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Exploratory Analysis of the English Business Survey

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Summary

Business surveys have been receiving increased prominence. They are regarded as an important complement to official hard data and they are also used as early economic indicators. It is because such data are available much earlier than the release of the official quantitative (hard) data, although the cost of that timeliness is its qualitative nature.

The English Business Survey (EBS) is a relatively new addition to the set of business surveys in operation in the UK. The coverage of this survey is different from most other surveys, in that it exclusively covers only England. The EBS survey started in November 2011. It is a workplace based survey and 3000 workplaces are interviewed each month in the England, using a stratified sample design. The resulting EBS datasets are therefore repeated cross-sections, sampled using a complex survey design.

This report aims to provide an analytical review of the EBS. By focusing the exploratory analysis on different aspects, and through which we hope to provide an understanding some of the properties of the EBS. In the first part of the report, we use publically available information to compare and contrast the EBS survey with other business surveys. These surveys include the Purchasing Manager Index conducted by Markit, the Regional Trends Surveys of the Confederation of Business Industry, the Quarterly Economic Survey of the British Chamber of Commerce, and the Business Confidence Monitor conducted by ICAEW/Grant Thornton. Comparison is made in terms of sample frame and coverage (including geographical and industrial dimensions), the period that the surveys cover and their publication frequency; the methodologies used to derive the aggregate data series; weighting methods adopted by the surveys; and the seasonal adjustment method used.

The second part of this report presents an analysis of the EBS data at the aggregate level. We first look at the consistency between the aggregate performance (retrospective trend) and the aggregate expectation (prospective trend) with the aid of graphical illustration and evaluation statistics. We take into account the reference period the aggregate series are pointing to and make the comparison accordingly. We attempted to quantify the predictive power of the expectation series. The results show the expectation series appears to track the aggregate performance series in general, despite a tendency of over-estimation, and the two series appears to have high correlation. These results hold true for both aggregate output and aggregate employment and they are not appear to be sensitive to whether an alternative grossing factor is used. We also examine the relationship between the EBS qualitative aggregates with their quantitative counterparts (NIESR monthly GDP and the LFS employment data). We found evidence that the EBS output

performance balance statistic is a leading indicator of GDP growth; and robust contemporaneous correlation between the performance balance statistic and the employment growth rate. These findings are reinforced by cross-correlation analysis.

The third part of this report presents an analytical framework for analysis with the EBS data at the workplace level. Such framework is based on economic theory and it provides the basis of the workplace level analysis presented later in the report. We briefly discuss how unconditional and conditional correlations among variables, and thus provide a preliminary understanding of the analysis we then present in the analysis using workplace level EBS data. With the aid of equations, we outline the conditional relationships among the EBS variables and how they can be related. These equations form the basis of the multivariate analysis presented later. We also highlight the limitations of the analysis due to the statistical properties of the data.

In the fourth part of this report, we present the findings from a multivariate analysis using workplace level EBS data. We conduct the workplace level analysis in two aspects: unconditional (bivariate) correlation analysis based on polychoric correlation and conditional correlation (multivariate) analysis using probability models (ordered probit and probit models). Results from the unconditional correlation analysis using a pooled sample show significant correlations among EBS workplace level variables in general and the findings are in line with economic theory. The breakdown of the unconditional correlation analysis into each wave and each region reveals certain variation of the correlation among the variables across time; but much less across regions. We then move on to the conditional correlation analysis. We take into account the impact of macroeconomic and specific shocks on the conditional correlations among variables by including different dummies in the models (employment size, industry, region and months). We found that these conditional correlations are significant in general regardless of whether different shocks are controlled for. Including the dummies only changes the estimated coefficients marginally, indicating the results are insensitive to macroeconomic and specific shocks. Though results show significant effects of employment size, industry and months, regional effects are found to be insignificant in general. We argue that if a longer sample period is available for analysis may lead to different results as economic conditions changes over time.

The final part of this report concludes our findings. We also provide some suggestions of future analysis of the EBS data. We highlight the drawbacks we have learnt about the data from this study, and some limitation due to the short sample available to us for this study. We made recommendations on how the data can be improved and what can then be done to provide more insightful and meaningful interpretation of the data in future.

