Office for National Statistics

Foreign Direct Investment

National Statistics Quality Review: Series 2

July 2016

Report No.: **4**

Editor: **Gareth James**

Office for National Statistics

NSQR Series 2

Report 4

About us

The Office for National Statistics

The Office for National Statistics (ONS) is the executive office of the UK Statistics Authority, a non-ministerial department which reports directly to Parliament. ONS is the UK government's single largest statistical producer. It compiles information about the UK's society and economy, and provides the evidence-base for policy and decision-making, the allocation of resources, and public accountability. The Directors General of ONS report directly to the National Statistician who is the Authority's Chief Executive and the Head of the Government Statistical Service.

The Government Statistical Service

The Government Statistical Service (GSS) is a network of professional statisticians and their staff operating both within the Office for National Statistics and across more than 30 other government departments and agencies.

Any enquiries regarding this publication should be sent to: info@statistics.gsi.gov.uk

This publication is available for download at:
www.ons.gov.uk

Contacts

This publication

For information about the content of this publication, contact: Dr Gareth James

Email: gareth.james@ons.gsi.gov.uk

National Statistics Quality Review Programme

For information about the National Statistics Quality Review Programme, please contact ONS Quality Centre

Email: ons.quality.centre@ons.gov.uk

Other customer enquiries

ONS Customer Contact Centre
Tel: 0845 601 3034
International: +44 (0)845 601 3034
Minicom: 01633 815044
Email: info@statistics.gsi.gov.uk

Fax: +44 (0)1633 652747
Post: Room D265, Government Buildings,
Cardiff Road, Newport, South Wales, NP10 8XG
www.ons.gov.uk

Media enquiries

Tel: 0845 604 1858
Email: press.office@ons.gsi.gov.uk

Table of contents

i. About this Quality Review

In December 2012, the Office for National Statistics (ONS) re-established its programme of National Statistics Quality Reviews (NSQRs). This is the fourth NSQR in the re-established series, and assesses Foreign Direct Investment (FDI) outputs and their compilation by the UK Office for National Statistics (ONS).

NSQRs are regulated by ONS's Quality Centre, which has oversight of quality in official statistics across the Government Statistical Service. Each NSQR has its own Review Board, consisting of senior methodologists from ONS, senior managers from the relevant statistical output area (FDI and National Accounts at ONS in this case), and independent, external expertise. The role of the Review Board is to ensure that the quality and methodology underpinning ONS outputs have kept pace with changing methods and users' needs, and that the review has been sufficiently inquiring and challenging in its approach and assessments.

Principles set for the NSQR programme broadly determine the shape of the review, and steer it towards taking a risk-based, tailored and efficient approach. Proportionate views are sought, which balance the potential benefits of investment against the associated costs.

This NSQR on FDI follows other recent reviews that have covered economic statistics more generally. In particular, the second NSQR in this series, on National Accounts and Balance of Payments (ONS, 2014a), and Professor Sir Charles Bean's Independent Review of UK Economic Statistics (Bean, 2015 and 2016) provide good context when considering FDI statistics.

This review considers, in particular, the fundamental methodologies and systems used to produce FDI statistical outputs. The focus is on current practices, but consideration is given to changes in approach that have occurred since 2008. That year marked the last in-depth and comprehensive review of FDI methodology, which led to a programme of improvements to FDI statistics, which is broadly reflected in the approach to the compilation of these statistics presently used.

As well as considering the more recent method and system changes, many interviews have been conducted with staff and teams who currently, or previously, have been involved in the compilation of FDI statistics. International organisations that produce FDI estimates for their own countries have also been contacted, and asked to provide information about their approach and methods of compilation.

This review has been undertaken throughout 2015, during which time further developments and changes took place on FDI. The aim has been to provide information in this review that relates to FDI as at the end of 2015.

ii. Review objectives

The objectives of this Quality Review on Foreign Direct Investment are to:

- assess the current methods and systems used to produce FDI outputs, forming judgements about their fitness-for-purpose
- highlight areas that do not comply with best practice or meet quality standards, or otherwise require improvement or correction
- make recommendations and suggestions for work that could bring short-term improvements, and identify areas that require further investigation for possible future implementation
- carry out, where applicable, international comparisons

iii. Review team

The review team for this NSQR comprised:

Gareth James (lead reviewer) – Gareth is the current head of the Sample Design and Estimation Centre within the Methodology Group at ONS. Gareth joined ONS in 2001, and has spent most of his time in Methodology, leading teams in Sample Design and Estimation on business and social surveys, as well as Statistical Computing.

Stuart Brown (external reviewer) – Stuart retired from ONS in 2009 after many years as Head of Balance of Payments compilation, analysis and publication. Since then he has carried out many short-term contracts for various organisations on all aspects of BoP methodology and compilation, especially Foreign Direct Investment and International Trade in Services.

Cheryl Blake – Cheryl is an experienced member of the International Transactions Development Team. Cheryl has worked at ONS for 15 years, gaining experience and developing expertise in a wide range of areas, including Methodology, National Accounts, statistical training and Social Surveys.

Kevin Moore – Kevin is the head of the CORA Development and Support Branch in Business Data Division in ONS, managing the delivery of a generic data take-on platform. He joined ONS in 1999, and has spent all of that time working with business survey data. Kevin spent the majority of his time in ONS in Methodology, gaining experience in Time Series Analysis and leading teams in Sample Design and Estimation and Statistical Computing.

iv. Acknowledgements

The review team would like to express their gratitude to the many people who have helped with this review, including, among others:

Adrian Chesson, Aileen Brown , Aled Jones, Ben Graham, Blu Mansfield, Charlotte Gaughan, Chloe Gibbs, Ciara Williams, Claire Dobbins, Craig Taylor, Daniel Lewis, Daniel Rees, Duncan Elliott, Emma Wright, Gary Brown, Gill Sanderson, Helen Babbington, Jo Channing, Jo Sheppard, John Abram, Joni Karanka, Julie Mallett, Katherine Kent, Laura Mulcahy, Matthew Greenaway, Michael Hardie, Neil Parkin, Owain Perry, Paul Gage, Paul Wetherill, Philip Lowthian, Rachel Jones, Ria Sanderson, Robert Bucknall, Robert Satherley, Salah Merad , Sami Hamroush, Silvia Manclossi, Simon Harrington and Tricia Dodd.

Without their assistance and willingness to share their experiences and knowledge of FDI, this review could not have been completed.

v. Overall judgement

Annual outputs: The FDI outputs published and produced from ONS's annual FDI surveys and should be regarded as the principal FDI outputs and be seen as fit-for-purpose in most regards. At a high level of aggregation, at least, the estimates can be regarded as authoritative, and produced on recently improved systems using sound methods that have been thoroughly reviewed and improved in recent years. Their compilation meets international standards and the overall UK approaches are comparable with other countries'. It is also pleasing to be able to note that various ad hoc analyses that make further use of FDI data have been produced recently.

The new production systems, brought into use in 2015, together with recent changes in FDI team structure are noteworthy, and should be applauded. These improvements mean that users of the annual FDI outputs can, justifiably, have confidence in their quality.

That there are areas noted for improvement should be borne in mind too. These affect the detail of various FDI compilation methods, and ONS should seek to rectify these issues, in order to improve the quality further. In particular, it will be useful to have standard errors produced again for FDI estimates, so as to provide a quantitative measure of the quality.

Quarterly outputs: The quarterly FDI outputs form part of the Balance of Payments, and any judgements about their quality should consider both the production process itself and the intended purpose of these outputs. On the latter, the quarterly outputs provide an early indication of short-term movements of FDI, whereas it is the annual outputs that provide the more authoritative and comprehensive estimates of FDI.

In terms of methods and quality, the current quarterly surveys are much improved on versions that existed only a few years ago. They now mirror the annual surveys in their design and methods (albeit with smaller sample sizes), and these improvements are to be commended. Likewise, the quarterly surveys also now benefit from the same new processing systems and improved team structures as the annual outputs.

However, the data collected on the quarterly survey are more subject to statistical error, caused mainly by the timely and tight processing timetables. Companies' responses are received throughout and beyond the processing period, which means the initial survey estimates can be quite volatile. Steps could be taken here to try to improve the quality of the responses received, though there is unlikely to be an easy solution. Companies' quarterly survey responses are also often based on unaudited accounts data, and later revisions to ensure coherence with annual FDI outputs seem inevitable. A revised approach to benchmarking will be used next in June 2016, and will bring benefits, though further work is recommended to consider also linking the most recent quarterly estimates to the benchmarked level.

The challenges of quarterly production are clearly not unique to the UK, with other countries reporting similar issues in their compilation of quarterly FDI outputs. However, it is clear that the use of surveys for the measurement of short-term FDI movements is essential in fulfilling user need, and judgements about fitness-for-purpose of these outputs should include consideration of the intended use of the statistics.

vi. Executive summary

Introduction

This is the fourth publication in the second series of NSQRs, and examines the Foreign Direct Investment (FDI) outputs produced by the Office for National Statistics (ONS). The broad aims of this review are to examine the methods and systems used in the production of those outputs, and to make recommendations and suggestions to improve their quality and fitness-for-purpose.

FDI statistics are published by ONS in a stand-alone statistical bulletin on an annual basis, and those estimates are also transmitted to Eurostat. The principal variables published are earnings, flows and positions, but the publication contains many other, more detailed breakdowns, and estimates are produced for aggregated and low-level domains. Estimates are also produced on a quarterly basis, and provide an early view of short-term movements of FDI; these outputs form part of the Balance of Payments (BoP) in National Accounts. There are many users of FDI statistics, and it is clear that the importance of statistics on such cross-border investments is growing.

Various sources of information exist about FDI. The official statistics compiled by ONS use some of this information, but the primary FDI outputs are based upon detailed financial information that has been collected from UK-based companies in sample surveys, with separate surveys measuring inward and outward investments. International frameworks – the OECD Benchmark Definition, European System of Accounts and BoP Regulation, and IMF's Balance of Payments Manual – provide definitive principles for that measurement, although precise details of compilation methods are not always prescribed, and are left for the organisation compiling the statistics to implement.

The measurement of FDI in the UK has a long history, and this review considers the period since 2008, at which time a methodological review was instigated following large quarterly-to-annual coherence revisions. Since then, the FDI surveys have been the subject of thorough reviews and development. The quarterly surveys have been enhanced and now mirror the annual ones in terms of methodological principles, and further improvements have been applied to both, though the annual FDI outputs remain regarded as being of better quality.

Target populations

The target populations for both the Inward and Outward surveys comprise UK companies (or groups of companies). Those UK companies in-scope of the Outward survey must hold at least a 10% shareholding in their foreign affiliates (or other foreign entities), and those in-scope of the Inward survey must have foreign parent companies that hold at least a 10% shareholding in the UK company.

Two sampling frames for each of the Inward and Outward surveys are used. The first is a bespoke frame, which consists of known FDI 'big players'; these have all been sampled previously and the frame developed over time. The second comes from Dun & Bradstreet's Worldbase database of company linkages, and thorough matching and cleaning operations take place annually to ensure there is no duplication between the frames. Potential sources of under- and over-coverage are explored in this review, and suggestions made on alternative sources of information that could be used to supplement the existing arrangements.

Sampling

Consideration of the sample design includes the stratification, sample allocation, sample-selection procedures, sample rotation, overlap between the quarterly and annual samples and sample sizes. In most respects, the principles applied for FDI align with many other ONS business surveys and follow good practice. However, the main recommendations on sample design are to review and update the details of the sample design (out of scope of this NSQR, and in any case due for review), and improve the implementation of methods, as some aspects are not functioning quite as intended. The sample sizes will need to be re-assessed once standard errors become available again.

Other recommendations and suggestions are to keep the quarterly sample as a subset of the annual sample, but to (re-)introduce sample rotation on the annual survey, something that has been lacking in recent years and was previously recommended. Arguably, the lack of rotation is currently over-burdening smaller companies selected in the sample. Re-introducing sample rotation will require new functionality to be written in the sample selection code, though this should not present any particular difficulties.

Data collection

Data collection presently takes place via a mix of paper questionnaires and spreadsheets transmitted via a secure portal. The questionnaires themselves have been the subject of a relatively recent review by the appropriate Methodology team at ONS, and saw some big changes for the introduction of ESA 2010 and BPM6. The topic expert engaged for this review has identified some areas for improvement in the questionnaires, and a number of typographical errors have also been identified and already provided to the FDI team for correction.

Electronic data collection (EDC) is scheduled for introduction on FDI in 2017, as part of ONS's wider programme. This should bring many benefits, both for respondents and ONS. However, because of the differences in data collection needs for FDI, the 'standard' electronic-questionnaire solution may not be that effective for FDI; the survey's specific nature requires each company to report on potentially many affiliates in a consistent manner. Careful thought will be required when introducing EDC to FDI to ensure companies can easily and accurately achieve this.

Data processing (capture, validation and cleaning or survey responses) works reasonably well, though there is room for improvement. The systems – new in 2013 – do not function quite as intended, but work-arounds have been built and provide a practical solution. There is ongoing discussion about the best solution for the processing system code; that in use is older (and non-generic) and contains functionality that is required for FDI (and not many other surveys) and that is not present in the most recent version.

Data cleaning, which sees the re-contact of many responding companies, is a big, and necessary operation. FDI data are particularly complex, and a large majority of responses fail validation checks when first processed. Clearance rate targets are in place, but these appear low. Although there are some explanations for this (such as some error warnings being triggered incorrectly and insufficient time to process the data), targets should be raised and extra resource put into the process. The validation rules themselves have been recently reviewed, and the resulting changes are being implemented.

The industry codes used for FDI are based around the Standard Industrial Classification, but deviate from it in some circumstances, without clear reason being given for doing so. There are opportunities here to improve the coding, add explanations, and possibly improve the quality of the coding itself by adopting good practice from other surveys.

Imputation (for non-responding companies) has been reviewed and new rules implemented during 2015. The new rules follow best practice, and see a small set of approaches adopted on variable-by-variable basis. The same approach and rules are now used on the quarterly and annual surveys, though the imputation classes are defined more broadly on the quarterly surveys because of the smaller sample sizes.

The Chancellor's Initiative Data file was introduced to FDI over 15 years ago because of the potential instability in imputation links, something that should no longer be a risk. The continued and unchanged use of this file, which appears to be artificial or modelled data, cannot be justified and should be stopped. Some brief analysis of its impact has been conducted, and shows it has little effect on most variables at the top level (a maximum of 0.4% change on the headline FDI measures), but, as would be expected, there is a much larger impact on specific variables that relate to branch data in a few particular, low-level domains (change of 65% noted in one instance).

Estimation

The approach used for estimation on FDI is certainly not common on business surveys in ONS, though it is also not unique, and has a sound, academic basis. The principle is to predict a response for all companies on the sampling frame that were not sampled, and then to derive all estimates by simply summing over the domains of interest. This approach works for FDI, and ensures consistency and simplicity. Other approaches have been considered previously, and may prove reasonable, but there's no evidence to suggest they would be appreciably better and would introduce complexity. As such, the current approach may be regarded as fit-for-purpose and no recommendations are made to change it. In detail, the recommended method has yet to be implemented in full (a default, particular-case version is currently applied). This review recommends carrying out the additional work required to allow implementation of the full version, if the investigations conclude it worthwhile.

Outlier detection in FDI currently uses a distance-from-the-mean method, and treatment is via trimming. This is not best practice, and the method of Winsorisation, used as standard on most other business surveys, has been previously recommended for FDI, but not implemented. This review recommends a change to Winsorisation, but acknowledges that work will need to be done first to calculate appropriate parameter settings, and to assess the effect the switch will have on outputs.

Standard errors have not been published for FDI since the 2010 annual release, and this must be rectified without delay. A method for their estimation, aligning with that of the change in the estimator itself, was specified some time ago but not implemented as priorities were rightly focused elsewhere, including on the development of a new estimation system. However, some priority must now be given to the re-introduction of these quality measures, and extended in scope to include lower-level domains, and the quarterly estimates.

With the last-calculated estimates of standard errors pertaining to a survey and methods that were somewhat different from the current ones, it is difficult to make sound judgments about whether the sample sizes are sufficient to produce estimates with an acceptable degree of precision. Using the previous estimates as a guide only, it is reasonable to conclude that the annual survey's sample size is probably sufficient to give acceptable precision in the top-level estimates. The sample sizes within particular domains, however, and for the quarterly surveys, are smaller again, leading to the potential for greater sampling error in these estimates. Once standard errors are available again, a further assessment of the survey sample sizes will be required.

Statistical disclosure control

Statistical disclosure control was reviewed in early 2015 by the specialist Methodology team in that area, and found a number of areas that could be improved. The conclusions suggested that the level of suppression on FDI outputs is currently higher than necessary (limiting utility of the data), and that the process itself could be made more efficient with the introduction of specialist software. This review recommends that the findings of the previous Methodology report be implemented.

Though the list of recommendations and areas for improvement in the survey design is relatively long, all issues noted have solutions that are technically fairly straightforward. Indeed, some of the work required is already planned or underway, and the rest will need to be resourced. The more difficult issue to solve probably lies in the coherence of the quarterly and annual estimates.

Coherence of quarterly and annual outputs

For consistency, the quarterly estimates are benchmarked to the (better quality) annual estimates once the latter become available, creating retrospective revisions that are sometimes large. The reasons lie mainly in the inherent quality of the data collected, and in the benchmarking procedure, but the lack of coherence itself is not a problem unique to the UK.

The mechanics of the benchmarking procedure were reviewed quickly in 2015, and a revised procedure is to be used in the 2016 benchmarking exercise, which should see a reduction of less desirable outcomes such as step changes between years. This review also suggests linking the un-benchmarked, tail of recent quarterly estimates onto the level set by the preceding benchmark, as this should minimise revisions later. A more comprehensive review of benchmarking is required that will consider this, alongside other related issues, and the practical implications of doing so.

However, benchmarking itself does not address the root causes of the incoherence, which is a more difficult problem to solve. Non-sampling error can be large, and results from a lack of timeliness in companies' survey responses (for many, the time allowed is simply too short), and by companies responding in-year with estimated or management accounts data rather than end-year audited accounts. Nonetheless, it seems quarterly surveys are a necessity, allowing short-term movements to be estimated, including the capture of those big and very public changes in foreign direct investment that can occur during the year.

International comparisons

Internationally, ONS's approach to measurement of FDI does not seem out of place. As already mentioned, there are tight, international definitions that are followed, and other countries' approaches and experiences in implementing these are similar to the UK's. Use of surveys is probably universal, and a common problem seems to be the reconciliation of quarterly and annual data.

Systems and processing arrangements

FDI has changed processing systems a number of times in recent years. The current arrangement, a bespoke system introduced at the start of 2015, seems well-suited for the purposes of FDI. However, it is stand-alone, so does not enjoy the benefits that come from use of a standardised platform. A platform-based approach was used for the current system's immediate predecessor, but experience showed it as being difficult to operate. That is probably a reflection of the various, but justified, non-standard approaches that are necessary and required for FDI, which is a particularly complicated survey operation, and one that cannot be satisfactorily aligned with more standard business survey operations in a number of respects. This review also notes the extensive assessment and overhaul of ONS's technology estate that is currently underway.

Onward processing of FDI estimates, ultimately for the Balance of Payments, is via a quite fragmented system that employs various software and systems. There should be an aim here to simplify and unify the systems where possible. Likewise, the current arrangements mean that, while most data come to BoP via the FDI team, some (data concerning banks) also come to BoP directly, and then need to be fed back to the FDI team to allow full compilation of the outputs. This process could probably be simplified, and it may be worth looking further at team structures, processes and responsibilities, though this review makes no specific recommendations about what that should look like.

Staffing arrangements

The FDI team itself, responsible for the majority of FDI outputs, has been restructured during 2015 by changing its skills-mix to include a greater number of statistical staff, with the aim of giving it greater resilience and capacity to fulfil its roles. Although budgets are limited, some extra resource to expand further the capability and capacity for research would be beneficial.

Conclusions

The conclusions to this review draw together the various aspects of quality examined to give an overall assessment. This states that FDI outputs are now in a better shape than they have been for many years, and that the developments that have occurred, and are planned, are to be commended. However, there is still some way to go. There is a long list of recommendations for improvement, some of which include the implementation of previously recommended approaches.

vii. Summary of recommendations, suggestions and issues

The recommendations (categorised as high, medium or lower priority) and suggestions made in this review, and the issues noted in it, are listed here in summary form. They are repeated from the text of the main report; the accompanying text in the main report provides the context and motivation.

Target populations

Recommendation R1 *(lower priority)***:** The procedure of adding to the FDI/(Non-Worldbase) NWB frame companies sampled in the previous year's Worldbase sample and found to be large (in terms of FDI) should be discussed with ONS's Methodology Group and changed as necessary to optimise the process.

Suggestion S1: Consider further the coverage of the sampling frames used in FDI, and potential additional sources of information.

Sampling

Main recommendations:

Recommendation R2 *(high priority)*: Commission methodological analysis to review in detail the specification of the sample design of the FDI surveys.

Recommendation R3 *(high priority)*: Improve the implementation of the sample selection mechanisms, so as to bring them in line with good practice and intended specifications.

the work for which would include:

Suggestion S2: The sampling stratum definitions should be reviewed and updated at least every 5 years.

Suggestion S3: In the next review of stratum boundaries, consider whether the use of a simpler and more consistent set of stratum boundaries would be beneficial.

Recommendation R4 *(high priority)*: Review the sample size allocation implementation procedures, paying particular regard to the merits of keeping sample sizes or keeping sampling fractions constant over time.

Suggestion S4: Review the total sample sizes used in each of the FDI surveys and frames to establish if a re-balance would be beneficial.

Suggestion S5: Review and re-write the sample selection program to make it less exposed to the risk of error, and reduce the amount of manual intervention required.

Issue I1: There is currently no functionality in the SAS® selection program code to implement rotation automatically in the FDI sample. The Inter-Departmental Business Register (IDBR) has this functionality, which is used for business surveys selected from it, and its approach should be replicated for use by FDI on its own frames.

Issue I2: The part of the sample selection program that creates permanent random numbers (PRNs) where necessary does not function as it needs to, and should be corrected.

Suggestion S6: Assuming the practice of not rotating the quarterly sample within calendar years is continued, consider introducing a top-up sample to compensate for the reducing sample size over the course of the year.

Recommendation R5 *(high priority)***:** Re-introduce sample rotation on the annual FDI surveys, co-ordinating the quarterly sample selection via correct use of PRNs.

Data collection

Suggestions S7 on guidance in the questionnaires from the topic expert consulted in this review are to:

(i) combine the guidance notes on FDI concepts, definitions and relationships into one section at the front of the questionnaires

(ii) explain immediate investment and indirect investment in terms of chains of control and significant influence, and then

(iii) explain the concepts of ultimate controlling parent, fellow relationships, reverse investment and special purpose entities

Recommendations R6 *(medium priority)* **on coverage and scope**:

(i) emphasise on the questionnaires that data on transactions and positions with indirect investors or investment enterprises are also requested,

(ii) specify on the questionnaires how and where these data with indirect investors or investment enterprises and with fellow enterprises should be recorded,

(iii) identify the questions on the questionnaires where data on reverse investment are requested

Issue I3: Typographical errors are present on the questionnaires, and need to be corrected.

Recommendation R7 *(high priority)*: Consider carefully the use of electronic questionnaires for FDI, and do this only once ONS's Electronic Data Collection (EDC) programme has delivered and embedded a proven, reliable and flexible tool. Do not simply transition the same questionnaire from paper to electronic form, without first researching whether this would prove effective for FDI, given its differences from most other business surveys.

Data processing

Recommendation R8 *(high priority)*: Introduce measures with regard to data processing aimed at improving the quality of data collected on the quarterly surveys. Such initiatives might include the introduction of targets for higher clearance rates to be reached one quarter later.

Recommendation R9 *(medium priority)*: Continue the work underway to evaluate the benefits and drawbacks of moving the FDI data take-on system to the latest, current version of CORA[1]. If a suitable arrangement can be obtained, migrate FDI to the current version, or otherwise update the FDI CORA code, as soon as possible.

[1] Common Open-Road Architecture

Suggestion S8: Identify and evaluate benefits of the functionality lost in the migration from OpenRoad to CORA version 3.1. If retention of any of such pieces of functionality is justified (some may not be), considered its re-introduction on the CORA FDI system.

Suggestion S9: Ask respondents to provide a description of the principal economic activity, the approach used on ONS's Business Register and Employment Survey (rather than asking for a self-coded industry), and code afterwards from that description using an automated coding tool.

Recommendation R10 *(lower priority)***:** The Official Statistics Code of Practice states that common classifications and coding standards (among others) should be adopted to promote comparability, and the reasons for any deviations made publicly available. ONS should seek to improve the coding used on FDI, and its presentation for respondents and users, on this basis.

Recommendation R11 *(high priority)*: Assuming no reason is found to retain use of the file, nor an updated version of it, ONS should discontinue use of the Chancellor's Initiative Data in FDI processing, and report fully on the impact of its removal on historical estimates.

Estimation

Recommendation R12 *(medium priority)*: To be fully compliant with the method specified in the literature, and as intended when specified for FDI, the full formula for prediction estimation would be used, and ρ estimated from the data rather than being assumed to be zero. Investigate the practical need for an adjustment for clustering, and the best approach for robustly estimating ρ if required on an ongoing basis.

Recommendation R13 *(medium priority)*: Complete investigations and report on the effect of switching outlier identification and treatment to Winsorisation. Once appropriate parameters have been established through analysis of recent data, effect the switch to Winsorisation as soon as possible.

Recommendation R14 *(high priority)*: Implement the proposed standard error calculation without delay, carrying out the necessary quality assurance of results. Then resume the calculation and publication of measures of precision for the FDI output's principal annual estimates as soon as possible.

Recommendation R15 *(medium priority)*: Once standard errors have been calculated for annual surveys at the top level, extend the analysis to estimate measures of precision for:

- lower-level domains
- the FDI quarterly surveys

Recommendation R16 *(medium priority)* **on sample size:** Commission an investigation to determine appropriate sample sizes to meet precision requirements for principal FDI output when all the relevant information required has been established.

