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Evaluation of EU Funded Infrastructure: Phase Four

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Evaluation of EU Funded Infrastructure: Phase Four

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Glossary

Acronym/Key word	Definition
ASHE	Annual Survey of Hours and Earnings
BDUK	Building Digital UK
BSD	Business Structure Database
CIE	Counterfactual Impact Evaluation
DiD	Difference in Difference
ERDF	European Regional Development Fund
FE	Further Education
FTTC	Fibre to the Cabinet
GIS	Geographical Information Systems
GVA	Gross Value Added
HEI	Higher Education Institution
HMRC	Her Majesty's Revenue and Customs
ILR	Individualised Learner Record
ONS	Office for National Statistics
POPE	Post Opening Project Evaluation
PSM	Propensity Score Matching
R&I	Research and Innovation
RDD	Regression Discontinuity Design
SFB	Superfast Broadband
SMS	Maryland Scientific Measurement Scale
STEAM	Scarborough Tourism Economic Activity Monitor
WEFO	Welsh European Funding Office

1. Introduction

1.1 The Welsh European Funding Office (WEFO) has appointed Hatch, OB3 and Beaufort Research to undertake an evaluation of EU funded infrastructure in Wales in the 2000-2006 and 2007-2013 programming periods.

1.2 The need for this project has arisen because of gaps in WEFO's and the Welsh Government's knowledge of how EU funded infrastructure is being used, how different types of investment have complemented each other and the economic contribution this has made to different parts of Wales.

1.3 The study has three specific aims:

- To investigate the usage and maintenance of the new/improved infrastructure;
- To investigate whether, and if so how, new and improved infrastructure within the regions of Wales work together, for the benefit of the region in terms of the local economy, residents and businesses; and
- To consider the feasibility of undertaking an impact evaluation of infrastructure and set out recommended methods.

1.4 The study covers the previous two programme periods:

- the 2000-06 Objective 1 and Objective 2 & Transitional Programmes
- the 2007-13 West Wales and the Valleys Convergence Region and East Wales Competitiveness Region ERDF Programmes.

1.5 Both programmes supported infrastructure projects across Wales, although the approach and scale of investment has changed over time. The main types of infrastructure investment in both programmes have included the following:

- Digital infrastructure
- Learning infrastructure (eg Further Education (FE) campuses)
- Research and Innovation facilities
- Sites and premises
- Tourism infrastructure
- Transport infrastructure

1.6 The study does not consider other types of infrastructure investment including energy infrastructure, flood defences or the public realm.

Research undertaken to date

1.7 The research is being conducted in a number of phases. This report follows on from two earlier reports:

- Phase 1 report: this phase carried out an initial mapping exercise of investments in infrastructure and reviewed the available monitoring data and evaluation evidence. The findings were used to set out a more detailed approach to the evaluation.

- Phase 2 report: this report carried out a detailed mapping exercise of how EU funding has been invested in economic infrastructure and evaluated how it is being used and maintained (responding to evaluation aim 1).
- Phase 3 report: this explored how infrastructure investments have worked together for the benefit of the region (responding to evaluation aim 2).

Purpose of this report

1.8 The purpose of this report is to consider the feasibility of undertaking an impact evaluation of infrastructure funded during the 2000-06 and 2007-13 programmes and set out recommended methods (responding to evaluation aim 3). It seeks to answer the following research questions:

- Does appropriate data exist?
- Can a counterfactual be constructed?
- Does the infrastructure have to be of a particular scale for an impact evaluation to be undertaken?
- What methods would be the most appropriate for an impact evaluation?
- What is the optimum time for undertaking an impact evaluation?

Structure of the Report

1.9 The structure of the report is as follows:

- Chapter 2 explains the meaning of counterfactual impact evaluation and introduces the Maryland Scientific Measurement Scale (SMS) which is used to assess the robustness of different evaluation methods.
- Chapters 3 to 8 assess the most appropriate and practical methods of carrying out an evaluation for each of the different types of infrastructure covered by this study. This includes:
    - A description of the nature of the different interventions and the types of outcomes/impacts that an evaluation should ideally assess.
    - The expected timescales for outcomes and impacts to emerge.
    - A summary of potential counterfactual approaches and possible limitations (eg data availability).
    - A description of alternative approaches that could be applied and their strengths and weaknesses.

2. What is counterfactual impact evaluation and why undertake it?

2.1 In its simplest form, counterfactual impact evaluation (CIE) is a method of evaluation which involves comparing the outcomes of interest of those having benefitted from a policy or programme (the "treated group") with those of a group similar in all respects to the treatment group (the "control group"), the only difference being that the control group has not been exposed to the policy or programme. The control group provides information on "what would have happened to the members subject to the intervention had they not been exposed to it", the counterfactual case. CIE therefore represents the most robust way of attributing outcomes and impacts to an intervention (establishing causality).

2.2 The case for counterfactual impact evaluation is based on the need to collect evidence and determine whether policy objectives have been met and, ultimately, whether the resources were used efficiently. These answers feed back into the design and implementation of future interventions and budgetary decisions.

2.3 However, there can be many challenges in designing and implementing a robust CIE. In particular, it is often difficult to identify a suitable control group which resembles the treatment group in all ways, so as to offer a plausible counterfactual of what would have happened in the absence of treatment.

2.4 A key issue in creating the control group is dealing with 'selection bias'. This occurs when participants in a programme differ from those who do not participate. For example, this could occur on a business support programme if more ambitious and motivated firms applied for support. If this happens, the estimate of impact from support may be biased upwards because better business outcomes are incorrectly attributed to the intervention rather than the fact that the more ambitious participants would have done better anyway. These factors are often unobservable to researchers.

2.5 The main challenge for counterfactual evaluation is dealing with these issues and demonstrating that the control group is plausible. The Maryland Scientific Measurement Scale (SMS) can be used to assess the relative robustness of different methods of evaluation based on the extent to which the control group is robust and has dealt with the issue of selection bias. The levels below are used by the What Works Centre for Local Economic Growth based on an adapted version of the SMS: The Centre's minimum standard required for a study to be considered to be robust is Level 3.

- **Level 5**: the highest possible level on the SMS scale is reserved mainly for randomised control trials where participants are randomly allocated to either the treatment or control group, and where it can be shown there are no significant differences between either group. It is very often impractical to apply these methods to evaluations of economic development interventions because treatment is very rarely random.
- **Level 4**: this applies to evaluations where treatment is not strictly random but where some degree of 'quasi-randomness' in selection can be exploited to construct a sample which is close, for most practical purposes, to a random sample. This may be where selection is based on non-random criteria such as an eligibility cut off mark, or where intervention was only available to certain groups for a reason that was, to some extent, random. While there is still a

risk of selection bias, this can be low if it is demonstrated that the only way in which the treated group differs from the control group is the random treatment.

- **Level 3**: Level 3 studies compare outcomes in a treatment group before and after an intervention and a control group considered to have similar observable characteristics. Techniques such as regression and propensity score matching (PSM) can be used to adjust for differences between the treatment and control groups but there are likely to be important unobserved differences remaining, meaning there is still a risk of selection bias.
- **Level 2**: this applies to either a) a cross sectional comparison of treated groups with untreated groups or b) a before-and-after comparison of treated groups, without an untreated comparison group. Control variables or matching techniques are used to account for cross sectional differences between the treated and untreated group, or to account for before and after changes in macro level factors. However, even if some observable characteristics are controlled for, unobservable differences between the groups remain. In before-and-after approaches, the "after" does not necessarily capture the pure treatment effect - it is possible that other contextual factors affected the outcome, as well as the individual's characteristics.
- **Level 1**: these approaches are the same as Level 2 except there is no use of control variables in statistical analysis to adjust for differences between treated and untreated groups or periods. This increases the risk that outcomes could have been caused by other factors besides the intervention.

2.6 This scoring system has been used when considering whether a control group could be constructed for an evaluation of the different types of infrastructure investment included in this study.

3. Digital Infrastructure

Nature of interventions

3.1 Interventions in this theme have all been investments in broadband infrastructure which aim to increase coverage and adoption of high speed broadband. This indirectly benefits SMEs and potentially larger businesses. There are also likely to be indirect benefits to households and public sector organisations, although these are not eligible in terms of ERDF grant.

3.2 The approach used to increase access to high speed broadband during the 2007-13 programme was through a gap-funded model where a commercial provider received a public subsidy to address remaining gaps in coverage of superfast broadband (SFB) in a geographical area, thus reducing risk and overcoming the commercial viability barrier. This was a single programme that covered the whole of Wales.

