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Benchmarking and Fostering
Transformative Use of ICT in EU Regions

WP1: State of the Art Review, Synthesis and Case Studies

– D1.2 Findings from Statistical Exploration –

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Abstract:

This Deliverable provides the findings from the Statistical Exploration work undertaken within WP1.2 of the TRANSFORM project. The purpose of the work carried out in WP1.2 was two-fold: First, to investigate, at an aggregate European level, the relationship between the (transformative) use of ICTs and regional development; and second, to provide a typology of European regions which could aid in the selection of case study regions.

Keyword List:

Information society, knowledge economy, regional development, regional typology, ICT diffusion.

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****Nature: R-Report, P-Prototype, D-Demonstrator, O-Other**

Contents

1 Introduction

This Deliverable (D1.2) provides a summary of the Statistical Exploration work undertaken within WP1.2 of the TRANSFORM project. The full report on the work is contained in a separate Annex (Annex 1). A second Annex (Annex 2) provides a set of graphics illustrating the typology developed in the main report by country.

The purpose of the work carried out in WP1.2 was two-fold:

- To investigate, at an aggregate European level, the relationship between the (transformative) use of ICTs and regional development;
- To provide a typology of European regions which could aid in the selection of case study regions.

Unfortunately (though predictably) we do not have an indicator of the transformative use of ICTs (nor has one, to our knowledge, been devised). We do, however, have an indicator of the up-take and use of ICTs, for Europe's NUTS 2 regions, in 2000-2001, which was developed as part of the ESPON Project on Telecommunications. It is a composite indicator, which incorporates both the up-take of ICTs at the household level (fixed line telephony, mobile telephony, Internet and broadband) and the business use of ICTs (firms with websites, and presence of Internet backbone networks). In instances where regional level data was missing (for example in much of Central and Eastern Europe), it was estimated using national data to predict regional data by means of least squares regression.[1]

The original ICT usage index developed in the ESPON project was re-worked, to make it more statistically robust, for the TRANSFORM project. It should though be stressed that the index has not been up-dated with more recent data; it therefore remains a snap-shot of the level of telecommunications usage across European regions in the early 2000s, and we would anticipate that there may well have been substantial changes in the relative levels of ICT up-take in the intervening years. In the absence of an up-dated index, however, it does at least provide some indication of regional variations in ICT up-take, across households and businesses, and different telecommunications technologies, in the early 2000s.

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[1] The regional ICT index was constructed as follows: 6 variables were used – % of households with a fixed telephone line; % of households with at least one mobile phone; % of households with internet access; % of households with broadband Internet access; number of Internet backbone networks with a node in the region; and % of firms with their own website. The first four variables were derived from a regional level household survey undertaken by INRA, the Internet backbone data was provided by KMI Research, and the firm website data was estimated for NUTS 2 regions using national level EUROSTAT survey data and regional GDP per capita data. Each of the 6 variables was translated into a score for each region which ranged from 1 (the lowest sixth) to 6 (the highest sixth), so that each variable was expressed on the same scale. A composite index was then constructed which combined these 6 re-scaled variables, with some of the variables double, triple or quadruple-weighted, according to following formula:

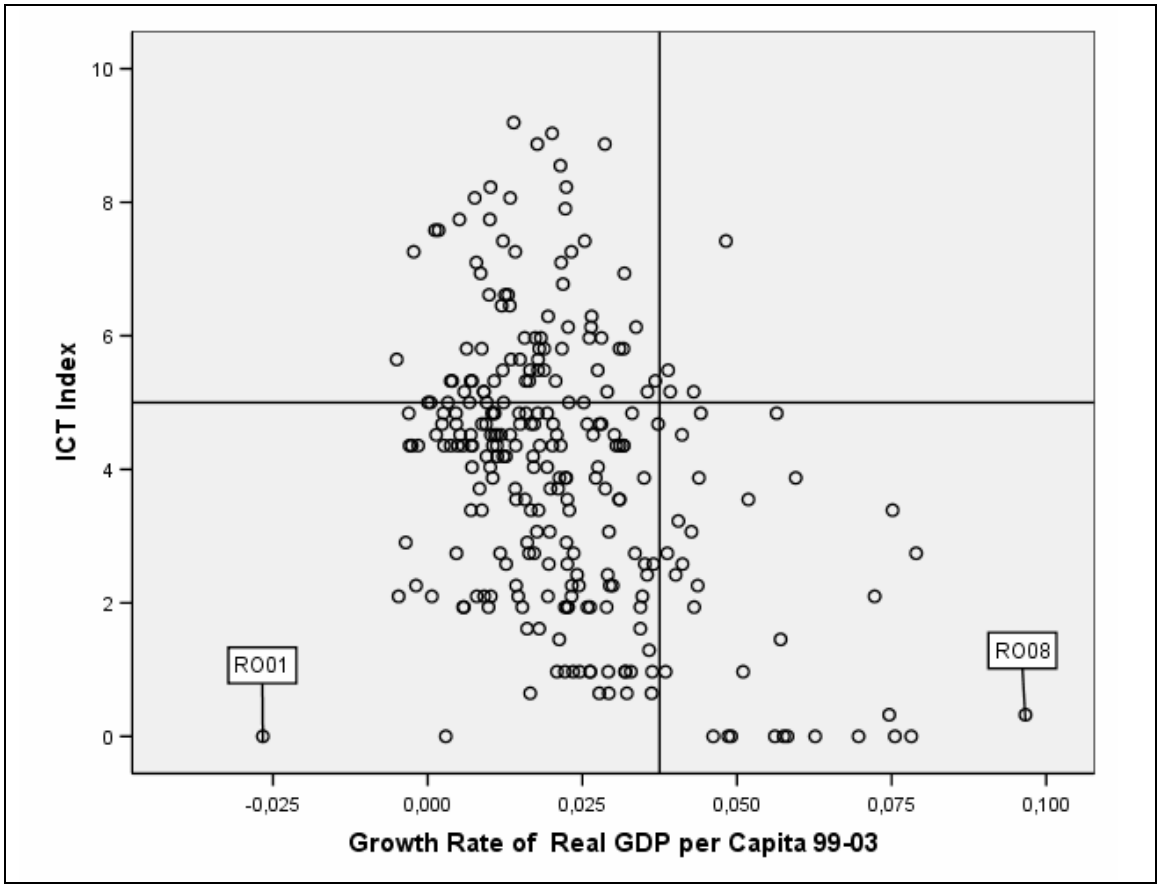
ICT Index= Fixed telephony % + 2*mobile telephony % + 3* Internet % + 4*Broadband % + number of Internet broadband networks with a node in the region + % of firms with their own website.