Abbreviations

BCC – British Chamber of Commerce

BCM – Business Confidence Monitor

CBI – Confederation of British Industry

BIS – Department for Business, Innovation and Skills

EBS – English Business Survey

GDP – Gross Domestic Product

GVA – Gross Value Added

HMT – Her Majesty's Treasury

ICAEW – The Institute of Chartered Accountants in England and Wales

ITS – Industrial Trends Survey

LFS – Labour Force Survey

LR – Likelihood Ratio

NIESR – National Institute of Economic and Social Research

NUTS - Nomenclature of Units for Territorial Statistics

ONS – Office for National Statistics

PMI – Purchasing Managers Index

QES – Quarterly Economic Survey

RMSE – Root mean squared error

RTS – Regional Trends Survey

SME – Small and medium sized enterprises

Introduction

Understanding real time economic issues is a perennial problem for policymakers and economic agents. Official statistics are usually published with considerable lag. Increased prominence has been attached to business surveys. They are widely seen as an important complement to official 'hard' data. They are also used as early economic indicators since they are available in a more timely fashion than the official quantitative (hard) data, although the cost of that timeliness is its qualitative nature. In qualitative surveys firms or workplaces are asked a range of questions to which they provide categorical instead of quantitative answers. For example, they are asked whether output has decreased/expect to decrease; stayed the same/expect to stay the same, or increase/expect to increase.

The English Business Survey (EBS) is a relatively new addition to the set of business surveys in operation in the UK. The coverage of this survey is different from most other surveys, in that it exclusively covers only England.

The Department for Business, Innovation and Skills (BIS) commissioned the EBS in order to provide a monthly source of the state of the English regions. In this respect it can be viewed as a potential complement to the existing qualitative business surveys in understanding near term developments in the English regions and English economies. The EBS survey started in November 2011[1]. It is a workplace based survey and 3000 workplaces are interviewed each month in the England, using a stratified sample design. The resulting EBS datasets are therefore repeated cross-sections, sampled using a complex survey design.

When interpreting the results from the EBS, we need to be acutely aware of the prevailing economic conditions. The EBS was commissioned with a backdrop of an absence of economic growth. At the same time, employment has continued to expand. The poor productivity performance since the end of the Great Recession remains a puzzle and must underpin any interpretation of the information content qualitative business surveys, such as the EBS[2].

Readers need to be aware of what this report can and cannot deliver. It is an exploration of dataset that is in its infancy. The analysis contained in this report is deliberately broad. The scope of the paper is designed to list how the EBS compares to other workplace/firm surveys, a limited investigation into the properties of macroeconomic variables derived from the survey, provide a framework for some analysis of the workplace level data, as well as some exploration of the some of the relationships within this data. The overall intention is to lay a foundation on which future analysis of the EBS can build.

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[1] The coding in the EBS by TNS-BMRB in the raw data codes the month of interview as the release month rather than the reference month. The first month in the survey is the December 2011 release.

[2] For a review of some of the proposed solutions to the productivity puzzle see OECD (2013).

Existing studies of qualitative survey data focuses on the use of the summary statistics from these surveys (Balance statistic). These studies include comparing the Balance statistic with aggregate quantitative data (see Driver and Urga (2004) and Pesaran and Weale (2006) for reviews of such comparisons). In the following section we present information on the different qualitative business surveys that include a regional dimension. The subsequent section focuses on the aggregate level analysis of the balance statistics.

There has been comparison between aggregate hard data and qualitative firm-level data (see Mitchell, Matheson and Silverstone (2010) and Mitchell, Smith and Weale (2005)) which provides a limited picture of how the two sets of data relate. However, recently Lui *et al*. (2011a,b) analyse the relationship between the micro-level qualitative and quantitative data and assess the reliability of the former in predicting the quantitative outturns (Lui *et al*., 2011a).