3.3 Investments during the 2000-06 programme were all quite small and local projects addressing gaps in basic broadband coverage, or giving local communities access to information technology and broadband connections which were not widely available at the time. A large proportion of the digital infrastructure funded in the earlier programme is now likely to be out of date and been superceded by newer technology, although there are exceptions to this (eg the fibrespeed project whose technology is not out of date and still in use).

3.4 This review has focused only on the SFB programme funded during the 2007-13 programme as this is likely to be of greater interest to policymakers.

Outcomes and impacts

3.5 The main outcomes for business beneficiaries are as follows:

- Increased coverage of broadband results in an increase in the number of businesses subscribing to faster broadband. This could include existing businesses, businesses that have moved in to the area to take advantage of the faster broadband, and new businesses which are created because the faster broadband has overcome a barrier to starting a business in the area (eg home based businesses).
- The subscription to high speed broadband enables businesses to increase productivity by allowing them to carry out existing processes more efficiently or to adopt new processes or business models.
- The access to high speed broadband could also enable businesses to grow turnover, profitability and employment by allowing businesses to access new markets (eg by being able to market their goods and services online or making greater use of social media) or by enabling them to develop new products and services.

3.6 The intended impacts which would need to be assessed include:

- The gross and net change in GVA which is the cumulative effect of the improvements in productivity (from efficiency savings and adoption of new processes and business models) and the growth in turnover and profitability which results from improved access to markets and innovation.

- The gross and net change in employment, which would arise as a result of improved access to markets and innovation and the increased demand for goods and services that this would generate.

3.7 The net change in these variables will be influenced by a number of factors which will need to be measured. These include:

- Displacement: broadband investment has the potential to displace economic activity in both product and labour markets. For product markets, displacement could occur if broadband enables firms to access clients in other parts of England which are currently served by other domestic businesses. Displacement of labour could occur as a result of productivity gains and the structural change that broadband may cause in an economy, with the loss of jobs in some sectors and the growth of others.
- Spillover effects: a benefit of access to broadband is that it permits greater interaction, collaboration, the forming of working relationships and the sharing of ideas (knowledge spillovers) and in that sense is similar to the agglomeration benefits of transport investments. These can increase the productivity of areas or sectors and contribute to GVA.
- Multiplier effects: businesses that grow as a result of increased access to broadband could cause multiplier effects through their supply chain expenditure and the expenditure of their employees.

Timing of outcomes and impacts

3.8 Once businesses have subscribed to SFB, businesses could begin to see cost savings after a very short amount of time, particularly if this does not require any further large scale investment or major changes to business models or processes (for instance through exploitation of time or money saving applications such as video-conferencing software or other online software packages). Other benefits are likely to take longer to accrue as businesses adjust to high speed broadband and take the time to explore and assess the benefits that it offers, and then make business decisions on how best to exploit it (for instance by switching to online sales).

3.9 Therefore it should be possible to detect and measure changes in business performance within one or two years of receiving support. This is verified by an evaluation of the Building Digital UK (BDUK) funded SFB programme between 2012 and 2016[1] which measured changes within one to two years of the infrastructure being installed and found significant effects on turnover, employment and productivity.

3.10 However, since take-up of broadband is likely to build gradually and incrementally in area based interventions, it is likely to take a longer time for the full impacts to emerge. Therefore, it may be prudent for an evaluation to allow at least three years from receiving support before measuring impacts. Given the elapsed time since the investment were made through the 2007-13 programme, then it should be possible to assess these impacts.

[1] Isos Mori (2018): Evaluation of the Economic Impact and Public Value of the Superfast Broadband Programme on behalf of Department for Media Culture and Sport

3.11 One further consideration is the length of time that impacts could persist for, and whether there is likely to be any decay in impacts. This is difficult to assess and has not been addressed in any of the UK based studies of the impacts of digital infrastructure.

3.12 SFB is a continuous service available to subscribing businesses, rather than a one-off form of support, so the benefits are likely to last for a number of years. However digital infrastructure is likely to have a higher obsolescence rate than other types of infrastructure because of the rapid rate of advancement in telecommunications technologies which continue to offer faster upload and download speeds. This suggests that the benefits for businesses may decay over time.

3.13 It is very difficult to be definitive about persistence effects as this has not been addressed in any of the UK based studies of the impacts of digital infrastructure. However, given that the download speeds available through SFB are still likely to be more than sufficient to meet most small businesses' bandwidth requirements it is reasonable to assume that impacts persist for ten years[2].

Potential Counterfactual Methods

3.14 Identifying control groups for area based broadband interventions is problematic because of the risk of reverse causality. Areas that receive investment are likely to do so because they offer greater potential for economic benefits than areas that do not. A comparison with areas that had not received investment could therefore give misleading results because they would be expected to outperform these areas anyway.

3.15 There are two approaches which could overcome this challenge:

- **Instrumental variable approaches**: an instrumental variable is a 'third' variable introduced into regression analysis that is correlated with the treatment variable (which in this case could be coverage of high-speed broadband) but is uncorrelated with anything else that might cause a change in economic outcomes. This allows the evaluation to estimate the true causal effect that coverage has on outcomes. Possible instruments include the weighted mean size of a BT cabinet in an area, the share of exchange-only lines and the distance to cabinet/exchange, which are all correlated with broadband availability or speed but not other economic outcomes. This avoids the need to identify a control group area. Although this approach could in theory achieve a score of 4 on the SMS, studies which have attempted it gave rise to inconsistent results with a very high degree of volatility, so there are likely to be a number of practical challenges.
- **Phasing approaches**: it may be possible to take advantage of the staggered roll-out of area based broadband programmes. Under this approach, those areas receiving investment at later stages, become a counterfactual for areas receiving investment earlier. These areas can be assumed to share more

[2] Research carried out for the Broadband Stakeholder Group modelled the bandwidth requirements of small businesses and found that downstream demand for small business premises will rise from 5 Mbps in 2015 to 8.1 Mbps in 2025 (Communications Chambers, 2015). At the upper end, it was estimated that 95th percentile demand would increase from 12.9 Mbps to 41.1 Mbps by 2025. The digital infrastructure delivered through the 2007-13 programme was based on fibre to the cabinet technology (FTTC). BT currently report that FTTC can deliver download speeds of up to 80 Mbps.

similarities (including unobserved features) than areas that did not eventually receive investment. This mitigates the risk of reverse causality and offers a robust measure of the impacts involved provided there are no systematic differences between areas that are correlated with business performance outcomes (eg if coverage was rolled out to higher productivity areas first, then this would overstate the impact of the programme). If this can be shown, then this approach can in principle attain a score equivalent to Level 4 on the SMS scale.

3.16 The evaluation of the SFB programme between 2012 and 2016 provides one example of where a phasing approach has been applied successfully (this covered the whole of the UK, but provided separate impact estimates for Wales).

3.17 This used data on firm-level employment and turnover over time from the ONS Business Structure Database (BSD) aggregated at postcode level. This is an annual register of the employment, turnover, age, industry, location of all UK employers and VAT-registered businesses. This dataset can then provide data about the annual performance of beneficiaries and businesses in control group areas.

3.18 Firms benefitting from subsidised coverage at different times were identified by linking postcodes of premises which had been upgraded to SFB with records in the BSD and their performance monitored pre and post treatment. This included firms that had not moved during the intervention period and firms that had moved to the upgraded postcodes. The modelling could then distinguish the share of economic outcomes driven by 'spatially stable' and incoming firms to estimate the impacts which arose as a result of business relocations.

3.19 'Local' impacts were then translated to national net additional economic impacts by making a number of assumptions and adjustments consistent with the HM Treasury Green Book. The report acknowledged that these adjustments may not have fully accounted for all of the factors affecting additionality (eg displacement).

3.20 This approach could, in theory, be applied retrospectively to areas that received broadband investment through the 2007-13 programme. BSD data is available from 1998 onwards, so it should be possible to match these records to the postcodes which were enabled with SFB (assuming these records still exist) and construct a control group using similar areas which received SFB later than treatment areas.

Alternative approaches

3.21 The main alternative to the counterfactual methods described above would be to carry out a 'theory of change' approach. This would involve analysis of change in economic performance in an area which has received broadband and then aim to understand the extent to which this can be attributed to the broadband investment. This would need to triangulate the following sources of information:

- Change in businesses, employment and GVA. It may also be difficult to obtain data on GVA at an appropriate spatial level.
- A business survey in areas that have benefitted from the roll-out, which would be used to provide an estimate of take-up and to understand how business subscribers have used their faster broadband connection and what the impact has been on their business. The sample should also aim to include new

businesses or businesses which have recently moved to the area to understand the role that broadband played.

3.22 Given that there has already been a large scale evaluation of the Wales SFB programme funded under the 2007-13 programme, which took a very similar approach to the above, there is likely to be little value in conducting a further evaluation using this method. Survey respondents may also find it difficult to recall the changes they implemented and the impact on their business, given the time that has elapsed.