The weighting was undertaken in order to give more emphasis in the index to mobile rather than fixed line telephony, and to emphasise household Internet access, and particularly broadband access, in the overall index. Finally the composite index for each region was re-scaled such that it ranged from 0 (the lowest value) to 10 (the highest value). For more information on the index and for an analysis and mapping of regional variations in its level, see the Final Report of the ESPON Project 1.2.2 Telecommunications Services and Networks: Territorial Trends and Basic Supply of Infrastructure for Territorial Cohesion. This report is available on the ESPON website (www.espon.lu).

2 Summary Findings

The link between ICT usage, as measured by the index, and regional development was explored through two measures of the latter: GDP (in Purchasing Power Parity) per capita in 1999; and the growth rate of real GDP per capita, 1999-2003. The relationships between these three indicators are shown in the scatter plots (Figures 1-3). The labelled regions are identified as outliers.

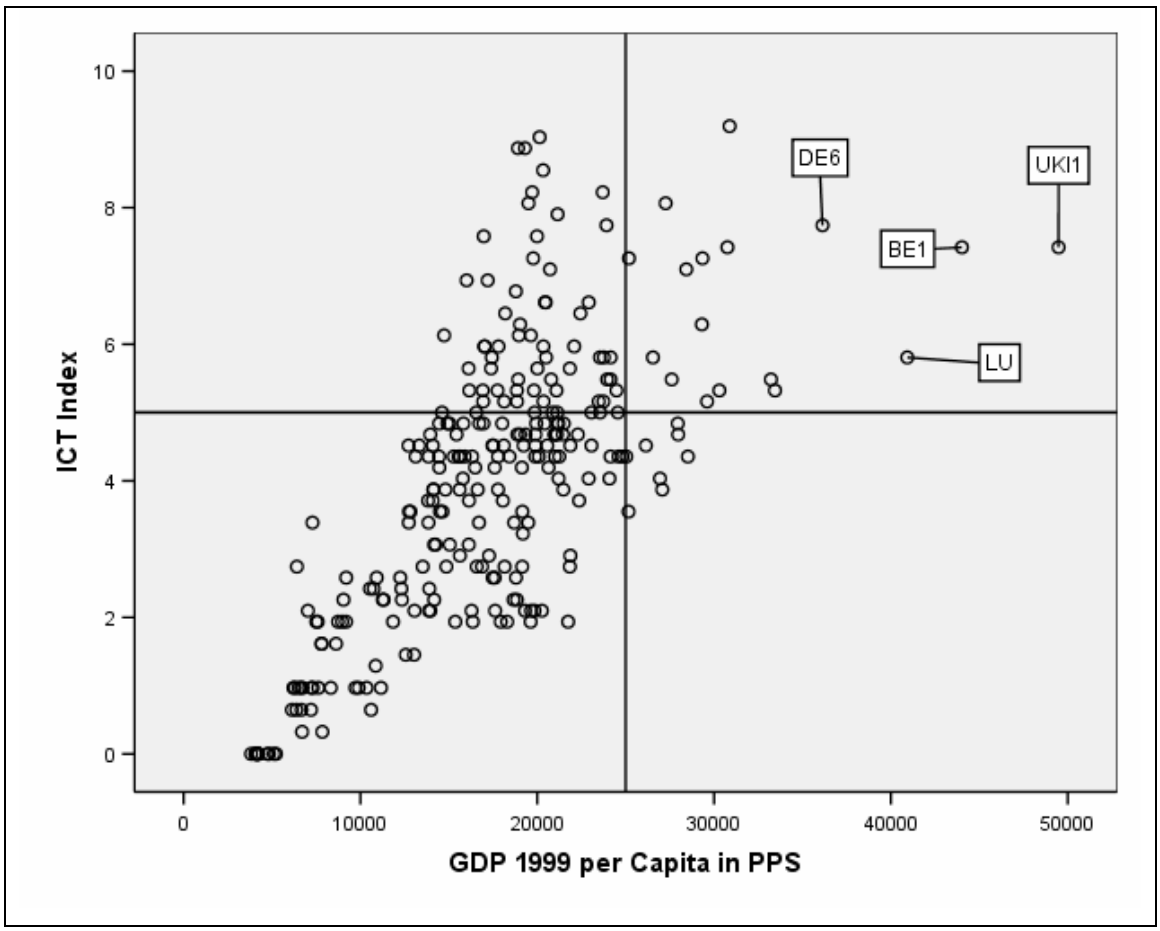
Figure 1: Scatterplot of relationship between ICT Index and the Growth Rate of Real GDP, 1999-2003



Outliers: RO01 Nord-Est Romania; RO08 Bucuresti (Romania))

The relationship between the regional ICT index and the growth rate in real GDP between 1999 and 2003 (Figure 1) is not particularly strong, but is negative, such that the regions with the highest ICT index values tend to have modest GDP growth rates, while the regions with the highest growth rates tend to have low ICT index values. The explanation for the latter occurrence is that the highest growth rates, during this period, were found in central and Eastern Europe, where low levels of ICT adoption are the norm.

