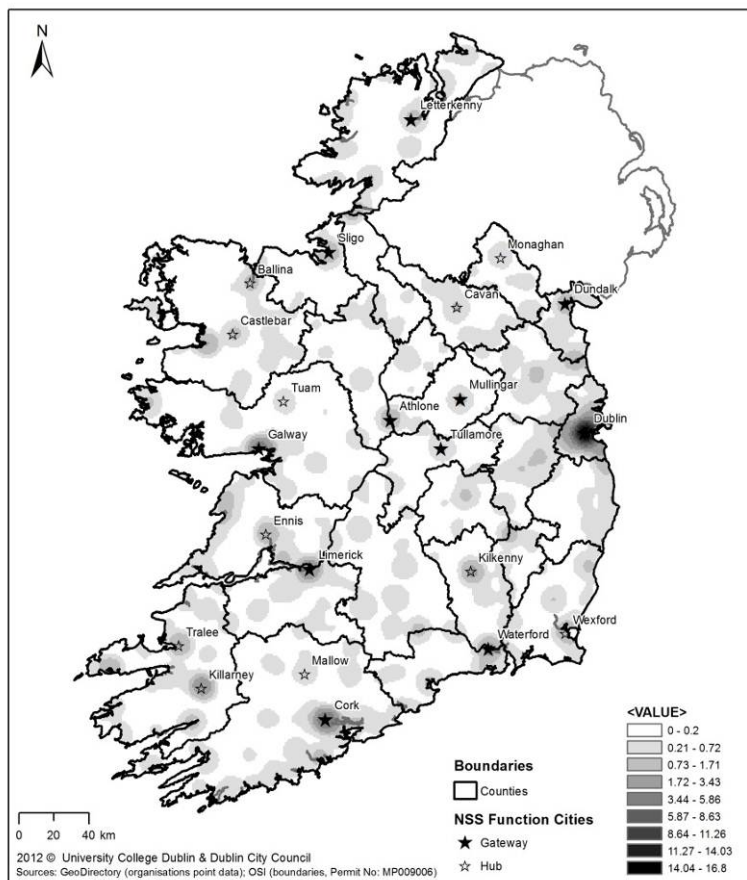
Notably, Cork exhibits a statistically significant hotpot which is limited in geographic scope compared to areas concentrated around Killarney-Dingle-Tralee, Galway and Dublin. For city of its size and reputation this may suggest that it is underutilising its potential in this sector. Especially as this sector is likely to have a potentially high proportion of SMEs. Further investigation would nonetheless be required to confirm this assumption.

Comparison with Failte Ireland data could be used to uncover if there is a relationship between business location and visitor travel and accommodation patterns.

The considerable geographic coverage of cold spots spanning the Midlands of the country suggests that as a tourism destination and as a destination renowned for areas of high quality food and environment that policy is under exploiting its potential in this spatial area.



Map 3-8: Clusters (Hot Spots) of organisations of Sector I in Rol in 2011.



Map 3-9: Density of organisations of Sector I in Rol in 2011.

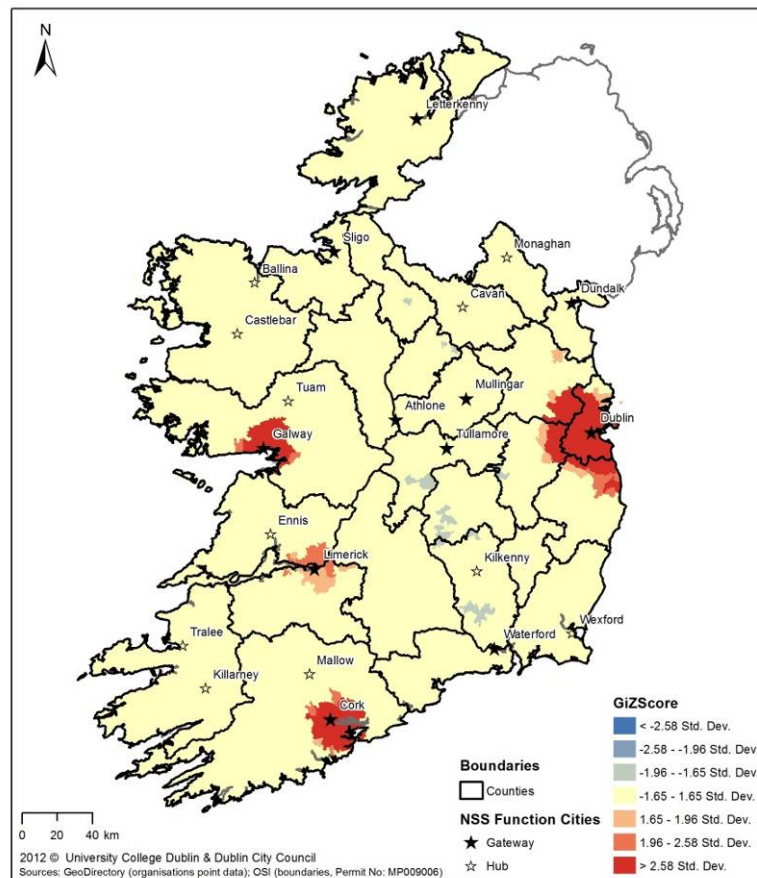
As a policy initiative, analysis of the length of visitor stays, travel patterns the tourism offering and services are recommended. The statistically significant hotspots in peripheral areas such as the Dingle Peninsula, around Galway Bay and the Clare coastline, parts of Mayo and Donegal show the potential to build viable clusters around established high quality brands and environments.

Density mapping, however, does point up more extensive concentration in selected locations (Map 3-9). These appear to be concentrated in gateways, hubs and county towns and a variety of selected locations. The importance of the Dublin effect not only within the core but in regards to its surrounding hinterland is demonstrated by a very high concentration of business addresses within the city region. There is a noticeable density of accommodation and food services businesses also extending along the eastern coastline.

Sector J: Information and Communication

The ICT sector was mapped due to its importance to the knowledge economy, its role as a facilitator of sectoral convergence and its potential to assist in and steer national and regional economic recovery.

The pattern of statistically significant distribution for this sector is clearly evident (Map 3-10). Dublin is once again the primary centre for business address concentration. The hot spot area extends beyond the Dublin regional boundary into parts of Kildare, Meath and Wicklow. North Fingal which is primarily a horticultural area does not exhibit a statistically significant hot or cold spot output.

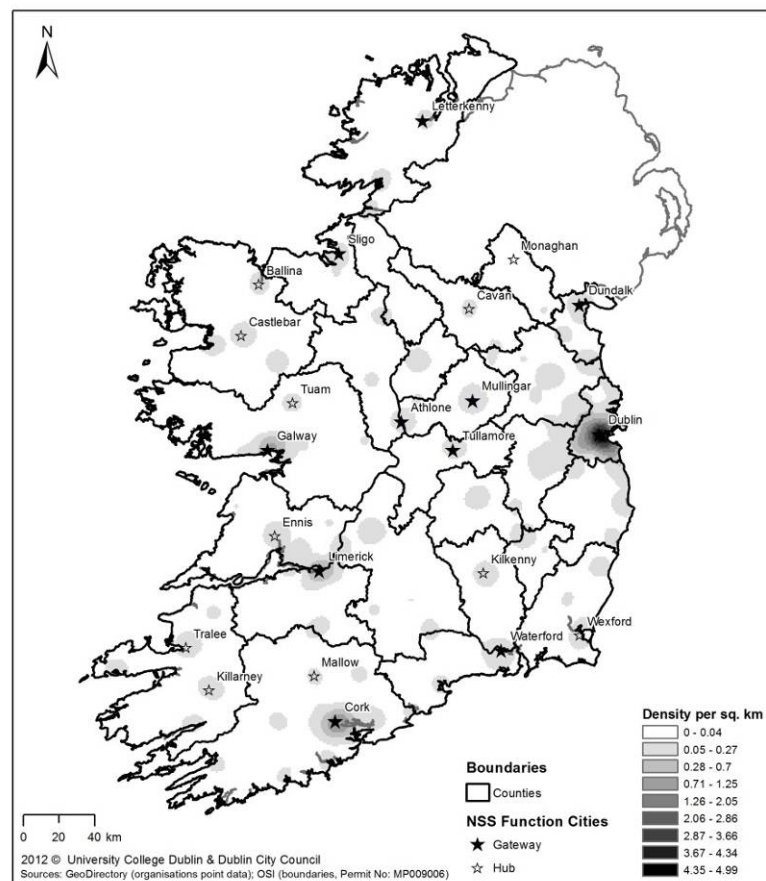


Map 3-10: Clusters (Hot Spots) of organisations of Sector J in RoI in 2011.

Apart from the overwhelming dominance of Dublin, what is most clearly visible is that in terms of ICT the major cities of the Atlantic Corridor including Cork, Galway and Limerick and the capital Dublin are the preferred and presumably most appropriate business locations for this sector.

Density mapping, unsurprisingly, indicates some levels of concentration of this sector within Gateways, hubs and county towns (Map 3-11).

The lack of statistical cold spots is related to the concentration of ICT businesses in the four major cities and the fact across the national distribution there are very few ICT businesses located outside of these urban centres.



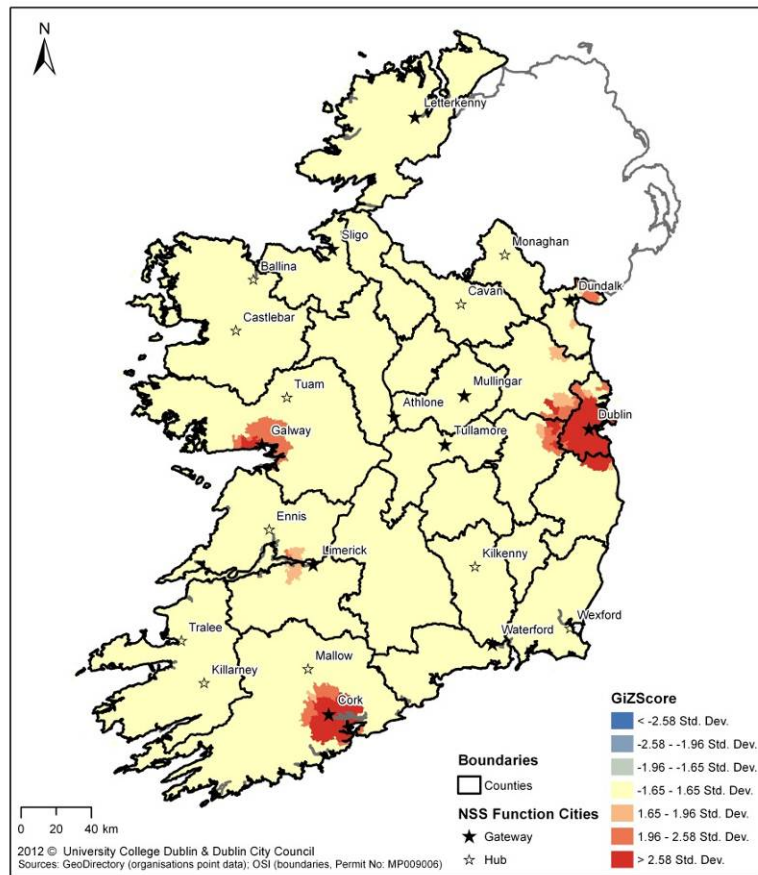
Map 3-11: Density of organisations of Sector J in Rol in 2011.

Sector K: Financial and insurance activities

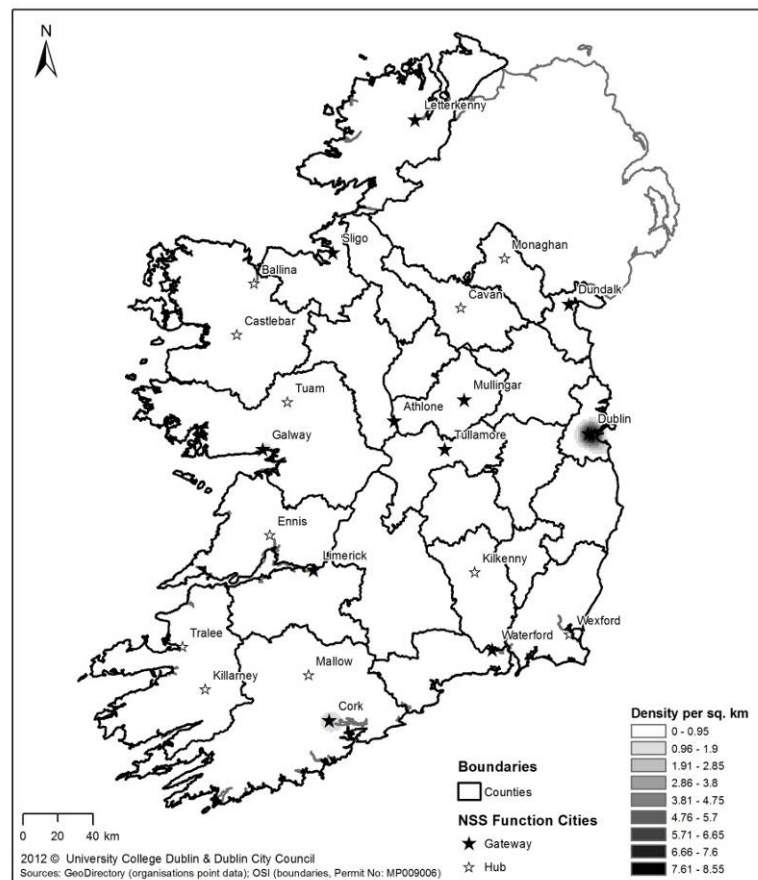
Like in case of the ICT, the Financial and insurance activities sector was mapped due to its importance to the Irish economy, its role as a facilitator of sectoral convergence and its potential to assist in and steer national and regional economic recovery.

From Map 3-12 the pattern of statistically significant distribution for this sector is evident. Dublin is once again the primary centre for business address concentration. The hot spot area extends beyond the Dublin regional boundary into parts of Kildare, Meath and Wicklow. Once more North Fingal does not exhibit a statistically significant hot or cold spot output.

Density mapping indicates slight concentration of financial companies in Cork and Galway in addition to Dublin (Map 3-13). There is almost no concentration of this sector within other certain Gateways (Limerick, Waterford and the ATM (Athlone, Tullamore and Mullingar), all hubs and other county towns.



Map 3-12: Clusters (Hot Spots) of organisations of Sector K in Rol in 2011.

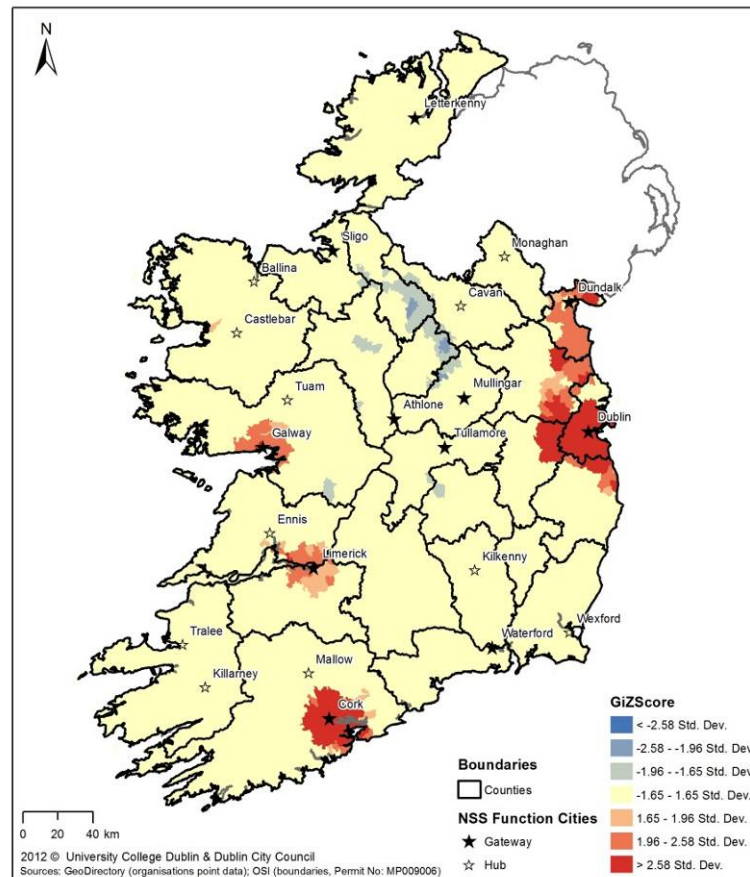


Map 3-13: Density of organisations of Sector K in Rol in 2011.

Sector M: Professional, scientific and technical services

Similar to ICT there is concentration of this industry growth sector in four key city locations, namely, Dublin, Cork, Limerick and Galway (Map 3-14). The influence of Dublin again extends beyond the city region limits with a notable pattern of clustering along the M1 economic corridor to the Dundalk gateway.