Statistical disclosure control

Recommendation R17 *(medium priority)***:** Commission the further work suggested by the report, as a way to improve FDI's disclosure-control processes and transparency. This should realise time savings in processing, and afford better utility of outputs.

Coherence of quarterly and annual outputs

Recommendation R18 *(high priority)***:** Conduct a more detailed review of benchmarking methods and approaches, exploring the various methodological options for benchmarking. This should include an assessment of:

- techniques that include quarters for which there is no annual data yet available, and the practicalities of how these can be incorporated
- a review of the most appropriate level for benchmarking and any associated consequences

Note: although the process of seasonal adjustment has not been considered in this review, it would be prudent to carry out a seasonal adjustment review (a standard and regular process at ONS) at the same time as the more detailed review of benchmarking.

Systems and processing arrangements

Suggestion S10: Notwithstanding the ongoing changes to ONS's technology estate, review the process flow of data and work required in the latter stages of FDI processing to determine if efficiencies could be made, and a more integrated system developed for the final stages of FDI data processing.

Suggestion S11: There appears to be some duplication of effort and process in the production of quarterly FDI estimates. Conduct a review of this to establish if more efficient ways of working might be obtained.

Staffing arrangements

Recommendation R19 *(high priority)***:** Increase the size of the FDI and International Transactions teams, to reduce the time pressure on regular production and allow more time to develop the survey and better understand the data.

Suggestion S12: Seek to improve the training offered about the FDI survey and processes for staff who are involved in the production of its outputs to increase knowledge about the survey, its limitations, and areas for development.

General

Recommendation R20 *(medium priority*) Review and increase the range of documentation available about the FDI surveys and outputs, making this available both internally and externally.

1. Introduction

1.1 Introduction to foreign direct investment statistics

1.01 The essence of the definition of foreign direct investment (FDI) lies in cross-border (international) investments. These are made by investors from one country into another with the aim of a establishing a lasting interest (and defined as at least 10% of the voting power) in the company receiving the investment. Such transactions are sometimes classified as greenfield investments (usually new projects or notable expansions) or brownfield investments (acquisitions of existing foreign companies or changes to existing investments), though the UK's official statistics on FDI do not make that distinction. The official statistics published about FDI are grouped into earnings, positions and flows variables, and form a major component of a country's Balance of Payments (BoP) within its national accounts. Users of these FDI statistics keenly monitor the levels, movements and patterns observed.

1.02 The importance of FDI has grown rapidly in recent decades because of ever-increasing globalisation. As such, the role FDI plays in establishing lasting links between economies, promoting technological transfer and innovation, and in providing investors with access to previously inaccessible markets has resulted in FDI statistics becoming a focus for many governments, financial analysts and academics.

1.03 International organisations that use FDI statistics include the United Nations, the International Monetary Fund (IMF), the Organisation for Economic Co-operation and Development (OECD), and Eurostat (the statistical office of the European Union). In the UK, the Bank of England monitors FDI as part of its assessment of financial stability, and UK Trade and Investment (a government department) has ambitions[1] to increase the value of inward UK FDI stock to £1.5 trillion by 2020. Other government departments (for example, HM Revenue and Customs, HM Treasury), as well as other organisations such as the Institute for Fiscal Studies from across the public, private and voluntary sectors, national and international media organisations, councils, academia and charities also make much use of FDI statistics. Further details of users and known uses of FDI statistics are presented in Table 1.1.

1.04 A measurement framework for FDI statistics is provided by OECD's Benchmark Definition of Foreign Direct Investment (fourth edition). This stipulates international standards and provides a detailed, operational manual for the measurement of FDI.

1.05 The Benchmark Definition is also fully consistent with IMF's Balance of Payments Manual (BPM, sixth edition). This details the transactions to be included within the accounts and how they are to be shown: FDI earnings statistics appear in the overall current account, FDI positions statistics are included within the international investment positions (IIP), and FDI flows form part of the financial account.

1.06 A country's official FDI statistics are usually compiled either by its National Statistical Institution (NSI) or its central bank. In the UK, the Office for National Statistics (ONS, the UK's NSI) has responsibility for the compilation of official statistics relating to FDI. Its outputs include:

- annual FDI statistics – the most recent publication[2] of annual FDI statistics was in December 2015 and reported that, for example, "the UK international investment position (outward investment) [was] £1,015.4 billion in 2014"; a table of some principal estimates from that publication is included here in

[1] https://www.gov.uk/government/organisations/uk-trade-investment/about

[2] http://www.ons.gov.uk/ons/rel/fdi/foreign-direct-investment/2014/stb-fdi-2014.html

Appendix 1.1A. The annual FDI statistics also appear in the National Accounts Pink Book, and are supplied to Eurostat under regulation

- quarterly FDI estimates, which appear in the Balance of Payments; there is no stand-alone publication of FDI statistics on a quarterly basis

- various other reports and analyses produced on an ad hoc basis; some recent FDI publications from ONS are listed in Appendix 1.1B

Other areas of ONS also make use of FDI statistics and data, and a list is provided as Appendix 1.1C.

User	Use of FDI statistics
Eurostat	European Commission policy directorates, embassies, students, journalists
Organisation for Economic Cooperation and Development (OECD)	OECD uses the estimates for regular trends analyses, for calculating OECD aggregates, OECD investments in or from various regions, and bilateral analyses
United Nations Conference on Trade and Development (UNCTAD)	Estimates are used to revise and update UNCTAD's FDI/TNC (transnational corporations) database, which is the basis for the analysis and the statistics reported in the World Investment Report and the World Investment Directory series
Department for Business, Innovation and Skills (BIS)	Providing briefing for ministers and UK Trade and Investment for speeches and policy documents. Answering Parliamentary Questions. Also some analyses for Foreign and Commonwealth Office
Foreign and Commonwealth Office (FCO)	Providing briefing for ministers
Cabinet Office	Providing briefing for ministers
HM Revenue and Customs (HMRC)	Tax policy analysis (for example, taxation of UK companies' foreign profits and foreign subsidiaries) to support HM Treasury's corporate tax team and HMRC policy colleagues (Business International and Corporation Tax and Value Added Tax (CT and VAT) Directorates).
Bank of England	Analysis of current account sustainability Analysis of yields at home and abroad and the implications for UK balance sheets Interest in global de-leveraging – sharp moves in BoP (winding down positions abroad) – affects exchange rates Monetary analysis feeds up to the Monetary Policy Committee
HM Treasury	Briefings – the UK is one of the largest contributors of FDI in the world As a core series in the forecast for the current account To provide in-depth analysis to inform the forecast of the current account
ABI (Association of British Insurers)	Regional and industry analysis for policy development
International Monetary Fund (IMF)	Estimates are used in preparing country-level, regional, and global aggregates in IMF statistical publications. They also are used for analyses, and in the IMF's surveillance work. ONS delivers FDI statistics to the IMF in accordance with the global Coordinated Direct Investment Survey (CDIS) initiative.

Table 1.1: Known users and uses of FDI statistics

1.2 The use of surveys (and other data sources) to measure FDI

ONS surveys

1.07 ONS collects the data upon which the UK's official FDI statistics are based by means of surveys, an approach taken for many years. The surveys collect from UK companies a wide range of financial information (up to 50 detailed questions are asked) regarding FDI, and cover various topics about assets and liabilities, which form the components used in the derivation of the principal variables:

- earnings: income from investments, for example, profits, interest and tax
- flows: changes within investments, for example re-invested earnings, acquisitions, disposals and loan movements
- positions: these data represent an enterprise's total investment value of equity capital and other capital at a given time; positions data are used to calculate the international investment position

1.08 Separate surveys are used to collect FDI data about inward and outward investment. With respect to the UK, the Inward FDI survey collects data about the investment between foreign parent companies and their UK-based affiliate companies, and the Outward FDI survey collects data about the investment between the UK companies as parents, and their foreign affiliates. Each survey also has annual and quarterly varieties, and it can be useful to consider the following as separate surveys: Quarterly Inward FDI, Quarterly Outward FDI, Annual Inward FDI and Annual Outward FDI.

1.09 All the surveys are conducted on a statutory basis under the Statistics of Trade Act (1947), which means that sampled companies have a legal obligation to comply with ONS's request for data. Further details of the various regulations, frameworks and policies that relate to FDI statistics and their production by ONS are provided in Appendix 1.2.

1.10 In terms of scope, the annual and quarterly surveys are comparable: the same questions are asked to companies selected from the same target population. In essence, the principal difference between the quarterly and annual surveys lies only in the reference period about which the questions are asked. All surveys refer to calendar periods: 'Q1' in the quarterly surveys refers to Quarter 1, the January to March reference period, and the 2015 annual survey refers to the January 2015 to December 2015 calendar year.

1.11 Although the methodology behind the surveys is explored in detail in subsequent chapters of this review, a brief summary of some key differences between the quarterly and annual surveys is provided here by way of introduction. The methodological approaches of both the annual and quarterly surveys are comparable, and have been standardised in recent years. However, it should be noted that the annual surveys have a larger sample size and benefit from better response rates. That alone means the estimates from the annual survey should have the greater accuracy.

1.12 However, a more fundamental difference lies in the data that respondents provide. Whereas for the annual survey, companies will usually provide data extracted directly from their statutory, audited annual accounts, the information provided on a quarterly basis is often based on their in-year management accounts, which can differ markedly from the final accounts for a variety of reasons. With annual data and estimates regarded as being of higher quality, the quarterly estimates are adjusted in due course to align with the annual estimates via a benchmarking process, which can give rise to notable revisions in the quarterly path.

Other sources of information about FDI

1.13 Although the use of surveys is current practice for collecting information about FDI in the UK, and similarly by the different institutions that compile official FDI statistics in many other countries (see Chapter 9), it is useful to consider other information that is available. Various sources of other data about FDI exist, though the information available is usually more limited than that available through a survey, which can be a very rich, timely and detailed source. That is not to say that such sources are not useful, however.

1.14 Private-sector data providers such as Dun & Bradstreet (D&B) and Bureau van Dijk (BvD) offer databases that include company linkages (identifying FDI relationships) and some information on flows and investments. Company accounts also provide some FDI-related information. The D&B database is used by ONS for identifying the target population and creating the sampling frame for the FDI survey (see Chapter 2); the auxiliary variables present, such as number of affiliates, are not used to produce FDI estimates directly, but are used by ONS to stratify the survey sample. Eurostat is also developing its Eurogroups Register, and further consideration is given to this within Section 2.1.

1.15 Project announcements in the media can provide a useful source of information about forthcoming (or potential) international transactions, which may impact upon FDI estimates. However, announcements are not necessarily a reliable indication of when transactions will occur, how they will be financed, nor provide details of changes in company structures. In time, completed transactions are included in ONS's Mergers and Acquisitions Survey, which collects detailed information and provides a feed into FDI statistics.

1.16 Real-time monitoring of FDI-related information is provided by some data sources, and may provide information about the value and number of projects, and the employment numbers generated. Examples include the Financial Times' fDi Markets database and Ernst & Young's European Investment Monitor database. These alternative sources focus on greenfield (new) investments, and are useful for the timely gauging of investor sentiment and may provide additional data series such as regional breakdowns.

1.17 Such sources may lack other information, however, that the current official statistics offer. Examples include data on brownfield investments (changes to existing investments), some mergers and acquisitions results, the earnings performance of underlying investments over time, and other detailed information that needs to be obtained. A further difference is the inclusion of projects at the time of announcement, in contrast to official statistics, which report only on completed transactions.

1.18 It is worth noting that UK FDI statistics produced by international organisations, such as the IMF and OECD, are themselves based heavily on the statistics compiled by ONS, although differences can be caused by timing issues, and whether the statistics are presented on an asset/liability or directional basis. UK government departments that publish economic analyses that include FDI base their work on FDI statistics sourced from ONS, and are not known to make extensive use of alternative sources of FDI-related data.

1.19 Therefore, it seems reasonable to conclude that the FDI survey will remain as the primary source of information about foreign direct investment for the foreseeable future, as it seems the only source of data that can currently meet the requirements in terms of detail, coverage and timeliness. However, alternative data sources may be able to provide additional information, and it would be prudent for ONS to remain mindful of these, and to explore opportunities arising from future changes in data-sharing legislation.

1.20 This Quality Review has as its focus the quality of the outputs that arise from the current, survey-based approach that is used by ONS in its production of statistics about FDI. It includes consideration of other sources of data that are used in the production of the official statistics where they arise, but otherwise doesn't consider direct replacement of survey data further, as the scope for doing this seems currently limited.

1.3 History and development of UK estimates of FDI

1.21 Though this Quality Review is interested primarily in the quality of the current FDI estimates, this section provides a brief history of the FDI survey and developments undertaken.

1.22 The first annual FDI estimates were collected by the Department of Trade and Industry (DTI) in 1958, with the survey expanding to collect quarterly data in 1962. A forerunner of ONS inherited the survey in 1987 and, by 1990, FDI statistics were statutory according to European Parliament legislation. By 1997, FDI statistics were required to be produced in adherence with the standards and definitions outlined in the IMF BPM version 5 (BPM5) and the European System of Accounts manual 1995 (ESA 1995). A bespoke list of companies known to be involved with FDI was (and still is) maintained, but in 2002, the sample was enlarged to include enterprises identified by Dun & Bradstreet.

1.23 A large benchmark revision to the quarterly FDI outputs occurred in late 2007 – the aggregate position for 2006 derived from the 4 quarters was quite different from that subsequently estimated directly from the 2006 annual survey – and this prompted the commissioning of a review by ONS's Methodology Group (ONS (2008)). The review examined most aspects of the methodology and made a number of recommendations, in particular for the quarterly surveys. As a response, the Division in ONS responsible for the FDI outputs assembled a development team in 2009, who proposed a programme of survey improvements (ONS (2009a)), and work began.

1.24 Around that same time, it was also identified that the FDI surveys would be required to deliver an expanded set of outputs to meet new requirements in the forthcoming revisions to the manuals, BPM6 and ESA 2010. It was acknowledged that the current systems (OpenRoad) would be unable to cope with the required changes, and thus a programme of development was started to review and revise FDI methods, and to provide a new FDI processing system, operating on a new platform that was to be developed for use by many of ONS's business surveys.

1.25 That new platform, known as Common Open-Road Architecture (CORA), was first made available to business surveys in 2013, and FDI was one of the first surveys to be migrated onto it. There would be distinct parts to the FDI CORA system: Data Take-on, and Analysis (Results), and the former was delivered to schedule. That Data Take-on system, comprising the loading and cleaning of survey responses, remains in use today, albeit with some quirks in the code that require workarounds; the version of CORA used for FDI is not the most recent up-to-date, however.

1.26 The delivery of the CORA FDI Analysis system was delayed, requiring that an interim SAS® program be written quickly by ONS Methodology's Statistical Computing Branch (SCB) in early 2013 in order to process the data for the initial quarters before the CORA FDI system became available. That CORA system has itself subsequently been taken out of use as not working as intended, its replacement being a new SAS® system built by Methodology in collaboration with the FDI team. This analysis system, the fourth for FDI in as many years, developed further the interim SAS® program written in 2013, and was introduced for the 2015 Q1 quarterly and 2014 annual survey processing rounds. Evidence to date suggests that the new FDI SAS® results system is more practical, workable and fit for purpose than its CORA predecessor. The current system is stand-alone, in that it does not run on a platform.

1.27 Since the methodological review in 2008, most aspects of FDI's methodology have been reviewed further by expert teams in Methodology in ONS, and many changes have been implemented following analysis, considerations of options, and recommendations. Thus it seems fair to summarise the current FDI surveys and systems are much improved on those that existed in 2007. In particular, the quarterly surveys now use methods that are consistent with the annual surveys, even though the samples are notably smaller in size, and the system developments that have been implemented over the past year seem particularly successful.

1.4 Overview of ONS FDI teams and their roles

1.28 This section contains a brief overview of the ONS teams involved in the production of FDI outputs, and gives an overview of their roles in the FDI production process. All aspects of that process are considered in greater detail in following chapters. For the purpose of this review, individual branches are grouped into broad teams that carry out groups of activities.

1.29 Three teams are heavily involved in the direct production of each FDI survey round:

1. The Editing and Validation (E&V) team are responsible for most aspects of FDI data collection and initial processing. This includes: contacting each sampled company to verify details and confirm whether it is still in scope of FDI in terms of meeting set criteria to be in the target population; response-chasing; handling respondent communications; and validating the data, querying returns with respondents where necessary. After cleaning, the data files are passed to the FDI team for the analysis and production of outputs.

2. The FDI team is part of the International Transactions Branch, which also runs a number of other surveys beside FDI. The team comprises several branches, including the Results, Analysis and Publication Branch, the Development Branch and the Systems Development Branch. The main responsibility of the FDI team is the running of the remaining survey processes (imputation, estimation and aggregation), and the analysis and publication of the survey results. The team is also responsible for maintenance of the FDI sampling frames, and the selection of the samples from these.

3. The Balance of Payments (BoP) team incorporate the quarterly FDI survey outputs into the National Accounts. The current process means that further processing is undertaken by the BoP team, and there is some iteration of work and data transfers between the FDI and BoP teams to complete the FDI outputs each quarter.

Further teams support various surveys (including FDI), through regular and ad hoc activities. These include:

4. The Business Registers team, which provides the FDI team with an annual extract of FDI-relevant companies from the Inter-Departmental Business Register (IDBR), from which the FDI team update and create the FDI sampling frames.

5. Methodology, which consists of specialist branches that broadly align with statistical methods or processes (branches include: Data Collection Methodology, Sample Design and Estimation, Editing and Imputation, Time Series Analysis, Statistical Disclosure Control, and Statistical Computing). Methodology provides general support for FDI, as well as undertaking development projects such as sample reviews.

1.5 Structure of this report

1.30 This report considers in Chapters 2 to 7 the quality of the current FDI surveys and their methodologies, looking at each stage of the survey process (similar to the Generic Statistical Business Survey Model) in turn. This includes consideration of the target population and sampling frames, the sample design and sample selection mechanism, the data collection methods, various aspects of data processing, estimation, and statistical disclosure control. For each aspect, the intended method is briefly described, other options are considered and an evaluation is provided of the implementation of the method and how well it works in practice.

1.31 Where appropriate:

- **issues** are highlighted, and indicate specific or technical aspects in error and need of correction
- **suggestions** are made for consideration. These are usually not urgent, and concern design options for inclusion in future methodological work that are likely to bring about incremental improvement. These should be investigated when resources allow
- **recommendations** are made for areas considered in need of improvement, some of which require further analytical investigation to determine the best technical solution. A relative priority assessment (high, medium or lower priority) has been made for each, which may serve as a guide to the urgency of the matter, rather than the importance

1.32 With each aspect of the survey processing considered, the report then considers in Chapter 8 the benchmarking process, and the coherence between estimates derived from the quarterly and annual surveys, and the problems caused by trying to ensure coherence. Though there is no immediately obvious solution to the current challenges, some options are presented for further consideration.

1.33 In Chapter 9, some comparisons are drawn with other, international organisations in the way in which they collect and compile estimates of foreign direct investment.

1.34 Chapter 10 considers further the processing systems in use on FDI. Considerations are restricted to those that directly affect FDI processing, rather than more generic systems at ONS, which are currently undergoing large-scale transformations. Finally, Chapter 11 considers staffing arrangements further.

1.35 The conclusion (Chapter 12) brings together considerations made of the various processes to present an overall assessment of the quality of FDI.

2. Target populations

2.01 As set out in the OECD Benchmark Definition of FDI, a foreign direct investor is defined as 'an entity resident in one economy that has acquired ... at least 10% of the voting power of a corporation ... resident in another country', and recommends a strict application of the 10% rule to achieve global consistency of FDI statistics. As such, the target population is clearly defined.

2.02 In fact, there are 2 target populations for the UK FDI surveys:

That for Inward FDI (investment by foreign parent businesses in UK businesses), comprises UK companies that have one or more foreign parents holding at least 10% of the voting power.

That for Outward FDI (investment by UK parent businesses in foreign businesses), comprises UK parent companies that hold at least 10% of the voting power of one or more foreign affiliates or branches.

2.1 Sampling frames

2.03 Separate sampling frames are compiled for the Inward and Outward surveys, and some companies feature on both. The quarterly and annual versions of the Inward FDI surveys are both drawn from the same frame, albeit at different times, and likewise for the quarterly and annual Outward surveys.

Principal sources of information

2.04 Two main sources are used to compile the Inward and Outward FDI frames:

The first is known as the 'FDI frame' or 'Non-Worldbase (NWB) frame' and is referenced as the FDI/NWB frame in this report. The frame, which is maintained by the FDI team in ONS, contains only a small fraction of all companies that meet the 10% ownership criterion, but is considered to list the known "major players" in terms of FDI.

The second, known simply as the 'Worldbase (WB) frame', is sourced from Dun & Bradstreet (D&B)'s Who-owns-Whom database of world linkages of companies. An annual data extract is procured at the start of the calendar year, and a thorough and established operation is run by the Business Registers team to clean the dataset and match it against the IDBR.

2.05 Naturally, some of the companies on D&B's register already appear on the FDI/NWB frame. Prior to any sample selections in the year, an operation takes place that ensures there is no duplication, and any companies appearing on both will be removed from the WB frame before sampling occurs.

2.06 An additional process has been implemented by the FDI team from 2015, in which units sampled previously from the WB frame and found to be large in terms of net book value (with thresholds defined by industry) are moved to the FDI/NWB frame, on which sampling fractions are greater, for the coming year. The rationale of this process is reasonable: for populations with variables that have highly skewed distributions, selecting the biggest units with high probability (or with certainty) is essential to ensure sampling error is reduced. (The information/variables available on the sampling frames cannot be relied upon to identify which units are the most important in terms of FDI). It is important to note, however, that using a survey to update its own sampling frame can introduce some bias, known as 'feedback' bias. In the case of FDI, the reduction in variance caused by ensuring 'important' companies are sampled with high probability arguably outweighs this additional bias, but discussion with ONS's Methodology Group may help clarify this trade-off.

Recommendation R1 *(lower priority)***:** The procedure of adding to the FDI/NWB frame companies sampled in the previous year's WB sample and found to be large (in terms of FDI) should be discussed with ONS's Methodology Group and changed as necessary to optimise the process.

2.07 Updating the sampling frames immediately prior to sample selection is the responsibility of the FDI team. This process has been refined and made more robust through development of programs in SAS® Enterprise Guide, an initiative that is continuing. The process includes many checks, and the new programs seem logically structured, and adhere to good programming practice. Praise for this particular development is merited.

2.08 The overall population sizes on the various frames, once cleaning and processing had taken place in early 2015, were:

	Inward	Outward
FDI/NWB frame	1,664	571
WB frame	21,891	6,834

2.09 The WB frames are over 12 times larger than the NWB/FDI frames in terms of number of companies listed, though their overall contribution to FDI estimates is smaller. In recent years and quarters, the WB frames have contributed between 25% and 45% of the estimates of Inward total FDI, and between 3% and 10% of the estimates of Outward total FDI. Further details of the contribution from each frame can be found in Appendix 2.1 (Section A2.1A), along with other analysis. The Inward survey populations are about 3 times larger than those of the Outward surveys.

2.10 A third source of information is ONS's established Mergers and Acquisitions Survey, which records details of all such transactions that have been identified; such transactions also update the FDI/NWB frame. This source of information is particularly important for FDI, as large transactions that take place during the course of the year would, naturally, have an effect on foreign direct investment, and users expect to see those changes reflected in FDI outputs as they occur. Without including them, these transactions would not be reflected in the outputs as the frame updates and main sample selections take place only annually. Including these transactions means that some companies are then subsequently included in the sample after the main selection has taken place, and care is needed to ensure this is correctly captured in the estimation.

Potential over- and under-coverage

2.11 Once the samples have been selected, a proving exercise is undertaken by the Editing and Validation (E&V) team. This involves contacting all the companies selected in the sample and before the dispatch of questionnaires, to check that they both still exist, and still meet the FDI 10%-ownership criterion; those that don't are removed from the frame and the sample as being out-of-scope.

2.12 The removal of dead (or otherwise out-of-scope) companies after sampling leads to a question of over-coverage, as it would be reasonable to expect a similar proportion of out-of-scope companies to exist in that part of the population not selected for the sample, and so not contacted for proving. These remain in the population, and are estimated for using data from the sampled companies. In other ONS business surveys, an adjustment is made in the calculation of weights to account for predicted deaths in the un-sampled part of the population, and likewise for births that are as-yet unidentified on the frame. That adjustment relies on assumptions that are difficult to verify, but no such adjustment is made on FDI, although the estimation approach used wouldn't easily lend itself to such adjustments anyway.

2.13 Documentation suggests that the number of entries listed on the frames has increased notably in recent years (ONS (2010)). Until about 2005, 13 to 14,000 companies were listed on the Inward frame, before increasing to 18 to 22,000 by 2015, and likewise the Outward population has increased from 3 to 4,000 before 2009 to over 7,000 by 2015. One possibility is that those companies existed before and were

in-scope, but were simply not being identified, which would be a case of under-coverage. However, there are other possible explanations. Of course, one is that this increase is real, and there has been a rise in the number of companies in-scope of FDI. It should be noted however, that an increase in the population, will not necessarily result in a proportional increase in FDI stock, earnings, and flows of investment. Companies now included in the population as a result of the increase are likely to be smaller, with the larger companies having been previously and consistently sampled, ensuring as full a coverage as possible. ONS has produced some analysis of the contribution made by newly identified FDI companies to UK assets and liabilities (see ONS (2015a)). Another explanation is that the reporting structure of listed companies (mainly Enterprise Groups) has changed, with more reporting now taking place via separate companies at lower levels within the group; the Business Registers team has noted an increase in this way of reporting. This latter explanation isn't under-coverage, as such, but it does increase the scope for duplication, although efforts are made to prevent that through careful matching and de-duplication of entries by the Business Registers team.

2.14 A further aspect of under-coverage relates to the percentage-ownership threshold for inclusion in FDI. Whereas FDI aims to include all relationships where ownership is more than 10%, only those cases of greater than 50% ownership are included on the D&B file. It is not known how much FDI is missed by not including those companies with between 10% and 50% ownership.