These analyses have been performed on longitudinal datasets. The panel of EBS data we use is a set of repeated cross sections. We derive a framework for the analysis that then guides bivariate and multivariate analysis of the workplace level data. It should be stressed that the analysis is exploratory. We would expect future analysis to focus more exclusively on particular policy questions or economic hypotheses rather than a broad approach to a set of questions of economic interest. In addition, the survey is in its infancy. The survey has potential, but it will be a number of years yet before we can truly test whether this potential has been realised.

Qualitative business surveys

Qualitative business surveys are readily used to inform us of the current state of the economy. The outputs from such surveys are published with considerably less of a lag than official statistics and are used by many as an input into nowcasts for the 'state' of the economy. While they dominate the non-official information flow at the national level in the UK, many of these surveys typically have a home nation/English region dimension.

In this section we summaries the core information of the five qualitative business surveys that provide information on the nine English regions[3]. The five business surveys are: the English Business Survey (EBS), funded by BIS and implemented by TNS-BMRB; the Purchasing Manager Index (PMI) of Markit; the Regional Trends Survey (RTS) of the Confederation of Business Industry (CBI); the Quarterly Economic Survey (QES) of the British Chamber

[3] The English Business Survey covers more than just 'business' workplaces. Nevertheless, we refer to all these as business surveys for ease of reference.

of Commerce (BCC) and the Business Confidence Monitor (BCM) of ICAEW/Grant Thornton.

We have used publically available information sources, together with some enquires to the survey providers. We focus on the details of the sample and surveying method, period of coverage and publication frequency, the reporting methodologies (typically a variant of a balance statistic), the survey weighting procedure used and whether the data is seasonally adjusted. The core information about these business confidence surveys is summarised in Table 1 below. Details on each of the surveys can be found in Appendix A.

We focus on surveys that have regional coverage. The output from each of the surveys is reported as some variant on a balance statistic. The EBS has a far broader coverage of the industrial structure of England than the comparator business surveys. In particular the EBS has a sampling frame that extends beyond the private sector, while the stratified sample is designed to ensure industries such as agriculture and the utilities are represented.

The EBS stands out in this regard as it is the only one where data are available on a subregional (NUTS2) and LEP level. The EBS, by definition, excludes the home nations of Wales, Scotland and Northern Ireland from its sampling frame.

Each of the surveys' has their own weighting methods in order to derive estimates representative of the population rather than just the sample. For all employment size of the workplace or firm play an important role. In the case of the RTS and BCM the weights applied are adjusted by official output data published by the Office for National Statistics (ONS).

At present the EBS is inhibited by a short time series. This is unsurprising given the first month's sample refers to October 2011. This is not the case for the comparator surveys. For example, the RTS time series if available from the second quarter of 1992, while the QES has been undertaken since the first quarter of 1989.

Responses to the EBS are seasonally unadjusted. As we discuss below the current length of the EBS time series is not long enough to allow seasonal adjustment. This is no the case for the comparator surveys, yet all but the PMI are seasonally unadjusted. However, this refers to the data are officially published and obviously does not preclude users of the data from seasonally adjusting for their purposes.

Table 1. Summary Table of business surveys

	EBS	CBI	BCC	PMI	BCM
Frequency	Monthly & Quarterly	Monthly & Quarterly	Quarterly	Monthly	Quarterly
Achieved responses	~3,000	~ 500	~ 7,500	~1,500	~1,000
Industry coverage	Total economy	Manuf only	Manuf & services	Manuf & services	Production &Services
Geographical Coverage	England, regional, NUTS2 and LEP	UK, regional (quarterly frequency only)	UK, regional	UK, regional	UK, regional
Sampling frame	IDBR	CBI members	BCC members	PMI subscribers	ICAEW Members
Weighting procedure	Employment (economic importance weights)	Dist of companies by size (emp or output)	Employment size of company	Employment	Employment, Turnover
Seasonally adjusted?	No	No	No	Yes	No

Aggregate level analysis

Introduction

The qualitative business surveys are typically used to provide more timely information on the state of the economy as their publication lags are much shorter, when compared to official statistics. Furthermore, qualitative survey data are usually seen as representing the 'true' state of the economy, when doubts are raised about official economic statistics (see Ashley et al. 2005). The common approach is to use the aggregate outputs from these surveys to estimate, in particular, the rate of economic growth (GDP growth).