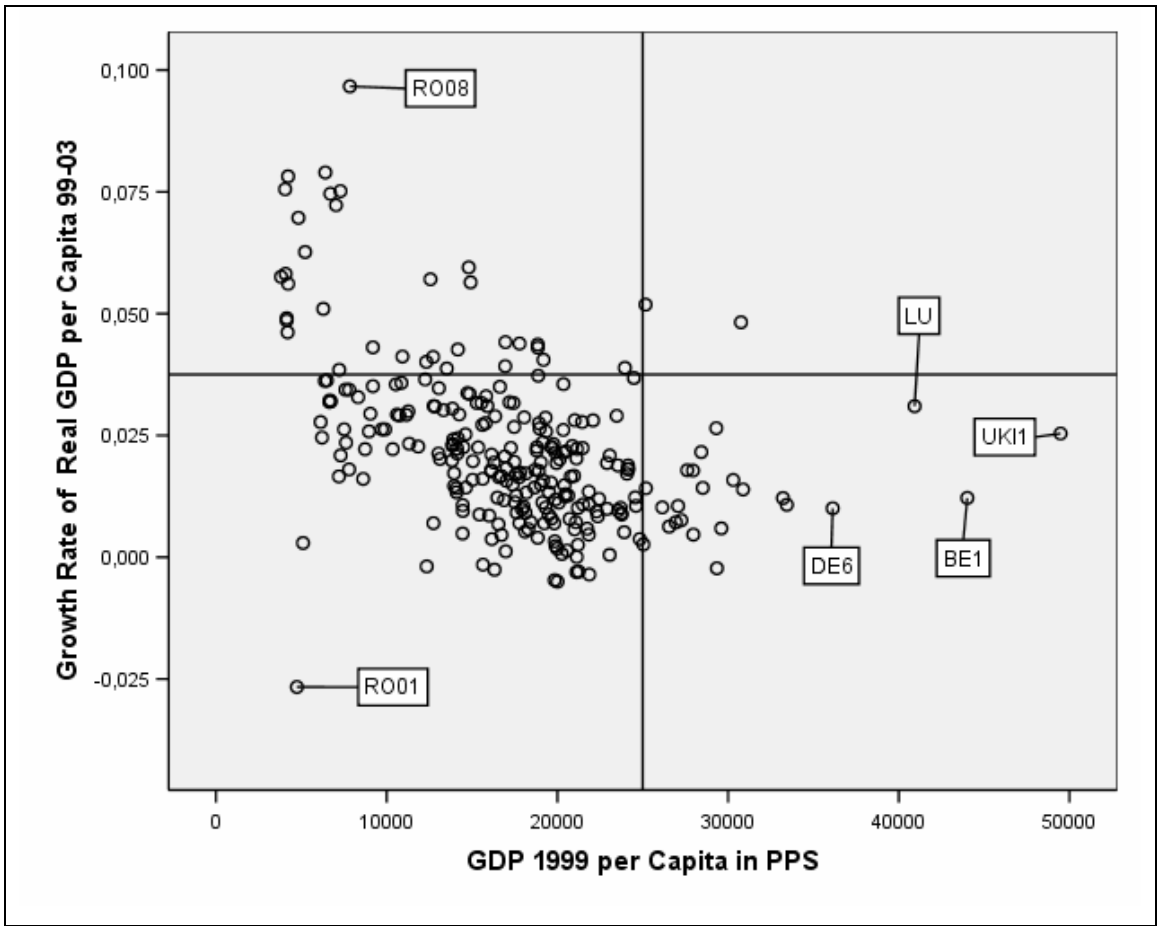
Figure 2: Scatterplot of relationship between ICT Index and GPD per capita in PPS in 1999



(Outliers: BE1 Region Bruxelles-capital; DE6 Hamburg; LU Luxembourg; UK11 Inner London).

The relationship between the ICT Index and the level of per capita GDP (Figure 2) is positive and rather stronger, with the regions with the lowest ICT Index values also tending to have low levels of per capita GDP, and the regions with the highest ICT Index values tending to have high levels of GDP. The outliers (Brussels, Hamburg, Luxembourg and Inner London) are all under-bounded metropolitan cores, with artificially high levels of per capita GDP due to commuting effects.

Figure 3: Scatterplot of relationship between Growth Rate in real GDP 1999-2003 and level of GDP per capita in PPS in 1999