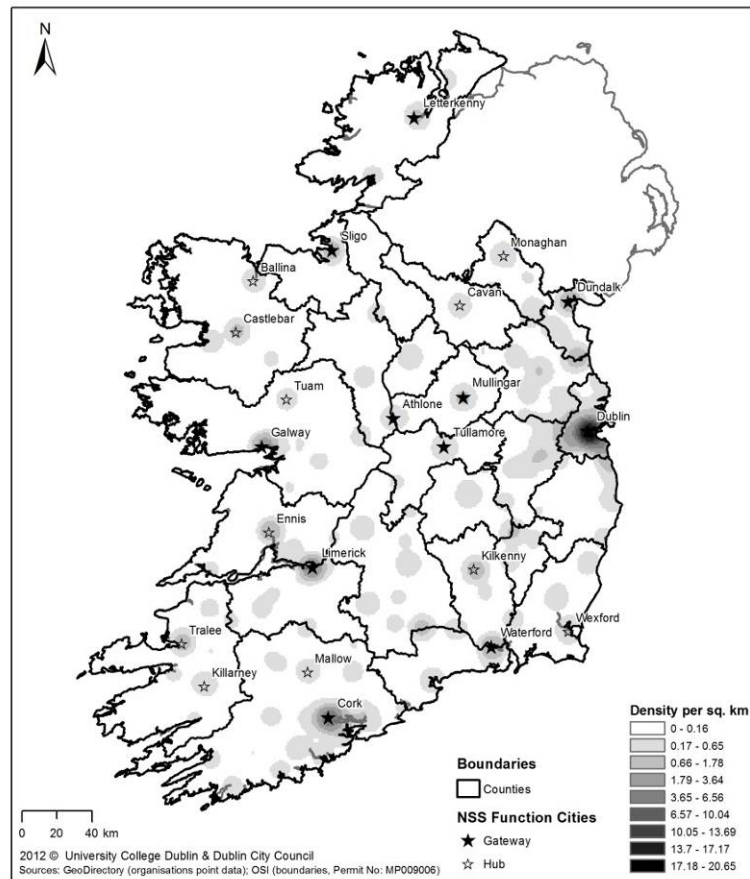
The geographic scope of the clustering agglomeration centred on Cork is relatively extensive compared to other sectors.



Map 3-14: Clusters (Hot Spots) of organisations of Sector M in ROI in 2011.

Density mapping again points up a high concentration of businesses address within the Dublin city limits extending outwards across the Dublin metropolitan area (Map 3-15). As for other sectors specific concentration of business address nested within this high density area would require a further disaggregation of density scale bands. Nonetheless, the importance of the Dublin city core is clearly evident. Elsewhere, nationwide, there is evidence of higher densities of locations across a number of key Gateway, hub and county settlements.

The lack of cold spots indicates, as for ICT, that businesses in this sector only locate in urban areas with a distinct preference for major urban centres. Distribution elsewhere is sparse.



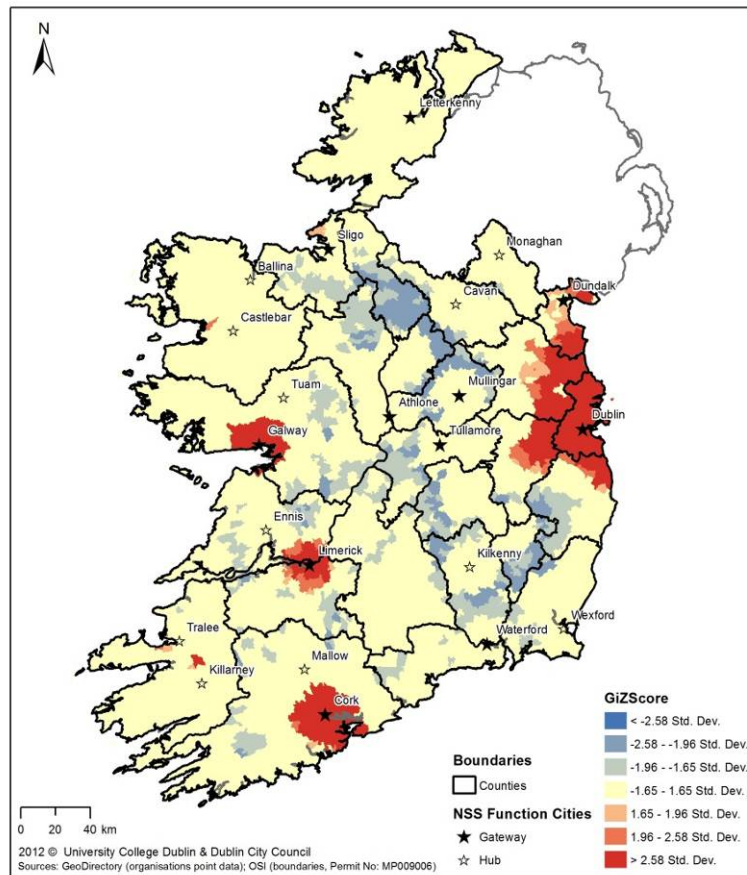
Map 3-15: Density of organisations of Sector M in RoI in 2011.

Sector Q: Human health and social work activities

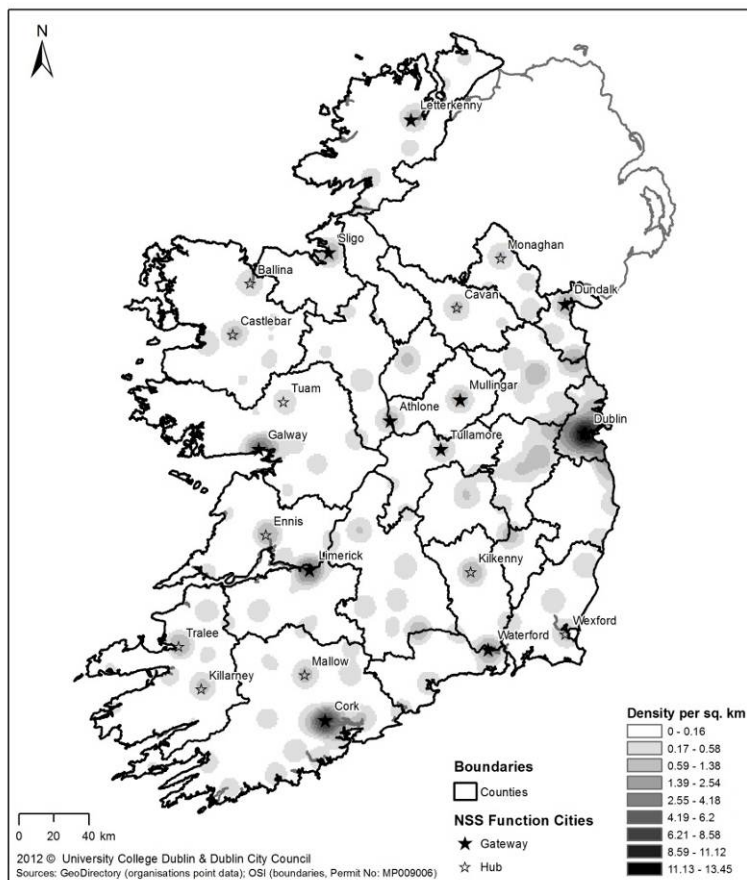
Human health and social work services are most clearly evident in the major cities of Dublin, Cork, Limerick and Galway (Map 3-16). The statistically significant hotspots extending beyond the city boundary especially in the case of Dublin, where its functional area clearly extends into the hinterland Mid-East Region and County Louth. The extension of functional area along the M1 corridor is notable as it repeats a spatial pattern evidenced across a number of other important sectors such as wholesale and retail.

The repeated absence of statistically significant relationships in the Gateway triad of Athlone, Tullamore and Mullingar and Waterford is notable, indicating a failure at broad sectoral level to establish business clustering in identified Gateway growth poles.

Density mapping shows significant concentration in the Dublin city region extending into the GDA (Map 3-17). Cork, Galway and Limerick have higher densities with the pattern of high densities in key county towns nationally repeated for this sector.



Map 3-16: Clusters (Hot Spots) of organisations of Sector Q in Rol in 2011.



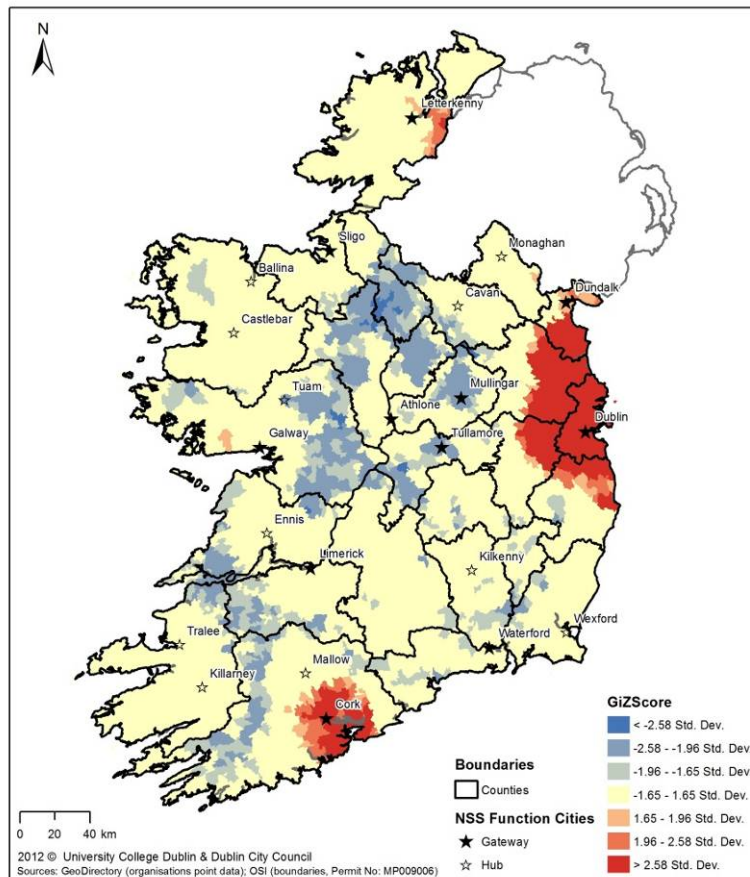
Map 3-17: Density of organisations of Sector Q in Rol in 2011.

Sector S: Other services

The analysis of this sector shows a statistically significant clustering within the GDA extending northwards in to County Louth (Map 3-18). The clustering effect is only evident in and around Dublin and to a lesser extent Cork.

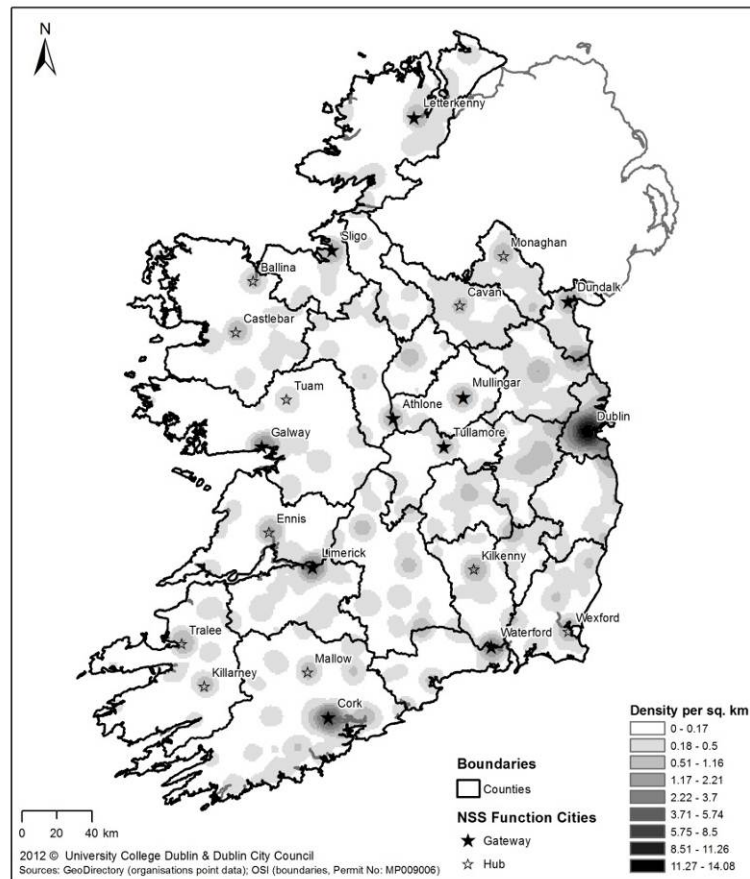
Relative to the national average this indicates the viability of these centres as locations for on-the-street services such as hairdressers, dry cleaners, gyms, electronic repair shops, funeral parlours and other personal services.

Clustering of business addresses in Dublin and Cork suggests healthy local economies in traditional service activity.



Map 3-18: Clusters (Hot Spots) of organisations of Sector S in Rol in 2011.

The Density mapping points up concentration of these services within other gateways, hubs and county and market towns respectively (Map 3-19). The primacy of the Dublin city core in terms of density of addresses is again clearly evident.



Map 3-19: Density of organisations of Sector S in RoI in 2011.

Foreign Direct Investment

In addition to the organisation addresses provided by GeoDirectory, we have also analysed the IDA Ireland’s (Industrial Development Agency) database on the companies with Foreign Direct Investment. Further analysis and commentary will be provided and contextualised in Report 3.

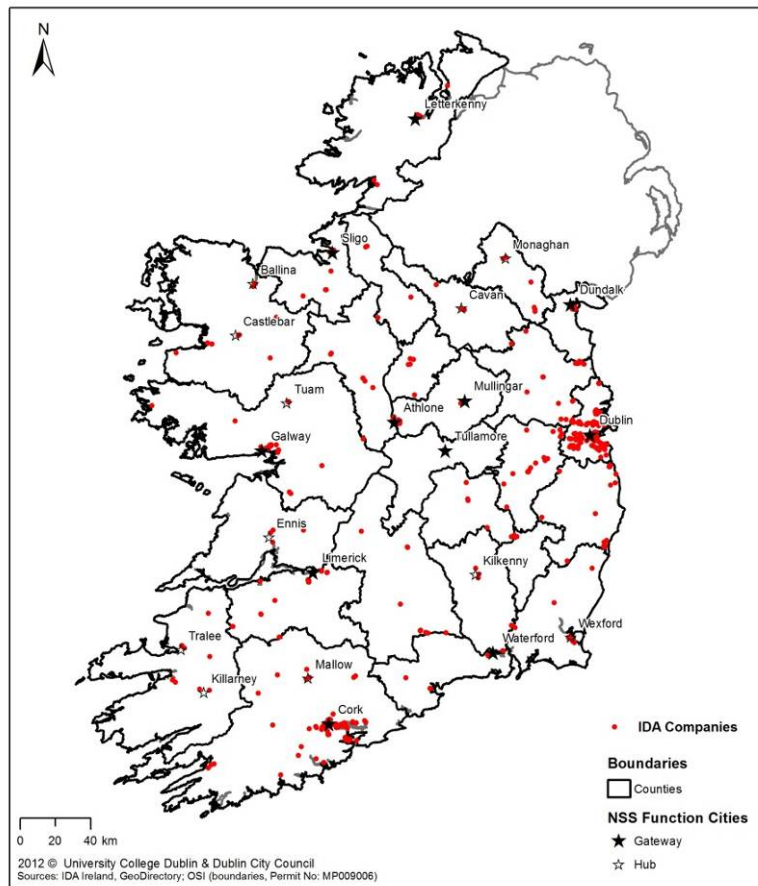
IDA Ireland is responsible for the attraction and development of foreign investment in Ireland. IDA Ireland’s strategy has focused on increasing the local potential for winning FDI through a national program of strategic investment in critical infrastructure, properties and large sites.

Many locations have benefited from overseas investment. All of the IDA site locations were extracted from the IDA Ireland address database on their website. In total there were 771 records of which 756 were mapped to a specific location. The following fields were captured in this dataset: Company Name, Sector, Nationality of the company and its address (Map 3-20).

The address information was matched against the National An Post GeoDirectory database and linked to an easting and northing. Almost 70% of the records matched using geocoding software¹. The remaining 30 per cent of the records were manually matched. Once the records were geocoded this allowed a county, enumeration district and a Dublin postcode (where appropriate) to be added to the dataset.

It is recommended that we propose to work with the IDA to improve the Sectoral Coding of site location and determine the feasibility to identify the approximate numbers employed at each IDA site.

¹ Department of Education GIS and forward planning unit



Map 3-20: IDA Supported companies in ROI in 2012.

Financial Services (29%) and ICT (21%) in particular account for half of all IDA supported sites in Ireland¹ (Figure 3-5).