Conclusion

3.23 DCMS's evaluation of the BDUK funded SFB programme shows that it is feasible to conduct a counterfactual impact evaluation of digital infrastructure investment in Wales. This could be applied retrospectively to the national roll out of SFB funded in the 2007-13 programme, by using areas that benefitted from broadband in later phases as a control group for areas that received coverage earlier. This is a quasi-random method which could potentially achieve a Level 4 on the SMS scale. However this approach is dependent on:

- There being no systematic differences between areas that received coverage at different times that are correlated with economic outcomes (eg higher productivity). This would need to be tested by the evaluation.
- The detailed data on roll-out at postcode level still being available.

3.24 This would be a firm-level approach and therefore would not capture all of the displacement, spill-over and multiplier effects that affect additionality. The evaluation would therefore need to make some additional adjustments to estimate impacts for Wales as a whole, either using a separate business survey or by making assumptions informed by guidance and existing studies.

4. Learning Infrastructure

Nature of interventions

4.1 The main focus of ERDF investments in learning infrastructure have been improving FE college campuses to provide modern learning environments and equipment for students. In the 2000-06 programme these tended to be small scale improvements to FE college facilities (eg new ICT teaching facilities and equipment). The 2007-13 programme funded only two investments, but these were both much larger projects involving the development of whole new FE campuses (Nantgarw, part of Coleg y Cymoedd, and the Blaenau Gwent Learning Zone, part of Coleg Gwent).

Outcomes and impacts

4.2 The main outcomes that an evaluation would need to measure include:

- Changes in participation in FE eg an increase in the number of learners studying and gaining qualifications.
- Change in the number of learners progressing to further study or employment and potentially future increases in earnings.
- Changes in employer engagement with colleges, leading to increased employer investment in training/apprenticeships and wider performance gains such as improved productivity.

4.3 Any impact assessment would also need to assess displacement, which could arise if students who would otherwise have studied at other colleges or campuses, choose to study at colleges which have received investment instead.

Timing of outcomes and impacts

4.4 Depending on the precise nature of the investments in FE facilities, they would be expected to generate outcomes and impacts over a sustained period (normally at least 10-15 years) providing the facilities and infrastructure continue to be used in the manner intended, the equipment is still fit for purpose (given obsolescence can occur and there may be a need for reinvestment) and there is continuing demand from students.

4.5 In terms of impacts on college level performance (eg enrolments and attainment levels) it should be possible to measure change within one or two years of the investment taking place, as the improved facilities should, in most cases, provide immediate benefits for teachers and learners. However it would take a longer time for other outcomes to emerge:

- Any impacts on progression would only emerge after 3 to 4 years as the first cohort of learners from the improved facilities enter the labour market.
- It may take time to raise employer awareness of the new facilities and to build relationships with employers before this results in any change in behaviour (eg increased investment in apprenticeships) and effects on productivity. It is difficult to be precise, but this should take at least five years from the investment.

Possible Counterfactual Methods

4.6 Studies which have successfully carried out counterfactual impact assessments of capital investment in FE colleges have done so by assessing change in performance for colleges themselves (eg numbers of enrolments, achievement and retention rates). The best example of this is a study by Frontier Economics and BMG[3] which compared the performance of colleges before and after capital investment, with regression analysis used to estimate the change in outcomes for every £1 million of capital spending completed over a given period.

4.7 This study ruled out a matched control group approach, in which the performance of FE colleges which received investment are compared with other colleges which did not, before and after investment (after controlling for differences in observable characteristics). This was on the basis that most colleges undertook some form of capital investment, meaning there are only a small number of colleges which have not undertaken capital investment that could act as a control group. Furthermore, treatment/control group approaches use a binary treatment variable (treated/untreated) whereas capital investment is a continuous variable, with some colleges receiving more investment than others.

4.8 A similar approach would not be feasible for ERDF funded investments for the following reasons:

a) the evaluation would need to assess the impact of the ERDF funded project, not the total capital investment in each college. Therefore a matched control group approach which compares performance with colleges that did not undertake capital investment may be the only option. This would encounter the same difficulties described above.

b) The number of colleges in the treatment group would also be very small. The Phase Two report identified 54 investments in learning infrastructure (52 of which were in the 2000-06 programme). Only 28 of these were investments in FE colleges, with the remainder being community based learning hubs, universities or other training facilities. The FE projects also include some very low value investments; six had a total project value of less than £300,000, which would make it difficult to detect measurable change in outcomes.

4.9 In summary, both the treatment and control groups may be too small to assess the impact of ERDF investment on college level performance in a way which yields robust results.

4.10 It should be possible to carry out a matched control group approach to assess the impact on student level performance and outcomes. In this case, the treated group would be students who enrolled at the college after the capital investment. The main challenge would be overcoming selection bias, which arises because some learners decisions of where to study could have been influenced by the investment. There is therefore likely to be some self-selection into the treatment group which could be due to unobserved characteristics which also affect learner outcomes (eg higher levels of ambition or people who place greater importance on the value of education).

[3] Frontier Economics Ltd and BMG Research Ltd (2012): Evaluation of the Impact of Capital Expenditure in FE Colleges on behalf of Department for Business Innovation & Skills

4.11 This risk could be reduced by only including learners whose home addresses fall within the catchment area of the previous college campus(es) in the treatment group, on the grounds that they are more likely to have enrolled at the campus anyway compared to learners from further afield. However the risk cannot be eliminated entirely.

4.12 It would be possible to construct matched control groups from the following, with matching based on observable characteristics such as prior attainment, ethnicity, subject studied and other socio-economic indicators:

- Learners who studied at the previous campuses (i.e. before the investment took place). This is likely to offer the most robust counterfactual since earlier cohorts of students from the same area are likely to share many characteristics with later cohorts.
- Learners at other campuses belonging to the same college group.
- Learners from other colleges, with matching also informed by college level and area based observables.

4.13 However this approach would only achieve a Level 2 on the SMS scale because it can only match on observable characteristics and does not fully address the issue of unobservable characteristics. As noted in Chapter 2, assessments using matching techniques can achieve Level 3 if outcomes for the treatment and control group can be compared before and after an intervention, using techniques such as difference in difference (this is explained in more detail in Chapter 5).

4.14 However a before-and-after assessment is not possible in this case because there are no consistent performance indicators available for the treated group. Students enrolled or achieved their qualification either before the capital investment or after it but not both, meaning it is not possible to assess change in participation or achievement before and after.

4.15 These approaches would be reliant on accessing data from the Individualised Learner Record (ILR) which provides data on pupil characteristics, location of study and education history for individual pupils. This is available from 2002/3 onwards so should be available for a retrospective evaluation. In theory, it should also be possible for an evaluation to assess the impacts of investment on longer term learner outcomes eg progression to sustained employment and future earnings. This would be reliant on matching ILR with other datasets such as HMRC tax records. This is now done routinely through the Longitudinal Education Outcomes dataset, but this does not match all records.

4.16 There are limited prospects through which to assess the impact of capital investment in college facilities on businesses. There is no current basis for linking individuals to employers or employers to colleges (other than via survey methods) and therefore no basis on which to assess the scale of any local contribution.

Alternative approaches

4.17 There are few obvious alternative approaches that could be applied to assess the impacts of investment in FE colleges. A theory of change approach could potentially be used to explore the factors which contributed to changes in college performance indicators such as enrolment and attainment, and the role of capital investment. This could use surveys or focus groups involving members of staff who taught at the

college before and after the investment, to investigate the ways in which improved facilities have improved the quality of teaching and learning and affected student behaviour and outcomes. This would only be feasible for the investments funded during the 2007-13 programme and would be less robust than the methods described above.

4.18 There may be value in conducting a local employer survey for the two most recent investments to capture impacts on local businesses. This could survey employers who have engaged with and benefited directly (e.g. from recruiting students) from the college to elicit their views on the benefits of the upgraded facilities relative to the previous campuses, the extent to which it has enabled the college to better meet their needs, and the nature and scale of any changes or investments they have made as a result. This would potentially encounter a number of challenges, including identifying a suitable sample of businesses that have engaged with the college and their ability to recall benefits or changes which may have occurred many years ago.

Conclusion

4.19 It would be very difficult to carry out an impact evaluation of investments in FE colleges that meets a minimum score of 3 on the SMS scale. The tried and tested approaches have all assessed impacts of infrastructure on the performance of colleges, however this would not be feasible in this case due to the low numbers of colleges that have received ERDF investment and the low numbers that have received no capital investment at all. This would make it difficult to construct a treatment and control group of sufficient size to give robust results.