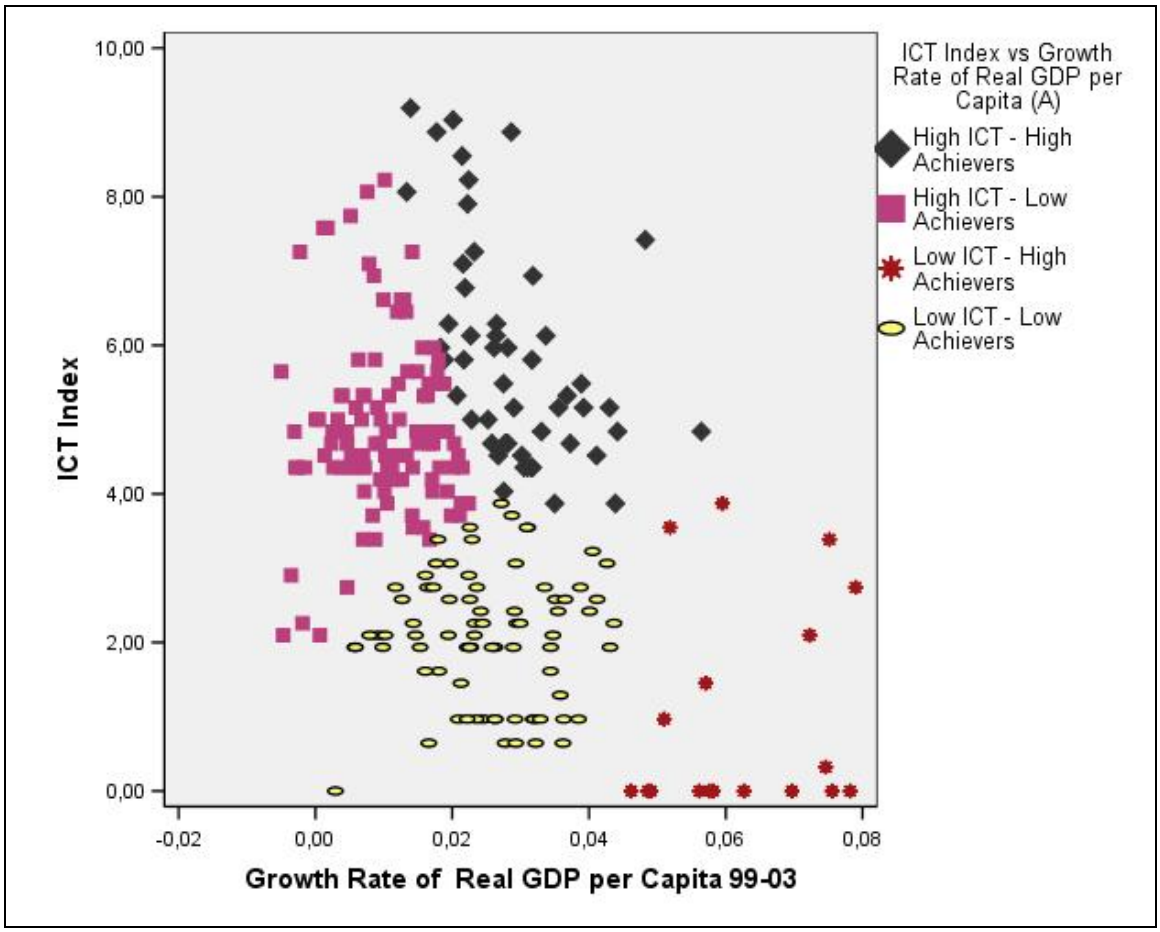


(Outliers: RO01 Nord-Est Romania; RO08 Bucaresti; BE1 Region Bruxelles-capitale; DE6 Hamburg; LU Luxembourg; UK11 Inner London)

The next stage of the analysis was to group regions together with similar attributes with respect to the main relationships we are exploring. Cluster analysis was undertaken on each of the two main relationships of interest, that between the ICT Index and GDP per capita growth, and the ICT Index and GDP per capita level (having first removed the outliers shown on the above plots). [2]

[2] Cluster analysis is a multivariate procedure for detecting groupings in data, and is often used as an exploratory technique. The purpose of a cluster analysis is to group the units in the analysis together so that the members of a cluster are relatively homogenous, and differ from other clusters. A non-hierarchical cluster analysis was performed, based on an iterative procedure in which every single observation is grouped into a number of clusters until the ratio of the variance between the clusters and within the clusters is maximised.

Figure 4: Cluster Analysis of the relationship between the ICT Index and Growth Rate of real GDP, 1999-2003.

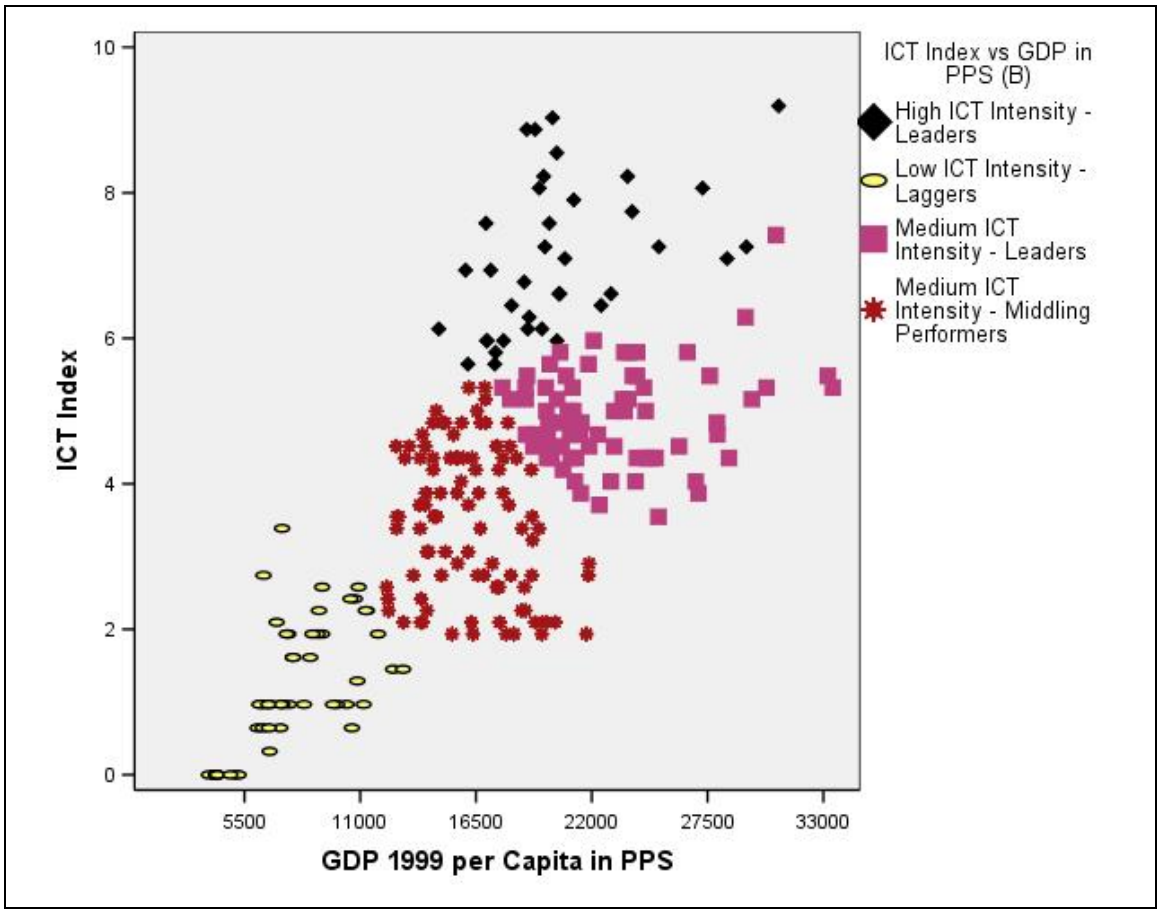


For the relationship between the ICT index and the real growth rate of per capita GDP, four clusters are identified (Figure 4).