The focus of this report is not to estimate models that explore the 'predictive' power of the EBS. This is largely due to the narrow window of time that the EBS has existed for, precluding a more detailed analysis of the relationship between the qualitative data from the EBS and the quantitative official statistics. Rather aggregate level analysis aims to explore some properties of the aggregate level data derived from the EBS. Using output as an example; we examine whether EBS output performance relates to EBS output

expectation via graphical illustration and correlation analysis. We also examine the relationship between EBS output performance and expectation with NIESR monthly GDP via cross-correlation analysis. Autocorrelation analysis of the EBS aggregate output series is also conducted to examine the temporal properties of the series.

The short time series inhibits, not just our approach to the analysis of the data, but the strength of any inference on the correlation between certain indicators. EBS data is not seasonally adjusted. Users of the data are, therefore, at times exposed to perceiving a change in the value of an EBS indicator through time that is due to seasonal factors. It also introduced bias into any analysis that attempts to derive an estimate of the correlation with a seasonally adjusted variable. The fact that the time series is not currently seasonally adjusted is itself a feature of the short time series currently available. The small sample size available for the analysis restricts a robust interpretation of the results. A more appropriate interpretation would be along the lines of an 'illustration' of the relationship between the times series of particular variables of interest.

The purpose of this chapter is to investigate the relationship between the different aggregate indicators derived from the EBS. We also introduce some preliminary analysis of the relationship between EBS variables and official statistics. This is an important point to stress, the analysis can only be considered preliminary given the limited time series available for the analysis. The analysis in this chapter is also intended to inform us about the performance of the EBS indicators as a lead or lagging indicator of official statistics. We also analyse the output and employment performance from the EBS against the expectations from previous waves of the EBS.

Part 1: Qualitative data

Qualitative performance and qualitative expectation balance statistics

We refer to the backward looking variables as performance, since these are designed to measure the performance of some economic variable with respect to the recent past. We refer to the forward-looking variables as expectation. This terminology is consistent with the monthly reports published by BIS[4]. The variables we examine throughout are derived from questions that ask workplace respondents about an indicator of interest and whether this has/is expected to increase, remain the same, or decrease over the reference period.

From these responses we compute balance statistics. That is the number of workplaces who respond with an increase less the number of workplaces that report a decline. A positive balance statistic is typically viewed of as indicating that the latent variable of interest expanded, while a negative balance statistic implies contraction. While different magnitudes to these variables are typically viewed as indicating different rates of change, bias in response due to such things as measurement error or threshold effects make such inference difficult.

[4] See for example https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/203470/bis-13-p139c-english-business-survey-march-2013.pdf

We analyse these backward and forward looking balance statistics for the period of October 2011 to December 2012. As noted previously, the short time period available inhibits the seasonal adjustment of these series.

Aggregate qualitative output indicators

The output performance question in the EBS asks whether the volume of output in the reference month was higher, the same or lower than 3 months ago. While the expectation question asks whether the respondent expects the volume of output 3 months later to be higher, the same or lower than in the reference month. Due to the way the questions were asked, the performance answers already reflect the actual change in the reference month as compared to 3 months ago, and answers to the expectation question reflect the expected change 3 months later as compared to the reference month[5].

Let t denote the reference month, t+3 thus denotes three months after the reference month. If the output expectation question asks the workplace to report, at month t, their expected change in volume of output three months later (i.e. at t+3), relative to their output in the reference month t. Then output expectations can be viewed as the aggregate forecast made by the workplaces, in the reference month, about their output growth three months into the future. The aggregate output performance reported by the workplace at month t+3 thus gives the actual realisation of the output change three months later relative to the reference month. In other words, the expectation balance statistics can be interpreted as the aggregate qualitative forecasts for the output change in t+3 relative to month t with respect to the performance balance statistic reported in month t+3.[6]