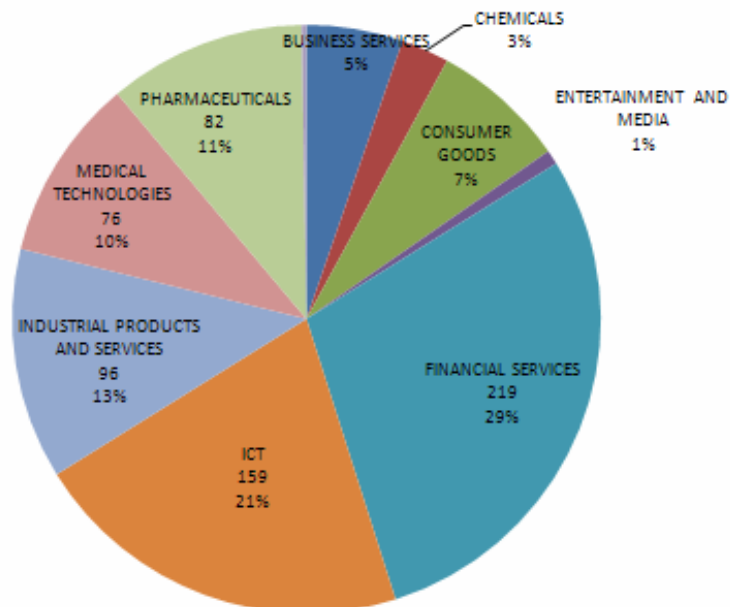
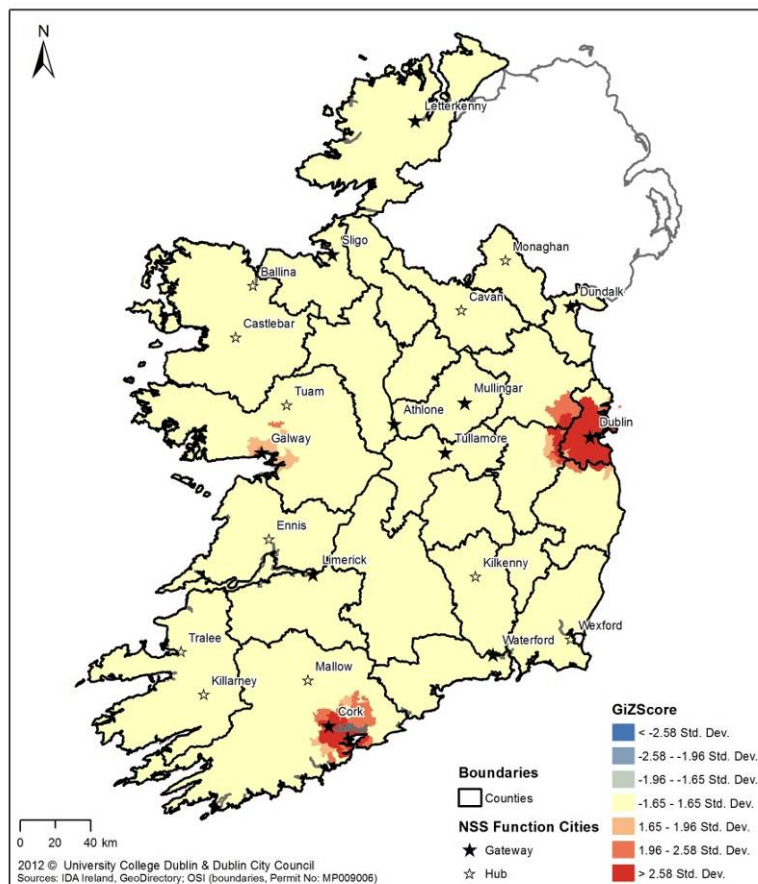


Figure 3-5: Sectoral Spread of IDA assisted Companies in Ireland in 2012

¹ It is important to note that we did not have access to employment number by site – such information would really enrich the quality of the analysis.

However, as presented in the Map 3-21 statistically significant clustering of IDA companies are noticed only in Dublin, Cork and Galway cities.

Table 3-3 demonstrates the regional spread of specific sectors nationally.



Map 3-21: Clusters (Hot Spots) of IDA supported companies in ROI in 2012.

Table 3-3: IDA Site Locations by Sector Type.

Sectors	Dublin	Cork	Galway	Limerick	Waterford	Other Areas	Total Nationally
Business Services	48%	25%	3%	5%	3%	16	100%
Chemicals	35%	25%	0%	15%	0%	25	100%
Consumer Goods	25%	11%	0%	4%	9%	51	100%
Entertainment and Media	83%	17%	0%	0%	0%	0%	100%
Financial Services	86%	2%	1%	1%	1%	9	100%
ICT	48%	19%	10%	5%	1%	17	100%
Industrial Products and Services	15%	16%	7%	4%	5%	53	100%
Medical Technologies	11%	11%	17%	7%	3%	51%	100%
Pharmaceuticals	29%	27%	0	0	6%	38	100%
Transportation	-	-	-	-	-	100%	100%
Total	47%	13%	5%	3%	3%	29%	100%

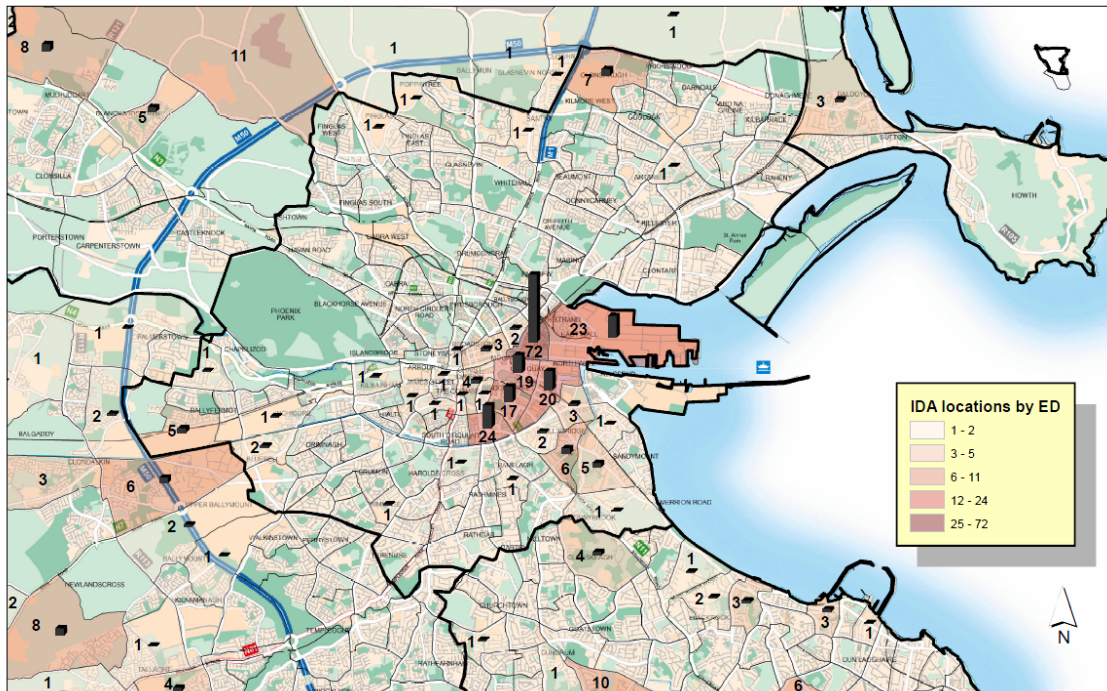
Dublin and Cork dominate in the area of Business Services (with 48% and 25% of the national totals), Chemicals (with 30% and 25%) and Pharmaceuticals (with 29% and 27%). Unsurprisingly Dublin dominates in the Financial Services sector and Entertainment and Media sectors with an over 80% national share. Over half of all the ICT sector locations were in the Dublin region. Cork leads in location of Industrial products and Services while Galway leads in the area of medical technologies accounting for 17% of the national total.

Table 3-4 lists where there are 5 or more IDA sites located in a particular Enumeration District. This does not incorporate numbers of employees as we do not have access to that level of information. The impact of the IFSC with over 73 sites located in the North Dock C ED is of particular interest. The Docklands and central city areas rank highly in the national perspective with 3 ED's with over 20 site locations.

Table 3-4: Enumeration Districts with 5 or more IDA Sites.

Location	Sites	Location	Sites	Location	Sites	Location	Sites
Dublin City	233	Fingal	45	Galway Co.	21	Limerick Co.	25
North Dock C	73	The Ward	11	Ballintemple (Pt.)	7	Ballycummin	10
St Kevin's	24	Swords-Seatown	9			Ballyvarra	8
North Dock B	23	Blanchardstown-Tyrrelstown	8	Galway City	19		
South Dock	20	Blanchardstown-Corduff	5	Ballybrit	9	Waterford City	17
Mansion House A	19			Wellpark	7	Ballybeg South	13
Mansion House B	17	Dun Laoghaire-Rathdown	42				
Priorswood A	7	Dundrum-Balally	10	Sligo County	18		
Pembroke West B	6	Glencullen	8	Sligo West	12		
Pembroke East E	5	Cabinteely-Pottery	6			Cork Co.	78
Cherry Orchard C	5			Donegal	10	Caherlag	15
		Wexford	10	Letterkenny Rural	7	Lehenagh	14
Wicklow Co.	18	Wexford Rural (Pt.)	5			Carrigaline	10
Kilmacanogue	5			Kerry County	12	Carrigtohill	8
Arklow Rural	4	Offaly Co.	6	Tralee Rural (Pt.)	5		
		Tullamore Urban	6			Louth County	19
Westmeath Co.	17			Louth County	19	Cork City	24
Athlone East Rural	9	Longford Co.	6	Dundalk Rural Pt.	7	Mahon B	9
		Longford Rural	5	St. Mary's (Louth)	5	Bishopstown A	5
South Dublin	35						
Tallaght-Fettercairn	8	South Tipperary	7				
Clondalkin-Monastery	6	Clonmel Rural	5				

Map 3-22 shows the distributive pattern across the city. There are interesting regional clusters such as Caherlag, Lehenagh and Carrigaline in Cork Country which all have over 10 IDA sites in their areas.



Map 3-22: IDA Locations by ED in Dublin City Council.

4. CONCLUSION

This report and the geo-spatial analysis therein are aimed to provide new information and assessments of the nationwide spatial distribution of business formation and investment in services, that is, to determine best locations for return on investment, business formation and where demand for social infrastructures are highest now and may be highest in the future.

The results of the spatial analysis show the statistically proven significance of the main Gateways and Hubs and in particular Dublin as key centres for the main sectors of business in Ireland. In the case of cluster analysis and opportunity mapping a clear pattern emerged whereby Dublin and the other Gateways across the State were the centres representing those broad geographic areas of greatest opportunity in the country.

While Dublin is both the global economic focal point for Ireland and the key component of a broader spatial distribution of Gateways and Hubs nationally the results can also be viewed in the context of Dublin and other key Gateways having a combined critical mass of business occurrence across key economic sectors which may be attractive to inward investment.

Main Results

The results of the spatial mapping exercises show the statistically proven significance of the main Gateways and Hubs as key centres for the main sectors of business in Ireland.

Hot spot analysis found that within all of the key sectors nationally barring Agriculture that significant concentrations were found in the main Gateways, Hubs and County Towns.

Dublin's functional area was found to extend beyond the boundary of the Dublin or metropolitan area into the GDA for a number of sectors including Construction (Map 3-3), Wholesale and Retail (Map 3-6), ICT (Map 3-10), Financial Services (Map 3-12), Professional Services (Map 3-14) and Human Health Sectors (Map 3-16). There was a notable pattern of significant clustering along the Dublin-Belfast Corridor across a number of sectors.

In general it would appear that the Gateways with most significant and extensive clustering patterns outside of Dublin were Cork, Galway and Limerick. The Midlands triad Gateway of Athlone-Tullamore-Mullingar and the Gateway of Waterford appeared to have much less significant levels of clustering across most sectors.

While the hot-spot analysis does not have an employment quantum built in it does point up the importance of the Dublin region. Coupled with other indicators of economic viability such as human capital (the knowledge and ability to absorb new knowledge of the region) and infrastructure Dublin is evidently a Gateway region with mutually reinforcing factors which have allowed to grow to a critical mass across a number of key economic sectors.

In the case of the Comprehensive Map of Opportunity (Map A2-9) a clear pattern emerged whereby Dublin and the other Gateways across the State were the centres which represent those broad geographic areas of greatest opportunity to realise return for investment on enterprise development.

While the spatial outputs from the indicator's mapping, hot spot analysis and the opportunity maps are described in relative isolation within this report they will be examined in conjunction within qualitative and quantitative review of other relevant reports and datasets, respectively in Report 3.

Recommendations and potential research applications

1. General

- 1.1. As part of a “Joined up data, Joined up thinking” initiative there is potential to collaborate with the Dublinked project to provide guidance and directions to the main datasets, spatial outputs and information points held by various organisations which relate to the Dublin and National economy. Examples of such publicly available sites now include MyPlan, CSO and AIRO Interactive Census Mapping, Pobal Deprivation Mapping etc.
- 1.2. To integrate the findings and spatial patterns found herein to policy action plans both at national and sub-national level.
- 1.3. To develop an All-Ireland series of hot-spot (and opportunity) analysis.
- 1.4. To map and carry out hot spot analysis of all agency assisted data, working closely with Forfás, Enterprise Ireland and the IDA to realise this ambition. In turn, to link employment and industry sector to total job numbers.
- 1.5. To carry out a mapping exercise of under-utilised and/or derelict sites within the administrative area of Dublin city council and provide qualitative assessment of the potential of these sites based on comparison with opportunity mapping, future land use demand and patterns of demographic change.

2. Transport

- 2.1. To examine commuting patterns, travel times to work, demographic trends to establish acceptable levels of commuting and make the case for centralisation of services strictly according to key Gateways (This would also look at the cost of commuting across the region).
- 2.2. To re-visit evidence from AIRO or others on the overloading effect that Dublin, Limerick, Cork and Galway have on commuting catchments; and to determine the acceptability of these commutes from a cost, time and quality of life perspective.
- 2.3. To examine retail commutes as part of broader retail catchment analysis and as a research piece which can complement the Retail Strategy for the GDA.
- 2.4. To explore the viability of office locations in term of public transport infrastructure provision.
- 2.5. In future iterations of this study to develop a catchment based spatial analysis which is based on combinations of EDs to better understand transport gravitations across the region and associated work travel patterns.

3. Opportunity Mapping

- 3.1. To further develop a conceptual framework of opportunity mapping that is clearly linked to policy development and implementation.
- 3.2. To build an opportunity map which incorporates health infrastructure, tertiary services, flood points and quality of living. Opportunity mapping is an excellent concept which has the potential to build in hard evidence on the viability of locations for investment and/or residential units according to a number of key indicators. At present, access to health infrastructure and other tertiary services are not included in this study due to a lack of data availability. However, these data have been generated by relevant organisations. Flood points builds in critical environmental factors, access to health services and

infrastructure will build in an added level of critical opportunity from both the perspective of realising enterprise potential and the perspective of the citizen. Other tertiary services point up the level of centrality of an area and include access to retail, (the area of retail), access to other services and this is an important indicator of the viability of a given location. It will be possible to utilise Valuation Office data for this purpose.

- 3.3. To utilise Natura 2000 area layers from the Department of the Environment, Community and Local Government, Flood zone layers from OPW and land use zoning layers from MyPlan as part of a suitability checking exercise of neighbourhood opportunity maps
- 3.4. Overlay of established/current government decentralisation locations¹ with opportunity maps to appraise the viability of these locations against opportunity mapping metrics.
- 3.5. Potential projects which would demonstrate the usefulness of opportunity mapping and land use modelling in the context of city planning and its impacts to provide a “what if” opportunity map and simulations are to examine the following two scenarios using the MOLAND model:
 - The extension of LUAS BX into the north inner city
 - The centralisation of DIT campus to the Grangegorman site in the North Inner City.
- 3.6. Use the MOLAND model to study different development scenarios: e.g. to determine how changes in employment by broad sector impacts land use in the GDA.
- 3.7. To investigate the feasibility to use Daft.ie housing data summarised at ED level to map average price per square metre / room for rental and house prices (housing affordability).
- 3.8. To compare public expenditure at county level (Local Authority Budgets) with estimates of revenue (Morgenroth, 2010) and further with per capita tax contributions per county from Revenue² linking these data with qualitative appraisal of sectoral cluster analysis and opportunity mapping.
- 3.9. To use Valuation Office³ data to summarise Office Spaces according to three level characteristics of 1st, 2nd and 3rd generation offices spaces⁴ and to link these data to expected demand for future office space.

¹ Decentralisation is a discontinued policy in that those towns now excluded from the programme will not be reconsidered. Some other locations are still under consideration and decentralisation has occurred to other towns.