- High ICT, High Growth (the black diamond symbols on the graph)
- High ICT, Low Growth (the red squares on the graph)
- Low ICT, High Growth (the red star symbols)
- Low ICT, Low Growth (the yellow open oval symbols).

In terms of how this type of analysis could aid in the selection of regional case studies, we might be particularly interested in regions towards the right hand of Figure 4, within each of the clusters identified. These regions display relatively high levels of GDP growth, within their respective clusters. It can be hypothesised (no more strongly than that!) that the growth displayed in such regions could be at least in part be explained by their effective, even transformative use of ICTs. Clearly such a hypothesis would need to be investigated within the regional case studies, for the statistical analysis, with all its shortcomings in terms of data availability (such as not having a direct proxy for the 'effectiveness' of ICT use), can do no more than hint at interesting possibilities for further investigation.

Figure 5: Cluster Analysis of the relationship between the ICT Index and level of GDP in PPS, 1999



For the relationship between the ICT index and the level of GDP per capita, four clusters are also identified (Figure 5). The four clusters can be described as follows:

- High ICT, High Income (the black diamond symbols on the graph)
- Low ICT, Low Income (the yellow open oval symbols)
- Medium ICT, High Income (the mauve squares)
- Low/Medium ICT, Low/Medium Income (the red star symbols).

In terms of contributing to case study selection, we might, for example, be interested in those regions on the top right of Figure 5, in which the hypothesis to explore would be to determine the extent to which their particularly high levels of GDP could be attributed or linked to high levels of effective use in ICTs. More generally, we might be interested in those regions towards the right of each of the clusters, in which relatively high levels of GDP are apparent for a particular level of ICT adoption. In such regions, the extent to which their relatively high levels of wealth can be attributed or linked to the effective, perhaps transformative use of ICTs would be worthy of exploration.

The results of the two cluster analyses, presented above in Figs 4 and 5, are summarised in matrix form in Figs 6 and 7 respectively.

Figure 6: Summary of the first cluster analysis

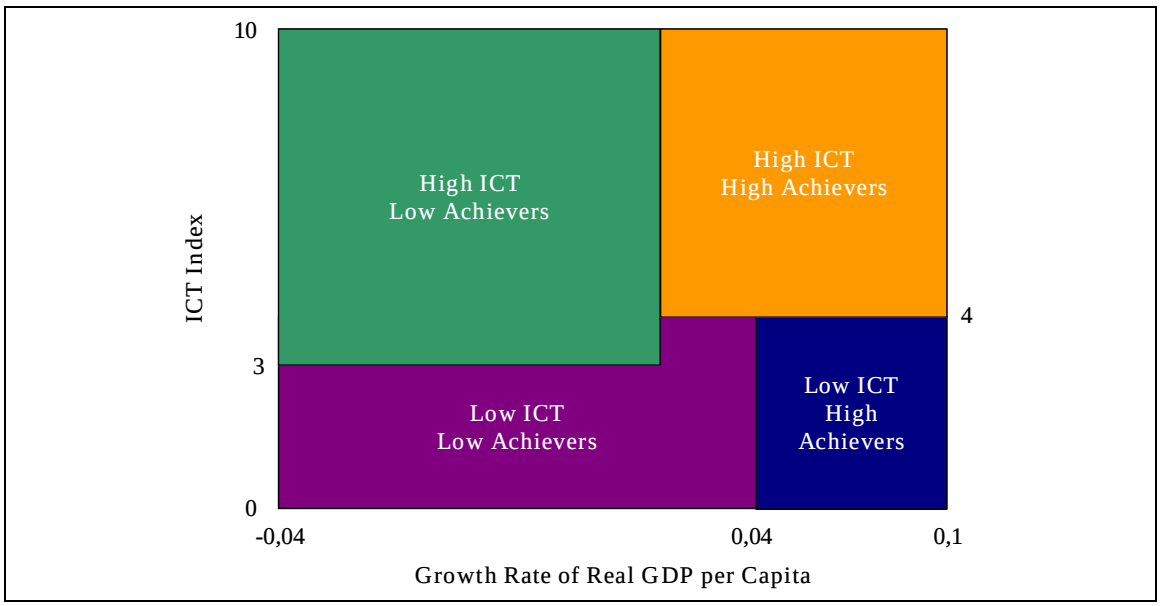
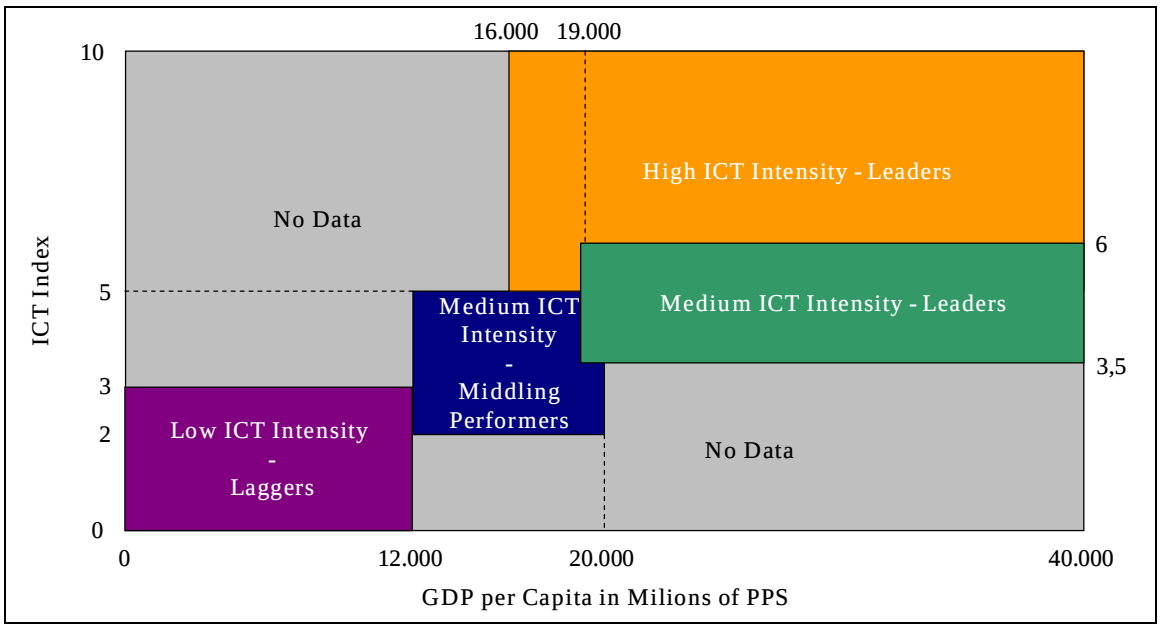