2.15 There are a number of factors which may cause under- or over-coverage in the FDI sampling frames, including out-of-scope companies in the non-sampled part of the population, and the percentage-ownership threshold for inclusion. The changing size of the frames over time does increase the risk that changes in coverage may have an impact on estimates, but there is no clear evidence that this is what's happening.

Other sources of information

2.16 Additional sources of information could be considered, probably to supplement rather than replace, the current frames. Such sources could act as a check on potential under-coverage of companies not identified on the current frames but in-scope of FDI , and include:

- the EuroGroups Register (EGR) (Eurostat (2015))

  Eurostat is developing a register of businesses that would be in-scope of FDI, which is available for use by every member state. Conversations with experts in ONS who have used the EGR suggest it could not yet be used for sampling for various reasons (such as more-recent ONS data on the EGR being over-written with older data provided subsequently by other countries). However, it might be worth investigating to what ends this source of information could be used, probably once it has developed further.

- the Inter-Departmental Business Register itself

  There could be benefit in surveying, even if only rarely, the largest businesses on the IDBR (say with employment of 1,000 or more) that don't otherwise have matches to the FDI/NWB or WB frames to establish if they would be in-scope of FDI. A variation would be to include questions that determine eligibility for FDI on existing, large surveys, such as the Annual Business Survey or the Business Register and Employment Survey. That approach is already used for some other topics (such as international trade in services). Of course, there would be cost implications both for ONS and in terms of respondent burden, but the balance of these costs and the statistical benefits is integral to designing all business surveys in ONS so is not a reason in itself.

Suggestion S1: Consider further the coverage of the sampling frames used in FDI, and potential additional sources of information.

2.2 Statistical units

2.17 ONS aims to collect information about what are called Truncated Enterprise Groups (TEGs) for FDI. TEGs have one UK-based company as the apex of the group of enterprises below it and which it controls; it may, or may not, be the ultimate owning company. The preference is to select such TEGs and to ask them, as the parent of the UK operation, to report on the companies (enterprises) within their group (that is, to provide a consolidated report).

2.18 However, the actual units that appear on the FDI frames, and thus can be sampled, are a mix of Enterprise Groups (including single Enterprises), and separate enterprises that are part of an Enterprise Group and, occasionally, parts of separate Enterprises that have requested the ability to report separately. Various, but thorough, exercises take place to ensure there is no duplication between, for example, an Enterprise Group and its separate Enterprises on the FDI frames.

3. Sampling and sample design considerations

3.01 The sample design for any official survey is naturally complex, and requires attention to detail both in its specification and implementation. Aspects for consideration include the overall design (details of stratification, for example), as well as sample-size specifications, and sample-selection procedures. This chapter considers many of the technical aspects of sampling, and notes several areas where improvement should prove possible. Specification of the precise details of any such improvements would require thorough and detailed investigations that are beyond the resource available for this review. As such, the following recommendations encompass all others made in this chapter:

Recommendation R2 *(high priority)*: Commission methodological analysis to review in detail the specification of the sample design of the FDI surveys.

Recommendation R3 *(high priority)*: Improve the implementation of the sample selection mechanisms, so as to bring them in line with good practice and intended specifications.

The rest of this chapter serves as a guide to the scope of this recommended work.

3.1 Sample design

3.02 Each of the FDI/Non-Worldbase (FDI/NWB) and Worldbase (WB) sampling frames is stratified by combinations of industry and a banded size measure, the definition of which is dependent on frame and investment direction. Since any company will feature on only one of those frames in each direction, it may be useful to regard the FDI/NWB and WB frames simply as separate sampling strata within each of the Inward and Outward surveys.

3.03 Summary of the FDI survey stratification:

Industry: All of the surveys and frames use the same industrial stratification of 7 broad industry sectors, defined in FDI as: Oil; Finance; Manufacturing; Retail; Information and Communication; Professional, Scientific and Cultural; and Other. Each UK company on the sampling frames is assigned to precisely one industry sector, which are based on the UK's Standard Industrial Classification (2007). Further discussion of the industry codes used and the coding process is given in Section 5.2.

Size measure: Each of the 7 industry strata is sub-divided into a maximum of 3 size bands, where the size measure used differs by frame and survey direction:

	Inward	Outward
FDI/NWB frame	*Net book value*	*Net book value*
WB frame	*Turnover*	*Number of subsidiaries*

The size measure variables used depend upon availability on the frame (net book value is not available on the D&B extracts used to create the WB frame).

Stratum numbering: Though only for internal use, the numbering convention adopted is potentially confusing, as the same numbers (1 to 17, 18 or 19 depending on frame) are re-used, but inconsistently, on the different frames. For example, Stratum Number 15 refers to the smallest companies in the Professional, Scientific and Technical industry on the Outward WB frame, while

also meaning the largest companies in the 'Other' industry on the FDI/NWB frames. The numbering convention should be made more consistent, reducing the risk of human error occurring.

3.04 The detail of the current definitions of the sampling strata are given in Appendix 3.1A (Industry Definitions) and in Appendix 3.1B (Industry-by-sizeband Stratum Definitions). As already noted, the same sampling-stratum definitions (though not sample sizes) apply to the quarterly and annual versions of each of the Inward and Outward surveys.

Review of the sample design:

3.05 Keeping the FDI/NWB and WB frames separate seems sensible, and allows for the FDI/NWB frame, which contains the most important companies in terms of FDI, to be sampled more heavily.

3.06 Stratification by a cross-classification of industry and company size is standard, good practice in business surveys, as it allows control of the sample in all domains of interest, and can help improve precision in estimates. In this respect there is no reason to recommend a different approach in principle for FDI, though improvements may be gained by further consideration of the detail.

3.07 FDI estimates (outputs) are calculated at a more detailed level of industry that the 7 sectors used for stratification; the statistical bulletin datasets provide estimates on an 18-industry by country basis. However, the output classifications are based on the details of the foreign affiliates and parents rather than that of the sampled UK companies. Nonetheless, a review of stratification should include the detail of the industry strata used. In addition, there are a few cases where the output industry codes are spuriously excluded from the sampling strata of the same name (see Section 5.2), and these should be investigated.

3.08 For the size measure used in stratification to improve precision, there would ideally be a strong correlation between it and survey outcomes (variables). Previous analysis (for example, ONS (2011, 2008, 2005)) have suggested that only relatively weak correlations exist with the obvious candidate variables for stratification. As such, there is probably little to be gained by changing from the variables currently used for stratification.

3.09 The number of sizebands, and the boundaries that define them, were last reviewed in 2011 by Methodology. It's common practice to leave these details in place for a few years before reviewing the details again. Standard techniques were applied in determining the sizeband boundaries (such as the 'cumulative root-f' rule, see Cochran (1977)), which should lead to better precision in estimates.

3.10 There are small variations from industry to industry in the stratum boundaries used (for example, a mix of 0-7, 0-10, 0-14 and '0-10 with 10-15' (£ million, turnover) for the smallest bands on the Inward WB frame. Although these boundaries were recommended as best based on the historical data used in the analysis, there is no guarantee that these very specific configurations remain optimal for subsequent years of the survey given changes in the survey population and the major changes made to the survey methodology around 2013. As such, this set of stratum boundaries seems overly complicated, and could be simplified. More consistent boundaries might prove easier to manage for the teams who work with them, and reduce any risk of errors occurring, while not noticeably affecting the quality of the estimates. Given the time since the last review of stratification, it would be prudent to review the stratum boundaries again now.

Suggestion S2: The sampling stratum definitions should be reviewed and updated at least every 5 years.

Suggestion S3: In the next review of stratum boundaries, consider whether the use of a simpler and more consistent set of stratum boundaries would be beneficial.

3.2 Sample sizes (dispatch and response)

3.11 The number of questionnaires dispatched remained relatively constant on all surveys until a notable boost was applied from 2013 (that is, with respect to the 2013 quarterly and 2012 annual surveys onward). Since then, the quarterly sample sizes have again remained relatively constant, whereas that for the annual Inward survey has grown each year since, and that for the annual Outward survey decreased for one year before growing again. The overall sample sizes (from the FDI/NWB and WB frames combined) have increased between the 2009 and 2015 dispatches by 27% for the Quarterly Inward, 66% for the Quarterly Outward, 34% for the Annual Inward and by 32% for the Annual Outward surveys.

3.12 The numbers of questionnaires dispatched and the numbers returned by the time of the main (second and final) delivery to the FDI team in each survey round are shown in Figures 3.2A and 3.2B, (and also in the table in Appendix 3.2). The time between dispatch and the main delivery can vary from quarter-to-quarter. The delivery usually takes places around 10 weeks after the questionnaires have been dispatched, but can be as early as 8 weeks or as late as 12, and this variation can account for much of the difference seen in response, so caution is advised when interpreting variations. It should be noted that variation in response rates between periods is probably detrimental to the quality of the estimates, and it would be useful to explore ways to reduce variability in the time between dispatch of questionnaires and the main delivery of data to the FDI team.

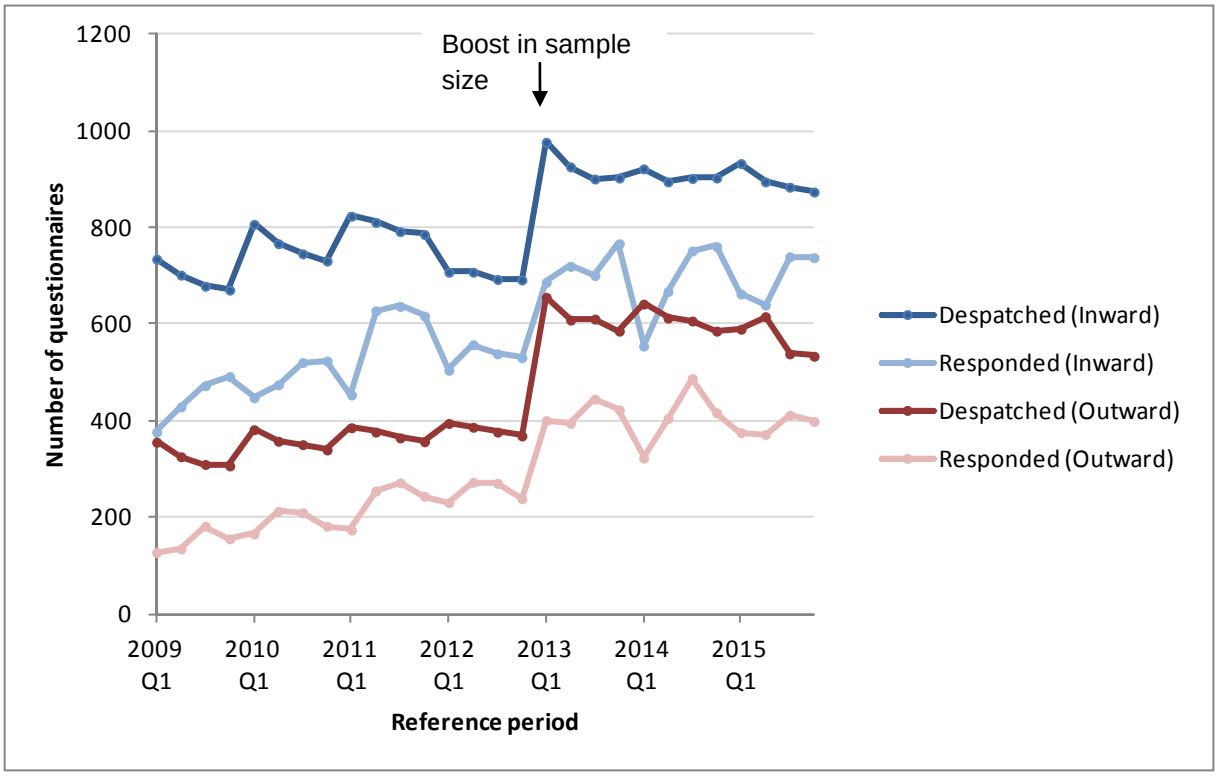


Figure 3.2A: Sample sizes (number of questionnaires dispatched and received in response by time of final delivery) for the quarterly FDI surveys. Any companies found not in scope have been removed from these numbers. Dispatch sample sizes for all quarters in the same calendar year are set for Q1, and then held constant except for the removal of deaths; the saw-tooth pattern this creates is evident.

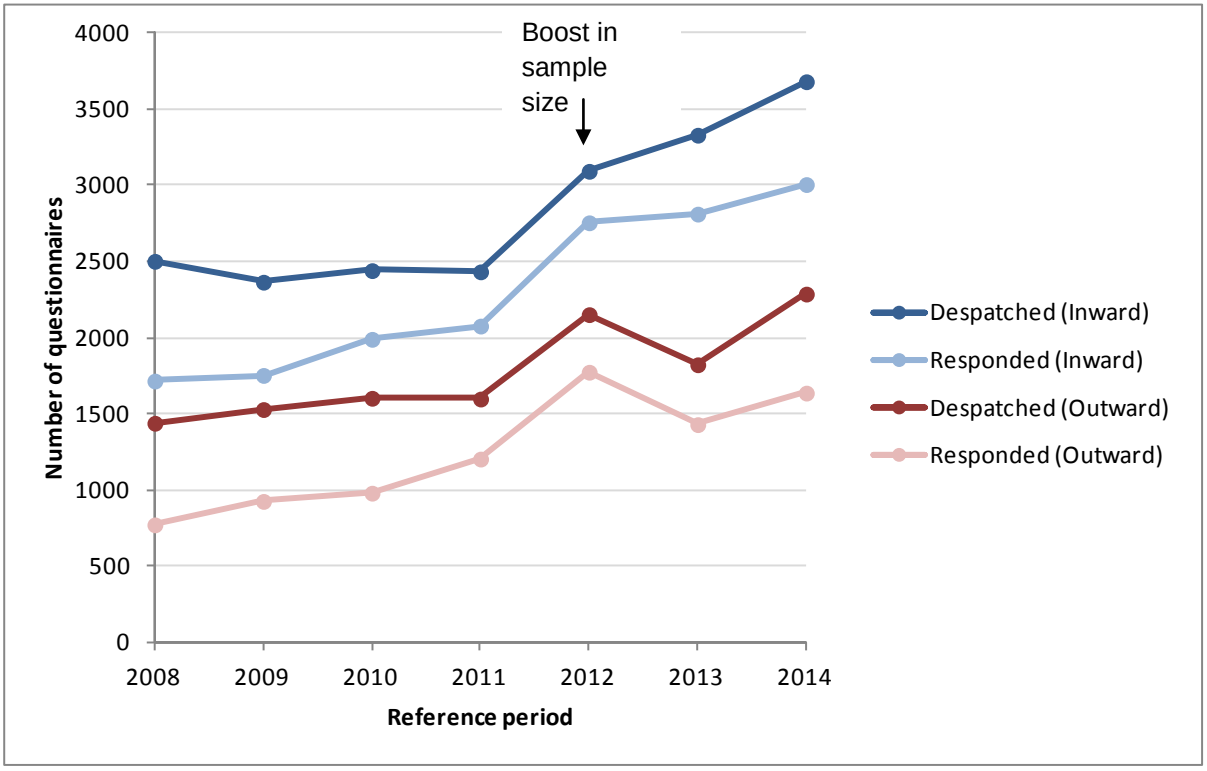


Figure 3.2B: Sample sizes (number of questionnaires dispatched and received in response by time of final delivery) for the annual FDI surveys. Any companies found not in scope have been removed from these numbers.

3.13 Response rate targets are used by the Editing and Validation (E&V) teams to help guide response-chasing procedures. They are stated in terms of both number of questionnaires and amount of net book value (where available). In terms of net book value (which has the higher of the targets, and is not shown in Figures 3.2A and 3.2B), the targets are 85% and 75% for the Annual Inward and Outward surveys respectively, and 75% and 50% for the Quarterly Inward and Outward surveys. The targets themselves are probably guided by the practicality of available resource and time available for data collection, rather than derived as any kind of optimum measure, but regular achievement helps provide consistency from period to period.

3.14 Naturally, responses arrive at ONS over a period of time. As an example, response rates (based on numbers of questionnaires received) are shown against time for one particular quarter's surveys in Figure 3.2C. Even after close down for final delivery, responses will continue to arrive and be processed at ONS, sometimes in quite substantial numbers (the requested response time on the quarterly surveys is quite short). Such late returns will be included in any future re-deliveries of data and can lead to revisions in estimates.

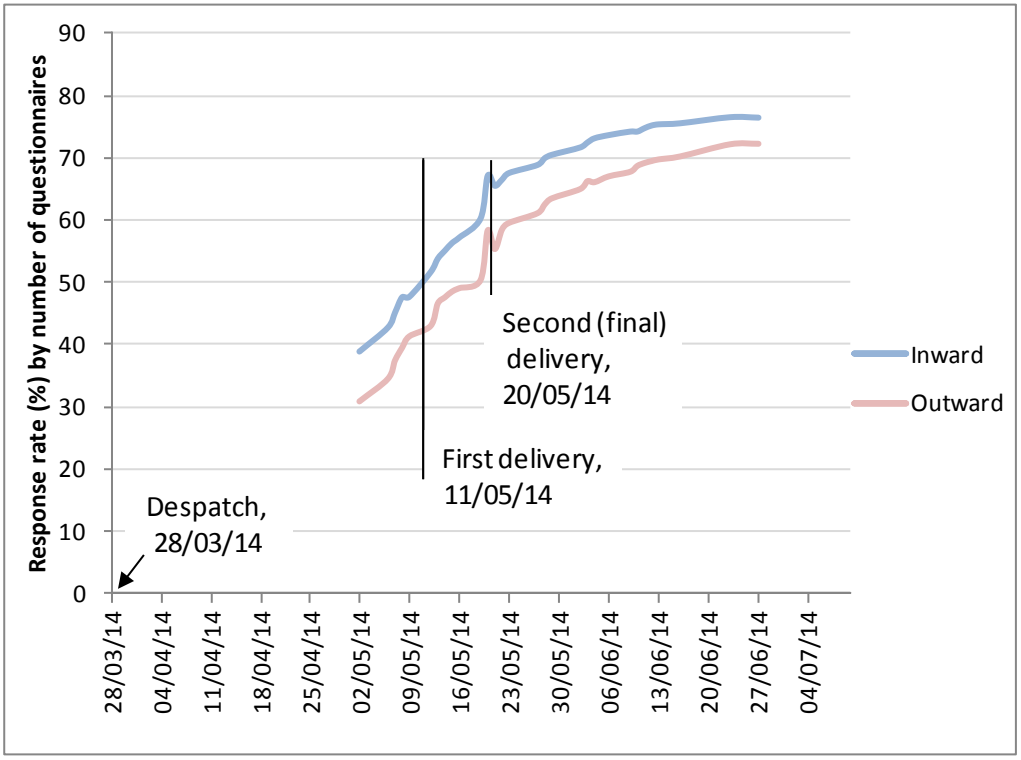


Figure 3.2C. Response profiles over time for the 2014 Q1 Inward and Outward surveys. The apparent decreases in response rate (for example, around the time of the second delivery) can be explained by the count of the number of dispatched questionnaires being decreased when deaths (or otherwise out-of-scope reasons) are notified for selected companies, and are thus removed from the denominator of the response rate calculation. Of note for this particular period is that another re-run was unusually conducted some months later, on 9 January 2015, by which time response was recorded as being in excess of 88% for Inward and 87% for Outward.

3.15 Sample sizes and the precision of estimates are inextricably linked, with larger sample sizes affording greater precision. As such, recommendations about sample sizes are made after consideration of precision, in Section 6.3.

3.3 Sample allocation

3.16 Sample allocation is the process of distributing the total sample size between the sampling strata, and is a task carried out by Methodology. The usual practice for ONS business surveys is to review a survey's sample allocation every few years, keeping the current allocation fixed in the intervening time by continuing to completely enumerate (that is, sample 100 per cent) the largest businesses in each industry (and maybe in some other strata too), while holding constant the number of businesses selected in other strata.

3.17 Although the allocation will tend to drift away from being optimal over the years between Methodology's reviews, that deviation tends to lead only to small decreases in optimality (in terms of precision of estimators), in the same way as already noted for the sample stratum definitions. The allocation of the sample, other things being equal, would not usually affect bias, only precision.

3.18 The usual approach of keeping sample sizes in each stratum constant means that sampling fractions (the ratio of sample size to population size in a stratum) vary over time if changes occur in the population size. The principal advantage of this approach is that the overall sample size remains approximately constant (varying only because of changes in the relatively small number of businesses in completely enumerated strata). Thus it proves a practical approach for controlling survey costs and planning resource allocations for survey processing.

3.19 The implementation of the allocated FDI sample(s) has taken different approaches at times. Sample sizes for each stratum have been specified by Methodology, as is usual practice, but what seems to have been intended for (some) subsequent years was keeping the sampling fractions constant. The rationale was reasonable: the WB population was increasing, and therefore the standard errors of estimates of totals would also increase unless sample sizes increased too. However, this approach created a conflict, in that the overall sample size has, as a consequence, become larger than that afforded by the available resource. In the most recent year, further adjustments were made to the sample allocation with the aims of:

- keeping the overall sample size to a manageable size, while
- not affecting the sample selection from the arguably more important FDI frame

and thus samples from the WB frame were reduced in most strata by a factor of 0.7. The application of this factor was a time-pressed, practical intervention, and done with the reasonable principles in mind. However, it was applied without consultation with Methodology, and without analysis of what would be optimal in terms of the sample balance between the frames.

3.20 FDI, with its population size fluctuating more than is seen in most business survey populations selected from the IDBR, may require an approach to sample allocation that differs a little from standard. The allocation used seems to have varied across years, sometimes on a somewhat ad hoc basis, and although this shouldn't bias estimates, procedures should be formalised. At the very least, any changes to the allocation on an annual basis should be implemented with Methodology's advice, but the FDI sample allocation might need a more frequent review than the allocations of other business surveys.

Recommendation R4 *(high priority)*: Review the sample size allocation implementation procedures, paying particular regard to the merits of keeping sample sizes or keeping sampling fractions constant over time.

3.21 The most recent FDI sample re-allocation by Methodology took place for the selections in 2014. As such, another re-allocation would not normally be recommended for another couple of years. The implementation of the 0.7 factor in early 2015, as noted above, had not been foreseen, and in the next re-allocation exercise it would be useful to ensure a check is made on the relative sample sizes from each frame.

Suggestion S4: Review the total sample sizes used in each of the FDI surveys and frames to establish if a re-balance would be beneficial.

3.22 Some further observations on the sample allocation currently used for FDI (details of sampling fractions are given in Appendix 3.3) are given below, and include some comparisons with the general principles used on most other ONS business surveys.

In any given industry and survey, smaller businesses should not be sampled with higher probability than larger ones. For FDI, that is currently true within each frame, with a few exceptions (all on the annual Inward sample from the WB frame, and these should be amended). It is difficult to compare directly between the FDI/NWB and WB frames because different size measures are used. However, the generally smaller sampling fractions on the WB frame mean that some 'small company' strata on the FDI/NWB frame have greater sampling fractions than the 'large company' strata for the same industry on the WB frame.

Companies on the FDI/NWB frame are sampled more heavily than those on the WB frame, which, as already noted, seems reasonable given the relatively rare and highly skewed nature of FDI variables.

The FDI/NWB frame is treated much like most other business surveys, with the largest sizeband in each industry being completely enumerated (for both the smaller, quarterly and larger, annual surveys), whereas the WB frame is clearly regarded much more as a supplementary data source, with no stratum being completely enumerated in any survey. That the largest sizebands on the WB frame are not completely enumerated, with some even having really quite small sampling fractions (especially on the quarterly surveys) may appear somewhat inconsistent when compared with good practice on other business surveys. However, as part of the frame cleaning process that takes place before selection, all companies on the WB frame identified as being large in terms of FDI are transferred to the FDI/NWB before selection takes place, a principle adopted for good reason.

3.4 Sample selection, rotation and overlap

3.23 This section considers 3 areas that relate to sampling, and in particular the way in which the quarterly and annual samples relate to each other, and between consecutive periods. The first part, on sample selection, provides context, by discussing the timing of the quarterly and annual selections and outlines the approaches used for making the sample selections. The part on sample rotation considers how samples in successive periods relate to one another, contrasting the benefits of a common sample with the burden placed on respondents, and, finally, sample overlap considers issues relating to commonality between the quarterly and annual samples.

3.24 **Sample selection** – the drawing of a survey sample – takes place for FDI once the sampling frames have been updated and cleaned, as described previously. That process is annual, and likewise so is sample selection. The following pattern of timing is used for the FDI surveys, the example given relates to 2015 reference periods.

Reference period	Date sample is selected (drawn)	Date of questionnaire dispatch to companies selected in sample
2015 Q1	January 2015	March 2015
2015 Q2	January 2015	June 2015
2015 Q3	January 2015	September 2015
2015 Q4	January 2015	December 2015
2015 (annual)	January 2016 (expected)	April 2016 (expected)

3.25 The quarterly samples are all selected at the start of the reference year, once the frames have been updated and cleaned. The annual sample for the same reference year is selected at the end of that year, in common with most other annual business surveys, but uses the next year's frames. Thus the quarterly samples with respect to year $y = t$ are selected at the same time as the annual sample with respect to year $y = t - 1$. This approach ensures the most up-to-date frames are used in each sample selection.

3.26 Samples are drawn using a bespoke program written in SAS®, and the selection mechanism is based around permanent random numbers (PRNs) (see Ohlsson (1995), Smith et al (2003)), which is the approach used on the IDBR for selection of random samples in most other business surveys. The SAS® selection program is maintained and run by the FDI team. The program has a number of aspects that don't conform to principles of good programming practice (an example is much use of repeated sections of hard-coded parameters), which make maintenance of the code more difficult and increase the risk of human error.

Suggestion S5: Review and re-write the sample selection program to make it less exposed to the risk of error, and reduce the amount of manual intervention required.