² “I believe that the Government should ask the ESRI or a similar body to carry out a geographical analysis of tax collection and public spending in Ireland and how it relates to population, wealth and social need. It is long overdue and politicians need information like this so that we can make the right decisions for the country as a whole.” (Varadkar, 2010, <http://www.leovaradkar.ie/?p=1076>)

³ <http://www.valoff.ie>

⁴ Here 1st generation office buildings are categorised as being built prior to the mid 1970s (O’Connell Bridge House); 2nd level are mid 1970s to mid 1980s (eg. IDA in Wilton Place); 3rd Generation are categorised as being built from the late 1980s onwards (eg. IFSC buildings).

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APPENDICES

Appendix 1: Hot Spot Analysis Concepts¹

The null hypothesis for the hot spot analysis tool is that values are randomly distributed among the features in the study area; the distribution of values simply reflects one of many, many possible versions of randomness. Output from Hot Spot Analysis tells where (for which features) the null hypothesis can be rejected. After running the Hot Spot Analysis tool, every feature gets a z score. A z score is simply a measure of standard deviation; it is a reference value associated with a standard normal distribution. A very high or a very low (negative) z-score is found in the tails of the normal distribution (Figure A1-1); and indicates a pattern that deviates significantly from a hypothetical random pattern. Consequently, for such cases the null hypothesis can be rejected and we can proceed with trying to figure out what might be causing the statistically significant clustering.

For example the Figure A1-1 shows the results of the ArcGIS Moran I Statistics tool applied for construction organisations (NACE sector F) map from GeoDirectory 2011. Given the z-score of 31.03, there is less than 1% likelihood that this clustered pattern of construction organisations in Rol could be the result of random chance.

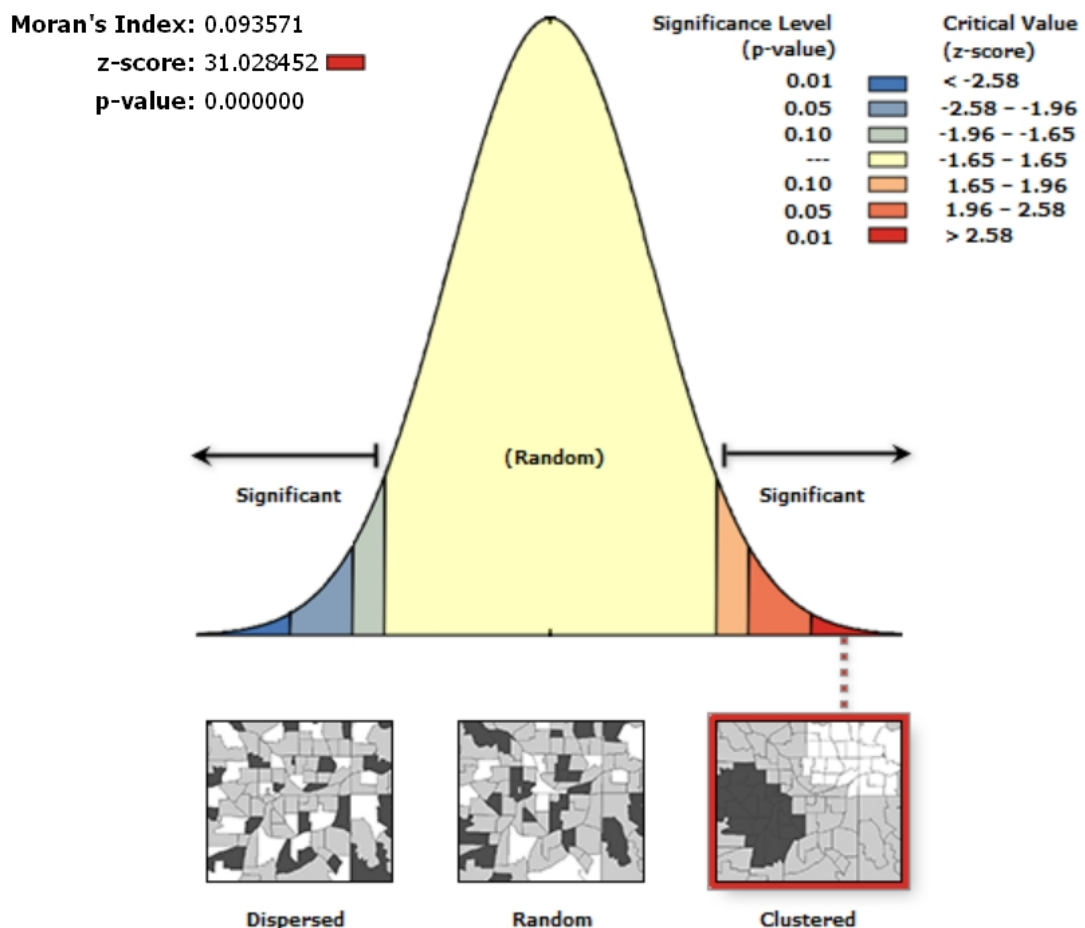


Figure A1-1: Spatial Autocorrelation report from ArcGIS Moran I statistics for Construction organisations registered in GeoDirectory in 2011.

¹ Adapted from ESRI ArcGIS Desktop Help

ArcGIS Hot Spot Analysis tool calculates the G_i^* statistic for each feature in a dataset:

$$G_i^* = \frac{\sum_{j=1}^n w_{i,j} x_j - \bar{X} \sum_{j=1}^n w_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^n w_{i,j}^2 - \left(\sum_{j=1}^n w_{i,j} \right)^2}{n-1}}}, \text{ where } \bar{X} = \frac{1}{n} \sum_{j=1}^n x_j, S = \sqrt{\frac{1}{n} \sum_{j=1}^n x_j^2 - \bar{X}^2},$$

and x_j is the attribute value for features j , $w_{i,j}$ is the spatial weight between feature i and j , n is equal to the total number of features.

The G_i^* statistic returned for each feature in the dataset is a z-score. The resultant z-scores and p-values tell where features with either high or low values cluster spatially. This tool works by looking at each feature within the context of neighbouring features. A feature with a high value is interesting but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. The local sum for a feature and its neighbours is compared proportionally to the sum of all features. When the local sum is very different from the expected local sum, and that difference is too large to be the result of random chance, a statistically significant z-score results.

For statistically significant positive z-scores, the larger the z-score is, the more intense the clustering of high values (hot spot). For statistically significant negative z-scores, the smaller the z-score is, the more intense the clustering of low values (cold spot). A z-score near zero indicates no apparent concentration (neighbours have a range of values).

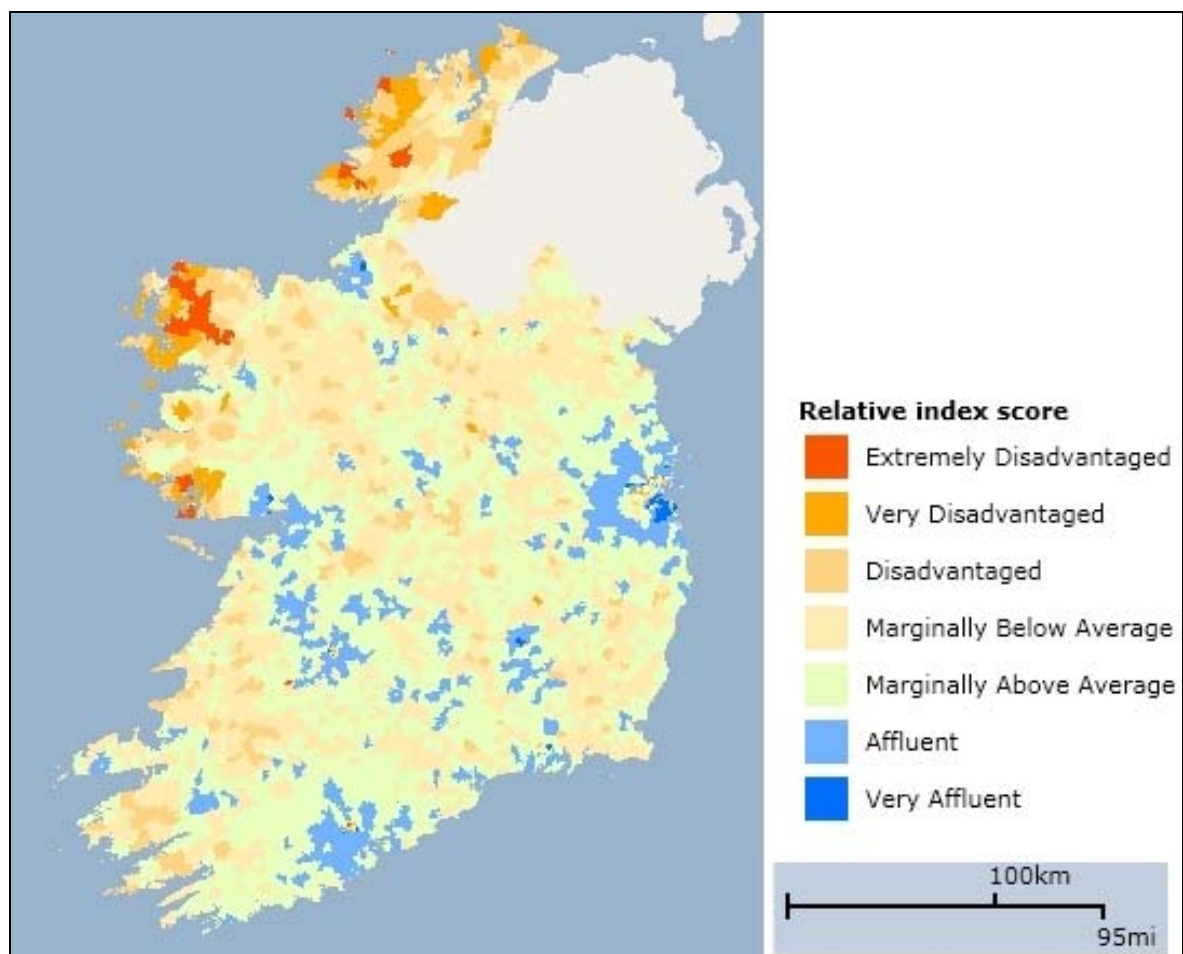
To determine if the z-score is statistically significant, it should be compared to the range of values for a particular confidence level. For example, at a significance level of 0.05, a z-score would have to be less than -1.96 or greater than 1.96 to be statistically significant.

Appendix 2: Opportunity Mapping

Opportunity mapping is an approach to conceptualise and visualize the varying levels of access to the opportunities which exist throughout different places and regions. Having high access to opportunity means having the ability to obtain a quality education, being able to have a safe place to live, having employment options, having access to transport network, health services, and more.

Conceptualising opportunity and analysing it across the country is important for a few reasons. First, decades of social science research have demonstrated that neighbourhood conditions and access to opportunity play a significant role in life outcomes. In view of this, understanding the opportunity landscape in Ireland is vital in order to improve the quality of life and outcomes of the residents. Second, mapping of these factors has shown that opportunity has a geographic footprint and is “specialised” - opportunity is unevenly distributed throughout counties and therefore impacts different groups’ access to opportunity structures in different ways.

There are other similar approaches such as the construction of the deprivation index for the country. Particularly, Haase and Pratschke (2005, 2008) developed the deprivation index for Ireland using three dimensions: demographic profile, social class composition and labour market situation. These dimensions are then linked to observable 15 indicators calculated using Census 2006 datasets.



Map A2-1: Relative deprivation index of ROI for 2006¹

¹ Haase and Pratschke, 2008 (the map obtained from www.pobal.ie)

However, various opportunity mapping exercises (Reece et al, 2009, 2010; Communities of Opportunity, 2003; Segregation vs. Opportunity, 2005) illustrate the fact that deprivation index or census statistics alone cannot capture the dynamics of living in high opportunity or low opportunity areas. Several different critical opportunity structures define neighbourhoods, including schools locations and quality, employment conditions and jobs locations, and housing conditions and accessibility to different services.

Moreover, a quick visual assessment of Map A2-1 "Relative deprivation index of Rol for 2006" reveals a more affluent profile along the outer commuter belt of the GDA. This belt represents an area of high population growth with some of the highest growth rates in the State between 2002 and 2011 recorded in the NUT3 area of the Mid East which comprises the counties of Meath, Wicklow and Kildare (CSO, 2011). This area was also a location for high levels of residential construction during the Celtic Tiger era and has seen high levels of job losses in the construction sector since the peak (72% of all job losses between Q4 2007 and Q2 2011 were in Construction, CSO, QNHS, 2011)

The Neighbourhood opportunity maps (Maps A2-6, A2-7) to some extent contradict the patterns of affluence and deprivation in Map A2-1. This is in part attributable to the fact that in 2006 a low proportion of people in this belt were residential occupants free of mortgage (Map 2-9). Falling house prices with a collapse of over 50% from the 2007 peak would leave many households in this area exposed to negative equity (CSO, 2012). In addition, as of February 2012 over 9% of all residential mortgages are in arrears of over 90 days, nationally, according to central bank figures. Measures of socio-economic group and level of education, in isolation may therefore not accurately depict affluence.

In scope of this study, the methodology developed in the Kirwan Institute for the Study of Race and Ethnicity¹ at the Ohio State University was adapted and applied for the Rol. As an applied research institute, Kirwan has utilized opportunity maps in policy advocacy, litigation, applied research, community organizing, coalition building and to inform service delivery. There is an extensive research implemented by the institute on this and using the wide knowledge developed there was a good base to initiate this research for Ireland.

The first step in applying an opportunity-based approach is to assess the regional distribution of opportunity (Powell, 2003). Mapping opportunity in the country requires selecting indicators that are indicative of high (or low) opportunity. Once derived, opportunity maps can be used to guide policy.

The indicators upon which we have focused include measures of economic opportunity, education opportunity, neighbourhood opportunity and mobility opportunity. Economic opportunity is primarily measured by focusing on the availability of jobs, labour force and on job growth as a way of determining future areas of job availability. Educational opportunity is primarily measured through accessibility to schools and universities as well as by number of population by their level of qualification. Neighbourhood quality is measured through a wide range of data reflecting neighbourhood stability and quality, including housing vacancy, live register and crime statistics. Mobility opportunity is measured by accessibility to roads, railway and public transport.

The following section presents the applied methodology and selected indicators for the opportunity analysis for Ireland.

¹ <http://www.kirwaninstitute.org>

Methodology

Indicators

Spatial distribution of opportunity and subsequent analysis were based on a number of indicators categorised under three sub areas of opportunity – Economic, Education and Neighbourhood. The comprehensive opportunity map represents the combined score based on these three sub-areas.

To map opportunity in the region, we have used variables that are indicative of high and low opportunity. High opportunity indicators include high-number of jobs, availability of sustainable employment, stable neighbourhoods and a safe environment. A central requirement of indicator selection is a clear connection between the indicator and opportunity. Opportunity is defined as environmental conditions or resources that are conducive to healthier, more vibrant communities and are more likely to be conducive to helping residents in a community succeed. Indicators could either be impediments to opportunity (which are analysed as negative neighbourhood factors, e.g., high crime rates) or conduits to opportunity (which are analysed as positive factors, e.g., an abundance of jobs). These multiple indicators of opportunity are assessed at the same geographic scale, thus enabling the production of a comprehensive opportunity map for the country.

For this research 34 indicators were selected based on the review of similar studies (Reece et al, 2009, 2010) as well as discussions with different specialists from UCD, Dublin City Council and steering group experts. However, this list is neither exhaustive nor binding. It is just an example aiming to demonstrate the capabilities of opportunity mapping and its potential applicability for decision makers in Ireland.

The data for indicators' calculation was collected from the following main datasets:

- GeoDirectory 2008, 2011
- Census 2006 Small Area Population Statistics (SAPS)
- CORINE Land Cover 2000, 2006
- Tele Atlas Street Map 2006
- NTA Bus and Railway Stations 2011
- RPA LUAS Stations 2012
- Deprivation Index (DI)¹ 2002, 2006
- CSO Live Register (LR) 2006, 2011
- CSO/AIRO Recorded Crime Dataset 2006

At present (March, 2012) some of the vital datasets such as SAPS, CORINE and DI, are not up to date. As the main goal of this study is to suggest innovative approaches using spatial analytic methods to support decision makers, we have used the available datasets for different years. However, for more accurate results, the opportunity maps presented below should be updated after the Census 2011 SAPS, POWCAR and other relevant data updates are available. The geodatabase will be provided for the ease of future updates.

The analysis was conducted using Electoral Divisions (ED) as geographic representations of neighbourhoods. For each indicator, data was gathered or aggregated at the ED level. GIS analytic methods were employed to evaluate non-Census based data to the ED level.

¹ Haase, and Pratschke, 2008

Error! Reference source not found. presents the selected indicators grouped into the three main categories: (i) *Economic* (13 indicators), (ii) *Education* (8 indicators) and (iii) *Neighbourhood* (13 indicators). Some of the indicators such as proximity to roads/railway/bus services were included in all 3 categories. Appendix 3 provides more detailed description of each indicator, its usefulness in determination of maps of opportunity and in some cases the limitations of the use of the indicator.