4.20 The most robust option in this case is likely to be a matched control group approach, which compares completion and attainment rates for a cohort of students who enrolled after the investment with a cohort from before the investment took place. This would need to control for any variables which could explain differences in performance between the two cohorts, including pupil characteristics and time related variables. It is also important that the treatment group is made up of students from within the college catchment area to minimise the risk of selection bias. It would also be feasible, in theory, to assess differences in longer term outcomes such as employment rates and earnings, although this would be subject to matching ILR wth other datasets which could be difficult in practice.

5. Research & Innovation Infrastructure

Nature of interventions

5.1 Interventions in this theme included:

- Development of incubation facilities which provide an environment for start-up businesses to grow, including access to flexible office space combined with onsite business support and advice. In some cases, these were located within higher education and research institutes and had a clear sector focus.
- Investment in new research and innovation facilities, equipment, and related infrastructure. Again this was often located in higher education and research institutes, and linked to the key research strengths of Welsh universities (e.g. Institute of Life Science at Swansea University).

Outcomes and impacts

5.2 The main intended business related outcomes from ERDF investment in R&I infrastructure was:

- an increased level of R&D and innovation activity amongst businesses that use the facilities and associated support services, possibly leading to registering of patents
- the introduction of new technologies, products, and services (both new to firm and market)
- the establishment and/or growth of the businesses that utilise the infrastructure and services
- the possibly of clusters of specialist technology and innovation rich business in particular sectors.

5.3 The investments may also encourage increased cooperation and collaboration between businesses and university researchers, leading to increased and better use of research for the purpose of innovation (i.e., translation of research into marketable innovations).

5.4 The investment may also help to increase the registration of patents, levels of R&D and enterprise and growth at a sub-national and national level.

Timing of outcomes and impacts

5.5 Depending on the precise nature of the R&I investments, they would be expected to generate outcomes and impacts over a sustained period (normally at least 10-15 years) providing the facilities and infrastructure continue to be used in the manner intended, the equipment is still fit for purpose (given obsolescence can occur and there may be a need for reinvestment) and there is continuing demand for use from businesses and researchers. There are instances where the R&I investments grant funded through the Wales ERDF programmes have ceased operating in their intended manner (eg a number of the Techniums) and this will have curtailed the benefit realisation.

5.6 In terms of the timing of impact on businesses using the R&I facilities, access and use can be expected to improve businesses' innovation behaviour over a relatively

short time-period. This might include, but is not limited to, increases in the business' investment in R&D, and the no. of collaborations (especially with universities) engaged in. These impacts might become evident and recordable within 1-2 years of an investment, or even sooner.

5.7 The ultimate impact of changes in innovation behaviour on improved business performance (via increased research and innovation) would be expected to occur over a much longer time-period. This is because innovation can take a long time to affect bottom-line performance, subject to the precise nature of the research and innovation undertaken, and assuming that the innovations produced are accepted by the market. The latter is an important consideration since most innovations fail.

5.8 However, it is important to bear in mind that research and innovation focused businesses may only use the facilities and equipment for a limited time period, as well as being likely to access other facilities and forms of business support. As a consequence, the attributable benefits associated with this use can be expected to decay over time[4]. Given the elapsed time since the investment were made through the 2000-06 and 2007-13 programmes, then it should be possible to assess these impacts subject to the availability of suitable data.

5.9 There is a premium on accurate record-keeping in terms of:

- when businesses or researchers began to make use of the new infrastructure/facilities and collaborative research support
- their level of innovation and R&D investment at this time
- their innovation-related behaviour such as degree of interaction and cooperation with HEIs at this point in time
- key business metrics including a URN, employment and turnover.

5.10 The gathering of this pre-treatment data is normally very important, so as to provide an accurate 'baseline' against which to compare later on when these businesses have made use of the new infrastructure/facilities for some time, and also for the purpose of accurate matching to businesses not making use of the new facilities / infrastructure, should a matching-control group approach be useful. However, in this instance this data was not systematically captured by projects, or if it was it is unlikely to be still available to evaluators.

Possible Counterfactual Methods

5.11 The options for counterfactual methods may be constrained by the available monitoring data for R&I investments. As indicated above, data covering the business and innovation metrics of the business users would need to be available pre and post support.

5.12 If information on the identities of the business users are available, the main way of Identifying a counterfactual would be to use statistical matching methods to control for observable/unobservable characteristics. One of the most common mechanisms for constructing control groups is Propensity Score Matching (PSM). The objective is

[4] Academic (Enterprise Research Centre (2017): Assessing the business performance effects of receiving publlicly funded science, research and innovation grants) and government research (BEIS (2017): The impact of public support for innovation on firm outcomes) on the persistence of business benefits of public sector funded R&I interventions suggest persistence of between 4-5 years

to identify treatment and control groups that are very close in terms of observable characteristics. Instead of trying to match based on individual characteristics, however, the match is made on the likelihood or propensity (effectively the probability) to participate or be treated.

5.13 The main drawback with PSM is that it can only match on observable characteristics and does not address the issue of unobservable characteristics. As such, matching is scored at level 2 on the SMS scale. Consequently, PSM is often combined with other techniques of which difference-in-difference (DiD) analysis is particularly prominent.

5.14 Difference-in-differences techniques are based on a simple contrast between the (before and after intervention) difference in outcomes for both a treatment and control group. The approach improves on matching because, in introducing a time element, it provides a way of dealing with unobservable differences between treatment and control groups. Introducing time is useful because if there are some unobservable factors that are time invariant, then any change in performance over time cannot be due to these if they do not change with time.

5.15 Consequently, on the assumption that treatment and control groups have already been matched, and that the composition of the groups does not alter, the primary benefit of the technique is that the before/after contrast can account or control for time-invariant unobserved characteristics between the treatment and control group. As such, matching and DiD combined, achieves a level 3 SMS score.

5.16 A key aspect of the analysis is determining the population or sample from which a counterfactual is drawn. The difficulty empirically in this instance is not only that the evaluator needs to data to identify the beneficiary businesses (which is not a complete dataset for the reasons described above), but that the same (or similar) data needs to be available for the comparison group. Further, impact analysis requires evidence both before and after support and accessing time-series data measuring performance is a further challenge.

5.17 The core approach uses the BSD to identify similar businesses. However this only has a limited set of variables, covering the level and recent change in employment and turnover of the business, its industry, age and location. Matching on these characteristics is relatively simple way of finding a control group, so that the control group looks similar to the supported businesses in a few variables, but leaving many unobserved aspects that could have driven the ERDF support. The main criticism is the approach using the BSD is that:

- it does not include data covering a business' inclination to grow, as well as factors which influence propensity to innovate, and there is a risk that supported businesses have a greater inclination innovate and grow
- the dataset does not cover very young businesses, although if enough time has been allowed to elapse (which is the case here) these should appear in the data if they grow.

5.18 ONS is prepared to link other datasets into the BSD, which may help to explain performance. Of relevance to R&I infrastructure is patents and other IP (often correlated with innovation), any past support that businesses have been given (correlating with a firm's ability and inclination to seek support) and ONS surveys such as ASHE and Innovation Survey (which may indicate quality of employment being created and innovation). However, it is important to remember that linking in

this way can only be done for the businesses sampled in the surveys, which will significantly reduce the value to this analysis.

Alternative methods

5.19 There is the possibility of using spatial differencing techniques which use a variant of the techniques described above in terms of the identification of the treatment businesses in the BSD (possibly in conjunction with PSM) if spatial boundaries act as form of discontinuity in receipt of support. If the unobservable characteristics of neighbouring areas vary smoothly or continuously across the boundary at which policy eligibility/intervention ceases, then it is possible to use treated and non-treated neighbouring areas as a basis for impact assessment and then PSM can improve the matching if other relevant data is available (see Chapter 6 which considers the strengths and limitations of this approach in more detail).

5.20 Whilst this method would be available for investment which have a clearly defined spatial impact, such as for incubation space due to businesses locating in the facility for a certain time period, it is less relevant for research facilities and equipment that can be accessed by researchers and businesses located in a much larger geographical area.

5.21 The other potential for a counterfactual is through the surveying of businesses receive R&I support as well as a comparison group which share similar characteristics but do not access the facilities. However, the elapsed time will mean that the businesses (and any comparison group) will struggle to recall accurately the impact of the support upon their business and may be unwilling to engage or no longer exist.

Conclusion

5.22 Whilst the counterfactual method described above (linking beneficiary business to the BSD, the use of PSM methods to select a comparison group, difference-in-difference analytical methods, and addition of other innovation datasets) is well tested for the types of R&I infrastructure covered by the ERDF programmes, the ability to undertake it successfully in this instance is heavily constrained by a number of factors:

- the very limited monitoring data available on the business beneficiaries which is necessary to allow successful linking to the BSD, as well as non-availability of other beneficiary level metrics on innovation activity pre and post support
- the considerable amount of time which has elapsed since businesses received the support, given the likelihood that innovation and growth orientated businesses are likely to have gone on to receive other forms of both free and paid for innovation and business support services; whilst does ensure that the impact of the ERDF will have been realised, it will be difficult to disentangle the impacts from other forms of support.