3.27 **Sample rotation** is defined here as the replacement of part of the sample period-on-period in a controlled way. This is desirable in business surveys as it both gives a prescribed sample overlap between different time periods (resulting in more precise estimates of change, as the positive covariance induced by having samples with a common component is deducted in estimates of the variance of change), and it controls and spreads the respondent burden placed on businesses in complying with surveys (proportionate burden is a principle in the Code of Practice for Official Statistics (2009)).

3.28 Also, when compared with drawing a completely fresh random sample each period, use of sample rotation reduces the effort required to get responses, as many of the selected units in the sample will already have responded on previous occasions.

3.29 Surveys that select directly from the IDBR benefit from its automated, rotation-control functionality. However, FDI samples from its own frames using its own bespoke SAS® program. Although this attempts to replicate the IDBR selection processes, that part related to sample rotation doesn't function automatically. Some additional functionality is also required:

(a) The 'PRN start', which controls period-on-period sample rotation, is hard coded in the program and needs manual intervention. To be implemented correctly, a PRN start is required for each stratum (currently there is only one per frame), and the functionality to calculate the next start point automatically needs to be added to the program.

Issue I1: There is currently no functionality in the SAS® selection program code to implement rotation automatically in the FDI sample. The IDBR has this functionality, which is used for business surveys selected from it, and its approach should be replicated for use by FDI on its own frames.

In recent years, the PRN starts in the FDI sample selection program were not updated at all from the previous year's samples, meaning there was no rotation of the sample, other than that caused by births or deaths (etc.). This is imposing some disproportionate burden on the sampled companies. Methodology's previous recommendation was to rotate half of the annual sample in non-completely enumerated strata each year, and this review considers sample rotation further later in this chapter.

(b) A "permanent" random number is created in the SAS® program for each company on the frame without one, which seems a reasonable thing to do (some companies may not have a PRN, as would be the case if there is no current (live) UK reporting unit, for example). However, the current implementation is not sufficient to create a PRN that actually is permanent: the program assigns a fresh random number to each such company on each occasion the program is run. Therefore a PRN assigned in this way is not permanent, and would change every year, causing rotation not to be correctly applied.

Issue I2: The part of the sample selection program that creates PRNs where necessary does not function as it needs to, and should be corrected.

From the population files in 2015, the proportions of missing PRNs were:

	Inward	Outward
FDI/NWB frame	33%	43%
WB frame	21%	25%

These numbers seem relatively large, especially for the FDI/NWB frame, the companies listed on which should have been sampled before. The reason(s) for the lack of PRNs for some companies on the sampling frames should be investigated to confirm that all such cases refer to companies without live UK reporting units.

3.30 The quarterly sample selection takes place only once per year, for Q1, with the samples in Q2, Q3 and Q4 being formed of the same set of companies except, of course, for those companies that become out of scope during the year, which are then removed, or a very limited number of subsequent manual additions (for example, large transactions identified by the Mergers and Acquisitions Survey). This means each subsequent quarterly sample within the same calendar year will (usually) be a subset of the previous one. The size of the loss from Q1 through to Q4 has varied from year-to-year, with a reduction of between 2% and 7% on the Inward survey and between 7% and 10% on the Outward survey in recent years (from data in Appendix 3.2).

3.31 Most other business surveys select a new (rotated) sample in each period from the IDBR, so one should ask whether the FDI quarterly sample should be selected in a similar way. The arguments for and against are presented below.

Arguments for quarterly rotation:

(a) A better spread of respondent burden on sampled companies

(b) The sample size remaining constant from quarter to quarter

Arguments against quarterly rotation:

(a) The FDI frames are only updated once a year (whereas the IDBR is continuously updated with births and deaths), therefore selecting a sample in each quarter would be no more representative than the current arrangement of selecting all samples at the same time early in the year. A top-up sample could be introduced to replace any companies that become out-of-scope during the year, which would maintain the quarterly sample size throughout the year.

(b) Controlling the overlap between the annual sample and its quarterly sub-samples (see Sample Overlap section, below) might prove quite complicated in some scenarios if the quarterly sample were rotated every quarter. If not controlled well, some companies could be in the sample for only one quarter, whereas others could be in for 2, 3 or all 4 quarters in the same calendar year.

(c) Reconciliation (benchmarking) between quarterly and annual estimates would be made more difficult if a rotating quarterly sample were introduced. As an example, there could be no companies in common between the Q1 and Q4 samples, so reconciliation between the annual opening and closing balances would be particularly difficult.

(d) Additional resource would be required for sample proving, as a greater number of different companies would be sampled during the course of the year than is the case with a static quarterly panel.

(e) Response rates may suffer; anecdotal evidence from the response-chasing teams at ONS suggests it is easier to get responses from companies that have responded before, than from those newly selected for a survey.

On balance, selecting the FDI quarterly sample just once per year and then sending quarterly questionnaires to that fixed panel of companies each quarter seems the best approach.

Suggestion S6: Assuming the practice of not rotating the quarterly sample within calendar years is continued, consider introducing a top-up sample to compensate for the reducing sample size over the course of the year.

3.32 Sample rotation in the annual survey is discussed below, alongside sample overlap.

3.33 **Sample overlap** is considered here in the context of commonality between the annual and quarterly samples that relate to the same reference year. As already noted, the quarterly samples are selected first (in January of year $y = t$, the questionnaires for each quarter's sample then being dispatched towards the end of the reference quarter), and the annual samples that refer to year $y = t$ are then selected and dispatched towards the start of year $y = t + 1$.

3.34 The quarterly sample sizes are intended to be no greater than the corresponding annual ones (though one exception is currently noted), and the preference is for the quarterly samples with respect to quarters in year $y = t$ to form, in each stratum, a subset of the annual sample for year $y = t$. The opposing arguments for having the quarterly sample as a subset of the annual sample follow:

Additional burden is placed on those companies selected in the quarterly survey; each is asked to complete 4 questionnaires during the year, and is then asked for the same information again on an annual basis. As well as the total burden of 5 questionnaires during the year, much of the information asked annually is theoretically the same as that already asked quarterly (the end-year position would be the same as the end-Q4 position, for example). However, and as already noted, the information supplied by the same company on a quarterly basis can be quite different from that supplied annually (the former often being estimates from management accounts, and the latter from the audited, statutory accounts).

The quarterly-to-annual benchmarking process (see Chapter 8) can, and has, resulted in large revisions to the quarterly estimates, but having as great an overlap as possible between the quarterly and annual samples is the best that can be done to mitigate this. In this regard, having companies in the quarterly sample that are not in the annual sample would not be helpful, and having as many of the companies selected quarterly answering for all periods in the year is beneficial (equivalent to having no quarterly rotation within the year). The only improvement would be to increase the size of the quarterly sample to be a greater proportion, and from a coherence point-of-view, ideally equal to that of the annual sample.

3.35 In summary, for FDI outputs, keeping the quarterly sample as a subset of the annual sample is best. However, the additional burden on these companies is unwelcome, and any other options to reduce that burden should be considered; these might include considerations around the timing of the questionnaire dispatch and return-by dates, the possibility of dependent interviewing (the playing back of previous responses to respondents), and the use of electronic data collection.

3.36 The mechanics of sample rotation are now considered further. This is made complicated by considering the rotation within the annual sample, the rotation from year-to-year of the quarterly sample, and constraining the quarterly sample to being a subset of the annual sample. As already noted, in recent years, no rotation has been applied, so a new process is sought for FDI.

3.37 Making the quarterly sample a sub-sample of the annual sample is best achieved through the co-ordination of PRN start points. The same start point should be used in the same stratum for selection of both

the quarterly and annual samples. Since the quarterly samples are selected one year before the annual samples, the start points used on the quarterly surveys will need to be retained for use one year later for the annual surveys.

3.38 The first scenario is to let the annual sample rotation take precedence. Immediately after the annual survey has been selected at the start of the year (with respect to the one just passed), the PRN start points will be calculated for the following year's annual survey (with rotation as prescribed), and these updated PRN start-points will be also used shortly to select the quarterly samples for the coming year. An example is shown in Figure 3.4A. Such an approach presents no problems for implementation, but a managed process for it doesn't currently exist and would be required.

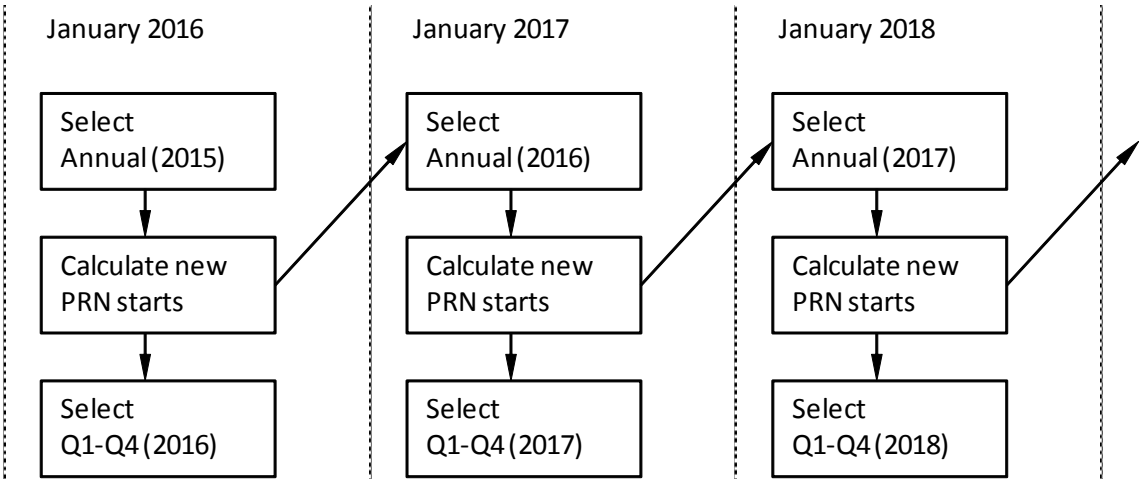


Figure 3.4A: Illustrative process diagram showing annual cycle of survey selection and PRN start-point calculations

3.39 Overlap between the Q4 (year *t*) and Q1 (year *t* + 1) quarterly samples is not guaranteed by this approach. The amount of overlap achieved would depend upon the rotation period of the annual survey, and the size of the quarterly sample relative to that of the annual sample in a given stratum (as well as any additional changes caused by births, deaths or other movements between strata). Different overlap scenarios are illustrated in Figure 3.4B.

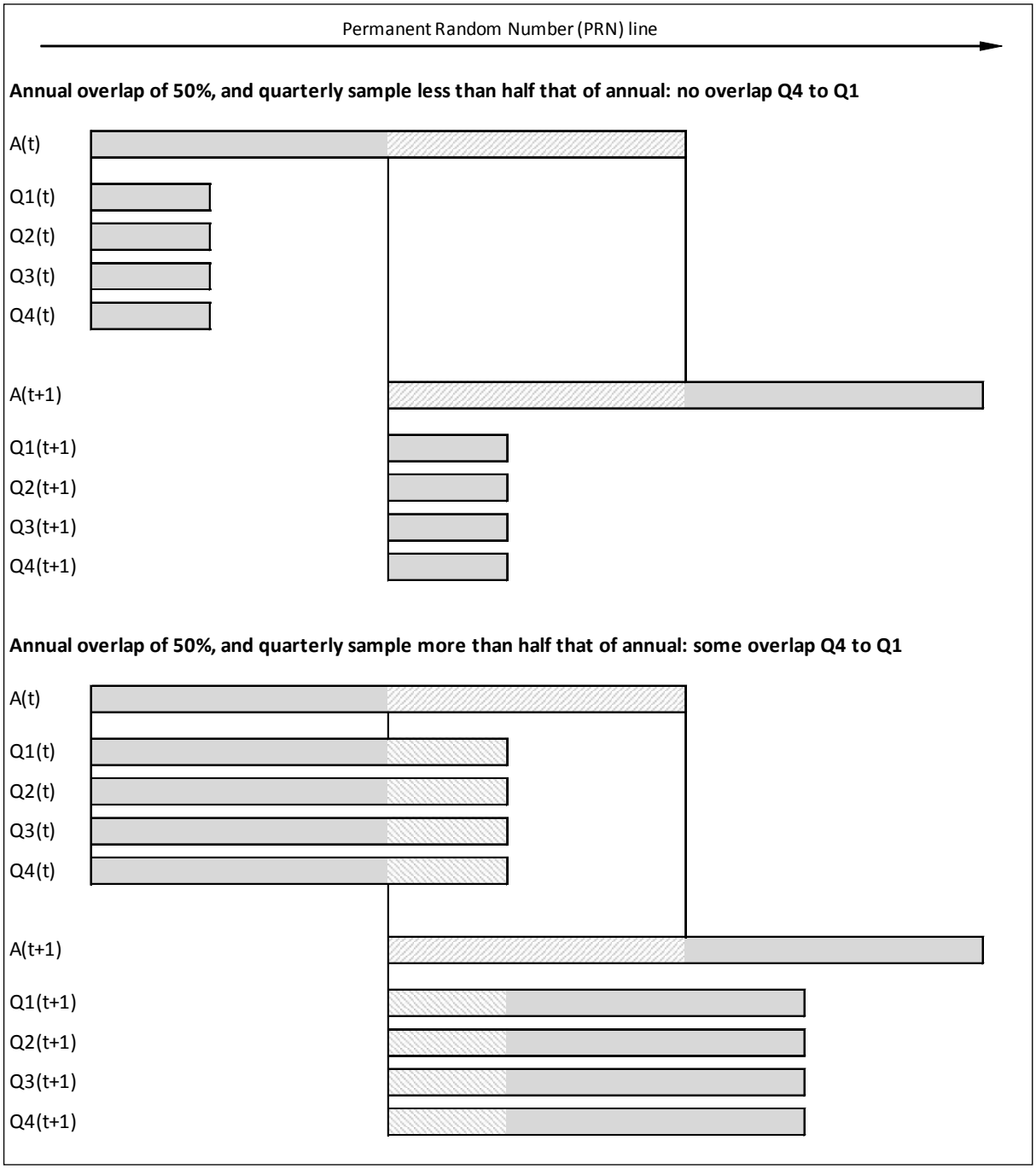


Figure 3.4B. Schematic diagram of samples selected via use of permanent random numbers. A prescribed year-on-year overlap of 50% in the annual sample means any overlap in the quarterly sample between Q4 and Q1 is dependent on whether or not the quarterly sample size is greater than 50% of the annual sample. The diagram shows theoretical samples drawn left-to-right from a start point on the PRN line. Hatching denotes overlap between samples.

3.40 Of the current strata on the FDI/NWB frame, the median ratio of quarterly-to-annual sample sizes is 0.88 for Inward, and 0.88 for Outward, though the lower tail extends further. For the WB frame, however, those ratios are much smaller; for Inward, the median is 0.25, and for Outward, 0.17.

3.41 As such, rotating the annual sample by 50% would lead to quite substantial overlap between the Q4 to Q1 quarterly samples on the FDI/NWB frame, but often none on the WB frame. However, to achieve a reasonable overlap on the samples from the WB frame, where the quarterly-to-annual ratios are often small (for example, only around 0.10), would require a rotation period on the annual surveys of around 10 years, which seems unjustifiably long from a respondent-burden perspective. Even making the annual rotation

period, say, 4 years (equivalent to 25% rotation each year) would fail to give any overlap in over half the strata.

3.42 The second scenario would be to give precedence to a prescribed level of overlap in the quarterly samples, and to draw the annual samples from the same start point as the corresponding quarterly samples. However, with most WB quarterly samples being much smaller than annual ones, this, similarly, would lead to excessively long periods for companies in the annual sample, and doesn't seem practicable.

3.43 In conclusion, the various desired constraints on quarterly and annual sample sizes, sample co-ordination and sample overlap cannot all be met simultaneously. If the previously recommended rotation of the annual sample by 50% were implemented, there would still be reasonable overlap from Q4 to Q1 on the quarterly survey on the FDI/NWB frame, which is the more important, but not on the WB frame. This seems a reasonable compromise, and continues to prioritise the (arguably better) annual surveys ahead of the quarterly surveys.

3.44 In terms of the rotation period itself for the annual survey, there is no single optimum number, but the 50% recommended, which would lead to companies being selected for 2 consecutive years before being dropped from the sample, seems reasonable. The balance is between reducing the variance of change, and increasing respondent burden on the sampled companies. There is currently no rotation in practice, and although introducing a 50% rotation rate in the sampled strata may seem operationally challenging in the first year it is applied, sample rotation should be (re-)introduced on FDI as a matter of priority.

Recommendation R5 *(high priority)***:** Re-introduce sample rotation on the annual FDI surveys, co-ordinating the quarterly sample selection via correct use of PRNs.

4. Data collection

4.01 Data from the sampled companies in the FDI surveys are collected either via paper questionnaires, which are posted to respondents and returned by post (or fax) to ONS for scanning using optical character recognition software, or via the Secure Electronic File Transfer (SEFT) system. SEFT provides a secure portal for the exchange of files and communication between respondents and ONS, and for which FDI supplies a spreadsheet equivalent of the paper questionnaire for respondents to complete and return via the same portal. Use of SEFT for FDI has many benefits for ONS, not least because data are captured automatically, and respondents are encouraged to use it.

4.02 The questionnaires for the quarterly and annual FDI surveys are identical in terms of questions asked, and differ only in respect of the reference period dates and durations. Each questionnaire has two parts: Part One asks about the (sampled) UK company's details, and Part Two asks about details of its Immediate Foreign Affiliates or Branches for Outward FDI, or Immediate Foreign Parent Companies, Head Offices and Fellow Enterprises for Inward FDI. A separate Part Two questionnaire must be completed for each such Affiliate or Parent, so a sampled UK company may have to complete many of these. If using SEFT, the details for each extra Part Two questionnaire are entered as separate columns on the spreadsheet, which allows for easier completion and comparisons by the respondent.

4.03 This chapter reviews the questionnaires currently in use for FDI, considering recent developments, the scope of the questions asked (topic coverage), for which a topic expert has been engaged in this review, and considers some operational issues encountered with data collection as well as the future use of electronic data collection.

4.1 Short questionnaires, questionnaire development and respondent guidance

4.04 All sampled companies were formerly sent the same questionnaire. However, some now receive a reduced-length version, or so-called "short" questionnaire. This asks only about half the number of questions in Part Two as are asked in the standard questionnaire, but is otherwise the same.

4.05 Analysis (ONS(2011a)) showed that the questions now omitted on the short questionnaire were found to be predominantly answered as zero, or with only small amounts, by the smallest companies in some industries. Companies in those sampling strata now receive the short questionnaire (details of which strata are affected are included in the sampling-stratum figure in Appendix 3.1B).

4.06 Two benefits were realised by introduction of the short questionnaire.

The first was a reduction in the respondent burden placed on each sampled small company, by not asking questions of it that are largely irrelevant.

The second was a reduction in the total compliance cost (overall respondent burden) of the survey, a quantity that is monitored and capped at ONS. That compliance saving was then used to offset an increase in overall sample size for FDI, resulting in better precision in estimates. The trade-off in doing so was to accept a little bias – as not all of the smaller companies would have provided a zero response – but the analysis showed this to be sufficiently small as to be negligible

4.07 The short version of the questionnaire was introduced in 2013 following a period of testing and development. Only the paper questionnaire has a short version; any company responding via SEFT completes the electronic version of the standard length questionnaire.

4.08 All substantial questionnaire developments in recent years on FDI, including the short questionnaire and the introduction of new questions required to meet the revised ESA[1] and BPM[2] regulations, have been conducted by Methodology. The approach has included cognitive interviewing of respondents, and results have included improvements to the questionnaire layout, question wording and guidance notes; those notes describe FDI concepts, make use of diagrams, and give instructions to the respondent on how to complete the questionnaires.

Suggestions S7 on guidance in the questionnaires from the topic expert consulted in this review are to:

(i) combine the guidance notes on FDI concepts, definitions and relationships into one section at the front of the questionnaires

(ii) explain immediate investment and indirect investment in terms of chains of control and significant influence, and then

(iii) explain the concepts of ultimate controlling parent, fellow relationships, reverse investment and special purpose entities

4.2 Scope of questionnaires

4.09 Questions are asked on a variety of topics at a fine level of detail. From these, estimates are produced, and the principal outputs – estimates of (total) flows, investments and investment positions – are derived as sums and differences of the component parts that are collected directly on the questionnaires.

4.10 The questionnaires used to collect the data from companies for the Inward and Outward FDI surveys have been reviewed as part of this Quality Review for consistency with the EU Balance of Payments Regulation and the international guidelines. The requested data on income, transactions, positions and other changes (for example those caused by exchange rate variations) seem comprehensive and well-defined, and meet the international requirements in coverage and specification.

4.11 Collection of data on reverse investment in equity is included in the international specifications. ONS conducted some research 4 years ago that showed zero or minimal values of such investment, inward or outward. Therefore the questionnaires do not attempt to collect these data. If time and resources allow it would be useful to repeat the research to check that the results are still valid.

4.12 Data are collected on reverse investment in debt, but the statistics are not systematically identified as such and are not shown separately in the FDI statistics delivered to the Eurostat, OECD and IMF international organisations.

4.13 Increasing user interest in FDI analyses of inward FDI statistics by country of ultimate controlling parent is likely. At present no such analyses are prepared from the data collected on the FDI questionnaire. The data collected on the revised inward FDI questionnaire should be sufficient to prepare regular analyses by country of ultimate controlling parent. The OECD BMD4 manual includes table specifications for these analyses.

[1] European System of Accounts

[2] Balance of Payments and International Investment Position Manual

Recommendations R6 *(medium priority)* **on coverage and scope**:

(i) emphasise on the questionnaires that data on transactions and positions with indirect investors or investment enterprises are also requested,

(ii) specify on the questionnaires how and where these data with indirect investors or investment enterprises and with fellow enterprises should be recorded,

(iii) identify the questions on the questionnaires where data on reverse investment are requested

4.3 Issues of detail in data collection

4.14 In addition to the suggestions on guidance and recommendations on scope, a number of further issues have been identified where corrections are needed or improvements could be made.

(a) There are typographical errors in the questionnaires, and a list of these has been supplied to the FDI team already. These include typing errors, inconsistencies in the text and duplications, and a couple of incorrect references to Inward or Outward FDI, which probably resulted from the copy-over of one questionnaire during its creation, but was missed in the quality assurance.

Issue I3: Typographical errors are present on the questionnaires, and need to be corrected.

(b) Anecdotal evidence from the Editing and Validation teams who liaise with respondents suggests that some questions are still not that well understood by respondents, including companies' accountants who often complete the questionnaires. The suggestions about improving the guidance, should help improve this, but there may be value in carrying out further research with respondents about particular issues.

(c) SEFT, while invaluable, also seems a source of frustration for both respondents and the teams at ONS who look after it and its users for a number of technical reasons. Particular issues reported include the system not working in all browsers, and the spreadsheet not being sufficiently well locked down allowing respondents to change formats and layouts (which causes problems in data uploading at ONS).

4.4 Electronic data collection

4.15 This final section on data collection relates more generally to electronic data collection for FDI, that is beyond the specific use of SEFT. ONS is currently investing heavily in this development and has its own Electronic Data Collection (EDC) programme. There is still much work to complete, but developments are happening quickly. A number of surveys are currently being trialled on EDC, but the programme has aims of moving most data collection in business surveys to this means in the coming years, and FDI should not be an exception to this. Indeed, a provisional date in 2017 has been assigned for FDI.

4.16 In considering this, it is important to recapitulate 2 particularly salient points about data collection on FDI, and these are ones by which FDI differs from most other business surveys. The first lies in the length and complexity of the questionnaire, and the need to ensure that the details provided by respondents are correct and consistent. By this measure, FDI exceeds the complexity of most other business surveys by some margin and also asks about topics not covered elsewhere. The second is that each sampled UK company may have to report, with the similar set of complex data, for multiple foreign affiliates or parents. It is this latter aspect where the use of spreadsheets is particularly practical, as it allows respondents to compare visually and easily the data for all its affiliates or parents on a question-by-question basis; the same

effect could be achieved by having the same page of each Part Two paper question open on the desk at the same time.

4.17 The EDC programme at ONS will make heavy use of electronic questionnaires, which may or may not be direct translations of the current paper versions. The use of such an approach for FDI, even if each questionnaire section (topic) is displayed on one page, might notably increase respondent burden, as respondents would need to navigate from page-to-page to compare data entries, whether for the same affiliate or parent, or between them. It is also possible that, with the current paper-questionnaire arrangement, that the UK company sends on each Part Two to its various affiliates or parents for them to complete, before co-ordinating the return to ONS. To accommodate this with EDC would require multiple user log-ons, and it is not yet known whether or when that functionality would be included. If these aspects cannot be accommodated practicably, there must be some risk to the quality of response (response rates, response timeliness and data quality) to FDI by using electronic questionnaires, and these will have to be well-considered at the appropriate time. In that respect, expanding the use of spreadsheets for data collection via a SEFT-like interface might be worth considering further for FDI.

Recommendation R7 *(high priority)*: Consider carefully the use of electronic questionnaires for FDI, and do this only once ONS's EDC programme has delivered and embedded a proven, reliable and flexible tool. Do not simply transition the same questionnaire from paper to electronic form, without first researching whether this would prove effective for FDI, given its differences from most other business surveys.

4.18 Of course, electronic data collection should bring many benefits for FDI, and more generally. In-built validation checks (especially if these can be linked with respondents' previous returns), automated routing, much improved scope for making guidance and help readily available, and instantaneous data capture should bring benefits for respondents and ONS alike, and help to improve the quality of FDI.

5. Data processing

5.1 Data take-on, validation and cleaning

5.01 FDI survey responses received at ONS are uploaded to the FDI data take-on system, which is built on the ONS platform known as CORA (Common Open-Road Architecture). Once on the system, the data are checked (validated), queries made by re-contacting respondents, and corrections made with the aim of 'clearing' the data before further processing and analysis takes place.

5.02 The complex nature of FDI data, the number of variables collected and the relationships between variables, company-subsidiary structures, and period-on-period congruences mean there is great scope for any one returned questionnaire to contain data that appear to be in error in some way. As such, the 'first time' clearance rates can be extremely low on FDI, though by end-2015 these are reported to average around 10% though there is fluctuation from quarter-to-quarter.