Figure 7: Summary of the second cluster analysis



The results of the two cluster analyses were then combined in order to produce a four fold typology of European regions.

- **Vanguard (or Leading) Regions**: all of these were allocated to the 'High ICT- High Achievers' cluster in the first cluster analysis, and to either the 'High ICT- Leaders' or 'Medium ICT Intensity – Leaders' in the second cluster analysis. What differentiates these regions therefore is that they have relatively high levels of ICT adoption, high levels of per capita GDP *and* high growth of GDP.

- **Potential Regions**: all of these regions were *either* in the 'High ICT - High Achievers' in the first cluster analysis and the 'Medium ICT Intensity – Middling Performers' in the second cluster analysis, *or* they were in the 'Low ICT – High Achievers' in the first cluster analysis and the 'Low ICT Intensity- Laggers' in the second cluster analysis. What differentiates these regions is that they tend to have high per capita GDP growth rates, in comparison with their level of GDP and their level of ICT adoption.
- **Sluggish Regions**: all of these regions were allocated to the 'High ICT – Low Achievers' in the first cluster analysis and to the 'Medium ICT Intensity – Leaders' in the second cluster analysis. What differentiates these regions is that having medium-high levels of ICT adoption and high levels of per capita income, but that they display relatively low income growth rates.
- **Lagging Regions**: all of these regions were allocated to *either* the 'High ICT –Low Achievers' in the first cluster analysis and to the 'Medium ICT Intensity – Middling Performers' in the second cluster analysis; *or* to the 'Low ICT – Low Achievers' in the first cluster analysis and to *either* the 'Low ICT Intensity Laggers' *or* the 'Medium ICT Intensity – Middling Performers' in the second cluster analysis. What categorises these regions is their low or medium level of ICT adoption, their low to medium levels of per capita GDP, and low-medium growth rates.

The characteristics of the four regional types are shown in Table 1

Table 1: Summary of characteristics of the 4 regional types

		VANGUARD REGIONS	POTENTIAL REGIONS	SLUGGISH REGIONS	LAGGING REGIONS
Number of Regions		36	33	76	114
GDP per capita in PPS 1999		21,226	10,739	22,538	13,941
Real rate of growth GDP per capita 1999/03		2.73%	4.90%	1.03%	2.03%
ICT Index		6,37	2,65	5,28	2,68
Percentage of Objective 1 Regions[3]	In the cluster	11.1% (4)	45.5% (15)	2.6% (2)	61.4% (70)
	In the sample	4.4%	16.5%	2.2%	76.9%
Percentage of Pentagon Regions3	In the cluster	30.6% (11)	0% (0)	59.2% (45)	19.3% (22)
	In the sample	14.1%	0%	57.7%	28.2%
Settlement Structure[4]		Medium-High 63.9%	Low 72.7%	Medium-High 76.3%	Medium-Low 65.8%

The **'Vanguard'** regions and the **'Sluggish'** regions have the highest average levels of per capita GDP and the highest levels of ICT adoption, but the former group have appreciably higher per capita income growth rates. Only 31% of the Vanguard regions are located in Europe's 'pentagon' (which does not extend to Scandinavia), whereas 59% of the Sluggish regions are within the pentagon. A relatively large proportion of regions in the Vanguard and Sluggish categories are urbanised.

[3] Data on Objective 1 and Pentagon Regions are taken from the ESPON database.

[4] This information is based on a Settlement structure category in the ESPON database. This index ranges from 1 (High Density) to 6 (Low Density). The most densely populated regions are in category 1 or 2, while the less densely populated regions are in category 5 or 6 and the regions with a medium population density are in category 3 or 4. The label "Medium-High" thus applies to categories 1, 2 and 3, the label "Medium-Low" to categories 4, 5 and 6, and the label "Low" to categories 5 and 6. The percentage shown represents the cumulative percentage of regions in each category.

Tables 2 and 3 show the composition of the Vanguard and Sluggish regions respectively in terms of their country. Of the Vanguard regions, the UK and Sweden account for 22 of the 36 regions in this group. Norway and the Netherlands are also well represented. Within the Sluggish regions' group, Germany, Italy, the UK, the Netherlands and Austrian regions are well represented. For Austria, the Netherlands, Italy and Germany, over half of their regions are assigned to this group.