6. Sites & Premises

Nature of interventions

6.1 These interventions all aim to increase the supply of business premises in Wales, either by:

- Providing support to bring forward employment sites for development by investing in site remediation or site infrastructure (eg access roads, utilities), or
- Development of new business premises, either through public sector delivery or a developer grant to overcome a commercial viability gap.

Outcomes and impacts

6.2 The main beneficiaries of ERDF support are growing businesses seeking higher quality or larger premises, and businesses moving into an area. This should enable these businesses to increase their turnover and employment as they grow, to enhance their productivity through occupying more suitable premises (and potentially from co-location with similar businesses or support providers) and to invest/relocate into a new location which provides new business opportunities.

6.3 In terms of the ERDF programme, these business occupiers are indirect beneficiaries and their details are not routinely collected as part of the project monitoring systems. This raises an issue about how the occupiers can be engaged with as part of the evaluation process.

6.4 The range of intended economic impacts include:

- Additional wealth and employment creation in local economies, and the growth of local businesses and the attraction of inward investors
- Enhanced economic competitiveness of local economies and the closing of the performance gaps with more prosperous areas.
- The establishment of new investment locations, often as part of a wider masterplan and in conjunction with other substantial investments from public and private sources
- Improved land values and rents for commercial and industrial property through the removal of negative externalities and increased demand in property markets (however, the increase in supply can also put downward pressure on property markets in the short term).

6.5 The investments can have a variety of other economic effects which need to be considered as part of an assessment of overall net economic impacts. These include:

- Investment deadweight - the extent to which developers would have made the particular investments which they did in the absence of ERDF support
- Occupier deadweight - the extent and nature in which the provision of the sites and premises influenced the locational and business decisions of the occupiers
- Relocation effects - the extent to which the provision of the ERDF backed sites and premises led to the relocation of business activity from other sites and

premises, thus leaving vacant floorspace elsewhere. The impact is less likely to be negative in terms of displacement if:

  - the new occupiers are from outside the local area (especially if they are international)
  - the move of local businesses facilities growth and improved productivity they otherwise would not have achieved
  - the freed up sites and premises enables the growth of other local businesses.

- Wider displacement and substitution effects - the enhanced performance of the occupiers, if this is achieved, may lead to a variety of wider dynamic market and factor effects including the displacement of activity of other local businesses or increased competition for labour and skills. There may also be multiplier effects associated with increased expenditure.

Timing of outcomes and impacts

6.6 Although it is possible for some schemes to be delivered and occupied fairly quickly (with lead in times of a minimum of two years), the delivery of remediation, site infrastructure, premises and marketing and the subsequent occupation by businesses usually takes much longer. This is particularly the case where the programme is funding major remediation and site infrastructure improvements, major new business locations or investment in areas where property markets are particularly weak.

6.7 Consequently, it is not uncommon for the full range of economic impacts to take between five and ten years to materialise. However it can take longer; the Phase Two report identified a number of employment sites that received investment in the 2000-06 and 2007-13 programmes which have yet to be fully developed (or in some cases even partially developed) and are still largely unoccupied. Therefore, if a retrospective evaluation was undertaken, this should ideally focus on large sites which have been fully developed and occupied.

Possible Counterfactual Methods

6.8 Any impact evaluation would need to consider:

- the extent to which development might have occurred in the absence of ERDF support
- the displacement of other development activity by the ERDF backed activity
- the role of the sites and property development in facilitating the growth amongst local SMEs, the retention of this activity or the attraction of new activity.

6.9 There are a number of possible approaches which could be considered, including between site-level, firm-level and spatial approaches.

Site-level approaches

6.10 Site level approaches construct a counterfactual by identifying other employment sites or development projects with similar characteristics to establish causality

between ERDF funding and the rate and nature of development. The main challenge for these approaches is resolving selection bias issues. These arise because those sites and projects which benefitted from ERDF investment were most likely selected because they were more attractive to the market (and therefore more likely to be developed) than other projects. The risk of selection bias could be mitigated through use of the following:

- Regression Discontinuity Design (RDD): A quasi-experimental approach which relies on the selection method for sites. If there is a quantitative score which determines if sites receive investment, this method would compare the outcomes for sites which are just above the success threshold to ones which are just below. The logic is that these sites, once observed differences are controlled for, should be similar in their challenges and market prospects. In theory, this could be feasible on certain sites and premises programmes such as the Property Infrastructure Fund and Property for Business Development Grants programmes funded during the 2014-20 programme which attracted a large number of applications and selected sites using a scoring system.
- Phasing: this would rely on comparing the outcomes associated with sites over time between an area which receives support in an initial phase to areas which receive support in subsequent phases.

6.11 However, both of these would need to address other challenges, not least the range of unobserved characteristics of sites (eg unknown contamination costs) and local property markets (eg local drivers of demand) which would be very difficult to control for.

6.12 Finally, these site level approaches would only help to establish the causal effects of ERDF in encouraging development, and would offer little insight into effects relating to ongoing business performance impacts. The approach would therefore need to be supplemented by other research methods to provide this information.

6.13 Given the evidence of the strength of market failure in most parts of Wales, it is highly unlikely that comparable sites would be progressed in the absence of public sector assistance. Therefore these site level approaches may provide very little additional insight.

Firm level approaches

6.14 A firm-level approach would focus on the locational decisions of occupiers drawing on longitudinal data for firms relocating or establishing new locations through the BSD. The propensity of relocation in areas with employment site and premises investment could then be compared to comparable areas (possibly based on areas with schemes completed at an earlier and a later stage).

6.15 The approach is considered to have limited viability for a number of reasons:

- The sites and premises funded by ERDF have very different characteristics and reasons for them being brought forward also differ, which it is difficult to control for

- Other factors may have a major influence on relocation effects, such as the attraction of a large company to the local economy which might have attracted suppliers to the ERDF backed sites
- It will not always be possible to identify occupiers of the ERDF backed schemes in the BSD, especially start-ups and younger companies.

6.16 A simpler variant of this approach would be to identify the change in turnover and employment amongst occupiers through the BSD and to compare this to a matched comparison group from the same locality identified through this database (matched on the basis of size, sector, location). However, there would be no information on the property and location choices of the comparison group and hence it would provide little insight into causality.

Spatial differencing approaches

6.17 These approaches (also sometimes referred to as Boundary Analysis or Proximate Area Analysis) focus on the change in outcomes (eg the number and performance of businesses) in a treated area compared to change in outcomes in neighbouring areas.

6.18 This exploits the fact that the spatial boundaries of the intervention site act as a form of discontinuity in receipt of support. If the unobservable characteristics of neighbouring areas vary smoothly or continuously across the boundary at which policy eligibility/intervention ceases, then it is possible to use treated and non-treated neighbouring areas as a basis for impact assessment, as long as other variation in observable characteristics can be controlled for (eg firm level or area level characteristics). In this case, the treated area could be defined around an employment site (eg within a certain radius or using existing geographies such as Lower Super Output Areas) and control areas configured as concentric rings around the employment site. A DiD approach can then be applied to BSD data to assess the impacts before and after investment. As such, it is likely that this option will achieve a level 3 SMS score.

6.19 Since it is possible that businesses could also benefit from being close to the employment site without being located within the boundary (eg through proximity to clients or collaborators), these approaches can also help to understand how the treatment effect varies with intensity at different distances from an intervention. The standard DiD approach can be altered to allow the control group to change in size by varying geographical distances of comparison firms (the control group will increase in size when more geographically distant firms are included in the analysis). This approach assumes all firms within a given distance of an intervention are treated, with areas close to an intervention receiving the treatment more intensively than areas further afield.

6.20 A spatial approach has the advantage of controlling for any displacement or crowding out effects within the treated area (since any effects would be accounted for by making an assessment at area rather than site level). However there is the risk of further displacement from locations outside the treatment area boundary, which would need to be accounted for. Relocation effects (eg jobs relocated from other parts of Wales) could be estimated using the BSD's tracking of firm location. Wider displacement effects would be more difficult to assess, and would need to be

estimated using a separate business survey or by making assumptions informed by guidance or existing studies.