5.03 A lot of resource is dedicated to the cleaning of data, a process which involves much re-contact with responding companies. Clearance targets are set, of between 30% and 60% of the dispatched sample, for the 4 FDI surveys, and these targets are usually met. The targets themselves appear quite low, but they reflect:

- non-response (non-responding companies are still included in the denominator)
- the difficulties respondents have in providing the data, given the complexity and short timescale they have in which to respond initially to the quarterly survey in particular
- the set of validation rules used, which have contained various logical inconsistencies or other errors
    - those validation rules, last reviewed in 2012, were not all initially implemented correctly, meaning that some error flags trigger incorrectly, suggesting errors are present when in fact there are not. Most cases have been corrected during 2015, with the rest reported to be in hand.

5.04 It would be useful to review the clearance targets again once the validation rules have been fully and correctly implemented in order to try to improve the quality of the collected data. This is particularly important for the quarterly surveys.

Recommendation R8 *(high priority)*: Introduce measures with regard to data processing aimed at improving the quality of data collected on the quarterly surveys. Such initiatives might include the introduction of targets for higher clearance rates to be reached one quarter later.

5.05 CORA was first used for FDI data take-on under the new ESA[1] 2010 requirements for the 2013 Q1 round, and has been used ever since. FDI was one of the first surveys to migrate on to CORA, and others have followed. In interviews, staff from the Editing and Validation (E&V) team have reported mixed opinions on the functionality and practicality of the FDI CORA data take-on system. In many respects, it seems a big improvement on its predecessor FDI system (built on an OpenRoad platform) in terms of user-friendliness and some enhanced functionality. Staff on the E&V team have reported that some functionality that was available and widely used in FDI on OpenRoad is now unavailable. Reasons for a reduction in functionality include some processes being withdrawn as non-standard, and others because the scope of the first version of CORA was reduced in order to still deliver the essential functions on time and within budget. Since that

[1] European System of Account

first delivery, very little resource has been available to improve the FDI CORA data take-on system, and FDI E&V staff have developed a number of work-arounds. With those in place, they seem in a position that enables them to meet data clearance targets consistently.

5.06 Further development has taken place with CORA generally, but not for the FDI system. Data take-on for FDI remains on version 3.1 of CORA, whereas the current version is 3.4. It has been reported that a non-trivial amount of resource would be required to migrate the FDI system to the current version, which uses a much more generic version of the code. It is not clear that that would be suitable for FDI, however, as version 3.1 contains a number of FDI-specific (or otherwise limited-use) processes that would not be used by many other business surveys; discussion on that matter are ongoing. If FDI can be accommodated on the latest version of CORA, its adoption should resolve many of the issues currently reported as problematic for FDI data take-on.

Recommendation R9 *(medium priority)*: Continue the work underway to evaluate the benefits and drawbacks of moving the FDI data take-on system to the latest, current version of CORA. If a suitable arrangement can be obtained, migrate FDI to the current version, or otherwise update the FDI CORA code, as soon as possible.

Suggestion S8: Identify and evaluate benefits of the functionality lost in the migration from OpenRoad to CORA version 3.1. If retention of any of such pieces of functionality is justified (some may not be), considered its re-introduction on the CORA FDI system.

5.2 Coding and classification

5.07 Companies selected are asked to code the 'country of residence' and 'primary industry sector' of each of their foreign affiliates or foreign parents according to lists of codes provided at the end of the questionnaire.

5.08 Whereas the list for countries seems self-explanatory and unlikely to lead to confusion, that for industry sectors is not presented in a wholly logical format. It is not possible to assess the quality of self-coded classification of economic activity, but this approach gives scope for measurement error.

Suggestion S9: Ask respondents to provide a description of the principal economic activity, the approach used on ONS's Business Register and Employment Survey (rather than asking for a self-coded industry), and code afterwards from that description using an automated coding tool.

5.09 The industry code list supplied on the questionnaire is said to be an abbreviated form of the UK's Standard Industrial Classification 2007 (SIC(2007)) – a 5-digit hierarchical classification of economic activity that is equivalent at the 4-digit level to the standardised NACE Rev. 2 in the EU (Eurostat). However this seems only to be partly the case. A number of the 3-digit FDI codes (which broadly align with SIC(2007) 3-digit codes) and descriptions deviate from that of SIC(2007), with some new codes created, and the SIC hierarchy of aggregation not always followed.

5.10 There seem to be different lists of FDI industry codes in publication: one supplied on the questionnaire for respondents to use, and one given in the FDI statistical bulletin. Both seems consistent, though are presented in very different ways, with that in the bulletin being more logical and providing extra detail (for example adding clarity on which SIC 5-digit codes map into which FDI 3-digit industry codes). Coding issues noted include:

- the re-use of some particular code numbers by FDI could cause confusion; examples include:
    - SIC code 64.192, which maps into FDI code 642, whereas
    - SIC code 64.201 maps into FDI code 644 (a code that doesn't exist as part of SIC(2007), and doesn't map into FDI code 642)
- the list on the questionnaire does not state which SIC codes map into the FDI codes
- the list on the questionnaire is not presented in a logical order
- the list in the statistical bulletin contains some duplication (for example FDI code 260 contains 261 to 268, so need not be listed separately)

Recommendation R10 ***(lower priority)*****:** The Official Statistics Code of Practice states that common classifications and coding standards (among others) should be adopted to promote comparability, and the reasons for any deviations made publicly available. ONS should seek to improve the coding used on FDI, and its presentation for respondents and users, on this basis.

5.11 A full list of FDI industry definitions, with some comparisons against the SIC structure, is given in Appendix 3.1A.

5.3 Imputation

5.12 Imputation – the prediction of unit-level data in cases of non-response in sampled units – takes place in FDI after data cleaning and as one of the first stages in the Analysis part of the FDI system. The FDI team runs this process. The aim of imputation is to reduce the potential for non-response bias, which could be caused by companies with different characteristics having different propensities to respond. Imputation is generally favoured in business surveys to non-response weighting because of the wealth of other information available about the non-responding businesses. Such information may come from the sampling frame, from respondents' data from previous periods, or (in the case of non-response in particular variables only) from other information on the returned questionnaire.

5.13 Until the 2015 Q1 survey round, imputation and estimation had taken place on the FDI Analysis system built on CORA. As already noted, that CORA system was replaced with a new SAS® system, as the former wasn't working as intended. Imputation was one particular aspect that was proving difficult to operate, and those problems are probably attributable to insufficiently detailed specifications being provided at the time, and not corrected afterwards. The new system has incorporated various improvements and corrections that allow the FDI methods to function as intended. Revised imputation methods have been included, which were reviewed again by Methodology for inclusion in the new system (ONS (2015b)). The methods specified and implemented now follow ONS best practice.

5.14 A small set of imputation approaches is employed, and different variables each use the approach assessed as being most appropriate. Examples include the rolling forward of responses from previous periods, imputation of zero as the most likely value, and the use of imputation links (the application of average growth rates calculated from similar and responding companies to responses in previous periods).

5.15 Also included in that most recent review was an analysis of imputation-class definitions (those classes define 'similar companies'). The classes used now have been designed to be broad enough to contain sufficient responders to allow robust calculations of imputation links.

5.16 The quarterly and annual surveys now have imputation methods and practices that are consistent, though the imputation classes are defined more broadly on the quarterly surveys than the annual surveys, reflecting their smaller sample sizes. In general, since the new imputation regime seems to align with best practice, has been reviewed recently, and receives positive feedback from the FDI team on its performance during 2015, it seems reasonable to conclude that the current approach is fit-for-purpose.

Chancellor's Initiative Data

5.17 One data input to FDI is a file termed the 'Chancellor's Initiative Data' (CID), and its continued inclusion (on the Annual Inward FDI survey only) is questionable. There is little detailed information now available about the history of the file or the data it contains, but it seems to have originated in about 1997, and has not been updated since.

5.18 It is reported the file was developed to ensure that imputation classes had sufficient cases to allow the calculation of robust imputation links. However, with the broader imputation classes now defined, that justification for such an approach is now much weaker, and the use of data that have been neither reviewed nor updated in almost 2 decades cannot be justified.

5.19 The file contains what appear to be artificial or modelled microdata comprising 7 companies with 3 branches each. Each company is assigned classification details, such as industry (all fall into the 'Other' sector) and country (those on the file include Netherlands, USA and France). Three of the branch-data variables on the file have non-zero values, and the value of all other variables (including other ones that

relate to branches) is zero. The data are fed into the production process with the cases treated alongside all others as though they were real returns.

5.20 Some preliminary analysis has been conducted for this review to help assess the impact the inclusion of this file is having on FDI outputs. To effect this, the CID file was simply removed from the production process, the system re-run, and outputs compared. The reference tables that accompanied the 2014 FDI statistical bulletin (published 7 December 2015) have been reproduced with no other adjustments or quality assurance applied, and the data lines from statistical bulletin Reference Tables 1.1 (Flows), 1.2 (Positions) and 1.3 (Earnings) where there is most impact are reproduced in Appendix 5.3 in this report.

5.21 It seems there is no or negligible impact on most FDI outputs, and such rows are not included in Appendix 5.3. On the principal outputs of total positions, earnings and flows, the maximum change in estimates is 0.4%. On variables that relate to branch data, the effect on high-level aggregates is also small for estimates of earnings and flows, but is notable for estimates of positions. The aggregate estimates in FDI statistical bulletin Reference Table 1.2 (which shows world totals) is split into country-level estimates in Reference Table 3.2, and some of these (in particular those for Netherlands, USA and France) are likely to change considerably as a result of stopping inclusion of the Chancellor's Initiative Data file; the change in those estimates has not been calculated for this review.

5.22 A full quality assurance of the revised results should be undertaken, and a check made that the imputation function performs properly without the inclusion of this file, though that is expected to be the case.

Recommendation R11 *(high priority)*: Assuming no reason is found to retain use of the file, nor an updated version of it, ONS should discontinue use of the Chancellor's Initiative Data in FDI processing, and report fully on the impact of its removal on historical estimates.

6. Estimation

6.01 As with any sample survey, other than censuses, not all units in the target population are surveyed, and there is therefore a need for inference about the population from the realised sample. For FDI, the overall size of the estimated component (not including imputations) of Total FDI (that is, the International Investment Position) is about 40% on the Inward quarterly survey and 20% on the annual survey, and under 3% on the Outward quarterly survey and 1% on the annual. Those proportions also vary by frame, with the estimated proportion of the Worldbase (WB) frame being greater than the corresponding proportion of the FDI/Non-Worldbase (FDI/NWB) frame, reflecting smaller sampling fractions. Further details can be found in Appendix 2.1.

6.02 The following sections examine the approaches to estimation used in the FDI surveys.

6.1 Outline of current estimation principles

6.03 FDI employs a prediction-estimation approach, which is well-established with accepted academic foundations, as described in, for example, Valiant *et al* (2000). In outline, response values are predicted for all affiliates of companies on the frame that were not sampled. (Information about affiliates is available for all companies on the frame, either from the WB source data, or from information supplied as FDI survey responses, and includes countries and industry groups). Estimates of totals that relate to the population are then derived simply by summing both the sampled responses (both real and imputed) and the predicted responses across the population within the domains of interest. Use of this approach ensures consistency across outputs, which might not otherwise be present if alternative weighting and estimation schemes are used. This approach also allows the effect of clustering of affiliates within parent companies to be taken into account, and is discussed in more detail later.

6.04 Prediction estimation is not common for business surveys administered by ONS (most other surveys produce estimates via weighting), but neither is it unique to FDI. Although these approaches may appear to differ fundamentally, they can be equivalent if particular conditions are satisfied (for example, about outlier treatment approaches, and the setting of particular parameter values).

6.05 Alternative estimation methods could be employed, and alternatives have been considered by Methodology (for example, ONS (2011a)). No obviously better alternatives have been found for FDI, and hence none were recommended for implementation. Different methods considered have included ratio estimation (standard for most ONS business surveys), but no auxiliary variables have been found that are strongly correlated with FDI outcomes; small-area estimation and parameter estimation via multi-level modelling (ONS (2011b) have also been considered and have potential, but could add much complexity to the currently simple-to-apply and understand process. There may be some merit in investigating the latter approaches further if resources allow.

6.06 In conclusion, it is noted that although predication estimation is somewhat non-standard in ONS, there appears to be good reason for its continued use on FDI. Given its theoretical justification, previous investigations, and the lack of clearly better alternative approaches, there is no reason to assume this approach is not fit-for-purpose for continued use on the current FDI surveys, in principle at least.

6.07 It is also worth noting that the estimation approach now used for the quarterly FDI surveys is consistent with that used on the annual FDI surveys, whereas the approach used previously differed quite markedly, and was regarded by some as not being fit for purpose. The estimation methods were aligned around 2009, with further improvements to the methodology being introduced at the same time, and these initiatives have clearly improved the quality of FDI estimates since the last substantial review of FDI (2008).

6.08 Having outlined the prediction estimation method above, attention is now paid to the detail of the approach. A description of the method is provided below, and a technical specification is provided in Appendix 6.1 for the interested reader.

Recall, first, that each company listed on the frame can have more than one foreign affiliate for outward FDI (and likewise foreign parent for Inward), and that it is the total of those affiliates' (parents') data within each company that is the primary variable of interest in estimation.

The prediction part of the estimation process takes place separately within each sampling stratum. Each affiliate of a non-sampled company within the same stratum is assigned a (weighted) mean value calculated from the units that were sampled (using actual, cleaned responses or imputed values where appropriate).

The calculation of that weighted mean is such that the potential clustering of affiliates (the similarity of affiliates of the same company to one another) is taken into account. The degree of clustering is represented by the parameter ρ (rho), which is the intra-cluster correlation coefficient, and this features in the prediction formula.

A value of ρ of 0 can be regarded as showing no clustering, whereas a value of 1 shows complete clustering. Setting $\rho = 0$ is also equivalent to the prediction being the mean of all affiliates' data in the stratum, whereas a value of $\rho = 1$ is equivalent to the prediction being the mean of the company-level means. Intuitively, this makes sense: no clustering means all affiliates are different, and complete clustering means all affiliates within the same company are regarded as the same.

In practice, however, the calculation of estimates of ρ (a separate estimate is required per stratum) has not taken place, reportedly because of concerns about stability of estimates and a lack of available data when the new methods were specified. This seemed reasonable when the new methods were introduced, and since then priority has instead focused on other issues.

Instead, a default and unchanging value of ρ was applied when prediction took place in the CORA Analysis system (the specification for which was subsequently found to contain an error, though a correction was issued), and the equivalent default (that of no effect of clustering) has been built in the first version of the new SAS® system. To implement ρ in the SAS® system will require the writing of an additional module of code, but this should present no real difficulty. Indeed, the new code has been written in such a way that any such change can be accommodated fairly easily should the estimation of ρ be desired.

Recommendation R12 *(medium priority)*: to be fully compliant with the method specified in the literature, and as intended when specified for FDI, the full formula for prediction estimation would be used, and ρ estimated from the data rather than being assumed to be zero. Investigate the practical need for an adjustment for clustering, and the best approach for robustly estimating ρ if required on an ongoing basis.

6.09 The coherence adjustments applied retrospectively to the quarterly estimates, as explored further in Chapter 8, may also be considered as part of the estimation procedure.

6.2 Outlier detection and treatment

6.10 In common with other business surveys, and for variables that tend to have a highly skewed distribution, outlier detection and treatment methods are used in FDI. Outliers are values returned by respondents that are regarded as correct, but atypical and unrepresentative of others. Since the sampled

unit would represent others in the estimation process, if the outlier is not treated, it can have a disproportionate, and undesirable, effect on the estimates. The outcome can be implausible estimates, with large estimated standard errors associated with them. Usual practice, therefore, is to treat such an outlier, either by changing the value itself, or making changes so that the sampled outlier represents only itself in estimation. In making such adjustments, the trade-off is the introduction of a little bias into the estimator while making much bigger gains in terms of precision, resulting in more reliable estimates.

6.11 The current FDI approach uses a distance-from-the-mean calculation to identify outliers. These are then trimmed, which means they are excluded from the prediction-estimation calculation. (It is the use of trimming that would prevent prediction estimation from being equivalent to expansion estimation, assuming unweighted mean prediction is used). Although trimming is an objective approach, it is not the recommended method of outlier treatment at ONS; the preferred approach is Winsorisation (Kokic and Bell, 1994), at least for positive values, a method which reduces the value of outliers in such a way as to minimise the mean square error (MSE = variance + the square of the bias) of estimates. Previous investigations by Methodology (for example, ONS (2015c, 2014b, 2012a) have recommended that Winsorisation be used in FDI, at least for positive values. The code for this has been programmed, but not yet implemented.

Recommendation R13 *(medium priority)*: Complete investigations and report on the effect of switching outlier identification and treatment to Winsorisation. Once appropriate parameters have been established through analysis of recent data, effect the switch to Winsorisation as soon as possible.

6.3 Precision, and the estimation of standard errors

6.12 Standard errors (and, likewise, coefficients of variation) are a measure of precision of estimates. They give an indication of the variability in estimates that would be seen if it were possible to achieve many different sample realisations from the same population and under the same survey design. Recommendations about the calculation of estimates of standard errors are made towards the end of this section, and are followed by a recommendation about sample sizes in light of consideration of the standard errors.

Published standard errors

6.13 Estimates of standard errors have been published, at times, for annual FDI, though the most recent occurrence was for the 2010 reference year. Table 6.3 shows those published (as relative standard errors or coefficients of variation (CVs)) in the MA4 Business Monitor publication (the name for the FDI statistical bulletin at the time) with respect to 2008 and 2010. A note in an earlier 2009 publication suggested they would be made available in the MA4 Business Monitor, but that doesn't seem to be the case. Estimates for 2011 were not included in the annual publication, but have been included in Table 6.3 from an internal report which also contains the 2010 estimates as published, so these can be considered as consistent. For 2012, the publication stated the standard error estimation methods were under review and that estimates would be made available, and the 2013 FDI statistical bulletin, published 20 January 2015, stated:

> "Due to a change in the estimation methodology for 2012, the standard error calculations are currently under review. Standard errors for the FDI 2012 annual data will be available in a supplementary paper, to be published in spring."

That paper didn't materialise, and the 2014 statistical bulletin (published 3 December 2015) also stated the calculations are currently under review). The reasons for the lack of published standard errors are discussed later.

	2008		2010		2011	
	Estimate (£ billion)	CV (%)	Estimate (£ billion)	CV (%)	Estimate (£ billion)	CV (%)
Inward						
Earnings	5.8	20.7	37.5	1.9	43.6	2.2
Flows	49.8	9.6	32.8	10.4	31.9	22.5
Position	672.9	1.1	731.6	1.0	766.2	1.7
Outward						
Earnings	71.3	2.7	79.1	3.8	101.6	1.2
Flows	85.8	8.6	23.4	25.7	68.2	5.3
Position	1039.5	1.7	1048.7	1.5	1098.1	1.0

Table 6.3: estimates and their coefficient of variation (CVs) from the 2008, 2010 (MA4 Business Monitors) and 2011 (internal document, but consistent with 2010) annual surveys, the most recent FDI surveys for which estimates of precision have been published. (Note: the estimates themselves will have been subject to revision since; these are the estimates as reported at the time the standard errors were estimated.)

6.14 The 2008 ONS review noted that the then standard error calculations failed to take into account covariances between the component variables used in the derivation of earnings, flows and positions (the main outputs, derived as sums and differences of variables collected directly). An internal Methodology report (ONS (2009b)) shows that changes were made in calculations for standard errors of these derived variables so that covariances would be taken into account. Therefore it is reasonable to have confidence that the published measures of precision with respect to 2010 survey at least (and perhaps also those from 2008) would be on that basis.

6.15 A new method for estimating standard errors – aligning with the change in estimation to the more formal use of prediction estimation from the 2012 reference year was specified (ONS (2012b)), but is yet to be implemented, which accounts for the lack of published standard errors in recent years. The writing of that code has, for some time now, been seen as a lower priority when compared with writing or amending the main analysis systems. The use of the new SAS® system in 2015 is an ideal opportunity to re-commence the calculation and publication of standard errors on the annual survey, and plans exist to write the required code during 2016.

6.16 In addition, given that the quarterly survey now uses the same methodology (stratification and estimators) as the annual survey, consideration should be given to extending the estimation of standard errors to the quarterly surveys. All other aspects being constant, estimates from the quarterly surveys will be subject to greater sampling error because of the smaller sample sizes, and the publication of standard errors would allow users to make an informed judgment about the likely sampling error. However, and as already noted, the non-sampling error in the quarterly surveys – especially that caused by companies responding with management-accounts information instead of audited annual accounts data, and the lower levels of response – may be considerable, but is also something that is not easily measured. There are also the large benchmarking revisions to be considered. As such, presenting measures of quality that relate only to the sampling error, though useful, would need suitable caveats to be added and the limitations explained well to users.

6.17 Although mitigated by a lack of resources and other priorities, that estimates of standard errors are not currently being calculated, and haven't been since the 2010 reference year is unacceptable. Given the specification for their estimation exists, this situation needs to be rectified with urgency.

Recommendation R14 *(high priority)*: Implement the proposed standard error calculation without delay, carrying out the necessary quality assurance of results. Then resume the calculation and publication of measures of precision for the FDI output's principal annual estimates as soon as possible.

Recommendation R15 *(medium priority)*: Once standard errors have been calculated for annual surveys at the top level, extend the analysis to estimate measures of precision for:

- lower-level domains
- the FDI quarterly surveys

It may be useful to implement these recommendations initially as a separate report on the accuracy of FDI outputs in recent periods, including in that report a discussion of sources of possible non-sampling error.

Precision implied by the estimated standard errors

6.18 In the time since the most recent estimates of standard errors were published (Table 6.3), a number of factors have changed:

- sample sizes have increased
- population sizes have increased
- FDI estimation methods have changed
- standard error estimation methods have changed

6.19 It is, therefore, difficult to predict standard error estimates for the current FDI surveys. The implementation of the appropriate methods would be necessary in order to carry out a full evaluation. However, the magnitude of standard errors where estimated under previous FDI designs may still serve as a useful guide.

6.20 Those figures in Table 6.3 suggest reasonable precision in most annual outputs for which they have been calculated. However, even where these are acceptable (for example, as shown by CVs of under 20%, say) these CVs relate to the overall, top-level estimates. At this level, estimates would be expected to have especially good precision (CVs under 5%, for example), but not all do. Estimation of flows seems particularly susceptible to sampling error, and the current sample size may not be supporting sufficiently precise estimation, even at this aggregate level. It would be expected that estimates for domains (such as by country or industry), and those from the quarterly surveys (which have smaller samples) will be less precise again. Of course, care in interpretation is required as the estimated CV (defined as the ratio of the standard error of the estimate to estimate itself) becomes less applicable if that estimate is near zero or negative, as is possible for some FDI outputs; it is probably better that CVs are not used as a measure of precision for estimates of flows.

6.21 While the review team acknowledges that ONS faces tough budgetary restrictions, there is a strong case for increasing the sample size of FDI, and an even stronger one for resisting any proposals to reduce the FDI sample size in any way. The extent of any proposed increase would follow an evaluation of all FDI outputs, to establish which estimates should be targeted in terms of minimum precision requirements, and decisions made as to what those targets should be. This would need to happen in light of the estimation of standard errors when that process is implemented in the system.

Recommendation R16 *(medium priority)* **on sample size:** Commission an investigation to determine appropriate sample sizes to meet precision requirements for principal FDI output when all the relevant information required has been established.

7. Statistical disclosure control

7.01 Statistical disclosure control (SDC) is the application of methods to reduce the risk of individual units (companies, for FDI) or their data being publicly identified from survey outputs. The application of such methods is particularly important for FDI because of: the sensitive nature of the data collected; the statutory requirements on ONS of the Statistics of Trade Act (1947), Statistics and Registration Service Act (2007) and the Code of Practice for Official Statistics (2009); and the moral and ethical obligation of ONS to protect its respondents' data. For FDI, the only data published publicly are the aggregate estimates, and it is these that are considered in this chapter.

7.02 A review of disclosure control in FDI was carried out by Methodology (ONS (2015d)), and the summarised findings from the initial review are presented below.

- A number of disclosure-control methods are used, though the parameters used do not always align with guidance given; it is recommended that further work takes place to establish if the current methods and settings should be changed.

- The overall level of suppression in table cells is relatively high, which could be indicative of over-suppression and may be limiting the utility of the outputs for users.

- The risk of disclosure is considered to be small, given the rules and procedures in place, that publications are at UK level, and that samples are used with estimation to create outputs.

- There is a lack of clear documentation available about the methods used.

- The process, and particularly that for secondary suppression, is long and labour-intensive; this could be reduced if specialist software were implemented, though further work is required to determine the best approach.

7.03 Work continues in ONS now to apply a range of SDC methods to data from many business surveys, including FDI.

Recommendation R17 *(medium priority)***:** Commission the further work suggested by the report, as a way to improve FDI's disclosure-control processes and transparency. This should realise time savings in processing, and afford better utility of outputs.

8. Coherence of quarterly and annual outputs

8.01 This chapter considers the quarterly and annual estimates, and approaches for making these coherent. The desire to have estimates that are consistent (Positions estimates for Q4, and for earnings and flows estimates the sum of Q1 to Q4, equal to the annual estimates) is obvious, but the approach for ensuring this deserves further attention. The current approach is to benchmark the quarterly series to the better quality annual series, a process that can only take place after the annual estimates have been compiled, and so results in historical revisions to the quarterly series.

8.02 At times, those revisions have been large, and indeed prompted the internal review of FDI methods (ONS, (2008)). Subsequent development and standardisation of the quarterly and annual FDI surveys followed, resulting in much greater consistency in methods and systems. However, notable differences between the quarterly and annual estimates still exist, and the benchmarking process continues to produce, at times, large revisions.