Error! Reference source not found. also presents the effect of each indicator on an opportunity. Obviously, the effects can be considered as positive or negative depended on the research question and undertaken assumptions. For this study the effects were defined from the point of general opportunities for people and businesses in Ireland. For example, high number of potential employers not far from the place of residence is considered as a positive factor for finding a relevant job, meaning that the more employers the higher the opportunity is. In contrary the commute distance to work is considered as a negative factor assuming that the longer the distance the lower the opportunity. Similarly, higher general unemployment rate is considered as a negative factor, but for example higher unemployment rate of people with high education is considered as a positive factor because it enriches the choice of skilled workers for employers and may be a prerequisite for a new business development.

Indicator Weighting

In a situation where multiple indicators (criteria) are involved, to get more realistic results, the importance of each indicator relative to the particular category of opportunity must be evaluated and included in the opportunity mapping process. Obviously reaching agreement on the relative importance of different indicators can be a complex and difficult task. Therefore, Multi-Criteria Analysis (CIFOR, 1999) has been applied to evaluate the relative importance of all indicators involved, and reflect their importance in the opportunity mapping process.

With the valuable input of the project steering group the following Multi-Criteria Analysis methodologies have been used for this study (CIFOR, 1999):

- *Ranking* involves assigning each indicator a rank that reflects its perceived degree of importance relative to the opportunity category studied.
- *Rating* is similar to ranking, except that the indicators are assigned 'scores' between 0 and 100. The scores for all elements being compared must add up to 100. Thus, to score one element high means that a different element must be scored lower.

The Regular Ranking method (CIFOR, 1999) was used by the steering group members for assigning each indicator relevant to the opportunity category a 'rank' depending on its perceived importance. Ranks were assigned according to the following 5-point scale:

1	2	3	4	5
Weakly Important	Less Important	Moderately Important	More Important	Extremely Important

Then a rating was applied, where each expert was asked to give each indicator a rating, or percentage score, between 0 and 100.

Once the experts on the steering group had assigned a rank and rating to each indicator, their responses were analysed to calculate the relative weight, or importance, of each indicator based on a synthesis of the different responses provided. The relative weights were calculated for both the Ranking and Rating results. Then, a final combined weight for each indicator was calculated by averaging the relative weights calculated for both the Ranking and Rating

techniques (CIFOR, 1999). Finally the combined weights presented in **Error! Reference source not found.** where used in the Opportunity mapping.

Table A2-1: Opportunity indicators

Indicators	Effect	Source	Details	Comb. Weight
Economic Opportunity (13 indicators)				
Number of potential employers	Positive	GeoDirectory	Number of organisations within 15km radius from ED centroid.	10.39
Change of number of employers	Positive	GeoDirectory	Change of number of organisations from 2008 to 2011 within 15km radius from ED centroid.	8.79
Number of employed people	Positive	POWCAR	Number of employed people in ED based on place of residence from POWCAR.	9.31
Number of jobs	Positive	POWCAR	Number of jobs in the ED based on the place of work from POWCAR.	9.44
Average commute distance to work	Negative	POWCAR	Average commute distance for workers traveling to work from each ED.	7.92
Unemployment rate	Negative	SAPS	Unemployment rate in the ED.	7.09
Unemployed people with high level of education	Positive	SAPS	Looking for first regular job or Unemployed people with Primary degree, Professional qualification, Both degree and professional qualification, Post-graduate certificate or diploma Post-graduate degree (masters) education.	7.93
Unemployed people with no formal or primary education only	Negative	SAPS	Looking for first regular job or Unemployed people with No formal education or Primary education only.	6.90
Age dependency ratio	Negative	SAPS	Ratio of dependents (people younger than 15 or older than 64) to the working-age population (aged 15-64).	6.12
Proximity to main roads ¹	Negative	Tele Atlas	Distance from the ED centroid to main roads (roads with speed limit higher than 60kmh).	4.99
Bus service coverage ¹	Positive	NTA, GeoDirectory	The percentage of the buildings (from GeoDirectory 2011) in the EDs within 1km distance from a bus stop (Dublin bus, Eireann Bus, Private bus operators).	5.42
Proximity to rail, Dart and LUAS	Negative	RPA, NTA	Distance from the ED centroid to rail stations.	6.31
Change in Industrial or commercial units areas	Positive	CORINE	Percentage change of Industrial or commercial land use areas within 15km radius from ED centroid.	4.14

¹ Proximity to roads, rail and bus service coverage indicators are used also in calculations of the opportunity indices for Education and Neighbourhood. However, in the comprehensive opportunity index they were used only once.

Indicators	Effect	Source	Details	Comb. Weight
Education Opportunity (8 indicators)				
People with primary education only	Negative	SAPS	Ratio of population with primary education only to total population in ED.	12.84
People with 3 rd level of qualification	Positive	SAPS	Ratio of population with 3rd level of qualification to total population in ED.	18.00
People with PhD	Positive	SAPS	Ratio of population with PHD to total population in ED.	13.98
Primary and secondary schools nearby	Positive	GeoDirectory	Number of schools within 5km radius from ED centroid (the average distance travelled by children at school aged 5-18 years is 5.8km (CSO, 2007)).	12.93
Tertiary education institutes nearby	Positive	GeoDirectory	Number of Tertiary institutes within 13km from ED centroid (the average distance travelled by students aged 19+ years is 13km (CSO, 2007)).	19.47
Proximity to main roads	Negative	Tele Atlas	Distance from the ED centroid to main roads (roads with speed limit higher than 60kmh).	11.66
Proximity to rail, Dart and LUAS	Negative	RPA, NTA	Distance from the ED centroid to rail stations.	11.39
Bus service coverage	Positive	NTA, GeoDirectory	The percentage of the buildings (from GeoDirectory 2011) in the EDs within 1km distance from a bus stop (Dublin bus, Eireann Bus, Private bus operators).	11.13
Neighbourhood Opportunity (14 indicators)				
Population increase	Positive	SAPS	Percentage change of population in ED from 2002 to 2006.	7.47
Household vacancy rate	Positive	SAPS	Ratio of number of vacant households to the total number of housing units.	7.04
Proximity to parks and open spaces	Negative	CORINE	Distance from ED centroid to nearest parks and open spaces (CORINE Forests and semi-natural areas) within 15km radius.	4.03
Proximity to coast	Negative	OSI	Distance from ED centroid to coastline.	3.24
Persons on Live Register	Negative	LR	Number of people on Live Register by Social Welfare Office.	8.47
Private households by owner occupied with no mortgage	Positive	SAPS	Ratio of the number of households by Owner occupied with no mortgage to the total number of households in ED.	4.89
Professional, managerial and technical workers	Positive	SAPS	Ratio of the number of Professional and Managerial/technical workers to the total population in ED.	7.83
Rate of semi-skilled or unskilled people	Negative	SAPS	Ratio of the number of semi-skilled or unskilled people to the total population in ED.	7.97

Indicators	Effect	Source	Details	Comb. Weight
Crime rate ¹	Negative	AIRO	Garda station level data aggregated to Garda districts. Garda districts population is calculated by aggregating included EDs SAPS data on population. Then crime rates per population for Garda districts are calculated by 9 major offence categories ² . Only for burglary the rate is calculated per household units. EDs were assigned with the relevant rate of the District they are included in.	9.69
Change in Absolute Deprivation Index Score	Positive	DI	Change in Absolute Deprivation Index Score for ED between 2002 and 2006.	7.76
Relative Deprivation index Score 2006	Positive	DI	Relative Deprivation index Score for ED.	11.48
Proximity to main roads	Negative	Tele Atlas	Distance from the ED centroid to main roads (roads with speed limit higher than 60kmh).	7.26
Proximity to rail, Dart and LUAS	Negative	RPA, NTA	Distance from the ED centroid to rail stations.	7.44
Bus service coverage	Positive	NTA, GeoDirectory	The percentage of the buildings (from GeoDirectory 2011) in the EDs within 1km distance from a bus stop (Dublin bus, Eireann Bus, Private bus operators).	7.62

A complexity in such approach is that reaching a general consensus in a multidisciplinary team can be very difficult to achieve. By using multi-criteria analysis the members don't have to agree on the relative importance of the Indicator or the rankings of the alternatives. Each member enters his or her own judgements, and makes a distinct, identifiable contribution to a jointly reached conclusion. However, this also means that the final combined weights are entirely dependent on the people included in the evaluation group. To this effect, a similar exercise could provide different weights if the indicator evaluation was done by different groups of policy makers, city planners, local residents, researchers, experts from different fields, etc. Moreover, the evaluation process is also dependent on the way evaluators consider the opportunity. The same indicator can have more importance and different effect from the perspective of opportunity for general public compared with the perspective of opportunity for businesses (enterprise potential) or planners. Therefore indicator weighting for opportunity mapping should be done with careful consideration of the research question and the decision it is aimed to support. In this study we have provided the weighted indicator opportunity mapping for demonstration purposes in addition to the un-weighted opportunity mapping, where all indicators were treated as equal in importance. The maps presented below show that the

¹ There are inherent biases built into the crime statistic. Areas which are more attractive to live in will be more susceptible to burglaries and areas with a high throughput of people will be susceptible to higher rates of reported on-street crime. These areas may not necessarily have higher rates of crime in terms of a person's exposure to crime.

² (1) Attempts/Threats to Murder, Assaults and Harassments; (2) Dangerous or Negligent Acts; (3) Robbery, Extortion and Hijacking Offences; (4) Theft and Related Offences; (5) Fraud, Deception and Related Offences; (6) Controlled Drug Offences; (7) Weapons and Explosives Offences; (8) Damage to Property and Environment; (9) Public Order and other Social Code Offences

patterns are very similar for both un-weighted and weighted opportunities at least at regional level.

Opportunity Index

The described opportunity indicators were analysed relative to the other EDs within the country by standardizing through the use of z-scores. A z-score is a statistical measure that quantifies the distance (measured in standard deviations) a data point is from the mean of a data set:

$$Z_j = \frac{x_j - \bar{X}}{S}, \text{ where } \bar{X} = \frac{1}{n} \sum_{j=1}^n x_j, S = \sqrt{\frac{1}{n} \sum_{j=1}^n x_j^2 - \bar{X}^2},$$

x_j is the attribute value for features j and n is equal to the total number of features.

The use of z-scores allows data for an ED to be measured based on their relative distance from the data average for the entire country. The final “opportunity index” for each ED is based on the average z-score for all indicators by category (Economic, Education and Neighbourhood). The corresponding level of opportunity (very low, low, moderate, high, very high) is determined by sorting all EDs into quintiles based on their opportunity index scores. Thus, the EDs identified as “very high” opportunity represent the top 20% of scores among all EDs in the country. Conversely, EDs identified as “very low” opportunity represent the lowest scoring 20% of all EDs.

z-scores are helpful in the interpretation of raw score performance, since they take into account both the mean of the distribution and the amount of variability (or the standard deviation). The z-score indicates how far the raw score is from the mean, either above it or below in standard deviation units. A positive z-score is always above the median (upper 50%). A negative z-score is always below the median (lower 50%) and a z-score of zero is always exactly on the median or equal to 50% of the cases. Thus, when trying to understand the overall comparative performance of different groups with respect to a certain variable, we can assess how a certain group (of individuals, EDs, etc.) is performing with respect to the median performance for the certain variable.

Opportunity Maps of Rol

In this section we present the main results of opportunity mapping exercise implemented for Ireland in scope of this study. It should be mentioned that the opportunity maps should be updated as soon census 2011 results are available, as currently they are based on the datasets from different years and therefore are not necessarily reflective of the present opportunity situation in Ireland. However, the goal of this research is not necessarily the provision of final and comprehensive opportunity maps but rather the introduction of a new approach for Ireland which can be used in parallel to other known approaches such as development of deprivation index. The development of a fine-tuned Opportunity Mapping process will not only serve to increase the knowledge base for forward planners but will offer policy makers a real evidence base for decision-making.

Error! Reference source not found. shows the indicators that have been initially selected to measure the economic, education and neighbourhood opportunity. These indicators include, amongst others, proximity to potential employers, current levels of employment, commute distance, age dependency ratio's and proximity to public transport. For each of the three categories a separate opportunity map was developed. Then the comprehensive opportunity map was developed based on all 34 indicators. The analysis of opportunity in Rol has shown

that opportunity is not evenly distributed throughout the country. While mobility indicators were included in each of economic, education and neighbourhood opportunity mapping they were not doubled counted in the calculation of the comprehensive map.

Economic Opportunity map (**Error! Reference source not found.**2, A2-3) showed up the strong concentration of activity in the main gateways including Waterford and to a lesser extent the combined gateway of Athlone, Tullamore and Mullingar. The darkest concentration was evident across the Dublin region extending into the wider GDA hinterland

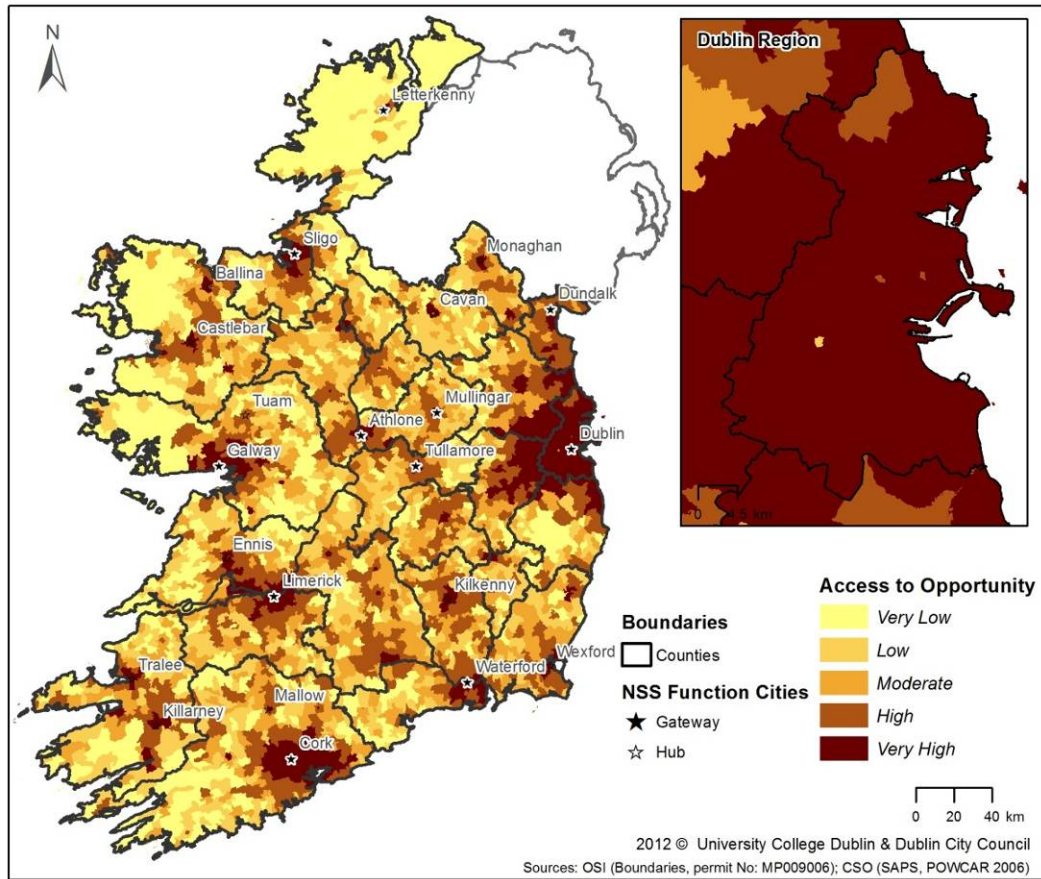
Education opportunity mapping followed a similar spatial pattern to economic opportunity mapping with greater levels of opportunity clustered in the GDA, main Gateways and county towns (Maps A2-4, A2-5**Error! Reference source not found.**).

In case of the neighbourhood opportunity, The GDA and other Gateways did not perform as well as western and south western areas of the country (Maps A2-6, A2-7). In particular the Midlands and Dublin commuter zone has relatively lower levels of opportunity within this category. The metropolitan area of Dublin had a higher level of Neighbourhood opportunity in comparison to the commuter belt. Numbers of households owner occupied with no mortgage, proximity to parks and open spaces and exposure to higher crime rates are some of the main contributory elements of neighbourhood opportunity.