6.21 Spatial differencing is an established method for assessing the impacts of area based interventions. However, the evaluators are not aware of any studies which have successfully applied this approach to employment site interventions in the UK. The main challenges that would be expected are as follows:

- Identifying beneficiary businesses: the details of beneficiary businesses (occupiers of ERDF funded sites and premises) have not been recorded so would need to be identified through another method in order to match with the BSD. This should be more straightforward than for R&I interventions as it could be done by matching postcodes within employment site locations with BSD records using Geographic Information Systems (GIS). However it should be noted that the research conducted in Phase 3 of this study was only able to identify 400 businesses occupying sites and premises funded by ERDF. This used Companies House data rather than BSD but raises the risk that the sample size may be limited.
- There are potentially a very wide range of factors which could influence outcomes in spatial zones of different proximity to the intervention site, which would be difficult to control for. Examples include density, land use designations and levels of investment from the public and private sector. It may also be difficult to gather all of the data needed for modelling at such a localised level.
- Many of the sites and premises interventions funded by ERDF are likely to be too small in scale to provide a meaningful basis for this type of analysis. It is difficult to provide a minimum size of intervention due to the lack of studies which have applied these techniques and the potential for different sizes of sites to have varying economic impacts depending on the nature of development. To maximise the chances of interventions having a measurable effect at area level, it is advised that any studies focus on large employment sites of at least 15 Ha. However this would further restrict the sample size.
- These approaches are also not likely to be feasible for employment sites in rural areas as the difference between treated and control areas is likely to be too great.

Alternative approaches

6.22 The main alternative to the counterfactual approaches described above would be a theory-of-change approach using an occupier survey. This would assess the benefits of occupation to businesses and the extent to which these could have been realised without ERDF investment. An occupier survey has already been undertaken as part of this study (see Phase 2 report) which encountered difficulties in terms of identifying business beneficiaries and, as a result, failed to generate a large enough sample to provide robust results. There is little value in repeating this exercise.

Conclusion

6.23 Spatial differencing approaches offer the best option for undertaking a counterfactual impact assessment of sites and premises interventions. As long as sufficient business beneficiary details can be identified through GIS analysis of the BSD, these approaches would be technically feasible in theory. However this would be an experimental and complex approach, with few examples of where this has been successfully applied. It offers greatest potential for large interventions which are more likely to have had a measurable effect at area level, however this risks further constraining the sample size of businesses. Further analysis and piloting would therefore be required to determine whether it is feasible to apply these methods to ERDF interventions.

7. Tourism

Nature of interventions

7.1 The 2000-06 programme invested in a large number of small schemes, many of which aimed to use tourism to promote rural and coastal regeneration. The 2007-13 programme took a more strategic approach, funding a number of mini-programmes focused on particular strengths of Wales's tourism offer (heritage, coastal tourism etc). Much of this investment went into extending and enhancing tourism and visitor attractions and supporting public realm.

Outcomes and impacts

7.2 The main expected economic outcomes and impacts of the investments were focused on:

- Increasing and sustaining visitor volume and value in particular rural and coastal tourism destinations
- Enhancing the visitor experience in order to encourage repat visiting
- To some extent, extending the visitor appeal in order to attract visitors year round.

7.3 The impacts will be reflected in absolute and comparative tourism volume and value, visitor satisfaction and repeat visiting, and visiting patterns throughout the year. The shift in the 2007-13 programme period to a more strategic and spatially concentrated approach would be expected, in theory at least, to generate impacts which could be measured in the relevant data sources at local authority level, and destination level where this is captured. The more disparate nature and lower overall value of the investment in the 2000-06 programme means that it is less likely to pick up the impacts in data at this level.

7.4 Outcomes may also be expected to arise at the level of individual tourism businesses, either directly where businesses have received grant funding or indirectly where businesses benefit from a general uplift in visitor numbers and spending (eg hospitality, bars and restaurants, retail, activity and events businesses, other supply chain businesses etc).

7.5 The evaluation of projects and programmes focusing on sub-national visitor economies must also take account of displacement. It is possible that any additional increase in visitors to an area is partially or fully offset by a reduction in visitor numbers in other areas. For domestic visitors, the evaluation would also have to consider wider displacement in product markets.

Timing of outcomes and impacts

7.6 Most impacts would be expected to materialise shortly after investment as these should immediately improve the attractiveness of tourism assets and the visitor experience. Although it may take some time to raise visitors' awareness of the improvements and for this to translate in to increased visitor numbers (although this will depend on the type of infrastructure investment).

7.7 As with other types of infrastructure, a key issue will be whether these impacts are sustained. This will depend on whether they are maintained to a high standard and continue to be used in the manner intended. If this is the case then they would be expected to generate outcomes and impacts over a sustained period (normally at least 10-15 years).

Possible Counterfactual Methods

7.8 It would be very difficult to establish a counterfactual of the impact of investment on the local visitor economy. There may be a number of area-based methods which could be considered, although all of them come with challenges which would be difficult to overcome. Possible methods include:

- Comparing the performance of destinations before and after investment (eg visitor numbers and expenditure), as well as to similar destinations which do not receive investment.
- Analysing the performance of tourism businesses in general in targeted destinations before and after investment, and in comparison to matched businesses in similar locations which are known not to receive similar investment
- As above, but focused on tourism businesses which are known to have received ERDF grant investment.

7.9 One of the key challenges of assessing counterfactual impact of tourism investment is the nature and quality of data available:

- The national tourism volume and value datasets (International Passenger Survey, Great Britain Tourism Survey and Great Britain Day Visits Survey) do not have large enough sample sizes to allow statistically significant disaggregation to smaller spatial areas, whilst bespoke volume and value analysis (eg using the STEAM[5] model) is not consistently available by local authority area (including breakdown in the data by destinations) and over time (pre and post investment). Hotel occupancy data could potentially be used but this would underestimate visitor numbers/expenditure as it does not include day visitors.
- Whilst national employment data cover the relevant tourism sectors and is available at lower spatial areas, changes are driven not only by tourist and day visitor activity and expenditure but also by wider economy and residential factors.
- Visitor satisfaction and accommodation provider surveys are used only in some areas and even where they are used they can be sporadic in frequency and variable in their coverage and quality.

7.10 A further challenge is the scope to compare visitor areas receiving investment with comparable areas which do not. Most destinations will receive some form of public sector backed support for the tourism sector, although the level of ERDF investment will vary. Furthermore, a large number of the destinations receiving investment in 2000-06 and 2007-13 will have received investment from earlier and to a lesser extent, later funding programmes and initiatives. This would make it difficult to disentangle the effects of ERDF investments from other tourism investments.

[5] Scarborough Tourism Economic Activity Monitor

7.11 The limited number of destinations across programme areas and Wales as a whole will also make finding suitable like for like comparators which do not receive ERDF (or much lower levels of investments) challenging. It is possible to use of comparators outside of Wales, although it would be necessary to allow for the differences in economic context and trends.

7.12 Finally, area based approaches would only be feasible in those destinations which have received large scale investment in tourism infrastructure. This is because it is likely be difficult to detect any measurable change in outcomes if the area has received only modest investment. There are no studies or guidance available to inform what may be a minimum level of investment, but it may be advisable to focus on areas that received at least £5m in investment. This would be challenging because it is difficult to spatially map investment in tourism infrastructure, particularly where investment has been delivered through themed programmes (eg coastal, heritage etc), which was the case during the 2007-13 programme. This may result in the sample size in the treated group being too small.

7.13 In terms of the scope to use the methods noted above the key points are:

- **Comparative assessment of the performance of destinations before and after investment**: there is limited scope to use volume and value data due to data issues. Whilst there is scope to use ONS employment data, the nature of this data and fact that jobs are not just supported by tourists and day visitors reduces its usefulness (plus there are discontinuities in the data sets). Finding suitable comparators which have not received investment is a further major challenge which reduces its feasibility.
- **Comparative analysis of the performance of tourism businesses in targeted destinations before and after investment**: whilst it would be possible to use the BSD and PSM methods, the challenge is again the issue of finding suitable comparator areas from which to draw businesses, as well as the interrelationship between tourism and the wider economy in influencing the performance of these businesses over time (although there may be ways of allowing for this through the use of control variables). It is unlikely that this approach could secure an SMS score of 2 given these challenges.
- **Comparative analysis of the performance of tourism businesses which are known to have received ERDF grant investment**: this approach is unlikely to be possible due to the lack of programme monitoring data on businesses receiving grants.

7.14 All of these approaches would also fail to take account of displacement from within Wales. This could be assessed by examining hotel occupancy rates in neighbouring localities to estimate the net effects on visitor numbers across a wider target area. However, in reality displacement effects are likely to be very diffuse across the country so direct observation of visitor behaviour is unlikely to capture this displacement fully. The only robust way of assessing displacement would therefore to carry out a visitor survey to ascertain where (if anywhere) people would have visited had they not come to the area.