Table 2: Composition of regions within the 'Vanguard' group of regions

		Frequency	Percentage	Cumulative Percentage	Regions in the cluster / Regions in the country
	Austria	1	2.8	2.8	11.1%
	Belgium	2	5.6	8.3	20.0%
	Czech Republic	1	2.8	11.1	12.5%
	Finland	1	2.8	13.9	20.0%
	Ireland	1	2.8	16.7	50.0%
	Netherlands	3	8.3	25.0	25.0%
	Norway	3	8.3	33.3	42.9%
	Spain	2	5.6	38.9	11.8%
	Sweden	8	22.2	61.1	100.0%
	United Kingdom	14	38.9	100.0	38.9%
	Total	36	100.0		

Table 3: Composition of regions within the 'Sluggish' group of regions

		Frequency	Percentage	Cumulative Percentage	Regions in the cluster / Regions in the country
	Austria	7	9.2	9.2	77.8%
	Belgium	4	5.3	14.5	40.0%
	Denmark	1	1.3	15.8	100.0%
	Finland	2	2.6	18.4	40.0%
	France	1	1.3	19.7	4.5%
	Germany	23	30.3	50.0	59.0%
	Italy	13	17.1	67.1	65.0%
	Netherlands	9	11.8	78.9	75.0%
	Spain	3	3.9	82.9	17.6%
	United Kingdom	13	17.1	100.0	36.1%
	Total	76	100.0		

The **'Potential'** regions have per capita levels of GDP which are on average less than half those of the Vanguard or Sluggish regions, and they have much lower levels of ICT adoption, but they do have very rapid per income growth rates. None of the Potential regions are located in the

pentagon, and 46% are Objective 1. A relatively high proportion of these region display relatively low levels of urbanisation.

The composition of the Potential regions in terms of country is shown in Table 4. Of the 33 regions, five or more are provided by the UK, Bulgaria and Romania. Most of the Bulgarian and all of the Romanian regions are in this category, along with Estonia, Latvia, Lithuania and Slovenia.

Table 4: Composition of regions within the 'Potential' group of regions

		Frequency	Percentage	Cumulative Percentage	Regions in the cluster / Regions in the country
	Austria	1	3.0	3.0	11.1%
	Bulgaria	5	15.2	18.2	83.3%
	Estonia	1	3.0	21.2	100.0%
	Finland	1	3.0	24.2	20.0%
	Greece	1	3.0	27.3	7.7%
	Hungary	2	6.1	33.3	28.6%
	Ireland	1	3.0	36.4	50.0%
	Latvia	1	3.0	39.4	100.0%
	Lithuania	1	3.0	42.4	100.0%
	Norway	4	12.1	54.5	57.1%
	Poland	1	3.0	57.6	6.3%
	Romania	6	18.2	75.8	100.0%
	Slovenia	1	3.0	78.8	100.0%
	Spain	2	6.1	84.8	11.8%
	United Kingdom	5	15.2	100.0	13.9%
	Total	33	100.0		

The **'Lagging'** regions are the largest single category (114 out of the total of 259 regions). They have on average per capita income levels which are appreciably lower that either the Vanguard or Sluggish regions, but which are above the Potential regions. Their levels of ICT adoption are low, similar to the Potential regions, but their levels of per capita income growth are less than half those of the Potential regions, albeit higher than the Sluggish regions. 61% of the Lagging regions are Objective 1, and 19% are located within the pentagon. They have an over-representation of regions displaying low-medium levels of urbanisation.

In national terms, the largest numbers of regions in this category are found in France, Germany, Poland, Greece and Spain (Table 5). All Portuguese and Slovakian regions are in this category, more than 90% of French and Polish regions, 88% of regions in the Czech Republic, 71% of Hungarian regions and 59% of Spanish regions.

Table 5: Composition of regions within the 'Lagging' group of regions

		Frequency	Percentage	Cumulative Percentage	Regions in the cluster / Regions in the country
	Belgium	4	3.5	3.5	40.0%
	Bulgaria	1	.9	4.4	16.7%
	Cyprus	1	.9	5.3	100.0%
	Czech Republic	7	6.1	11.4	87.5%
	Finland	1	.9	12.3	20.0%
	France	21	18.4	30.7	95.5%
	Germany	16	14.0	44.7	41.0%
	Greece	12	10.5	55.3	92.3%
	Hungary	5	4.4	59.6	71.4%
	Italy	7	6.1	65.8	35.0%
	Malta	1	.9	66.7	100.0%
	Poland	15	13.2	79.8	93.8%
	Portugal	5	4.4	84.2	100.0%
	Slovakia	4	3.5	87.7	100.0%
	Spain	10	8.8	96.5	58.8%
	United Kingdom	4	3.5	100.0	11.1%
	Total	114	100.0		

In terms of the uses of the statistical analysis in the TRANSFORM project, one obvious use is to ensure that our case study regions are drawn from each of the four regional types, thereby ensuring that we have a good range of regions represented.

The logistics and practicalities of selecting case study locations (eg the language competencies of the study team) will to an extent lead to cou*ntries* being first selected, and then one or two regions within these countries being selected for case study investigation. While the above four-fold typology of Europe's regions will be of assistance in helping to determine which region or regions to select, we can also make use directly of each region's ICT index value, its per capita GDP level and its growth in GDP. These can be presented graphically for the regions of a given country, as shown in the example below for Spain (Figs 8 and 9). A series of such graphs for each country in Europe are presented in Annex 2.