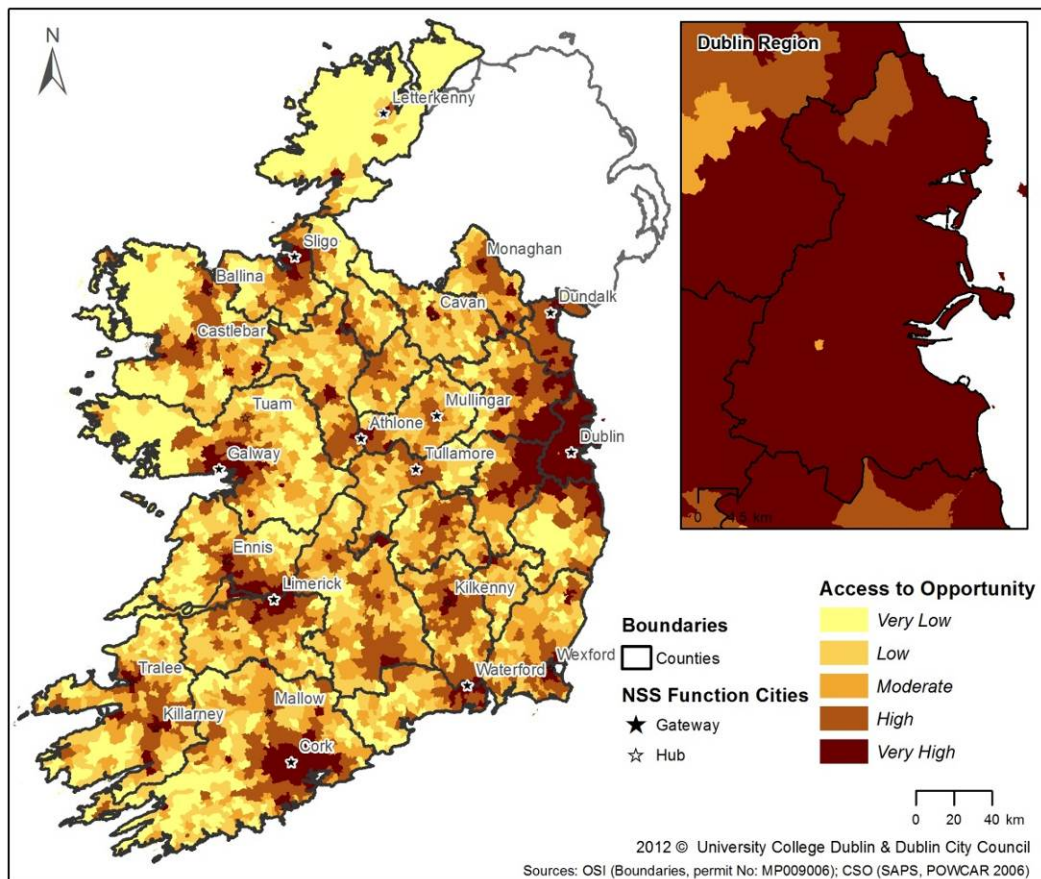
Error! Reference source not found.A2-8 and A2-9**Error! Reference source not found.** displays the spatial distribution of comprehensive opportunity in the Republic based on economic, education and neighbourhood indicators at the ED level. It shows that high opportunities are mainly concentrated in Dublin metropolitan area and main Gateway cities including Cork, Galway and Limerick. The patterns are similar in case of Economic opportunity and Education opportunity **Error! Reference source not found.**maps. However, the picture is different in case of Neighbourhood opportunity, where western counties include vast areas with high opportunities, while the opportunities in the North and South-West Dublin are low. Contributory factors to this trend may include access to green areas and as shown in Map 2-9: Households by owner occupied with no mortgage per 1000 households in 2006.

Comprehensive opportunity map also shows small high opportunity areas near NSS gateway and hubs towns. But in the Midland and Donegal counties as well as North-West part of County Mayo the opportunities are mainly low or very low. In addition, as for hot spot analysis of sectoral clustering the Waterford Gateway performs relatively poorly in comparison to its sister Gateways.

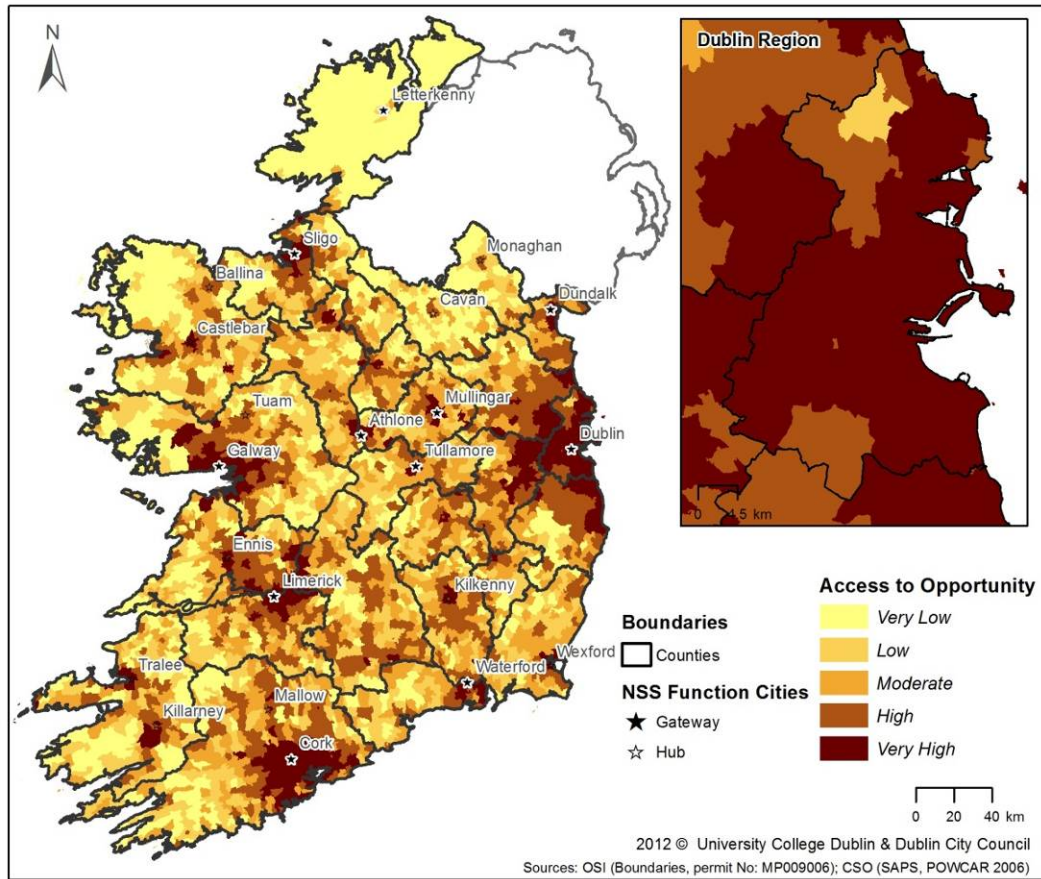
Interestingly, these patterns are in a way mirroring the patterns presented in the deprivation index map (Map A2-1). However, for opportunity mapping, in addition to the general census based indicators, several spatial indicators were also used such as the distances to roads, open-space, coast and rail, bus service coverage areas, number of schools nearby, and so forth.



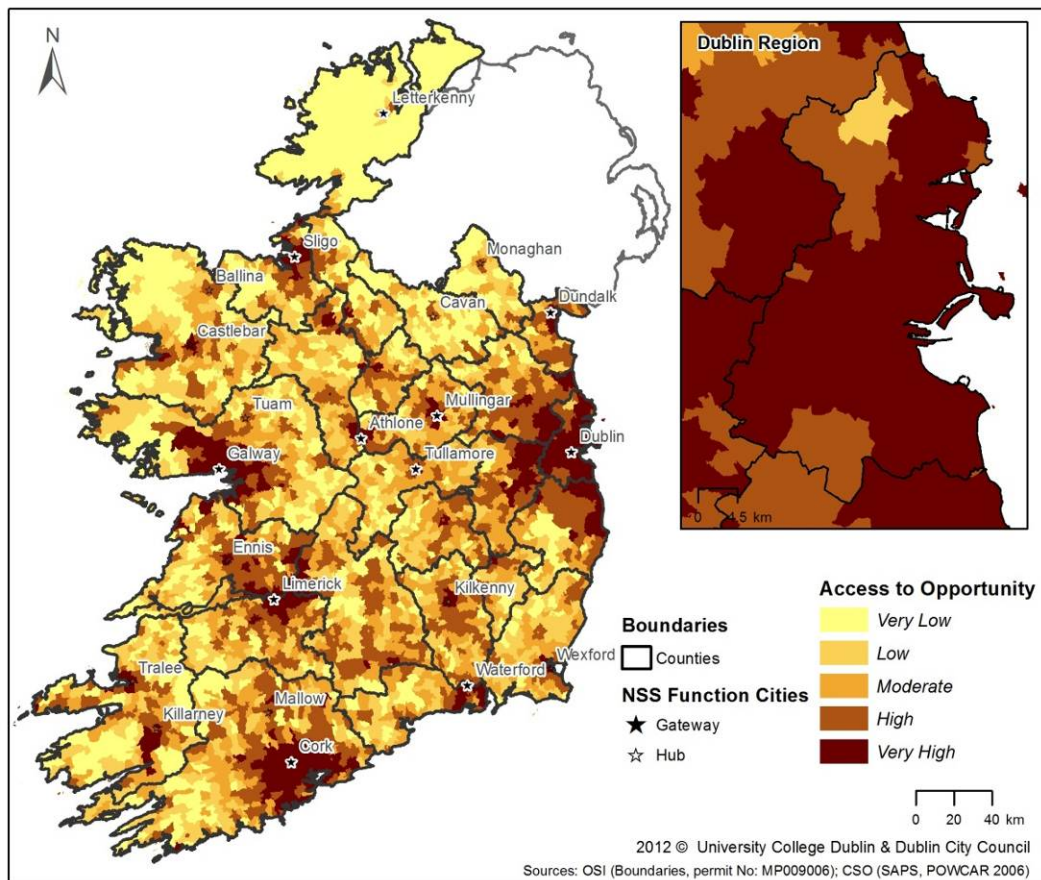
Map A2-2: Economic Opportunity (un-weighted)



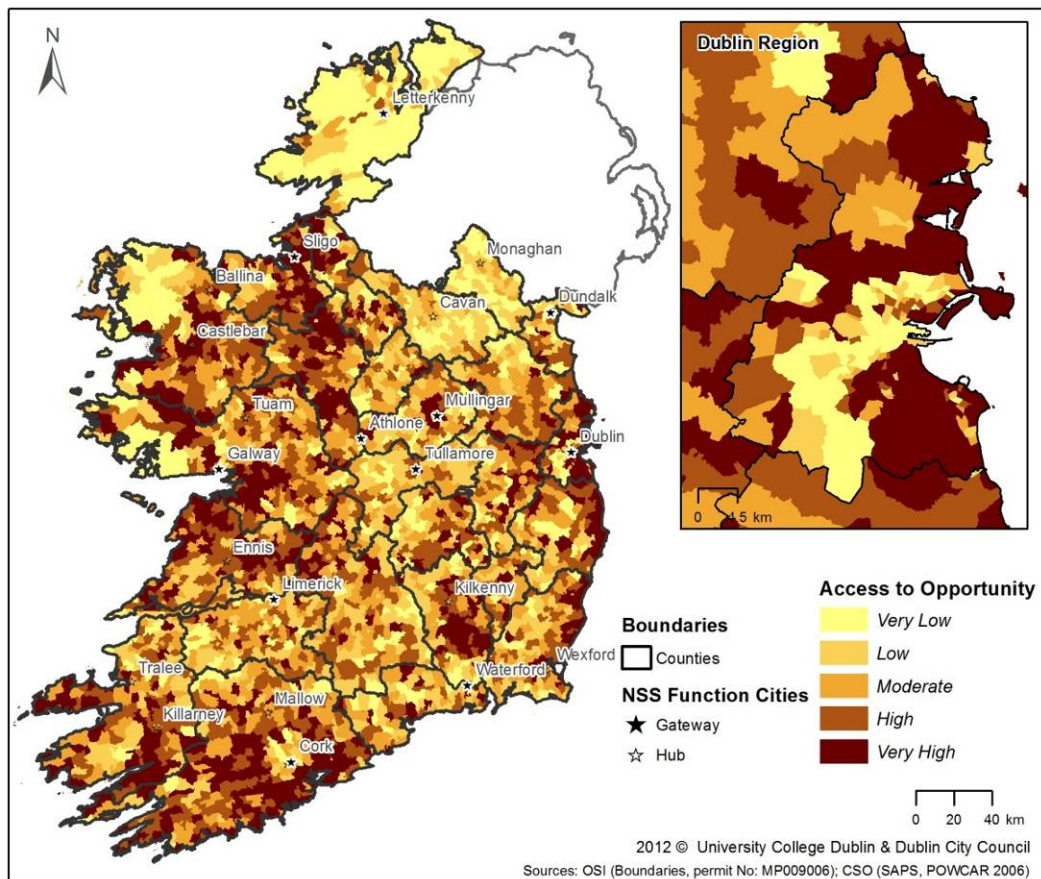
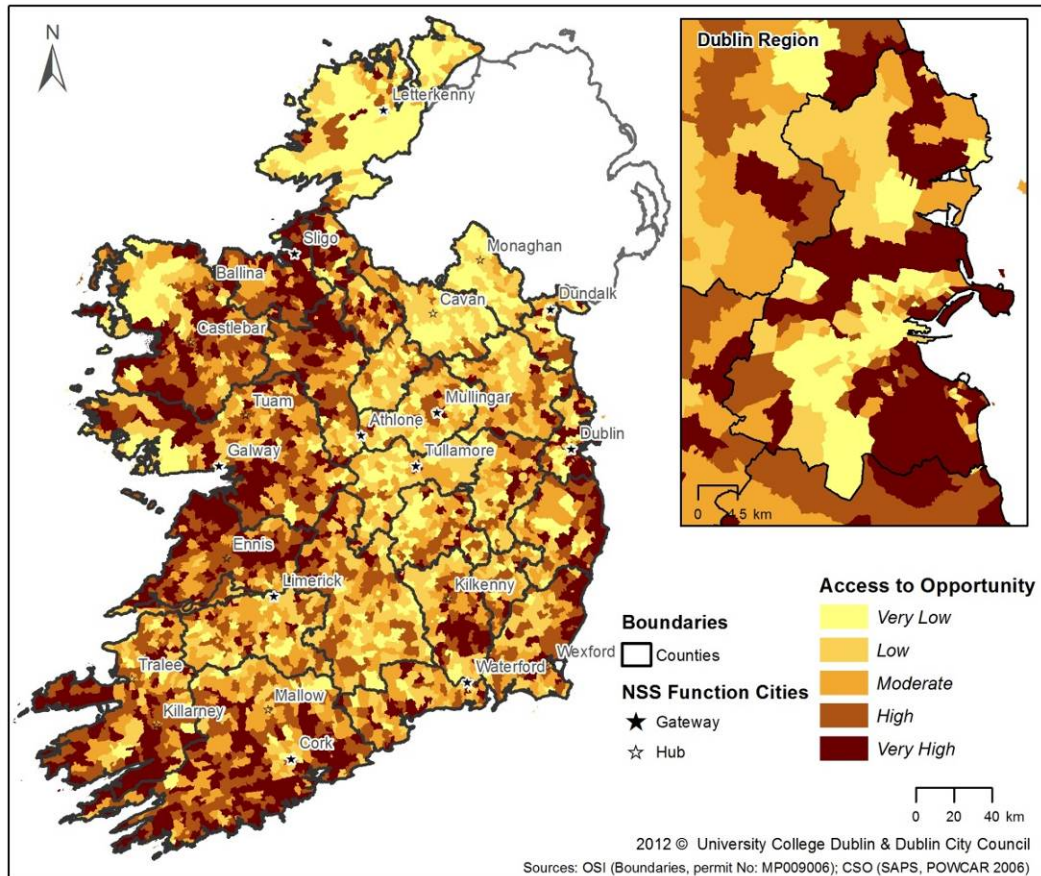
Map A2-3: Economic Opportunity (weighted)