8.1 Illustrative example of benchmarking

8.03 An illustrative example of the effect of benchmarking revisions is provided in Figures 8A(i), 8A(ii) and 8A(iii). These show the development of quarterly time series estimates through the most recent 3 vintages (those published in June, September and December 2015). The example is of net direct investment (a principal functional category of the international investment position), and has been chosen simply because it illustrates well the benchmarking process and its revisions, rather than for any particular intrinsic reason. The data have been sourced from publicly available Balance of Payments (BoP) quarterly releases (for example, ONS (2015f)).

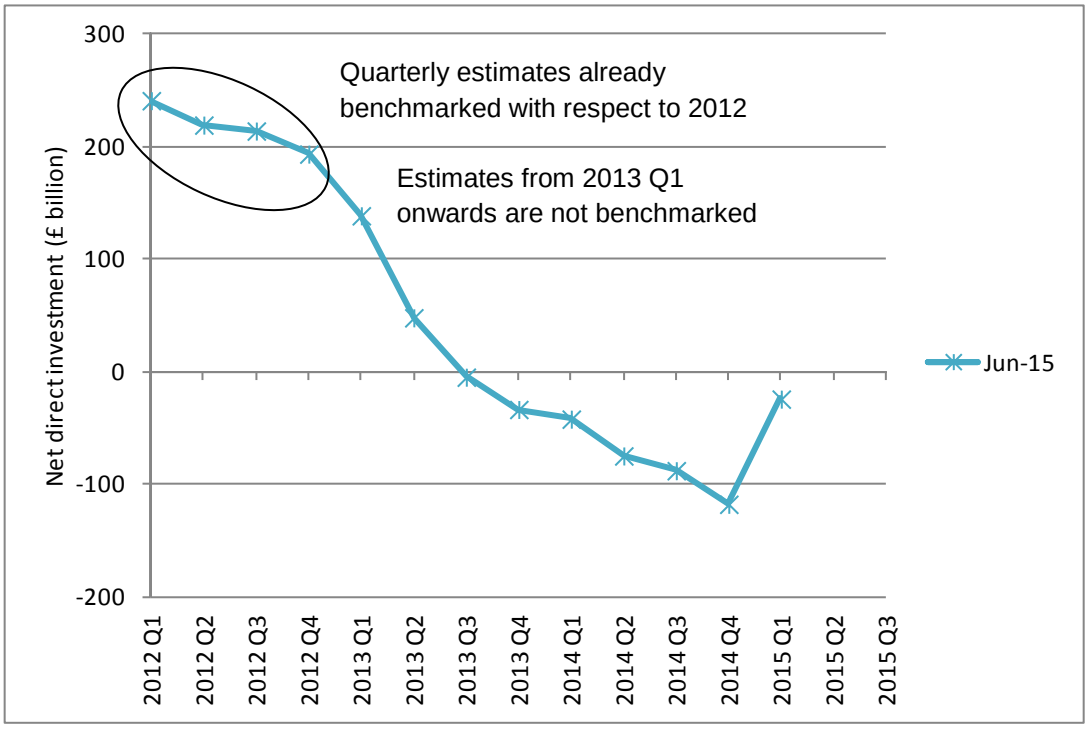


Figure 8A(i): Time series of June-2015 vintage shown, with most recent estimate for 2015 Q1. All estimates are on a BPM6-basis, and are already benchmarked in 2012, but not beyond. Note: the possible step-change from 2014 Q4 to 2015 Q1 is not as any result of benchmarking.

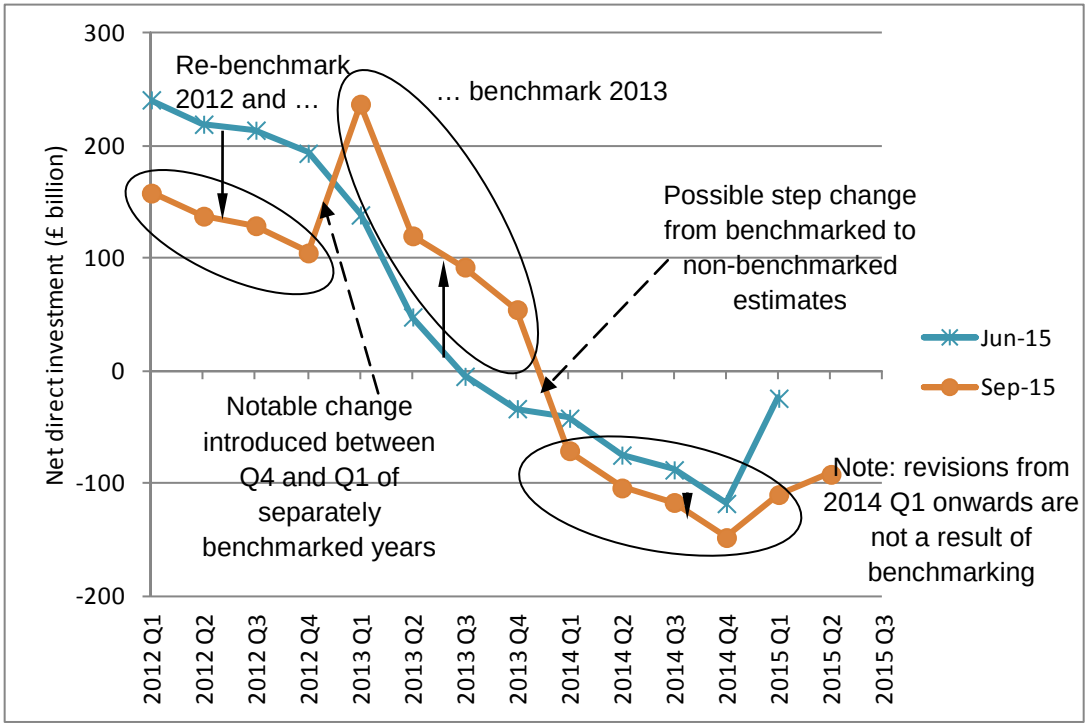


Figure 8A(ii): September-2015 vintage, and the first estimates for Q2 2015 are included. Revised benchmarks are applied in 2012, decreasing estimates, and, separately, new benchmarks are applied in 2013 (for the first time) revising estimates up; note the step change introduced from 2012 Q4 to 2013 Q1. Estimates for 2014 Q1 (and onwards) are not benchmarked or otherwise linked-on, but have been subject to other (smaller) revisions from the usual annual process; a potential step change shows between the benchmarked 2013 Q4 and the un-benchmarked 2014 Q1 estimates.

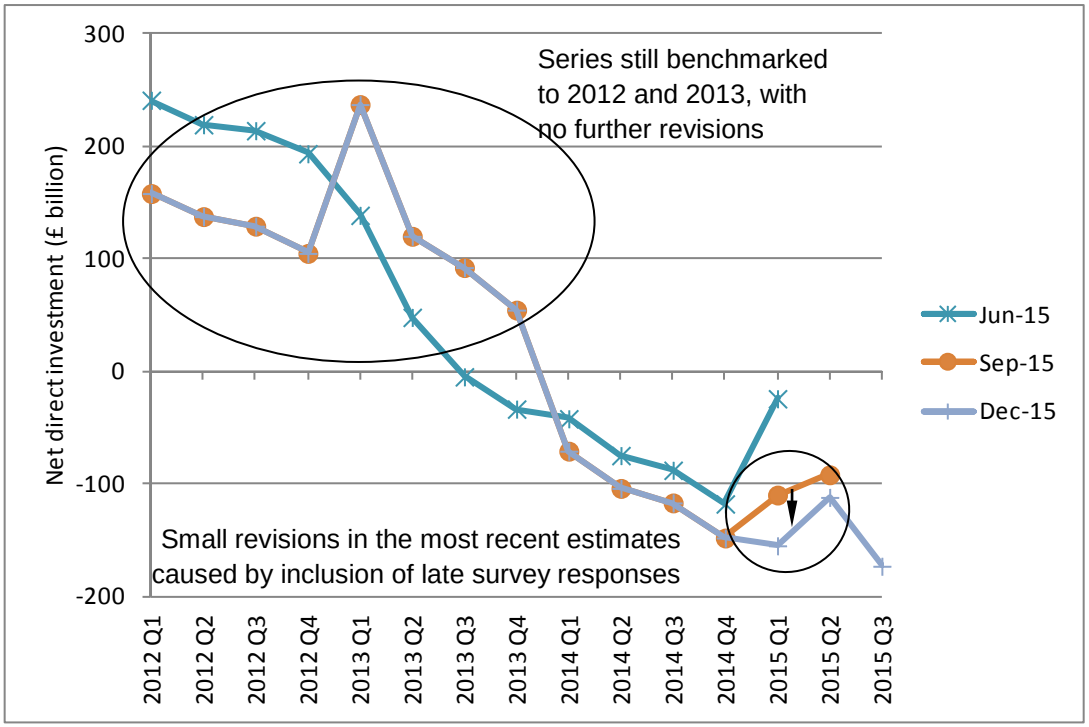


Figure 8A(iii): December-2015 vintage, and first estimate for Q3 2015 included . Series still benchmarked to 2012 and 2013; the revisions to 2015 Q1 and Q2 are all small, and caused by usual survey processes (for example, inclusion of late responses).

8.04 It should be noted that a number of reasons other than benchmarking – the inclusion of late responses, for example – also cause revisions in estimates. These have not been excluded from Figures 8A(i), 8A(ii) and 8A(iii), and it would be impossible to disentangle the reasons for revisions in this way. A plot

showing revisions between the first and most recent estimates over the same period is provided in Appendix 8.1.

8.2 Benchmarking methods

8.05 The benchmarking procedure itself is now considered in more detail.

8.06 Since it is the quarterly series that is benchmarked to the annual series, only the former series is revised. This approach is equivalent to regarding the annual series as being 'right' and the quarterly series not. Given both are the result of a sample survey, some compromise could be considered, with more weight paid to the annual survey because of its larger sample size. However, there are 2 reasons for the principle of the quarterly series taking all the revisions being preferable: (i) the quarterly sample is (or should be) a sub-set of the annual sample, and (ii) the greater non-sampling errors likely on the quarterly survey (for example as a result of company returns being estimated rather than audited accounts).

8.07 The essence of the benchmarking procedures used to date, and for recent years, has been to preserve the growth rates from Q1 to Q2, Q2 to Q3 and Q3 to Q4 within the same calendar year, treating different calendar years independently. This approach has meant the growth seen in survey estimates from Q4 to Q1 is not preserved, and large and unrealistic step changes can occur as a result, as illustrated in Figure 8A(ii). The method, which involves the use of multiplicative ratio adjustments, is not well suited when zero, close-to-zero or negative values are included in ratio calculations, as can be the case with some FDI variables.

8.08 The Time Series Branch of Methodology recently conducted a quick review of benchmarking (ONS (2015e), and recommended use of the regression-based method of Cholette and Dagum (Dagum and Cholette (2006)), application of which is standard in much of National Accounts. This new method will be used when the next benchmark revisions are taken on in FDI outputs in BoP in June 2016, with each time series being reviewed on a case-by-case basis and the additive or multiplicative version of Cholette and Dagum being applied as appropriate, and depending on the characteristics of the series. The quality of the adjustments made should improve further over time, as the length of the time series data available in the system expands (currently this is limited, see also Chapter 10).

8.09 The new benchmarking method should bring benefits, which will be seen first later in 2016. However, as implemented, it will still only benchmark quarterly estimates where the corresponding annual estimates exist. This means the most recent quarterly estimates (that is, those for quarters in years beyond the benchmark) remain as the survey estimates themselves and are not linked to the level set by the previous benchmark. Intuitively, there would be sense in linking the most recent quarters onto the level set by the benchmark as a matter of course to minimise future revisions. This could be achieved simply via the Cholette and Dagum method, but needs further investigation, and the practicalities of combining estimates benchmarked annually in this way with subsequent survey revisions on a quarterly basis needs to be determined.

8.10 Benchmarking would, ideally, take place on the lowest level FDI series with subsequent aggregation to higher levels. However, the lowest-level series have proved too volatile for the process to work satisfactorily. Therefore benchmarking is currently applied at a higher level, with a process of apportionment and re-aggregation taking place to produce all the outputs.

Recommendation R18 *(high priority)***:** Conduct a more detailed review of benchmarking methods and approaches, exploring the various methodological options for benchmarking. This should include an assessment of:

- techniques that include quarters for which there is no annual data yet available, and the practicalities of how these can be incorporated

- a review of the most appropriate level for benchmarking and any associated consequences

Note: although the process of seasonal adjustment has not been considered in this review, it would be prudent to carry out a seasonal adjustment review (a standard and regular process at ONS) at the same time as the more detailed review of benchmarking.

8.3 Other options for improvement

8.11 The revised methods for the 2016 benchmarking, together with the results of a more detailed review, should bring about improvements to the quality of the benchmarked part and recent tail of the quarterly series. However, although benchmarking provides a remedy, it doesn't address the root causes of the differences between the quarterly and annual survey estimates. Therefore, this review now explores further some other options that could improve the situation. All of these assume it is still necessary for the quarterly and annual estimates to be made coherent.

i. Changes to the sample design:

8.12 The main sample design considerations for the quarterly and annual surveys have been discussed already in Section 3.4 (Sample selection, rotation and overlap), and also in Section 6.3 (Precision and the estimation of standard errors) in the context of sample sizes. Beyond increasing the size of the quarterly survey, with it remaining a sub-sample of the annual survey, there is little else that could be done to improve the accuracy of the quarterly estimates.

8.13 However, an improved sample design may not be sufficient because of the non-sampling error that is likely present in the quarterly surveys. Also discussed previously, this is mainly attributable to a mix of respondent-estimated data and greater non-response caused by the tight response deadlines. Some improvements to survey processes may be possible though, for example setting higher targets for response and clearance to be achieved by the following quarter.

8.14 Naturally, it is preferable to use good practice in survey design. However, the inherent shortcomings of the situation might mean there are alternative designs that could produce a less expensive, but still acceptable quarterly output. Cut-off sampling designs would be one such example, and there may be some merit in exploring these further should the need arise, although the use of such an approach could not be recommended as a way of improving quality.

ii. Modelling the quarterly path

8.15 The current survey approach to estimating FDI on a quarterly basis contains inherent difficulties. A number of factors combine to make the process difficult, and include the relatively small sample size; short timescale for response (a single, additional response can lead to big changes in estimates), and the measurement error induced by companies responding with estimates rather than audited accounts data.

8.16 The quarterly process of compilation also seems fraught (discussed further in Chapters 10 and 11), and the whole process is expensive, both in terms of ONS staff time and respondent burden. One should ask, therefore, whether a survey approach for the production of quarterly estimates is value for money, and whether any alternative would be less expensive but still acceptable.

8.17 The modelling of quarterly estimates would be ideal, but probably not practical. The data series from the current survey, many of which are produced at a detailed level, are simply too volatile to be modelled or

forecast reliably using any of the standard time-series based techniques. That volatility is not just a result of sampling variation, but often includes the measurement of large and real changes in FDI. Many of these reflect individual transactions that would never be predicted by a model, but need to be reflected in the outputs, and a quarterly survey that includes the biggest contributors is the only timely way to ensure this. Thus it seems that, despite concerns about the quality of the data, that a quarterly survey of some kind is essential.

iii. Annual data compiled by aggregation of quarterly data, with removal of the annual survey:

8.18 A final idea for (brief) consideration is removal of the annual survey, with the annual estimates being compiled through aggregation of (probably enhanced) quarterly surveys. Such an approach has some immediate attractions:

No benchmarking exercise would be necessary, and there would be no associated revisions; the quarterly surveys would be used to derive the annual position, all estimates would be consistent by design, and production of the annual estimates could be much more timely.

A disbandment of the annual survey would give savings (in terms of budget and respondent compliance burden), which could then be used to increase the size of the quarterly survey. That would improve precision in the quarterly surveys, though those savings on an annual basis would not cover an increase in the quarterly sample size to that of the current annual survey.

8.19 The main drawback, as already noted, is the inherent measurement error present in the quarterly survey returns from companies, which may result in large non-sampling error, and possibly bias, in the estimates, and this is not easily resolved.

8.20 Limited consideration was previously given to this approach at ONS as part of the FDI development around 2009, though the idea was never developed into an acceptable proposal, probably because of the non-sampling error issue. However, there may be ways this approach could be developed further. The United States' Bureau of Economic Analysis, along with other organisations, also encounters similar problems with differences between quarterly and annual data. Its approach (see also Chapter 9) is:

- no annual survey is conducted, but there is a 5-yearly census, to which the quarterly series are benchmarked; the quarterly survey estimates are based upon large survey sample sizes

- the quarterly estimates are subsequently adjusted after reconciliation with audited accounts data

8.21 If such an approach were ever adopted by ONS, new operations would be required, including running a large, regular (but maybe less frequent than annual) benchmark survey, and a new process introduced by which quarterly returns could be adjusted once audited, annual data become available. (It may be possible to ask companies retrospectively about their quarterly positions in a later survey). Such a process would be complicated (and likely expensive), and would lead to revisions, which somewhat negates its very purpose. However, there may be some merit to considering this further, should resources allow.

9. International comparisons

9.01 Every country attempts to compile its FDI statistics in accordance with the international guidelines set out in IMF BPM6 and OECD BMD4 manuals. Every country runs its own FDI survey, although the survey materials and methodologies can be very different. The definitions and coverage of the data collected on the FDI survey should be consistent across all countries, especially for the more developed economies. However, factors such as construction and maintenance of the sampling frame, sample size and design, survey questionnaire, receipt, input and validation of survey data will be largely determined by the circumstances and survey practices within each country.

9.02 In the UK, the FDI survey is one of a wide range of economic, business and social surveys run by ONS, and is subject to the usual ONS survey practices, systems, budget constraints and prioritisations. ONS knows what data need to be collected and what statistics need to be compiled, and has set up the FDI survey to meet these needs. Refinements and improvements can always be identified and a number are suggested in this Quality Review.

9.03 It is interesting to research how other countries run their FDI surveys and to look at their survey materials, as time and resources allow. But generally this is unlikely to result in significant changes to the ONS FDI survey. For example the diagrams used in the notes of the USA FDI questionnaires run by the Bureau of Economic Analysis (BEA) may be helpful in re-designing the guidance notes of the ONS questionnaire, but it is unlikely that the very detailed questions would be consistent with the ONS corporate house style.

9.04 The EU Balance of Payments (BoP) Regulation requires EU countries to meet these guidelines, but does not specify the methodology that a country should use. However, the Regulation on Quality of BoP Statistics requires each country to submit and monitor quality indicators of its FDI estimates. The regular and ad hoc meetings at Eurostat concerning FDI statistics should give adequate opportunities to compare UK practices with other EU countries if there is any specific aspect under review. Eurostat itself keeps a watching brief over the methodologies used in each EU country, but probably not in great detail. The network of EU FDI compilers is a potential resource that can be used to compare detailed aspects of FDI survey methodologies.

Methodological comparisons

9.05 FDI compilers in a number of countries regarded as international leaders in BoP concepts were contacted and asked how their systems handled various, specific aspects of the methodology. Helpful and full replies were received from BEA and Statistics Canada. The specific questions asked and summary replies are shown below, together with the current ONS approach.

Question	Bureau of Economic Analysis	Statistics Canada	ONS
(i) What are the sampled units – enterprises or local enterprise groups?	Local enterprise groups	Enterprises	Truncated (local) enterprise groups
(ii) Are data collected with respect to separate enterprises or with respect to whole local enterprise groups?	Separate enterprises	Separate enterprises	Group reporting where possible (See Section 2.2)
(iii) What are the stratification variables for the sample design?	Asset size of affiliates and industry	Asset size measure, geography and industry	Asset size measure (NBV), where available, or other size measures and industry (See Section 3.1)
(iv) How are outliers identified, and how are they treated in the compilation process?	"Deemed" outliers (after verification) are excluded from imputation and grossing up, but included in final estimates	Hidiroglou-Berthelot method * used; outliers only represent themselves	Trimming ("distance from mean" used in each stratum): excluded from imputation and prediction-estimation calculations, but remain in dataset
(v) How are imputations made for non-respondents?	Increases for matched samples applied to previous data from non-respondent	Carry forward previous data, and re-weight for remaining total non-response by strata	Various methods used depending on variable, but include application of factors from matched respondents and carry-forward methods
(vi) How are the survey results weighted up to population estimates?	Ratios for sample/non-sample from 5-year benchmark data applied to sample data (for flows): increases for matched sample applied to benchmark data for non-sample (for levels)	Asset size weight of sample to population by strata	Mass prediction estimation using stratum sample means
(vii) Is any account taken of clustering effects of enterprises, either resident or foreign? If so, how?	No	No	Method is specified (but particular case of no clustering is currently applied)

* Hidiroglou and Berthelot (1986)

9.06 ONS seems to adopt different approaches from BEA and Statistics Canada in a number of areas, including on identification of outliers and estimation. Only the ONS system seems to have considered the potential effect of clustering of affiliates within a parent, though at present does not use this. This may be a good opportunity to take a leading role internationally in FDI estimation, as it seems unlikely that many or any other FDI compiling organisations employ such an approach. A research project in ONS evaluating whether there is a strong clustering would be received with interest by all FDI compilers and all stakeholder international organisations.

Benchmarking

9.07 Another issue raised by ONS compilers is the potential to compile statistics on FDI levels showing implausible shifts between the end-Q4 levels in one year and the start-Q1 levels in the following year, as explored in Chapter 8. This effect can be caused by the reconciliation of Q4 quarterly data and end-year annual data, and corresponding adjustments to the quarterly path throughout the year. Annual data are generally gleaned from the audited accounts of a company whereas quarterly data are usually provisional estimates by the respondent.

9.08 BEA and Statistics Canada were asked whether they had similar potential compilation problems. BEA explained that it has the same issue with reconciling provisional quarterly data with audited data, but it runs quarterly surveys in between a 5f-year census benchmark survey. The sample sizes of the quarterly surveys are much larger than the quarterly ONS surveys (around 4,000 enterprises for inward FDI and around 1,900 US parent enterprises for outward FDI), and BEA does not conduct a separate annual survey. Quarterly paths are adjusted after reconciliation with audited data, but the BEA approach should avoid the Q4-to-Q1 level shift problem sometimes encountered by ONS.

9.09 Statistics Canada has similar problems to ONS with potentially implausible Q4-to-Q1level shifts when quarterly estimates are reconciled with annual results. It checks the extent to which the shifts may be caused by volume changes such as write-downs and reclassifications. Appropriate manual adjustments are made to the estimates following validation of the data at enterprise level and analyses of time series of the statistics. The necessary revision of quarterly estimates when audited annual data are received is an issue for all FDI compilers.

10. Further thoughts on systems and processing arrangements

10.01 This chapter draws together in summary and expands upon information about systems reported variously in other chapters of this review.

Survey processing

10.02 As mentioned in Section 1.3, a variety of systems have been used in recent years to produce the estimates from the main FDI surveys. It was realised at the time that a new system was required to cope with the expanded ESA[1] and BPM[2] requirements, and the generic CORA[3] platform was developed for this purpose with distinct parts: data take-on, and analysis.

10.03 The early development of CORA, however, suffered delays, with only the data take-on part being ready on time, and thus an interim SAS® program was hurriedly written to fill the gap until the CORA analysis system became available for FDI, after which a period of reconciliation was required to ensure both the CORA and SAS® systems were producing the same results.

10.04 A number of problems with the FDI CORA build became evident, however, and these were not just teething problems. Although the systems appeared to be working according to specifications that had been signed-off, they weren't working as required in practice, and were causing many operational problems for the teams that operated them. No doubt there are wider lessons that could be learnt here about the specification and build of new systems, but those are outside the scope of this NSQR.

10.05 Although one solution to these issues would have been to change and correct the FDI CORA systems and their specifications, the substantial resource required to do so had already been diverted to ensuring a more generic version of CORA would be ready to accept other surveys. In any case, some less generic processes would still be required for FDI, and these have, to date, not been included in the more generic version. As a result, the following has approach has been adopted.

10.06 The code lines for data take-on have been split. FDI, with its many specific intricacies, remains on version 3.1, as already noted in Section 5.1. The Editing and Validation teams who operate it work with various incorrect error messages and other irritants in the system, but the work-arounds they have developed, together with more recent improvements, make the system operable, though not ideal. Meanwhile, the more generic CORA development for Data Take-on continues, the current version being number 3.4. A recommendation on the data take-on system is made in Section 5.1.

10.07 The CORA analysis module was taken out of use in 2015 by the FDI team as impractical to operate, and replaced with an improved SAS® system, which, with a year's experience now gained, seems much more suited to the task being quicker to operate, more flexible and gives much more confidence in its outputs. However, there are a number of factors that should be borne in mind regarding this arrangement:

(a) The SAS system, being stand-alone, is at greater risk of error (for example corruption of files, inadvertent changes to code) than using a more corporate platform approach.

(b) The SAS system also needs updating, maintenance, support and version control. Though this is currently in place via the FDI and Methodology teams, there are some aspects that would be better served via a dedicated information technology team.

[1] European System of Accounts

[2] Balance of Payments and International Investment Position Manual

[3] Common Open-Road Architecture

(c) A platform-based system has greater security, but, naturally, is also much more locked-down. FDI seems a survey that requires, and likely always will, a high degree of manual intervention, which is easier to achieve on a stand-alone system

(d) Although the new arrangement seems much improved for current survey rounds, the number of systems used in recent periods has presented problems in accessing data for past periods, with only the most recent years now easily available. If possible, this should be improved

10.08 Given the above, and that ONS is currently reviewing its entire technology estate, there seems little point in recommending a change to the FDI analysis system at this time. That said, the risks of running a stand-alone system should be acknowledged and reduced as far as possible via good management, documentation, training, and use of appropriate expertise.

Balance of Payments and National Accounts

10.09 Though the focus of this review lies mainly in the FDI surveys and their implementation, the onward processing and publication of the quarterly estimates that takes place by the Balance of Payments (BoP) team in National Accounts should also be considered in the context of their systems.

10.10 Further processing takes place, with data for banks being supplied directly to BoP from the Bank of England (a new supply of bank holding data is also expected from 2016), and an aggregated dataset is then returned to the FDI team.