Figure 8: Graph of ICT Index and Growth Rate of Real GDP for Spain

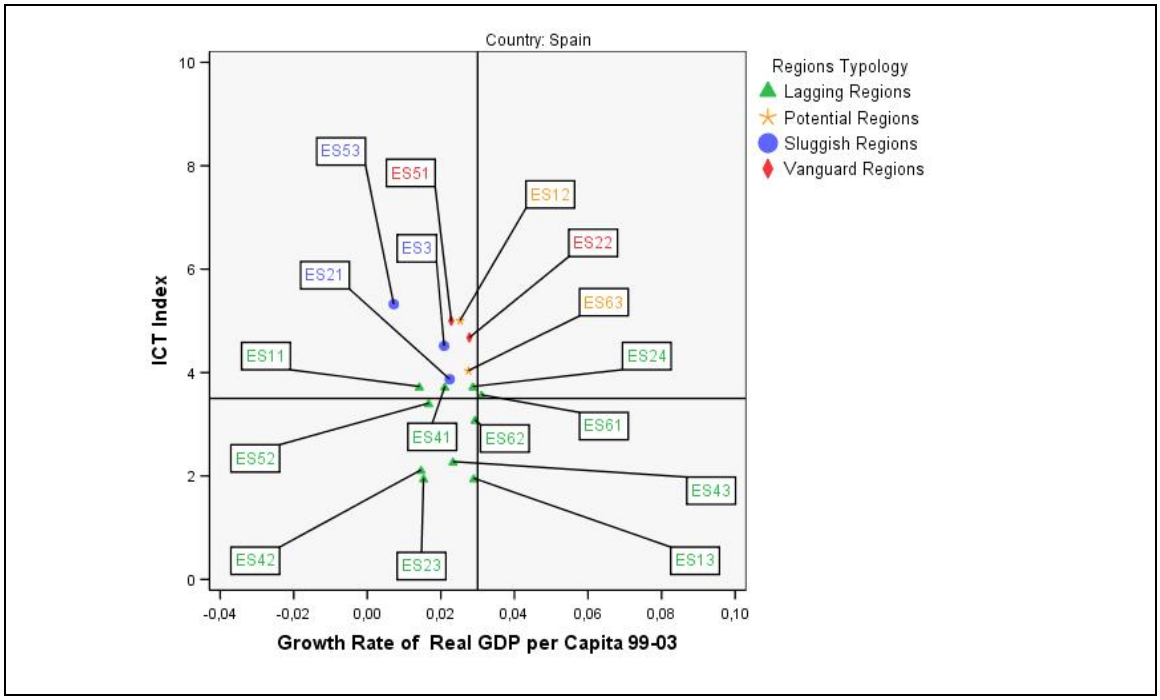
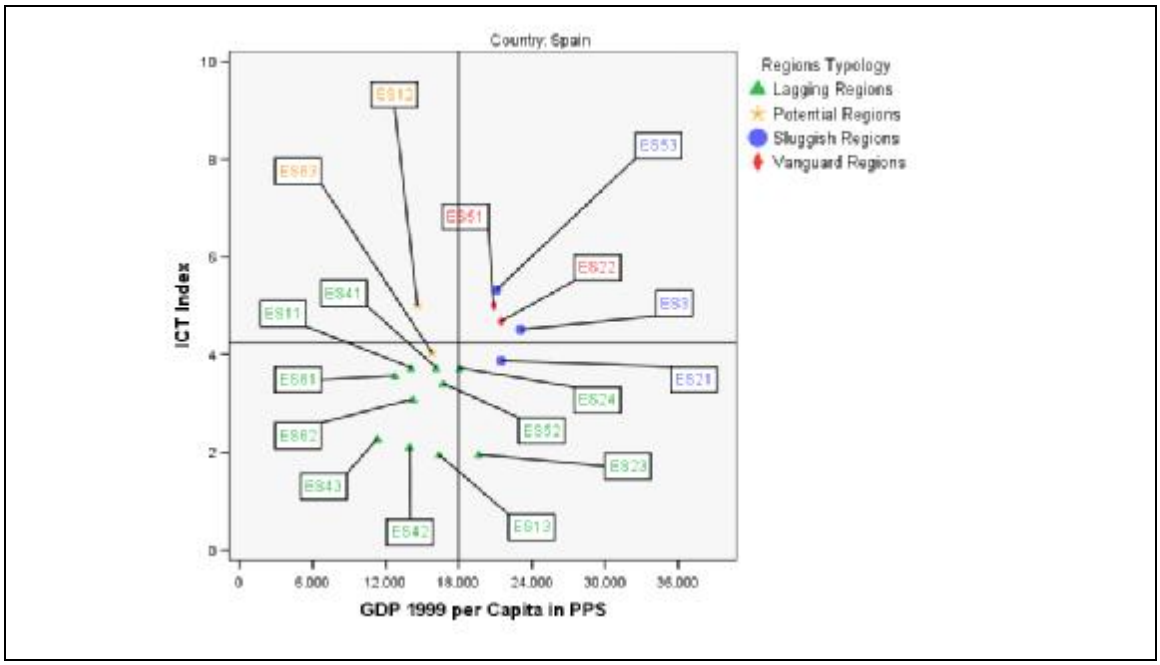


Figure 9: Graph of ICT Index and per capita GDP for Spain



Beyond the use of the above analysis and regional typology in the selection of case study regions, there may also some use of the analysis in providing pointers towards types of policy intervention. Although the ICT index is only an indicator of the up-take of technology, rather than

of its use (let alone transformative use), and a dated one at that, it might provide some hints towards policy priorities in terms of the links between ICTs and regional development.

The **Vanguard Regions** in the above typology, for example, display high levels of ICT usage, high income growth and high income. Given that they are doing relatively well on each of these indicators, it could reasonably argued that they are low priorities for policy intervention, though there may be lessons for other regions which the TRANSFORM project could benefit from drawing out in the case studies.

The **Potential Regions** are achieving high rates of income growth, from a low starting point, but with relatively low levels of ICT adoption. They constitute strong candidates for stimulating ICT up-take and usage, in order to maintain their growth potential and to ensure that the benefits of growth are widely diffused.

The **Sluggish Regions** are prosperous, but display low growth rates and relatively low levels of ICT adoption. In policy terms, it would be reasonable to stimulate the up-take and usage of ICTs within the context of reducing growth barriers and under-performance.

The **Lagging Regions**, finally, can be regarded as the mirror image of the Vanguard regions, in that their levels of ICT adoption, income growth and income levels are all in the low-medium range. They constitute prime candidates for policy intervention, which should aim to increase both the up-take and effective use of ICTs, with the intention of stimulating positive growth dynamics. It is likely, however, that the regions in this category will display very different capacities and propensities for achieving growth through the transformative use of ICTs. It will be the aim of the TRANSFORM project regional case studies to attempt to understand why these capacities vary so widely between regions.