Alternative methods

7.15 The main alternative approach would be to assess impacts through a visitor survey, which explored people's reasons for visiting a particular location and the contribution made by ERDF investments. However this is unlikely to be feasible for the 2000-06 projects due to their small size and the amount of time that has elapsed. The tourism programmes funded through the 2007-13 programme have already been the focus of major evaluations including extensive visitor surveys. There is likely to be little value in repeating this exercise.

Conclusion

7.16 Counterfactual methods which score higher on the SMS scale do not lend themselves to tourism investments, and would be very difficult (if not impossible) to apply retrospectively. This is due to limitations with the data, difficulties isolating the impact of ERDF investment from other public investment and challenges identifying control areas that have not benefitted from investment. As such, there is likely to be little value in undertaking an impact assessment.

8. Transport

Nature of interventions

8.1 The main types of transport investment funded through ERDF have included the following:

- Investments in the strategic transport network, including road and rail investments. Examples include the Heads of the Valleys road investment and the Gowerton Redoubling rail project in Swansea.
- Investment in new or improved road infrastructure which improves access to employment sites or regeneration areas. Examples include the investments in new Peripheral Distributor Routes in Port Talbot and at the Works in Ebbw Vale.
- Investments in sustainable transport infrastructure, including pedestrian/cycling infrastructure and (non-strategic) public transport infrastructure. Examples include the redevelopment of the Quadrant Bus Interchange in Swansea and the opening of a new train station at Ebbw Vale Town.

Outcomes and impacts

8.2 There are a wide range of intended outcomes and impacts from investment in transport infrastructure, depending on the type of investment. These include:

- **Journey time savings**: the direct benefits to users (whether firms or individuals) of transport improvements can be measured in terms of time saved and/or reduced costs eg through reduced congestion. For business users this would translate into improved productivity.
- **Agglomeration effects**: productivity could also be improved through agglomeration effects by improving the matching of businesses and workers and creating the conditions for greater interaction and knowledge sharing between various economic actors (businesses, clients, suppliers, workers and collaborators).
- **Inward investment, locational patterns and land use**: transport investments can impact on the location decisions of firms and can influence housing policy and other land uses by helping to 'unlock' development sites.
- **Spending patterns and the visitor economy**: transport may have an important influence on the willingness of consumers and visitors to travel, which could lead to turnover growth in certain sectors such as retail and tourism.
- **Environmental benefits**: investments in public transport or pedestrian/cycling infrastructure could promote modal shift by encouraging some people to reduce the number of trips made by car, reducing congestion and carbon emissions.
- **Access to employment**: transport investments can reduce the cost of commuting, which can increase the distance a commuter is willing to travel for

employment, potentially encouraging greater participation in the workforce or a move to more productive jobs.

8.3 There is potential for displacement effects for some of the impacts described above, which would reduce the scale of net economic benefits. This particularly relates to increases in growth in a particular location which arise as a result of improved access to client markets following a transport intervention. If these client markets are predominantly based within Wales then displacement is likely to be high and would also need to be assessed as part of an evaluation. Similarly, any growth at employment sites which are unlocked by transport investment could be displaced from other parts of Wales which would need to be accounted for when translating gross into net impacts.

Timing of outcomes and impacts

8.4 The timing for outcomes will vary depending on which is being considered. User benefits arising from reduced journey times should start to accrue fairly quickly from the date the investment is completed, assuming that this immediately starts to reduce journey times or make travel easier (for instance by alleviating congestion).

8.5 Other outcomes could take longer to arise. Agglomeration effects will depend on how long it takes firms and workers to adjust their behaviour in response to greater connectivity (e.g. widening search areas or forming new relationships with clients or suppliers) and the time it takes for this to translate in to higher productivity. A study which carried out a meta-analysis of evidence from studies assessing the agglomeration effects of transport investment compared the scale of agglomeration elasticities over different time periods, distinguishing between the scale of effects in the short term (one year), medium term (up to five years) and long term (more than five years) (Melo et al, 2013[6]). The study found positive agglomeration elasticities over each time period, but that these were "considerably stronger in the long run than in the short or medium run", which suggests that these effects should ideally be assessed over a period of at least five years, but preferably longer.

8.6 The timing of growth and investment effects are also likely to vary. There may be immediate benefits if the intervention results in an increase in demand for businesses through improved accessibility (eg an increase in visitor numbers). Other effects may take longer to occur, and will depend on the time it takes existing firms and potential investors to adjust their investment decisions in response to the new road infrastructure. It will also depend on other practical factors, such as the time it takes to gain consent (if applicable) and for new commercial premises to be developed. There is no guidance on how long these effects might take to occur, although again it is likely to be around five years before the full scale of benefits can be assessed.

8.7 It is therefore expected that sufficient time has elapsed for impacts from the transport interventions covered by this study to have emerged.

[6] Melo et al (2013). The productivity of transport infrastructure investment: A meta-analysis of empirical evidence, Regional Science and Urban Economics, Volume 43, Issue 5, September 2013, p 995-706

Possible Counterfactual Methods

8.8 There are very few well established CIE methods for evaluating impacts of transport investment on productivity, and those that do exist are extremely complex.

8.9 RDD and control group approaches are not feasible because of the many differences between areas and transport projects and the large number of variables that would need to be controlled for (eg junctions, roads, roundabouts, sites with similar traffic levels, functions, capacity, mode mix, local area characteristics, proximity and underlying accessibility).

8.10 The most proven method for assessing impacts of transport investment is accessibility modelling. This involves the construction of a pre and post-investment matrix of journey times to identify potentially significant travel time savings between relevant origin-destination pairs. These and other relevant control variables are then fed into a modelling framework designed to assess the extent to which the transport investment explains variations in small area economic performance between locations at varying distances from the scheme as a basis for assessing their impacts. Examples of studies which have successfully implemented this type of approach are Gibbons et al (2012)[7] and Sanchis Guarner (2013)[8].

8.11 However it is not feasible to apply this approach retrospectively as it requires a large amount of monitoring data to be gathered before the investment takes place to build the matrix of pre-investment journey times. This data is not available for any of the ERDF funded transport investments.

8.12 A simpler and more feasible approach would be to use a spatial differencing method similar to the one described in Chapter 6 for sites and premises. This would draw isochrones of varying distances around transport infrastructure (eg around roads/junctions or stations in the case of rail infrastructure) and identify firms in the vicinity of investments and in surrounding rings using GIS analysis of BRD data. The performance of businesses in inner rings (most likely to be treated) could then be compared with those in rings at varying distances using a difference in difference approach, after controlling for variation in observable characteristics. If done effectively this option would achieve a level 3 SMS score.

8.13 While this could be an effective method for assessing the local impacts of transport investment, it would not capture all productivity benefits from journey time savings, and it would be necessary to make further adjustments to account for any growth in turnover or jobs that was displaced at a national level. Relocation effects (eg jobs relocated from other parts of Wales to be closer to the transport infrastructure) could be estimated using the BSD's tracking of firm location, but it would be more difficult to estimate other sources of displacement.

8.14 A spatial differencing approach would also face some of the same technical challenges described in Chapter 6. In particular, it may be very difficult to control for the wide range of factors which could influence economic outcomes in spatial zones of different proximity to the infrastructure.

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[7] Gibbons et al (2012): New road infrastructure: the effects on firms, SERC Discussion Papers, No. 117. Spatial Economics Research Centre, LSE.

[8] Sanchis-Guarner (2013) Driving up wages: the effects of road construction in Great Britain. SERC Discussion Papers, No. 120. Spatial Economics Research Centre, LSE.

Alternative approaches

8.15 Alternative approaches are as follows:

- **Post completion surveys/monitoring**: there are established methods for determining whether a transport scheme has delivered the benefits that were anticipated by comparing the costs and benefits predicted by the appraisal with the outturn figures. For example the Highways Agency's post opening project evaluations (POPEs) carry out an assessment of journey times and traffic flows after the project has been completed and use this to quantify user benefits. User benefits can also be estimated separately for business and none business user benefits. A similar approach can be undertaken for rail investments through monitoring and analysis of passenger numbers.
- **User surveys**: the use of user surveys is more feasible for public transport investments than for road investments. These can be used to assess the main benefits of investment e.g. modal shift and improved access to employment and other services (see the rail passenger surveys undertaken for the Phase 3 report).
- **Land use and development analysis**: where transport schemes were designed to unlock sites, analysis of local development framework documents, planning decisions and discussions with local planning officers can be used to determine whether development would have occurred in the absence of development. If this is the case, the level and nature of development can be assessed, and the number of jobs supported could be estimated using HCA job density benchmarks. This would need to take account of any relocation within the study area.