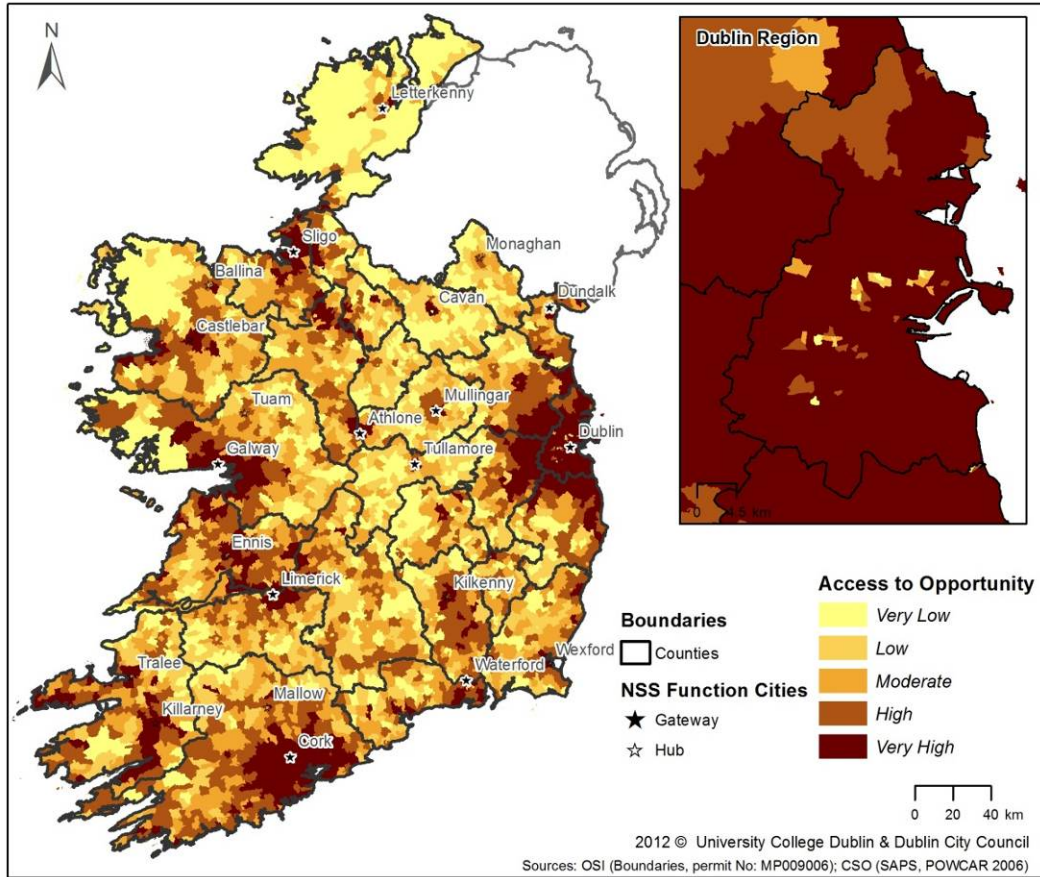


Map A2-4: Education Opportunity (un-weighted)

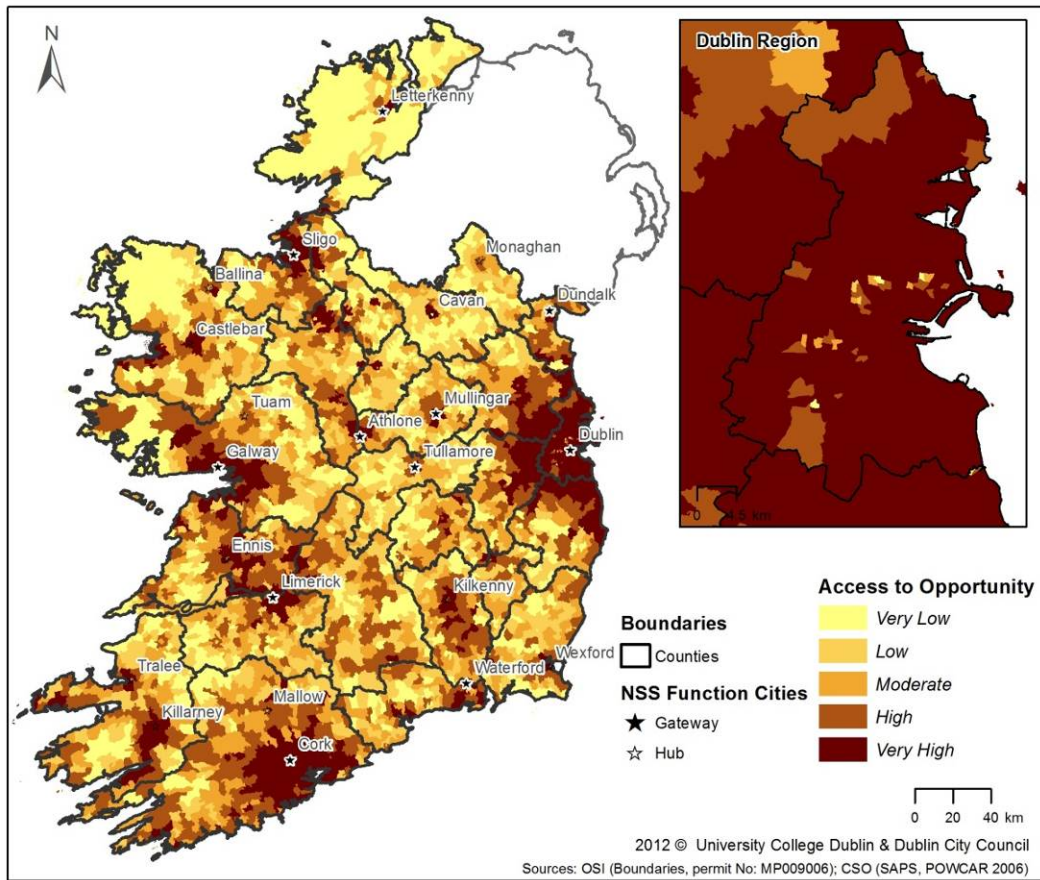


Map A2-5: Education Opportunity (weighted)





Map A2-8: Comprehensive Opportunity (un-weighted)



Map A2-9: Comprehensive Opportunity (weighted)

Summary

Opportunity mapping affords the potential to have multiple data sets scaled, matched and in this case summarised at ED level. The examination of groups of socio-economic data through advanced geo-spatial analysis provides a powerful evidence base for policy formation. The comprehensive opportunity map displays the composite of many indicators. In-combination appraisal with other socio-economic datasets will result in a greater understanding of the dynamics of opportunity both regionally and nationally with potential for better informed policy formation. The primacy and enormous potential of Dublin and the Gateways of Cork, Galway and Limerick in particular have been demonstrated.

Feedback from the steering group was very constructive and indicated that the concept of using opportunity maps is both informative and worthwhile. The weighting exercise was very beneficial in that it not only allowed indicators to be scored and weighted according to their usability but also to identify shortcomings in the methodological process and areas for improvement.

One considerable advantage of the indicators used is that they are measurable and reliable and therefore not exposed to any levels of subjectivity. Weightings naturally introduce subjectivity but have usefulness in identifying perceived strengths and weaknesses of indicators chosen and the potential to improve the methodology

Objective of Opportunity Mapping

The objective of the opportunity map needs to be clearly defined. Two clear perspectives were identified, firstly, the perspective of business that is, the “realisation of enterprise potential” and secondly, the perspective of “citizen opportunity.” The weightings attributed were intended to reflect opportunity from the perspective of realisation of enterprise opportunity. While some indicators are complementary across perspectives, for example, a smaller commute distance is amenable to both citizen (employee) and employer (enterprise) some indicators differ between perspectives.

Take the case of unemployment. From an enterprise perspective it is difficult to determine whether the “effect” of higher unemployment is positive or negative. Higher unemployment means an available workforce. However, the workforce must be appropriately qualified for employment opportunities. In addition higher unemployment is an indicator that the fundamentals of economic functioning may be undermined by an over-riding factor such as the economic downturn.

Moreover, comparing across perspectives, higher unemployment may indicate available workforce which is positive from an enterprise perspective. From the perspective of the citizen, higher unemployment is clearly negative. The counter argument is that by determining the “effect” – positive or negative – you are normally identifying the perspective. Nonetheless, even when the effect is the same for both enterprise and citizen, the magnitude of the effect may be greater for one over the other.

The indicators are described in some detail in the Appendix 3, their limitations are identified and the potential areas to fine-tune the methodology at a later date are examined

Broad level methodological recommendations

Based on the feedback from steering group members as well as discussions with other experts the following methodological recommendations were attained aiming to improve the reliability of opportunity mapping for Ireland.

1. There may be a high degree of correlation between certain indicators. For example, numbers of jobs and numbers of employers would be likely to significantly positively correlate. Similarly, numbers of unemployment and employment rate would negatively correlate. There is danger in trend reinforcement through measures which are very similar and there may be merit in reducing the numbers of similar indicators for example through Factor Analysis¹.
2. It may be better to use the term “measures” instead of indicators in this study. Thus, each measure can be grouped into classes which are then, in aggregate form, indicators of locational or opportunity preferences. (For the purposes of consistency this report uses the term indicator to describe the variables used to determine Opportunity)
3. There are three clear classes of indicators being used currently. These are Quality of Life indicators; Measures of Wealth and Economic Opportunity indicators, and; Accessibility indicators. There is merit in scoring and weighting indicators within these classes.
4. There may have been merit in including accessibility and transport as a separate opportunity category thus creating 4th category in addition to the Economic, Education and Neighbourhood categories which combined would measure comprehensive opportunity.
5. Using an ED centroid to determine proximity to public transport should be replaced by a network analysis solution – matching opportunity to supply and access parameters. Proximity to main roads and public transport needs to consider access to both products and access to labour in order to be useful.
6. It is suggested that the Electoral Division is too small an area for investment consideration and that future iterations need to consider more flexible boundary delineation.
7. An analysis of the skills base required for the broad indicator categories should be used to inform the broader level.
8. To include “checks” of maps as Opportunity mapping may imply an opportunity for investment in an area where investment and/or development is restricted or prohibited. For example, areas which are protected under the Habitats Directive or which are prone to flooding are not viable as investment locations.
9. If Opportunity maps are considering opportunity from the perspective of enterprise only, then proximity to public transport and main roads may not be as critical as in the case of Opportunity maps which look at the Opportunity of the citizen.
10. Access to international airports, ports, general practitioners (GP), hospitals, clinics, credit unions, banks, post offices, playgrounds, garda stations, etc. would be useful to add in the future iterations of Opportunity mapping. Valuation or rates data may be useful in this regard for future Opportunity mapping iterations. Some other relevant datasets which can be used to enhance the results are described in the Appendix 5.

In conclusion, the opportunity maps are useful not only for discovering the areas with high or low opportunities, but also for overlaying it with different other data layers. For example the distribution of different population groups by opportunity areas can be a useful socio-economic indicator for decision makers targeting specific social groups of population.

The opportunity mapping initiative for Ireland is a new approach to explore the distribution of population and businesses within Ireland’s geography of opportunity. It provides a new way of

¹ The general notion of Factor Analysis includes “a variety of statistical techniques whose common objective is to represent a set of variables in terms of a smaller number of hypothetical variables” (Kim & Mueller, 1978, p. 9)

evaluation of the conditions in the counties and how some residents are spatially close/isolated to/from opportunity.

Appendix 3: Indicators

Number of actual employers

Number of organisations within 15km radius from ED centroid. This presents the potential employers within each sector and is a very valuable information piece in that it is a clear indication of employment opportunity and the presence of clustering.

Limitations

- Defining the catchment within a 15km radius of an ED centroid as it is done for this study may not necessarily represent a functional catchment area. While 15km relates to average commute distance for an individual nationally (CSO, 2007), using the same average commute distances between Dublin and the rest of the country is not comparing like with like. 15km is too expansive a measure, as areas would appear to change even within metropolitan area over much smaller distances.
- The 15km average may not relate to what we are trying to measure via opportunity mapping. The question is asked: are we measuring accessibility to goods or to labour? Measures should be split between origin and destination, employer and individual.
- These data do not point up the numbers of persons in employment. It only indicates the numbers and points of occurrences of a business type.

Opportunities

- In later iterations of this work to examine transport and community catchments or zones and to subsequently repeat similar analysis within these catchments or zones – Network Analysis would allow the creation of demand areas and the examination of distribution of access points within those demand areas.
- The average commute distance is a best fit spatial measure given time and resource constraints in which to develop a buffer to measure potential employers. While 15km is expansive, in terms of judging Dublin and other Gateways in relation to national averages it offers potential to indirectly explore the benefits and constraints of urban agglomerations.
- FAME and Data Ireland data do contain information on the quantum of employment per individual organisation and these data could be married with GeoDirectory and/or geo-coded. There is a heavy cost element to be considered. These data are normally made available for commercial purposes and further effort should be made to acquire a reduced cost licence for academic/research purposes.

Change of number of employers

Change of number of organisations from 2008 to 2011 within 15km radius from ED centroid. This indicator shows the change between 2008 and 2011 in the sectoral quantum and spread of businesses nationally according to GeoDirectory. It is useful in that it may indicate sectoral movement, the transformation to a smart economy or new clustering effects.

Limitations

- The 2008-2011 data whilst providing a three year time-line does not currently measure changes in employment type which may have accrued prior to and immediately after the peak of 2007.
- Defining the catchment within a 15km radius of an ED centroid may not necessarily represent a functional catchment area.
- These data do not point up the numbers of persons in employment. They only indicate the numbers and points of occurrences of a business type.

Opportunities

- Regarding the definition of catchment area a 15km radius is currently used based on average commute distance nationally. In later iterations of this work, to examine using Network Analysis transport and/or community catchments or zones and to subsequently repeat similar analysis within these catchments or zones. At present the NTA has divided the Greater Dublin Region into 657 number of zones which could be used as part of more extensive analyses.
- To compare the density and spread of employment type against the spread of business type across the Dublin Region and nationally.

Number of employed people

Number of employed people in ED based on place of residence from POWCAR.

Limitations

- These data are from 2006 and will be available in late Q3 2012 for the 2011 Census.
- ED in some instances may be too small an area for investment consideration. Improvements may be measured from a small base in some instances.
- The spatial analysis does not include data from Northern Ireland (NI).

Opportunities

- To update these data and compare the changes in employment across broad sectors between 2006 and 2011
- To agree a cross definition for and examine emerging sectors such as creative industries (cultural, gaming, ICT, etc.), clean and green industries and so forth.
- To examine more detailed NACE codes.
- To combine these data with data from NI to ascertain an All-Ireland picture of employment and in particular to inform policy on the M1 economic corridor.

Number of Jobs

Number of jobs by ED based on the place of work from POWCAR. This indicator shows how many people work within an ED rather than their residence people. It is useful in terms of comparing sectoral clustering by business type with employment type

Limitations

- These data are from 2006 and will be available in late Q3 2012 for the 2011 Census.
- Needs to be merged over wider area to be an effective indicator

Data Opportunities

- To update these data and compare the changes in employment across broad sectors between 2006 and 2011

- To compare employment type and quantum with the sectoral clustering within an ED taken from the Geo-Directory.
- To agree a cross definition for and examine emerging sectors such as creative industries (cultural, gaming, ICT, etc) clean and green industries and so forth.
- To examine more detailed NACE codes to ascertain clustering of specific business types and emerging growth areas.
- To examine at Revenue data during intercensal periods to ascertain proximate levels of migration between countries and regions nationally.
- To consider aggregation of data into wider functional areas or combinations of EDs in future iterations of opportunity maps. These areas should be broadly analogous to functional community or settlement hierarchy catchments.

Average commute distance to work

Average commute distance for workers travelling to work from each ED.

Limitations

- These data are from POWCAR 2006 and will be available in late Q3 2012 for the 2011 Census.
- You cannot infer that distance travelled and time taken correlate. The use of average time take to travel to work may be a better measurement of accessibility. It would take account of differences between the time taken on routes over similar distances. For example, a heavily subscribed route (into the metropolitan area) such as the M4/N4 may have higher average time travelled to work from origin to destination than a less busy routes such as the M3/N3.

Opportunities

- To examine commute patterns across the GDA in the context of national, regional and local planning.
- To consider the use of time taken to travel rather than commute distance (Though this will be more realistic, but it will add also more complexity as the travel time depends on several factors such as day, time, chosen route, and transport mean. That is why in scope of this research the distance was used as generally more objective).
- For further research to relate commute distance within EDs or groups of EDs (up to county level) to petrol and diesel prices between 2006 and 2011. To relate this expense to disposable income.

Unemployment

Unemployment rate in the ED is an indicator which relates the total numbers of working age within an ED who are unemployed to the total numbers of persons within an ED who are eligible for employment.

Limitations

- These data are from Census 2006 and will not account for job losses (or gains) which may have occurred in the intercensal period 2006 to 2011. In particular this indicator will not account for job losses in EDs which may have had above average employment in sectors which have seen greatest job losses since the peak of 2007. Quarterly National Household Survey data shows that are considerable regional and sectoral variations in

job losses. The construction sector is a case in point. This sector has seen a dramatic decline in job losses since 2007 and in the case of the Mid East region accounts for almost three-quarters of all job losses between Q4 2007 and Q4 2011 (CSO, 2011). Relative job/loss gain is therefore likely to vary considerably between regions and EDs.

Opportunities

- To update 2006 Census SAPS with 2011 Census SAPS and/or to build in a regional job loss/gain factor from QNHS data which could be applied (as a factor) to EDs within a given region

Unemployed people with high level of education

Description

This indicator includes those persons looking for first regular job or those unemployed people with a “Primary degree”, “Professional qualification”, “Both degree and professional qualification”, “Post-graduate certificate or diploma”, or “Post-graduate degree (masters) education”.

Limitations

- Data are taken from 2006 Census and require update using 2011 Census when the tables at ED level are released later in 2012 (late Q3, 2012).