10.11 Further operations benchmark quarterly estimates to annual estimates (see Chapter 8), as well as trying to achieve consistency across various domains. Many hundreds of series have to be processed, and several proprietary and bespoke systems are used in the operation, with datasets being passed variously between them. It is reported that in the final 10 days of a quarterly round, datasets are passed through systems in CORA to SAS to CSDB (an ONS system), back to CORA (with some additional work in spreadsheets), then to SAS and finally to CORD (another ONS system) for inclusion in the National Accounts.

Suggestion S10: Notwithstanding the ongoing changes to ONS's technology estate, review the process flow of data and work required in the latter stages of FDI processing to determine if efficiencies could be made, and a more integrated system developed for the final stages of FDI data processing.

Suggestion S11: There appears to be some duplication of effort and process in the production of quarterly FDI estimates. Conduct a review of this to establish if more efficient ways of working might be obtained.

11. Further thoughts on staffing arrangements

11.01 In this review, various staff from the various Editing and Validation, FDI, Balance of Payments, Business Registers and Methodology teams (see Section 1.4 for roles) have been interviewed and the review team has worked closely with the FDI team in particular to gain access to much of the information used to compile this report.

11.02 The FDI team is part of the wider International Transactions team, and so has commitments to other outputs too. This has made for a very pressing workload, which is not helped by having systems that have been difficult to use, though the situation seems to have improved for FDI through 2015. However, in order to achieve consistent delivery of outputs, including appropriate quality assurance and answering of queries, long hours sometimes need to be worked and overtime is by no means uncommon. As such the team appears under-resourced for the task in hand.

11.03 The pressing workload also precludes there being much scope for development work to be undertaken. This has resulted in a number of short-term solutions being used to ensure that FDI statistics are delivered to meet the various internal, domestic and international data requirements. The combination of complex processes and a demanding schedule result in the team being unable to fully investigate and implement change. It would be beneficial for there to be more curiosity about FDI methodology, data and processes, but the high work demands seem to mean that compiling and publishing the statistics (for whichever survey is most pressing at the time) is prioritised ahead of other developments. It would be good to see the FDI team in the future in a position to have more scope to be more inquiring about the design of the survey, and bringing about improvements of the sort suggested in this review. The FDI team has recently found scope to publish a range of analysis on FDI and the UK Current Account, which received positive feedback from a range of stakeholders across government and the private sector.

11.04 There is clearly a lot of goodwill and enthusiasm for FDI work among the team members. Several, including those on the E&V team, said they thoroughly enjoy the challenge and complexity of working on FDI, and wouldn't be content with working on simpler surveys. There are some team members who have dedicated many years of their time at ONS to FDI. However, there is also a notable turnover of staff in some areas of the FDI and E&V teams, which represents a notable loss of expertise. Many staff on the teams are relatively new to FDI, and FDI is clearly a survey on which it takes some considerable time to build knowledge and expertise because of its complexity and differences in approach from most other surveys.

11.05 The FDI team structure has been changed over the past 12 months, and now comprises more technical posts, and a greater number of posts at a higher grade, which is helping to increase the capability to deliver. The new SAS® system seems to be performing well, giving more reliable results, more control, and faster delivery times, which in turns is creating more time for further analysis. It seems the FDI team is now in much better position than it once was, and likewise so is FDI. But there is an acknowledgement there is more to be done.

Recommendation R19 *(high priority)***:** Increase the size of the FDI and International Transactions teams, to reduce the time pressure on regular production and allow more time to develop the survey and better understand the data.

Suggestion S12: Seek to improve the training offered about the FDI survey and processes for staff who are involved in the production of its outputs to increase knowledge about the survey, its limitations, and areas for development.

12. Conclusions

12.01 When evaluating the overall quality of the FDI outputs, there are many diverse, contributing factors that must be considered. This review has found some of these are better than others, and there is some room for improvement.

12.02 Overall, the annual survey is clearly of better quality than the quarterly survey. Data quality is intrinsic to this evaluation, and is an important element when comparing the two, as the methods and systems are all-but-identical, except in respect of sample size.

12.03 The FDI survey methods are not all in common use, and some differ quite notably from those employed on other business surveys, but they are also not unique. They have come about as a result of good research and development, and appear justified and the differences from other surveys' approaches justifiable given the complicated nature of FDI data. Most areas of methodology have been reviewed in detail in recent years, and seem reasonable, at least in principle. It's good to be able to report that many of the recommendations made in the last full review of FDI (ONS (2008)) have been implemented.

12.04 There are some issues that need to be resolved. Of particular note, and needing urgent attention are the continued use of the Chancellor's Initiative Data file, an oddity that should not be present; the lack of published standard-error estimates for a number of years; and the recent lack of rotation in the samples of smaller companies. There are a few other instances of implementation of methods that are not complete, or not functioning as intended, and some other aspects that would benefit from further review. However, there is nothing on the list of methodological recommendations that cannot be easily rectified, with further work being needed in some cases to determine the detail of the application required.

12.05 The new, bespoke analysis system in use since the start of 2015 seems a huge improvement on its more corporate predecessor. The success of this, beyond the dedication and expertise of the teams that have created it, probably lies in the necessarily non-standard aspects of FDI it accommodates. However, it would be good to see some of the benefit of a platform-based approach brought to the new FDI system, if these can be accommodated. The FDI processing system, when viewed in its entirety, is somewhat fragmented, and entails data transfer between various pieces of software in the latter stages of processing. It would be good to see a more integrated system for doing this, and there may be benefits in looking more widely at processes and the associated team responsibilities here too.

12.06 All things considered, and on balance, the annual FDI outputs should probably be regarded as fit-for-purpose, and users can have confidence in their quality. The sample size is probably sufficient to give acceptable precision in top-level estimates (though that is difficult to objectively judge without the availability of standard-error estimates). However, it is possibly small when considering the quality of estimates in lower-level domains, though the review team appreciates that reducing budgets make an increase in sample size quite unlikely in the short term. Any attempts to reduce sample size on FDI should be resisted.

12.07 The measurement of FDI on a quarterly basis presents more of a challenge. Though the survey methods have been improved greatly since 2008 to now correspond with those of the annual survey, and likewise the analysis system brought into use in 2015, there remain some fundamental challenges. These lie mainly with the problems of getting sufficiently timely responses from sampled companies on a quarterly basis, and of those companies simply not having all the required data available until their annual, audited accounts are compiled, and having to supply estimates instead. The smaller sample size does not help, and it seems that this combination of factors means that the quarterly outputs can be quite volatile (an extra, late response can have a large effect on estimates), and the estimated quarterly path will always be subject to coherence adjustments applied through the benchmarking process. Though the quality of the estimates may therefore be questioned, the value of having a quarterly survey is not in doubt, as there is no obvious alternative source of information or approach.

12.08 Changes are already planned to the mechanics of the benchmarking process, which should see improvements, and more as the length of the data series available expands. This review has suggested investigating the application of standard benchmarking techniques that deal with the full quarterly and available annual time series and not to continue the current approach of making no adjustment to the quarterly path in periods after the most recent annual benchmark.

12.09 ONS's overall approach to measuring FDI seems in-line with practice observed internationally, and it is not surprising to see that other countries face similar challenges, especially around the issues of quarterly-annual coherence.

12.10 Credit must be given to the teams who produce, and support production of FDI outputs at ONS. Their job is not an easy one, given the complexity of the data and processes. They have implemented many changes to improve FDI, with more planned, and taken initiatives to improve the surveys and broaden the scope of the outputs.

12.11 There is something of a backlog of work to be completed, as evidenced by the list of recommendations, suggestions and issues made in this review, and more resource will be needed to make these happen in a timely way. It would seem that more resource for FDI is probably required in any case, as the teams often seem especially over-stretched in the usual work that they do, and that situation is something that should be addressed.

12.12 Looking to the future, the introduction of electronic data collection is the next big change likely to affect the quality of FDI. It is an initiative that offers big gains for both survey respondents and ONS, though the nature of its application to FDI will need to be considered carefully given the intricacies and requirements of the survey. However, this, and other developments and the continued building of experience and capability on the team, should see the quality FDI improve further.

12.13 A final **Recommendation** (**R20**, *medium priority*) comes from the experience of conducting this review, and that relates to documentation. While there is some documentation already available, it would be useful to review and increase the range of documentation available about the FDI surveys, making this available both internally and externally. Given the number of changes that have, and are taking place, having up-to-date and comprehensive information available would be hugely beneficial for all.

Appendix 1.1A: Summary table of recent principal FDI outputs

£ billion

	2013		2014
	first estimate	revised estimate	first estimate
FDI flows into the UK by foreign companies (inward)	43.7	33.0	27.8
FDI international investment position in the UK held by foreign companies (inward)	975.4	910.3	1,034.3
Foreign companies' earnings from foreign direct investment in the UK (inward)	54.3	50.8	52.3
FDI flows abroad by UK companies (outward)	17.2	28.4	-79.9
UK companies' FDI international investment position abroad (outward)	1,035.0	1,024.6	1,015.4
UK companies' earnings from foreign direct investment abroad (outward)	68.7	78.7	65.6

Appendix 1.1B: Recent FDI publications

An analysis of the drivers behind the fall in direct investment earnings and their impact on the UK's current account deficit	31 Mar 2016	https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/articles/ananalysisofthedriversbehindthefallindirectinvestmentearningsandtheirimpactontheukscurrentaccountdeficit/2016-03-31
An analysis of Foreign Direct Investment, the main driver of the recent deterioration of the UK's Current Account – January 2016	19 Jan 2016	https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/articles/ananalysisofforeigndirectinvestmentthemaindriveroftherecentdeteriorationintheukscurrentaccount/january2016
Coherence between Balance of Payments Quarter 3 (July to Sept) 2015 and the FDI bulletin for 2014	23 Dec 2015	https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/articles/foreigndirectinvestment/coherencebetweenbalanceofpaymentsquarter3julytosept2015andfdibulletinfor2014
Foreign Direct Investment involving UK companies, 2014	3 Dec 2015	https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/foreigndirectinvestmentinvolvingukcompanies/2014
The UK's trade and investment relationship with India	18 Nov 2015	http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/rel/international-transactions/outward-foreign-affiliates-statistics/the-uk-s-trade-and-investment-relationship-with-india/sty-india.html
An analysis of Foreign Direct Investment, the key driver of the recent deterioration in the UK's Current Account	30 Oct 2015	https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/articles/ananalysisofforeigndirectinvestment/2015-10-30
How important is the European Union to UK trade and investment?	26 Jun 2015	http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/rel/international-transactions/outward-foreign-affiliates-statistics/how-important-is-the-european-union-to-uk-trade-and-investment-/sty-eu.html
How important is China to the UK economy?	9 Jun 2015	http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/rel/international-transactions/outward-foreign-affiliates-statistics/how-important-is-china-to-the-uk-economy-/sty-china.html
Recent deterioration in the current account has been partly driven by a weaker primary income balance, of which Foreign Direct Investment is a key component	23 Jan 2015	http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/rel/fdi/foreign-direct-investment/2013/sty-recent-trends-in-foreign-direct-investment.html
Foreign Direct Investment Involving UK Companies, 2013	20 Jan 2015	https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/foreigndirectinvestmentinvolvingukcompanies/2015-01-20
Investment by the UK overseas has increased by 76% since 2002	19 Jun 2014	http://webarchive.nationalarchives.gov.uk/20160105160709/http://www.ons.gov.uk/ons/rel/fdi/foreign-direct-investment/2012-ma4/sty-fdi.html

Appendix 1.1C: ONS-internal users and uses of FDI estimates and data

User	Use of FDI data and outputs
ONS Press Office (London)	For briefings
ONS Private Office	For briefings
ONS Balance of Payments	Sector accounts BoP publications (quarterly statistical bulletins and annual Pink Book) Regulatory international submissions (Eurostat, IMF, ECB) UK Economic Accounts quarterly publication – geography and sector estimates Published WinCSDB (an ONS processing system) series to Bank of England
ONS Mergers and Acquisitions (M&A)	Quarterly and annual FDI datasets used as a primary source for M&A data
ONS International Trade in Services (ITIS)	To assist the selection panel for the International Trade in Services (ITIS) survey reference list, where new share and loan companies could potentially have ITIS data
ONS Financial Statistics	Statistical Bulletin – annual data
ONS Inter-Departmental Business Register	Uses Worldbase data to update business register information

Appendix 1.2: Regulations, frameworks, policies and acts relating to FDI

1. Statistics of Trade Act 1947
http://www.legislation.gov.uk/ukpga/Geo6/10-11/39/contents

2. Code of Practice for Official Statistics
http://www.statisticsauthority.gov.uk/assessment/code-of-practice/index.html

3. International Monetary Funds' Balance of Payments Manual 6
http://www.imf.org/external/pubs/ft/bop/2007/bopman6.htm

4. International Monetary Funds' Balance of Payments Manual 5
http://www.imf.org/external/np/sta/bop/bopman5.htm

5. The European System of Accounts (ESA95)
http://ec.europa.eu/eurostat/en/web/products-manuals-and-guidelines/-/CA-15-96-001

6. The European System of Accounts (ESA 2010))
http://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-02-13-269

7. Organisation for Economic Co-Operation and Development (OECD) Benchmark Definition of Foreign Direct Investment (4th edition)
http://www.oecd.org/investment/fdibenchmarkdefinition.htm

8. Standard Industrial Classification 2007 (SIC 2007)
https://www.ons.gov.uk/methodology/classificationsandstandards/ukstandardindustrialclassificationofeconomicactivities/uksic2007

9. FDI Statistics: explanatory notes
https://www.oecd.org/daf/inv/FDI-statistics-explanatory-notes.pdf

10. Principles on Confidentiality
for example: http://www.ons.gov.uk/census/2011census/confidentiality

11. Statistical Disclosure Control Methodology page on the ONS website
http://www.ons.gov.uk/methodology/methodologytopicsandstatisticalconcepts/disclosurecontrol

12. Copyright and reuse of published data
http://www.nationalarchives.gov.uk/doc/open-government-licence/version/3/

13. Pre-release access (including conditions of access)
https://www.statisticsauthority.gov.uk/about-the-authority/uk-statistical-system/legislation/pre-release-access/

14. National Statistician's Guidance: Confidentiality of Official Statistics
http://www.statisticsauthority.gov.uk/national-statistician/ns-reports--reviews-and-guidance/national-statistician-s-guidance/index.html

Appendix 2.1 Contributions to estimates of FDI

This appendix reports on the contribution to estimates of total FDI positions by units with different types of response, and from different sources (sampling frames).

In this circumstance, the units are the foreign parents or foreign affiliates linked to the UK companies found on the sampling frames. The datasets at this level are complete, in the sense that they comprise all such units known in the population from both frames, and each unit has a value for total FDI positions. Those values will be one of a survey response (noting that the positions variable is derived from other variables collected directly), an imputed value (in cases on non-response), or a value predicted through the estimation process. Values of all types of response are then summed to provide FDI estimates.

Notes:

- Statistics are shown for the 2 most recent datasets available at the time of writing for both the quarterly surveys (Q2 and Q3 2015) and the annual surveys (2013 and 2014).
- Rounding mean figures do not always add up.
- The percentages reported show the contribution relative to the total estimate of FDI positions. For individual units, the value of FDI positions can be negative, zero or positive. Further analysis of the contribution of each of these to the Total FDI positions estimate is presented in Section A2.1D.

Table A2.1A: Contribution to estimates of Total FDI Positions by units linked to companies sampled from the different frames

Quarterly surveys	Inward		Outward	
	Q2 2015	Q3 2015	Q2 2015	Q3 2015
FDI/NWB frame	64.1%	64.1%	96.2%	95.5%
WB frame	35.9%	35.9%	3.8%	4.5%
Total FDI positions	100.0%	100.0%	100.0%	100.0%

Annual surveys	Inward		Outward	
	2013	2014	2013	2014
FDI/NWB frame	55.1%	73.3%	90.2%	93.0%
WB frame	44.9%	26.7%	9.8%	7.0%
Total FDI positions	100.0%	100.0%	100.0%	100.0%

Observations:

- For both Inward and Outward FDI, the bigger contribution comes from the FDI/Non-Worldbase(NWB) frame.
- The contribution from the FDI/NWB frame is larger (at least 90%) on the Outward surveys (both quarterly and annual) than on the Inward survey (between 55% and 74%).
- The contribution to the Inward FDI IIP estimate from the FDI/NWB frame notably increased from the 2013 survey to the 2014 survey. This may be a reflection of the new practice of moving WB companies found to be large in the previous sample to the FDI/NWB frame.

Table A2.1B: Contributions to estimates of Total FDI Positions by units linked with UK companies on the sampling frame from those that were sampled (split by responded and imputed) and those predicted (and were not sampled)

Quarterly surveys	Inward		Outward	
	Q2 2015	Q3 2015	Q2 2015	Q3 2015
Sampled	59.8%	60.2%	97.5%	97.2%
… of which:				
Imputed	3.7pp	6.5pp	6.3pp	42.1pp
Responded	56.1pp	53.7pp	91.2pp	55.1pp
Predicted	40.1%	39.7%	2.6%	2.8%
Total FDI positions	100.0%	100.0%	100.0%	100.0%

Annual surveys	Inward		Outward	
	2013	2014	2013	2014
Sampled	80.9%	79.0%	99.3%	99.1%
… of which:				
Imputed	6.3pp	5.6pp	6.0pp	4.4pp
Responded	74.6pp	73.4pp	93.3pp	94.7pp
Predicted	19.1%	21.0%	0.7%	1.0%
Total FDI positions	100.0%	100.0%	100.0%	100.0%

pp = percentage points

Observations:

- For Inward, sampled units provide about 60% of Total FDI positions on the quarterly surveys, and about 80% on the annual surveys.
- For Outward, sampled units provide about 97% of Total FDI positions on the quarterly surveys, and about 99% on the annual surveys.
- The contribution of imputed responses (in cases of non-response from sampled units) varies between 3% and 7% of FDI positions, except for the most recent quarter for Outward, in which the much higher contribution (42%) is largely a reflection of outstanding (late) returns, something particularly prevalent on the Quarterly Outward survey.

Table A2.1C: Contributions to estimates of Total FDI Positions by units linked with companies sampled and those predicted, by frame

Quarterly surveys	Inward				Outward			
	Q2 2015		Q3 2015		Q2 2015		Q3 2015	
	FDI/ NWB	WB	FDI/ NWB	WB	FDI/ NWB	WB	FDI/ NWB	WB
Sampled	53.7%	6.1%	53.7%	6.6%	95.2%	2.2%	94.7%	2.5%
Predicted	10.4%	29.8%	10.4%	29.3%	1.0%	1.6%	0.9%	2.0%
Total FDI positions	100.0%		100.0%		100.0%		100.0%	

Annual surveys	Inward				Outward			
	2013		2014		2013		2014	
	FDI/ NWB	WB	FDI/ NWB	WB	FDI/ NWB	WB	FDI/ NWB	WB
Sampled	50.8%	30.1%	65.9%	13.1%	90.0%	9.3%	92.6%	6.5%
Predicted	4.3%	14.8%	7.4%	13.6%	0.1%	0.6%	0.4%	0.5%
Total FDI positions	100.0%		100.0%		100.0%		100.0%	

Observation:

- The much smaller sampling fractions applied on the WB frame are reflected in much greater proportions being Predicted than Sampled when compared with those on the FDI/NWB frame.

Table A2.1D: Analysis of positive and negative contributions to estimates of Total FDI Positions

Quarterly surveys	Inward (£ billion)		Outward (£ billion)	
	Q2 2015	Q3 2015	Q2 2015	Q3 2015
Negative FDI positions	-13	-13	-59	-78
Positive FDI positions	940	964	768	754
Total FDI positions	927	950	710	676
…of which:				
Contribution from top 10	18.6%	19.4%	22.7%	24.3%

Note: the Total FDI Positions estimate reported here is consistent with the Balance of Payments (BoP) publication, in that the base data set is the same; however, the figures reported in the BoP publication are on an asset-and-liability basis, whereas that reported here is on a direction basis.

Annual surveys	Inward (£ billion)		Outward (£ billion)	
	2013	2014	2013	2014
Negative FDI positions	-27	-18	-50	-61
Positive FDI positions	937	1052	1074	1077
Total FDI positions	910	1034	1025	1015
…of which:				
Contribution from top 10	22.0%	21.3%	24.1%	22.4%

Note: the Total FDI Positions ('International Investment Position') estimate reported here on an annual basis is consistent with the 2014 FDI statistical bulletin

Observations:

- The aggregate negative contribution to IIP is presently much smaller in absolute size than the aggregate positive contribution, and the number of units (not shown) having negative IIP values is similarly small.
- That the 10 largest unit-level IIP values (out of a population size of over 30,000 Inward units and over 20,000 Outward units) contribute about 20% of the total estimate is a reflection of the very skewed distribution of FDI. This illustrates the need to ensure the biggest companies are sampled, respond and that their responses are validated (cleaned).

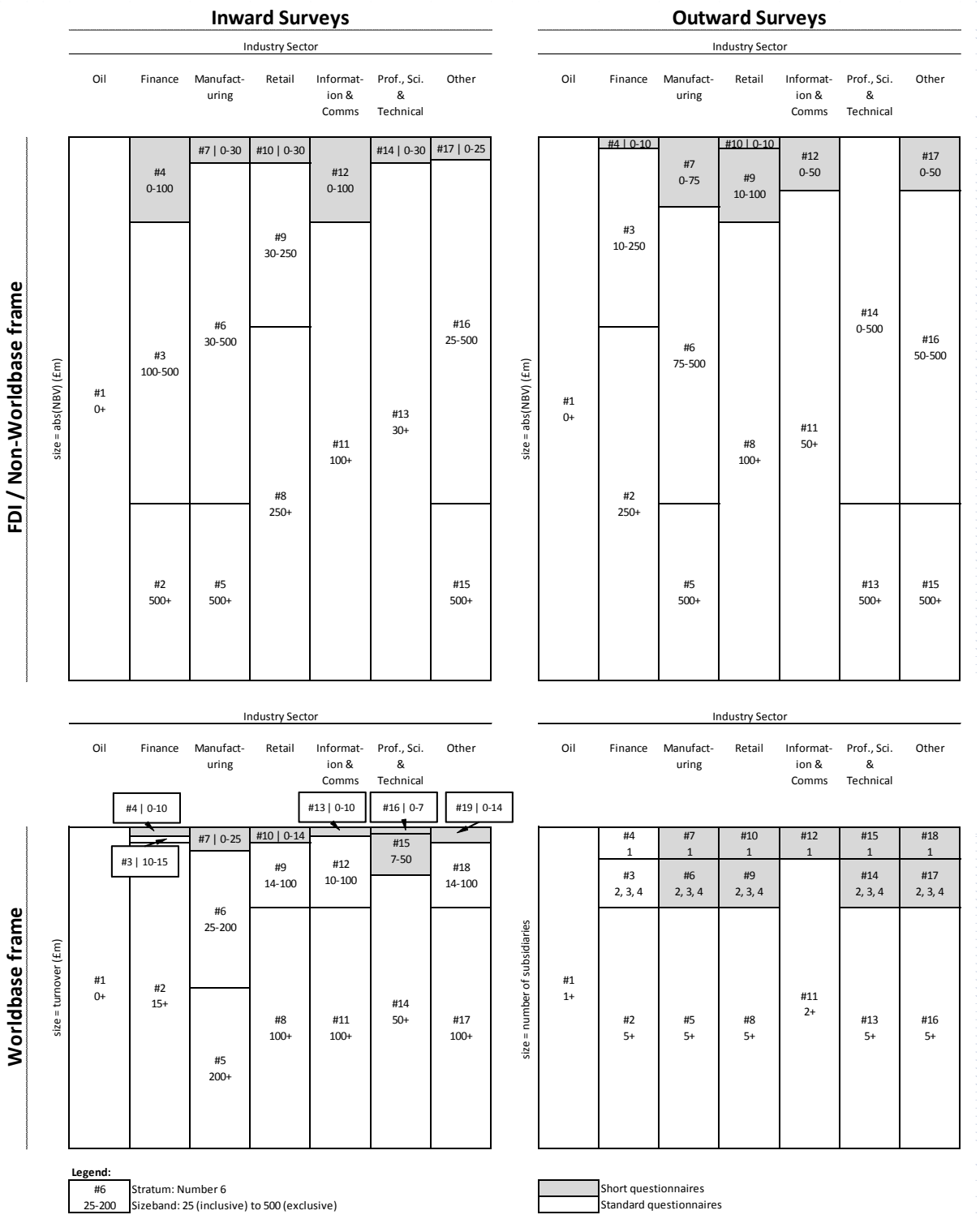
Appendix 3.1A: Industry definitions in FDI sampling strata and outputs

The following table compares industry sampling strata (UK companies) and the output industry group (for foreign affiliates and parents) using the FDI industry classification. This is based around the SIC(2007) 3-digit level codes. Deviations from SIC(2007) codes in the Finance industry are noted.