8.16 The approaches above are less robust than counterfactual methods and would not capture all of the impacts of transport investment, particularly quantitative estimates of the full range of productivity benefits. Nevertheless they are far less complex and resource intensive, and can be combined with each other through a case study approach to provide a good and rounded assessment of the key benefits of major transport investments funded by ERDF.

Conclusion

8.17 As with sites and premises, the CIE method which offers greatest potential for assessing the impacts of transport investment is spatial differencing combined with DiD. However, the same caveats made in Chapter 6 apply here. This would be an experimental and complex approach best suited to large transport investments, and it may prove difficult to control for the full range of variables which explain differences in economic performance in zones of different distance from the transport infrastructure. Further analysis and piloting would therefore be required to determine whether it is feasible to apply these methods to ERDF interventions.

8.18 If it is not considered to be feasible, an alternative would be to scrutinise some of the larger transport investments funded through ERDF through a case study approach using secondary evidence on effects on journey times and land use and development alongside survey evidence and qualitative evidence gathered from local planning officers, project delivery staff and other local stakeholders.

9. Conclusions and Recommendations

9.1 This report shows that the feasibility of retrospectively assessing the impact of infrastructure investment using CIE methods varies for different types of infrastructure:

- Feasibility is greatest for digital infrastructure. There is a proven method for assessing these impacts in Walse (taking advantage of the staggered rollout of broadband investments), and the data should still be available to replicate this approach for the investment in SFB during the 2007-13 programme, subject to certain caveats.
- It should also be feasible to assess the impact of investments in new FE colleges using ILR data to implement a matched control group approach. However, since this could not be combined with DiD, this would only be able to achieve a Level 2 score on the SMS scale.
- Spatial differencing combined with DiD should be feasible for large investments in sites and premises and transport infrastructure. However this is an experimental approach which is untested in the UK. Therefore its feasibility would need to be tested further through a pilot study. This approach would also not capture the full range of impacts of transport investment.
- CIE methods are unlikely to be feasible for investments in tourism and R&I infrastructure. Although there are proven methods for assessing impacts from R&I these require monitoring data which is unlikely to be available for the 2007-13 programmes. Applying CIE methods to tourism infrastructure would face a number of insurmountable challenges.

9.2 The table overleaf provides our conclusions in relation to each of the research questions for each type of infrastructure.

9.3 Although retrospective CIE should be possible in a number of cases, the evaluators' view is that this is better planned pre-investment as part of a monitoring and evaluation strategy. This has a number of advantages:

- It allows for the collection of tailored and high-quality monitoring data, which is essential to measure the impacts of certain types of infrastructure.
- It allows the evaluators to combine CIE with other methods to provide more insightful findings (eg survey evidence). Although CIE methods can provide quantitative estimates of impact, these provide limited insight on how benefits were generated or what worked well. By combining with survey evidence and other methods (eg linking administrative datasets such as BSD with the responses to longitudinal surveys) it is possible to gain far greater insight into an intervention's key success factors, and generate lessons for future interventions.

	Most suitable counterfactual methods	Data requirements	Minimum scale	Timing
Digital infrastructure	DiD approach comparing performance of businesses in postcodes that received coverage of SFB earlier in the roll-out with those who received it later (max SMS Level 4)	Monitoring data on the postcodes which received coverage at different points in time. This would be matched with BSD records.	The main concern is that there are sufficient data points (postcodes) in the treated and control group to generate robust results. This should not be an issue given the size of the programme funded in 2007-13	Impacts should be assessed after three years of receiving support, but this can be done retrospectively.
Learning infrastructure	Matched control group approach comparing attainment and longer term outcomes for learners pre and post investment (max SMS Level 2).	ILR data needed to match learners based on observable characteristics. This would need to be matched with HMRC data is examining longer term outcomes which may be problematic.	This would be best applied to investments which have affected a large number of learners. Therefore large campus redevelopments such as those funded in 2007-13 would be more suitable than smaller projects from 2000-06.	Impacts on attainment could be assessed one to two years after investment. Impacts on learner outcomes should be assessed five years after investment. This could be done retrospectively.
Research & Innovation	Use of PSM and DiD for assessing impacts is well established (max SMS Level 3). But unlikely to be feasible in the absence of monitoring data.	Extensive monitoring data required on beneficiary businesses, support received and innovation behaviour, which is unlikely to be available.	No minimum scale of capital investment, but studies would be best focused on larger investments to maximise the sample size in the treated group.	Changes in innovation behaviour could be measured within two years of investment but impacts on business performance likely to take at least five years.
Sites & premises	Spatial differencing combined with DiD offers greatest potential (max SMS Level 3). But further work would be required to determine whether this is feasible due to experimental approach and risk of low sample sizes.	Businesses within treatment and neighbouring areas would need to be identified in BSD using GIS.	Approach would be best suited to large investments which are more likely to have had a measurable impact on local economic performance. There is no guidance on this, but a minimum size of 15 Ha may be advisable.	Given the time required for sites to be developed and occupied, an impact evaluation should be undertaken at least five years after the investment. This could be done retrospectively.
Tourism	Area based, matched control group approaches are possible in theory, but unlikely to be feasible in practice due to lack of data,	Local data on the volume and value of tourism would be required. Existing datasets do not have large enough sample sizes to provide robust data at	Area based approaches would only be suitable in locations which have received large scale investment in tourism infrastructure. There is no	Impacts should be measurable within two years of investment, but could take a longer time for full impacts to emerge. This could be done retrospectively.

	difficulties isolating ERDF from other tourism investment, identifying control areas and small sample sizes in the treatment group.	local level. All alternative datasets have weaknesses which may be unsurmountable. Data would also be required on total public investment in tourism infrastructure to identify control areas, which is also unlikely to be available on a consistent basis.	guidance on this, but a minimum investment of £5m may be advisable.	
Transport	Spatial differencing combined with DiD offers greatest potential (max SMS Level 3). But further work would be required to determine whether this is feasible due to experimental approach.	Businesses within treatment and neighbouring areas would need to be identified in BSD using GIS.	Approach would be best suited to large investments which are more likely to have had a measurable impact on local economic performance. This should focus on strategic road and rail investments.	Given the time required for firms to adjust to new transport infrastructure, an impact evaluation should be undertaken at least five years after the investment. This could be done retrospectively.

Recommendations for Future Evaluation

9.4 The main purpose of the report has been to assess the feasibility of undertaking a retrospective impact evaluation of investments in economic infrastructure rather than planning evaluation of future interventions. Given the wide range of interventions which could be funded it is very difficult to make specific recommendations. However, there are a number of general best-practice recommendations for the design of future evaluations which should be applied on future evaluations.

9.5 We would recommend that all evaluations are conducted in line with the HM Treasury Magenta Book[9], which provides guidance on what to consider when designing an evaluation. Key recommendations from the Magenta Book are as follows:

- Planning for the design of an evaluation should start early. Building evaluation onto an intervention's design will ensure that the evaluation delivers useful findings and that the right data is collected in the most efficient way possible.
- Undertake an initial scoping exercise before the intervention starts. This should be built on a thorough examination of the theory of change for the intervention, which synthesises the existing evidence for the intervention, identifies the nature of outcomes, who is affected and how these outcomes will come about. Key considerations for infrastructure evaluations are whether there are direct or indirect beneficiaries, and the time it will take for outcomes and impacts to emerge
- After understanding the theory of change, the evaluation will need to determine the most suitable approaches to assessing outcomes and impacts. The main types are experimental and quasi-experimental approaches and theory-based approaches. Although the former is considered to be more robust, these are often not practical for many evaluations. The Magenta Book provides guidance on the factors which should be considered when choosing the most appropriate approach, and the full range of specific methods that could be applied. For each of the main outcomes and impacts, the scoping exercise should set out the most appropriate method and the justification for this.
- The collection of data required for an evaluation should be planned as part of the scoping exercise. A robust theory of change can be used to identify data needs and gaps. This should consider:
    - What type of data will be required to answer the key evaluation questions?
    - Who or what can provide this data?
    - Are there any issues with accessing or collecting this data?
    - What section of the population of interest should data be collected from?

[9] HMT_Magenta_Book.pdf (publishing.service.gov.uk)

- How will the proposed data analysis method influence the data required?

After answering these questions, the scoping exercise should set out the monitoring requirements for the evaluation and recommend the systems which should be put in place.

- The scoping exercise should consider when is the best time to evaluate impacts. This should be informed by an assessment of the time it will take for impacts to emerge. However there may be value in undertaking evaluation at different points, particularly if the impact evaluation is being undertaken alongside a process evaluation. Undertaking a formative or interim evaluation while the intervention is still in delivery can allow the evaluators to undertake an initial impact assessment or tests its feasibility, and to assess whether there is a need for changes to any monitoring systems or data requirements.

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