Opportunities

- This indicator is particularly useful in that it provides for economic opportunity best guide to the levels of skills and education available within at ED level which potential inward investment or indigenous enterprise would have available in proximity to their business should they choose to locate within or adjacent to that ED.

Unemployed people with no formal or primary education only

This indicator includes those persons “Looking for first regular job” or “Unemployed people with no formal education” or “Primary education only.”

Limitations

- These data are taken from 2006 Census and require update using 2011 Census when the tables at ED level are released later in 2012 (late Q3, 2012).

Opportunities

- To update this layer with 2011 Census data once it becomes available

Age dependency ratio

Ratio of dependents (people younger than 15 or older than 64) to the working-age population (aged 15-64).

Limitations

- These data are taken from 2006 Census and require update using 2011 Census when the tables at ED level are released later in 2012 (late Q3, 2012).
- There is a diametric argument that young age dependency is a positive rather than a negative (as used here) opportunity. Young age dependency affords potential to grow

vibrant and highly skilled communities on the basis of appropriate training, education provision and employment opportunities.

Opportunities

- Old Age Dependency is taken as a negative opportunity indicator in that points up pressure points for appropriate service delivery. It can also be used to ensure that suitable services, infrastructure and schemes are delivered in appropriate locations. Old age dependency also has macro-economic implications which are not directly considered here. Future research could compare the cost effectiveness of delivery of these services to an aging population between urban, suburban and rural locations
- Similarly young age dependency places additional strain on service provision. In particular this indicator has relevance to the provision of educational facilities such as crèches and primary schools. These data are available from Pobal and the Department of Education and Skills respectively. The Department of Education and Skills has a relative real-time feed on growth of young age dependency through its access to child benefit data.

Proximity to main roads

Distance from the ED centroid to main roads (roads with speed limit higher than 60kmh).

Limitations

- The distance from an ED centroid to a main road is relatively meaningless unless there is a junction on the road on which it can be accessed.
- The relevance of accessing a main road varies between urban and rural areas due to factors such as alternative travel options and urban versus extra-urban driving conditions.

Opportunities

- Network analysis would mean that access points to main roads would be considered in determining the benefit of proximity.

Bus service coverage

The percentage of the buildings (from GeoDirectory 2011) in the EDs within 1km distance from a bus stop (Dublin bus, Eireann Bus, Private bus operators).

Limitations

- These data consider only the availability of a nearby public transport access point it does not consider frequency of service.
- There is a need to relate this indicator to enterprise potential. The question is asked how much do business, both indigenous and foreign (multi-nationals) value the importance of public transport over private transport and secondly what is the role of walking and cycling and thirdly what is the perception of the various modes of public transport on offer in Dublin and Ireland.

- The 1km distance is taken as a maximum walking distance to a public transport access point. Literature indicates that this distance could be as low as 100 metres¹, though it also depends on the country, people and accepted practice there.

Opportunities

- By querying the percentage of buildings in EDs within 1km of a bus stop a useful proxy for general access from building to public transport point is developed. Taking buildings into account allows the query to consider multiple locations from residences to work locations and shops.
- There is potential to build in trip frequency data available from Dublin City Council. There is a need to build in a frequency of service component for all bus transport access points.
- There is potential to examine these bus transport access points using established catchment based areas of the NTA travel zones across the GDA.
- There is merit in setting a shorter distance buffer (e.g. 0.5km) for accessing a bus stop.

Proximity to rail, Dart and LUAS

Distance from the ED centroid to the closest rail station.

Limitations

- Distance does not necessarily equate to accessibility. Network analysis would mean that ease of access to DART, rail stations would be considered in determining the benefit of proximity.

Opportunities

- The average distance to railway stations within a 1km buffer is recommended for which persons are likely to travel to access rail.

Change in Industrial or commercial units' areas

Percentage change of Industrial or commercial land use areas within 15km radius from ED centroid.

Data Limitations

- These data consider the change in the land use and as such are influenced by zoning decisions. Lands may be re-zoned and not developed.
- Currently this indicator is calculated based on CORINE 2000 and 2006 datasets

Data Opportunities

- To update this layer when the next round of CORINE land cover data is available for Ireland.
- The land use model MOLAND can be used to generate future land use maps for the Greater Dublin Region, which can be then used for estimation of this indicator in case of different development scenarios.

¹ Extracting data from the *American Housing Survey*, Cervero (1996) concluded that when retail shops and other consumer services are within 100m of a person's residence, commuting by walking or cycling was encouraged. However, when the same services were between 100m and 1.6km car commuting was encouraged because of the ability to link efficiently trips to work and shops.

People with primary education only

Ratio of population with primary education only to total population in ED.

Limitations

- From an enterprise potential perspective this indicator is less important when the indicator showing persons with 3rd Level education are included in the analysis.
- These data are taken from 2006 Census and require update using 2011 Census when the tables at ED level are released later in 2012 (late Q3, 2012).

Opportunities

- To update with 2011 Census data

People with 3rd level of qualification

Ratio of population with 3rd level of qualification to total population in ED.

Limitations

- Data taken from SAPS 2006 and more recent results are expected to be available in late Q3 2012 from the 2011 Census

Opportunities

- To update this indicator with 2011 Census data.

People with a PhD

Ratio of population with PhD to total population in ED.

Limitations

- The usefulness of this indicator is questionable due to the low numbers of persons with a PhD and the likelihood of these individuals to cluster in cities and or around 3rd level institutions.

Opportunities

- Nevertheless, it is considered as urban centres and/or locations or business with a requirement for persons with PhDs is a useful measure of the innovation capital of an area.

Tertiary education institutes nearby

Number of Tertiary institutes within 13km (the average distance travelled by students aged 19+ years (CSO, 2007)) from ED centroid.

Limitations

- As a measure of citizen opportunity, proximity to 3rd level institutes does not necessarily mean that a citizen will gain entry to that institution.
- The buffer used is based on student average distance travelled which suggests that the value to human/social capital is being considered rather than the potential opportunity afforded to enterprise.

Opportunities

- From an enterprise potential perspective this is a useful measurement of the innovative value of physical capital in or around a given area.

Primary and secondary schools nearby

Number of schools within 5km radius (the average distance travelled by children at school aged 5-18 years is 5.8km (CSO, 2007)) from ED centroid.

Limitations

- Within urban areas in particular it is argued that that local people will not necessarily attend the schools closest to their homes.

Opportunities

- To link these data in the future with Department of Education and Department of Social Affairs data to show the potential numbers of children who are coming into the primary school system. This is currently measured by the Department of Education using Child Benefit data.
- To examine enrolment trends to show where demand has been strongest in recent years and where demand for services and infrastructure outside of the education system (playgrounds, parks, other facilities) is likely to be most acute.

Population Increase

Percentage change of population in ED from 2006 to 2011.

Limitations

- N/a

Opportunities

- There is a potential to have a negative index for population decrease. This would be particularly relevant to areas of the city centres of Dublin, Cork and Limerick and peripheral rural areas.
- Data should be updated to 2006-2011 population changes.

Household vacancy rate

Ratio of number of vacant households to the total number of housing units.

Limitations

- Higher levels of vacancy can be considered negative. A threshold for acceptable/optimal vacancy levels should be established.

Opportunities

- To establish an "optimal" vacancy threshold
- To map ghost estates.

Proximity to parks and open spaces

Distance from ED centroid to nearest parks and open spaces (CORINE Forests and semi-natural areas) within 15km radius.

Limitations

- The question is asked: is the 15km buffer the most appropriate radius to base measurement. This buffer is appropriate for Habitat and Environmental Assessments but in travel terms should proximity be measured according to acceptable walking and cycling distances?
- From an “enterprise perspective” greater distances from areas of restricted development could also be seen as a positive.
- Forested areas are not necessarily an amenity - may be commercial forest, private forest and not accessible to the public, may also indicate remoteness therefore greater distance from these areas might be a positive.

Opportunities

- To use indicators only concerned with public amenity areas, playgrounds etc. These may be available from Department of Environment (DOECLG) “MyPlan” national land use zonings. As a caveat these mapping layers may only reflect zoned rather than developed areas.

Proximity to coast

Distance from ED centroid to coastline.

Limitations

- Proximity to coast is a positive but does create an inherent bias against inland locations which may have attractive natural amenities not accounted for.
- In the absence of appropriate flood defences proximity to coast for both residential and business locations is a potential negative.

Opportunities

- To consider incorporating flood risk points in the determination of neighbourhood Opportunity maps.

Persons on Live Register

Number of people on Live Register by Social Welfare Office.

Limitations

- These figures are not necessarily related to local neighbourhoods and could be replaced by unemployment levels per ED from 2011 Census

Opportunities

- To consider using live register figures by social welfare office as a proxy factor to update 2011 unemployment by ED.

Private households by owner occupied with no mortgage

Ratio of the number of households by Owner occupied with no mortgage to the total number of households in ED.

Limitations

- The age of the mortgage is not accounted for. The question is asked: Is mortgage ownership an indicator of poverty? It might well be associated with a younger, affluent population, while no mortgage might mean older profile. In terms of the realisation of

enterprise potential a younger age profile would be more amenable to the achievement of this goal.

- Data are taken from 2006 Census and are out of date.

Opportunities

- To consider investigating the age of the mortgage as part of future work. Household age could be used as a proxy for this work.
- To consider household formation – one person, two persons as part of a wider societal examination of the impact of the distribution of this indicator.
- To update these data with 2011 census data. Tables at ED level will be released later in 2012 (late Q3, 2012). These data do however largely correspond to when house purchases, house prices mortgage applications were approaching their peak and when mortgage levels were proportionally approaching their highest levels relative to disposable income.

Professional, managerial and technical workers

Ratio of the number of Professional and Managerial/technical workers to the total population in ED.

Limitations

- Data are taken from 2006 Census

Data Opportunities

- In due course to update these data with 2011 census data. Tables at ED level will be released later in 2012 (late Q3, 2012).

Rate of semi-skilled or unskilled people

Ratio of the number of semi-skilled or unskilled people to the total population in ED.

Limitations

- Data are taken from 2006 Census and are out of date

Opportunities

- In due course to update these data with 2011 census data. Tables at ED level will be released later in 2012 (late Q3, 2012).

Crime rate

Garda station level crime data aggregated to Garda districts. Garda districts population is calculated by aggregating included EDs SAPS data on population. Then crime rates per population for Garda districts are calculated by 9 major offence categories: (1) Attempts/Threats to Murder, Assaults and Harassments; (2) Dangerous or Negligent Acts; (3) Robbery, Extortion and Hijacking Offences; (4) Theft and Related Offences; (5) Fraud, Deception and Related Offences; (6) Controlled Drug Offences; (7) Weapons and Explosives Offences; (8) Damage to Property and Environment; (9) Public Order and other Social Code Offences. Only for burglary the rate is calculated per household units. EDs were assigned with the relevant rate of the District they are located within.

Limitations

- Total crime data are a crude measurement of crime levels

Opportunities

- To consider the use of burglary levels to indicate neighbourhood sensitivity to crime. On-street muggings, robberies are prejudiced by footfall.

Change in Absolute Deprivation Index Score

Change in Absolute Deprivation Index Score for ED between 2002 and 2006.

Limitations

- This measurement is a composite of Census 2002 and 2006 employment levels, education levels and socio-economic class. There is a certain amount of double counting therefore inherent in the Opportunity Mapping model. However, this indicator is included to show the change of deprivation rather than the level of deprivation.

Opportunities

- These data can be updated through Pobal for 2011.
- These data are now also available at small area (groupings of 150 household approximately) which is a more informative measure of deprivation as ED analysis of deprivation can mask higher and lower levels of deprivation especially in high density urban areas where deprivation levels can change between streets and immediate neighbourhoods.

Relative Deprivation index Score 2006

Relative Deprivation index Score for ED.

Limitations

- This measurement is a composite of Census 2002 and 2006 employment levels, education levels and socio-economic class.

Opportunities

- These data can be updated through Pobal for 2011.
- These data are now also available at small area which is a more informative measure of deprivation as ED analysis of deprivation can mask higher and lower levels of deprivation especially in high density urban areas where deprivation levels can change between streets and immediate neighbourhoods.

Appendix 4: Some Statistics on the Irish Economy

Dublin Region	Q2 2007	Q2 2011	State Comparison Q2 2011	Source
Employed	616,000	520,500	1,821,300	CSO, Q2 QNHS 2011
Unemployed	31,000	72,000	304,500	CSO, 2012
Unemployment Rate	4.8%	12.1%	14.3%	CSO, Q2 QNHS 2011
Participation Rate	65.4%	62.2%	60.7%	CSO, Q2 QNHS 2011
Labour Force	647,000	592,500	2,125,900	CSO, Q2 QNHS 2011
Service Sector Employment	80% Services 20% Non- Services	88% Services Sector 12% Non Services ¹	77% Services Sector 23% Non Services	CSO, Q2 QNHS 2011

	Dublin	Nationally	Source
GNP		2009-2010: 0.3% at constant prices -3% at current prices	
GDP		2009-2010: -0.4% at constant prices -2.9% at current prices	
Debt ²		Q3 2010: €139 Billion <i>Debt Ratio as % of GDP:</i> 88% Q3 2011: €162 Billion <i>Debt Ratio: 105%</i>	Central Bank 2012
Disposable Income Per Capita (CSO, 2012)	2008: €26,414 2009: €24,316 % change: -7.90%	2008: €23,239 2009: €21,356 % change: -8.06%	CSO, 2012

	Nationally	Dublin	Dublin losses as a % of national total
Job Losses Q2 2007 – Q2 2011	317,500	95,500	30%
Proportion of job Losses Males	80%	66%	N/A
Live Register September 2011	437,441	105,422	24%
Vacancy Rates 2011 (preliminary)	14.7% (State)	10.7% (Dublin)	
House Prices (Base 100, Jan 2005)	Year End 2011: 68.9 Year End 2007: 129.5	Year End 2011: 131.2 Year End 2007: 60.7	

¹ Non Services include NACE Rev 2 Economic Sectors codes A-F: Agriculture, Forestry, Fishing; Industry and Construction. Services include all other Sectors.

² AIRO Website: <http://www.airo.ie/news/eurostat-euro-area-general-government-debt-q3-2011>

Appendix 5: Additional Datasets to be Considered for Improving the Study Results

Source	Description	Availability
Health Atlas Data – data on health infrastructure and services nationally	These data are available from the HSE. A meeting to ascertain the extent of access to data that may be possible was planned with the HSE for March 8 th but was cancelled due to unforeseen circumstances on the part of the HSE. In terms of Health Infrastructure GeoDirectory could be used in any case to point source hospitals and primary care centres and incorporated into Opportunity maps.	Pending
Forfas Annual Business Survey Data (ABSEI) – numbers of agency assisted businesses nationally including sectoral and employment attributes	Forfas data on agency assisted business from both the Enterprise Ireland and IDA databases and Annual Business Survey were not made available due to data protection issues. Indications are that Forfas do intend to map these data themselves in the near future. This will provide a mapped database of over 7,000 businesses nationwide using their own broad sectoral classifications.	Not geo-coded and not available in GIS format
Forward Planning Data from the Department of Education and Skills – including historical trends of school enrolment data.	The team are awaiting receipt of education enrolment data which will provide year on year demand for primary and secondary places nationwide. Catchment based maps formed through Department of Education in-house analysis of child benefit may also be made available though these will not be in an interactive GIS format.	Pending
Data from Pobal and AIRO on Deprivation Levels	Deprivation data at small area are measured according to employment status, socio-economic grouping and level of education. In many respects deprivation mapping is a mirror reflection of Opportunity mapping. While the current deprivation index is from 2006 it is relative and therefore its use as a comparability tool is likely not to have diminished considerably. Opportunity mapping builds into its model a wider range of indicator data across multiple reliable sources which arguably makes it a more diverse and robust metric.	Request is pending for point source layers of private and public childcare facilities and Community Support Programmes. Small Area deprivation and spatial mapping of community facilities and is available online at Pobal

Source	Description	Availability
		website
<i>MyPlan</i> data on land use zonings from the Department of Environment, Community and Local Government	<i>MyPlan</i> GIS interactive layers for zonings in the RoI is available for download since April 2012 from the Department of Environment, Community and Local Government website. These layers can be utilised to check Opportunity map outputs for suitability for neighbourhood development.	Available from April 4 th 2012
Valuation Office Data across 11 broad sectoral categories	<p>The Valuation Office has mapped the types of business using their own broad categorisations and sub-categorisations. These data are available for the Dublin City Council area only for the following categories: Fuel Depot, Industrial, Miscellaneous, Retail – Warehouse, Health, Leisure, Office, Utility, Hospitality, Minerals, Retail – Shops.</p> <p>The Valuation Office is open to further cooperation and will assess any request for data on a case by case basis.</p>	Data provided
NTA data	<p>The NTA provided their full dataset to the research team and these have been incorporated into opportunity mapping.</p> <p>Report 3 will further query these data providing commentary on the viability of locations for public transport locations.</p>	Data provided