FDI industry codes used to form sampling strata (of UK companies) The names given are those used internally.	**Comparable FDI industry codes (of foreign affiliates and parents) used in output domains** The names given are those in the FDI statistical bulletin and datasets
'Oil' = {060, 090}	*Part of* 'Mining & quarrying' = {050–090}
'Manufacturing' = {110–330}	*Part of* 'Food products, beverages & tobacco products' = {100–120} 'Textiles & wood activities' = {130, 140,160–180} 'Petroleum, chemicals, pharmaceuticals, rubber, plastic products' = {190–220} 'Metal and machinery products' = {240, 250, 280} 'Computer, electronic and optical products' = {260 = 261–268} 'Transport equipment' = {290, 300 = 301–304/9} 'Other manufacturing' = {150, 230, 270, 310–330}
'Retail' = {460, 470}	*Part of* 'Retail & wholesale trade, repair of motor vehicles & motor cycles' = {450, 460, 470}
'Information and communication' = {590–630}	*Part of* 'Information and communication' = {580–630}
'Finance' = {641 (= *SIC 64.11, 64.191*): Banks, not sampled on FDI survey, 642(= *SIC 64.192*), 643 (= *SIC 64.201–4*), 644 (= *SIC 64.205*), 645 (= *SIC 64.209, 64.3, 64.9*), 651 (= *SIC 65.11*), 652 (= *SIC 65.12, 65.2, 65.3 = rest of 65*), 661 (= *SIC 64.12, 64.19*), 662 (= *SIC 66.11, 66.19, 66.2, 66.3 = rest of 66*), 663 (= *no mapping to this code; review of scope underway*)}	'Financial services' = {641–663}

‘Professional, scientific and technical’ = {691–740}	*Part of* ‘Professional, scientific & technical services’ = {691–750}
‘Other’ = {codes not elsewhere specified}	‘Agriculture, forestry & fishing’ = {010–030} ‘Electricity, gas, water and waste’ = {350–390} ‘Construction’ = {410–430} ‘Transportation & storage’ = {490–530} ‘Administrative and support service activities’ = {770–820} ‘Other services’ = {550, 560, 680, 840–880, 900–990} *and contributions to:* ‘Mining & quarrying’ = {050–090} via [050, 070, 080] ‘Food products, beverages & tobacco products’ = {100–120} via [100] ‘Retail & wholesale trade, repair of motor vehicles & motor cycles’ = {450, 460, 470} via [450] ‘Information and communication’ = {580–630} via [580] ‘Professional, scientific & technical services’ = {691–750} via [750]

Appendix 3.1B: FDI sampling stratum definitions



The figure is illustrative (and not to scale), and details information about the sampling frames in use in early 2015 to draw the samples for the 2015 quarterly and 2014 annual surveys.

Appendix 3.2: Sample sizes and response

Response is at time of final delivery closedown; that time (in weeks from dispatch date) can vary from period to period.

	Quarterly, Inward			Quarterly, Outward		
Reference period	Sample dispatched	Sample responded	Response rate (%)	Sample dispatched	Sample responded	Response rate (%)
2009 Q1	735	377	51	356	128	36
2009 Q2	702	429	61	326	135	41
2009 Q3	679	473	70	310	182	59
2009 Q4	671	492	73	307	156	51
2010 Q1	807	448	56	382	166	43
2010 Q2	767	475	62	358	213	59
2010 Q3	746	521	70	351	210	60
2010 Q4	731	524	72	340	182	54
2011 Q1	824	454	55	386	174	45
2011 Q2	811	628	77	377	255	68
2011 Q3	792	637	80	365	272	75
2011 Q4	786	617	78	357	244	68
2012 Q1	708	505	71	395	231	58
2012 Q2	708	558	79	387	273	71
2012 Q3	693	539	78	377	271	72
2012 Q4	692	531	77	369	239	65
2013 Q1	977	687	70	656	401	61
2013 Q2	926	720	78	609	395	65
2013 Q3	901	701	78	611	445	73
2013 Q4	903	767	85	586	423	72
2014 Q1	922	555	60	642	323	50
2014 Q2	895	668	75	613	405	66
2014 Q3	902	752	83	607	488	80
2014 Q4	903	761	84	586	417	71
2015 Q1	933	663	71	590	376	64
2015 Q2	895	640	72	616	372	60
2015 Q3	884	740	84	539	412	76
2015 Q4	874	738	84	534	399	75

	Annual, Inward			Annual, Outward		
Reference period	Sample dispatched	Sample responded	Response rate (%)	Sample dispatched	Sample responded	Response rate (%)
2008	2503	1717	69	1440	773	54
2009	2366	1754	74	1530	927	61
2010	2442	1991	82	1604	981	61
2011	2434	2078	85	1599	1205	75
2012	3094	2756	89	2153	1775	82
2013	3331	2813	84	1824	1431	78
2014	3682	3007	82	2288	1638	72

Appendix 3.3: Sampling fractions and quarterly-to-annual sample ratios

Inward

	Oil	Finance	Manufact-uring	Retail	Information & Communications	Professional, Scientific & Technical	Other
FDI/NWB							
Small	0.97	0.13	0.08	0.07	0.37	0.32	0.14
Medium		0.39	0.12	0.26		0.90	0.29
Large		0.95	0.88	1.00	0.91		0.89
WB							
Small	0.19	0.02	0.01	0.00	0.04	0.04	0.00
Medium		0.07	0.03	0.02	0.05	0.04	0.03
Large		0.12	0.13	0.07	0.13	0.13	0.07

Outward

	Oil	Finance	Manufact-uring	Retail	Information & Communications	Professional, Scientific & Technical	Other
FDI/NWB							
Small	1.00	0.88	0.41	0.42	0.55	0.45	0.45
Medium		1.00	0.48	0.54			0.45
Large		0.97	1.00	0.96	0.92	1.00	0.97
WB							
Small	0.67	0.06	0.03	0.03	0.03	0.02	0.01
Medium		0.15	0.05	0.08	0.08	0.05	0.04
Large		0.20	0.13	0.13		0.09	0.07

Figure A3.3(i): Quarterly sampling fractions: n_Q / N at time of sample selection in early 2015, for the 2015 quarterly surveys.

Inward

	Oil	Finance	Manufact-uring	Retail	Information & Communications	Professional, Scientific & Technical	Other
FDI/NWB							
Small	1.00	0.19	0.10	0.10	0.41	0.40	0.14
Medium		0.50	0.49	0.38		1.00	0.44
Large		1.00	1.00	1.00	1.00		1.00
WB							
Small	0.29	0.07	0.19	0.03	0.35	0.03	0.28
Medium		0.12	0.11	0.07	0.10	0.07	0.08
Large		0.70	0.36	0.35	0.70	0.16	0.26

Outward

	Oil	Finance	Manufact-uring	Retail	Information & Communications	Professional, Scientific & Technical	Other
FDI/NWB							
Small	1.00	1.00	0.51	1.00	1.00	1.00	0.51
Medium		1.00	1.00	1.00			1.00
Large		1.00	1.00	1.00	1.00	1.00	1.00
WB							
Small	0.73	0.70	0.35	0.07	0.35	0.07	0.07
Medium		0.70	0.70	0.35	0.70	0.35	0.70
Large		0.70	0.70	0.70		0.70	0.70

Figure A3.3(ii): Annual sampling fractions: n_A / N at time of sample selection in early 2015, for 2014 annual surveys.

Inward

	Oil	Finance	Manufact-uring	Retail	Information & Communications	Professional, Scientific & Technical	Other
FDI/NWB							
Small	0.97	0.70	0.77	0.69	0.90	0.81	0.96
Medium		0.77	0.25	0.70		0.90	0.66
Large		0.95	0.88	1.00	0.91		0.89
WB							
Small	0.67	0.25	0.03	0.10	0.11	1.28	0.02
Medium		0.55	0.25	0.25	0.51	0.53	0.30
Large		0.17	0.37	0.20	0.19	0.82	0.27

Outward

	Oil	Finance	Manufact-uring	Retail	Information & Communications	Professional, Scientific & Technical	Other
FDI/NWB							
Small	1.00	0.88	0.81	0.42	0.55	0.45	0.88
Medium		1.00	0.48	0.54			0.45
Large		0.97	1.00	0.96	0.92	1.00	0.97
WB							
Small	0.91	0.09	0.08	0.38	0.10	0.27	0.19
Medium		0.22	0.08	0.21	0.12	0.15	0.06
Large		0.29	0.19	0.18		0.13	0.10

Figure A3.3(iii): Ratio of n_Q to n_A , as in (i) and (ii), above.

Notes:
(a) Strata shown are as in Appendix 3.1B. Thus, 'Small', 'Medium' and 'Large' have definitions that are determined by frame and by industry, and should not be regarded as consistent across frames or industries.
(b) The 0.7-factor on the WB frames (see Section 3.3) has been applied and is reflected in these data.

Appendix 5.3: Effect of removing the Chancellor's Initiative Data file

The tables in this appendix are a re-worked version of the 2014 FDI statistical bulletin datasets. From that publication, the rows in Reference Tables 1.1, 1.2 and 1.3 most affected by the Chancellor's Initiative Data have been reworked by removing the Chancellor's Initiative Data file from the production process; no other processes have been changed.

	2013			2014		
	published (£m)	reworked (£m)	difference (%)	published (£m)	reworked (£m)	difference (%)
FDI flows into the UK by foreign companies (inward)						
(Source: Table 1.1 of reference tables)						
Foreign companies' share of UK subsidiaries' and associates' net profits	47,521	47,493	-0.1	48,259	48,259	0.0
Unremitted profits (reinvested earnings)	14,754	14,726	-0.2	9,982	9,954	-0.3
Net increase in amounts due to foreign parents on the branch head-office account	-255	-256	0.4	1,232	1,232	0.0
Increase in amounts due to foreign parents on the branch head-office account	150	150	0.0	2,296	2,296	0.0
Total net FDI flows in the UK	**33,016**	**33,016**	0.0	**27,801**	**27,801**	0.0

FDI international investment position in the UK held by foreign companies (inward)

(Source: Table 1.2 of reference tables)

	2013			2014		
	published (£m)	reworked (£m)	difference (%)	published (£m)	reworked (£m)	difference (%)
Net amounts due to foreign parents on the branch head-office account at end period	4,981	1,717	-65.5	10,069	6,805	-32.4
Amounts due to foreign parents on the branch head-office account at end period	24,023	20,759	-13.6	23,567	20,303	-13.8
Total foreign FDI international investment position in the UK at end period	**910,280**	**907,016**	-0.4	**1,034,335**	**1,031,071**	-0.3

Foreign companies' earnings from foreign direct investment in the UK (inward)

(Source: Table 1.3 of reference tables)

	2013			2014		
	published (£m)	reworked (£m)	difference (%)	published (£m)	reworked (£m)	difference (%)
Foreign companies' share of UK branches' net profits	6,809	6,871	0.9	3,333	3,305	-0.8
Foreign companies' share of UK branches' profits	10,803	10,775	-0.3	8,014	7,986	-0.3
Total net earnings from foreign direct investment in the UK	**50,839**	**50,811**	-0.1	**52,315**	**52,287**	-0.1

Appendix 6.1: Prediction estimation in FDI

This appendix contains a specification of the prediction estimation approach that should be applied to FDI, although the approach currently used is equivalent to setting the value of ρ (rho) to a default of zero. The description given here relies heavily upon that in Valliant *et al* (2000), but has been tailored to use in FDI.

Consider a population of affiliates or parents (or, likewise branches, subsidiaries, etc.) that are clustered within companies; companies are the sampling units listed on the frame(s).

The prediction estimator is based on the following, the group mean model, for variable *y*. The estimation is to be applied separately within each sampling stratum; for clarity, the stratum indicator has been omitted from the notation.

The model, and the expectation and covariances under this, are given by:

$$E\left(y_{ij}\right) = \mu$$

$$Cov\ \left(y_{i,j}, y_{i',j'}\right) = \begin{cases} \sigma^2 & i = i', j = j' \\ \sigma^2\rho & i = i', j \neq j \\ 0 & otherwise, \end{cases}$$

where:

i and *i*' represent (sampled) companies, which may be considered as clusters of affiliates (etc.);
j and *j*' represent affiliates (etc.) associated with the companies;
ρ is the intra-cluster correlation coefficient, which measures the homogeneity of the returns of affiliates (etc.) that belong to the same company, and
σ^2 is the variance of the variable *y*.

Let *N* denote the number of companies in the population, and let *n* denote the size of the sample, *s*, of these.

Let *M* denote the total number of affiliates (etc.) that belong to the *N* companies in the population, and let *m* denote the total number of affiliates that belong to the *n* sampled companies.
Let M_i and m_i respectively denote the number of affiliates in company *i* in total and that are sampled, noting that for FDI, $M_i = m_i$ for every company *i* in the sample, *s*.

Under the model, the best linear unbiased estimator of the population total for variable *y* is given by formula 8.2.9 in Valliant *et al* (2000), which, with $M_i = m_i$ reduces to:

$$\hat{T}_y = \sum_{i \in s} \sum_{j=1}^{M_i} y_{ij} + \sum_{i \in U \setminus s} M_i \hat{\mu}$$

where $\hat{\mu}$ denotes the prediction used for each unsampled unit in the stratum, whose value is calculated as a weighted average of the company-level averages of affiliate means, as given by:

$\hat{\mu} = \sum_{i \in s} u_i \bar{Y}_{si}$, where $\bar{Y}_{si} = \sum_{j \in s_i} \frac{Y_j}{m_i}$ is the mean response of all affiliates in sampled company *i*, and

$\{u_i\}$ are weights, with $u_i = \frac{m_i / v_i}{\sum_{k=1}^{n} m_k / v_k}$ and $v_i = \sigma^2[1 + (m_i - 1)\rho]$,

as in Theorem 8.2.2 in Valliant *et al* (2000).

Thus, the value of the intra-cluster correlation coefficient, ρ, impacts on the estimate (it also impacts on the model variance of the estimator).

Setting $\rho = 0$ gives $v_i = \sigma^2$ so that $u_i = \dfrac{m_i}{\sum_{k \in s} m_k}$ and $\hat{\mu} = \sum_{i \in s} \dfrac{m_i}{\sum_{k \in s} m_k} \sum_{j \in s_i} \dfrac{Y_{ij}}{m_i} = \dfrac{1}{m} \sum_{i \in s} \sum_{j \in s_i} Y_{ij}$,

i.e. the affiliate-level mean.

Setting $\rho = 1$ gives $v_i = \sigma^2 m_i$, such that $u_i = \dfrac{1}{n}$ and $\hat{\mu} = \sum_{i \in s} \dfrac{1}{n} \bar{Y}_{si}$, i.e. the mean of the company-level means.

The variance, σ^2, and the intra-cluster correlation coefficient, ρ, can be estimated from the data. For example, using the ANOVA model (see Table 8.2 of Valliant *et al* (2000)):

$$\rho = 1 - \frac{WD}{WD + B - W} \text{ and } \sigma^2 = \frac{B}{1 + \rho(D-1)}$$

where: $B = \dfrac{1}{n-1} \sum_{i \in s} m_i (\bar{Y}_{si} - \bar{Y}_s)^2$; $W = \dfrac{1}{n} \sum_{i \in s} \sum_{j \in s_i} \dfrac{(Y_{ij} - \bar{Y}_{si})^2}{m_i - 1}$; and $D = \dfrac{1}{n-1} \left(m - \sum_{i \in s} \dfrac{m_i^2}{m} \right)$

Estimation of the parameters is also possible through a maximum-likelihood approach.

Note: no guarantees are given that, for example, the estimated value of ρ in each stratum would obey the usual limits for correlation coefficients, nor that the estimates would be stable from period-to-period. Some adjustments, pooling of data over time, or smoothing of estimates of σ^2 and ρ may prove beneficial.

Appendix 8.1: Benchmarking and other revisions to the quarterly path

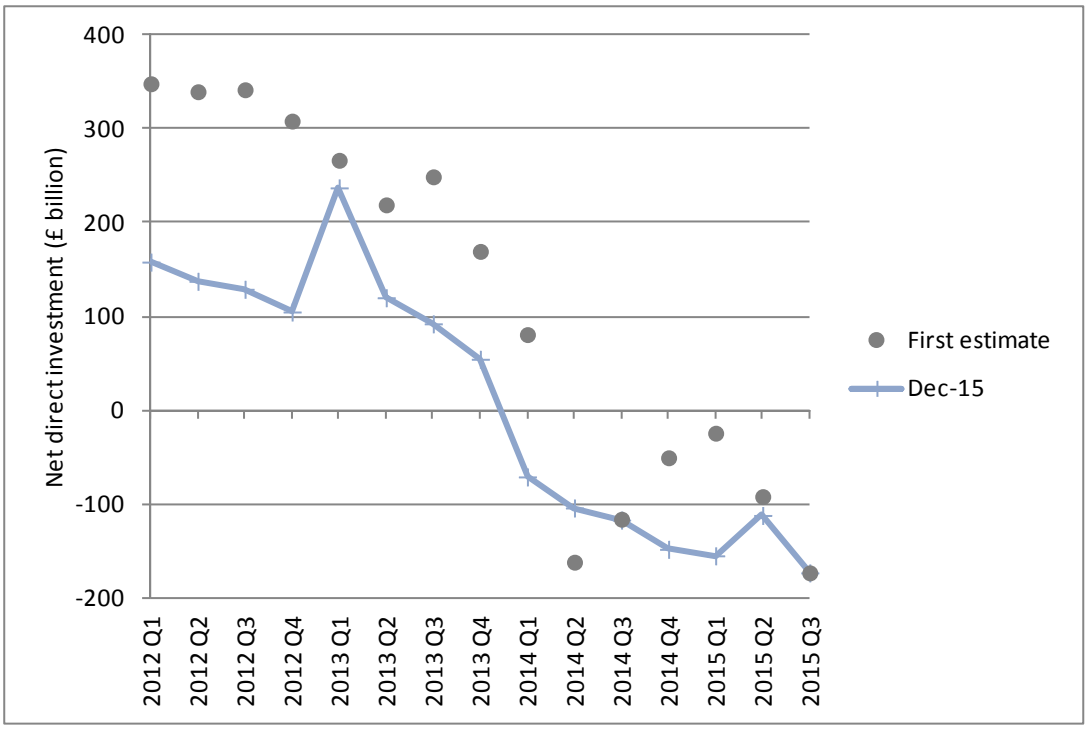


Figure A8.1: Comparison of the first and most recent quarterly estimates of net direct investment from 2012 Q1 to present. The first estimates are shown without joining lines, as adjacent points should only be compared with caution since various changes may cause later revisions. Examples include: BPM6, 2011 and 2012 benchmarks (all introduced September 2014 and showing first on Q2 2014 estimates); and 2012, 2013 benchmarks and some smaller revisions for cross-border property (all introduced September 2015 and first showing on 2015 Q2 estimates).

viii. Glossary, abbreviations and notation

Assets and liabilities: one basis on which FDI outputs can be presented. The alternative basis is 'inward and outward' (or 'directional').

Blue Book: one of the principal, annual publications of National Accounts.

BoP: Balance of Payments. That part of the National Accounts in which FDI estimates are used and appear.

BPM: Balance of Payments and International Investment Position Manual. BPM6 is the sixth (and current) edition.

CID: Chancellor's Initiative Data. A data input file used in the processing of the annual, Inward FDI survey.

CORA: Common Open-Road Architecture. An information technology platform developed at ONS from c.2008 for the holding and processing of data.

CV: coefficient of variation: the relative standard error associated with a survey estimate.

E&V: editing and validation. The E&V team has responsibility for cleaning the data supplied by survey respondents.

ECB: European Central Bank.

EGR: EuroGroups Register, a register of businesses maintained by Eurostat and available to NSI in member states.

ESA: the European System of National and Regional Accounts. The current version is ESA 2010, which superseded ESA 1995.

Eurostat: the statistical organisation of the European Union.

FDI: foreign direct investment (referring to the concept itself), or Foreign Direct Investment (referring to the ONS statistical product or survey of the same name).

FDI/NWB frame: the FDI or Non-Worldbase (NWB) sampling frame.

IIP: international investment position.

IMF: International Monetary Fund.

Inward and outward: A basis on which FDI statistics can be presented; also known as the 'directional' basis. An alternative basis is 'assets and liabilities'. Also the names of FDI surveys at ONS.

IDBR: Inter-Departmental Business Register. A database of mainly VAT- or PAYE-registered in the UK maintained by ONS, and used as sampling frame for most of ONS's business surveys, though not used directly for selecting FDI samples.

M&A: Mergers and Acquisitions. A continuous ONS survey, which collects information about changes of ownership of companies.

NBV: net book value, a financial concept and variable that is available for all businesses listed on the FDI/NWB frame and so can be used for stratification of the sample.

NWB frame: Non-Worldbase. See FDI/NWB frame.

NSI: National Statistical Institute. ONS is the recognised NSI of the UK.

ONS: the Office for National Statistics, the UK's National Statistical Institute and organisation that compiles FDI estimates.

OpenRoad: an IT platform on which FDI data were stored and processed prior to the introduction of CORA.

Pink Book: one of the principal, annual publications of National Accounts, and the one that contains FDI estimates.

Proving: its general use refers to an ONS process to establish that the businesses listed on a sample frame actually do exist. In the context of FDI, the proving exercise establishes that a company selected for the sample still exists and is in-scope of FDI.

PRN: permanent random number. A randomly generated number between 0 and 1 (with 9 decimal places) that is assigned to each business on the sampling frame and should never change over time. PRNs are used to draw random samples of businesses, and allow management of sample rotation from period to period.

Q1: Quarter 1 (January to March). The 3-month reference period used in FDI statistics based on a calendar quarter. Similarly for Q2 (April to June), Q3 (July to September) and Q4 (October to December).

SAS®: a commercial statistical computing software and language, used variously in ONS, and since 2015 for the Analysis part of the FDI process.

SEFT: Secure Electronic File Transfer. A method and name of an electronic portal used by ONS to securely transmit files (such as data collection spreadsheets), and other communications, between the Office and survey respondents.

SIC(2007). The UK's current Standard Industrial Classification 2007. It is a 5-digit, hierarchical classification of economic activity, and is consistent at the 4-digit level with the EU's NACE Rev. 2.

TEG: Truncated Enterprise Group. The group of enterprises with a UK company at its head.

WB: Worldbase, a sampling frame currently used to draw part of the FDI sample in ONS; the other frame used in called FDI/NWB.

ix. References

Bean, C (2015) 'Independent Review of UK Economic Statistics: Interim Report'. https://www.gov.uk/government/publications/independent-review-of-uk-economic-statistics-interim-report Site accessed 12 May 2016.

Bean, C (2016) 'Independent Review of UK Economic Statistics: Final Report'. https://www.gov.uk/government/publications/independent-review-of-uk-economic-statistics-final-report Site accessed 12 May 2016.

Dagum, EB and Cholette, PA (2006) 'Benchmarking, Temporal Distribution, and Reconciliation Methods for Time Series'. New York: Springer Science+Business Media, LLC.

European System of Accounts (ESA) 2010. http://ec.europa.eu/eurostat/web/products-manuals-and-guidelines/-/KS-02-13-269 Site accessed 7 January 2016.

Eurostat (2015) EuroGroups Register. http://ec.europa.eu/eurostat/statistics-explained/index.php/EuroGroups_register Site accessed 8 September 2015.

Hidiroglou, MA and Berthelot, J-M (1986). 'Statistical Editing and Imputation for Periodic Business Surveys'. Survey Methodology, 12, pp. 73-83.

International Monetary Fund 'Balance of Payments and International Investment Position Manual Sixth Edition'. http://www.imf.org/external/pubs/ft/bop/2007/bopman6.htm Site accessed 7 January 2016.

Kokic, PN and Bell, PA (1994), 'Optimal Winsorising Cut-offs for a Stratified Finite Population Estimator', Journal of Official Statistics, Vol. 10, pp.419-435.

NACE Rev 2. http://ec.europa.eu/eurostat/web/nace-rev2 Site accessed 7 January 2016.

OECD 'Benchmark Definition of Foreign Direct Investment Fourth Edition 2008' http://www.oecd.org/daf/inv/investmentstatisticsandanalysis/40193734.pdf Site accessed 7 January 2016.

Ohlsson, E (1995) 'Co-ordination of samples using permanent random numbers'. In Business Survey Methods (eds B. Cox, D. Binder, B. Chinnappa, A. Christianson, M. Colledge and P. Kott), pp. 153-169. New York: Wiley.

'Official Statistics Code of Practice', Version 1.0 (January 2009), UK Statistics Authority. http://www.statisticsauthority.gov.uk/assessment/code-of-practice/index.html Site accessed 7 January 2016.

ONS (2005) 'Annex to Report Evaluating FDI Sampling Frame'. Internal ONS report.

ONS (2008) 'Report of FDI High Level Review, February 2008'. Internal ONS report.

ONS (2009a) 'Revised Design for FDI surveys: Initial proposals'. Internal ONS report.

ONS (2009b) 'FDI – Standard Errors'. Internal ONS report.

ONS (2010) 'FDI Sample and Population Sizes Analysis'. Internal ONS report.

ONS (2011a) 'Sample Design & Estimation Recommendations for Quarterly FDI'. Internal ONS report.

ONS (2011b) 'The Use of Multi-level Modelling for Outwards FDI'. Internal ONS report.

ONS (2012a) 'FDI Outlier Detection: Report'. Internal ONS report.

ONS (2012b) 'FDI Estimation System Specification'. Internal ONS report.

ONS (2014a) 'National Statistics Quality Review, (NSQR) Series (2) Report No. 2: Review of National Accounts and Balance of Payments'.
http://webarchive.nationalarchives.gov.uk/20160105160709/http://ons.gov.uk/ons/rel/naa1-rd/national-statistics-quality-review/-nsqr--series--2--report-no--2--review-of-national-accounts-and-balance-of-payments/index.html Site accessed 24 June 2016.

ONS (2014b) 'FDI Outliering – Quarterly and Annual'. Internal ONS report.

ONS (2015a) 'An analysis of Foreign Direct Investment, the key driver of the recent deterioration in the UK's Current Account: New and Existing FDI'
https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/articles/ananalysisofforeigndirectinvestment/2015-10-30 Site accessed 24 June 2016.

ONS (2015b) 'FDI Imputation'. Internal ONS report.

ONS(2015c) 'L-values for FDI Quarterly – 2014/15'. Internal ONS report.

ONS (2015d) 'Disclosure Control for Business Output –Short Report on International Transactions Methodology'. Internal ONS report.

ONS (2015e) 'Review of benchmarking methods for FDI position variables'. Internal ONS report.

ONS (2015f) 'Balance of Payments, Quarter 3 (July to September) 2015' Datasets accessible from
https://www.ons.gov.uk/economy/nationalaccounts/balanceofpayments/bulletins/balanceofpayments/quarter3julytosept2015/relateddata Site accessed 24 June 2016.

Smith, P, Pont, M and Jones, T (2003). 'Developments in business survey methodology in the Office for National Statistics', 1994-2000 (with discussion). Journal of the Royal Statistical Society, Series D **52** pp. 257-295.

Valliant, R, Dorfman, A, and Royall, RM (2000), 'Finite Population Sampling and Inference: A Prediction Approach'. New York: John Wiley.