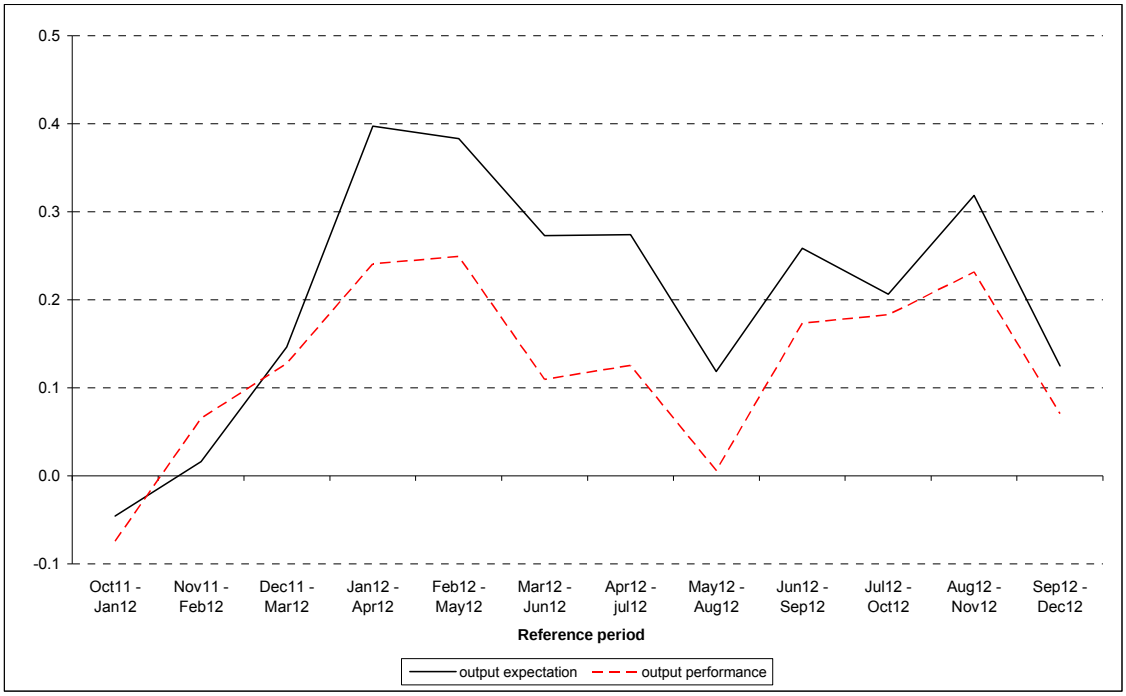
To assess the consistency between the expectation and performance balance statistics, we compare the aggregate expectation made for reference month t relative to month t+3 with the performance reported for reference month t+3 relative to month t. This approach shrinks our, already small sample, by three data points.

Figure 1 plots the balance statistics of output expectation alongside the balance statistics of the output performance. Figure 1 shows that although the expectation appears to track the performance well, it has over-estimated the actual change in output in general. The exception is that it has under-estimated the negative change for the 3-month period October 2011-January 2012 and the positive change for the 3-month period November 2011-February 2012.

As aforementioned, the expectation reported in the reference month t about three months later (t+3) can be viewed as an aggregate output forecast formed at month t about month t+3. So comparing this aggregate series with the performance series reported at month t+3 (about the output change relative to month t) can give some indication of how well the

[5] We define these periods as the 'reference periods'.
[6] Note, fieldwork is takes place in month t+1. So although expectation is made in t+1, workplaces are asked to make the expectation based on month t.

Figure 1. Balance statistics of output performance and expectations



output expectation predicts the output performance. We evaluate the explanatory power of the EBS aggregate output expectation using squared forecast error. That is, the squared difference of the output expectation reported in month t from the output performance reported in month t+3. Figure 2 shows the plot of the squared error of the expectation relative to the performance. If one is to interpret the qualitative expectation as the aggregate qualitative forecasts for the output change in t+3 relative to month t as aforementioned, this plot reflects the squared forecast errors of the aggregate qualitative expectation. Consistent with Figure 1, the forecast errors became largest for the reference period December 2011-March 2012, indicating a larger inconsistency between the qualitative expectation and performance reflected in the aggregate balance statistics. The forecast error is largest for the prediction made for the period March 2012-June 2012, and it has subsequently moved noticeably much closer to zero.

Figure 2. Squared error of output expectation

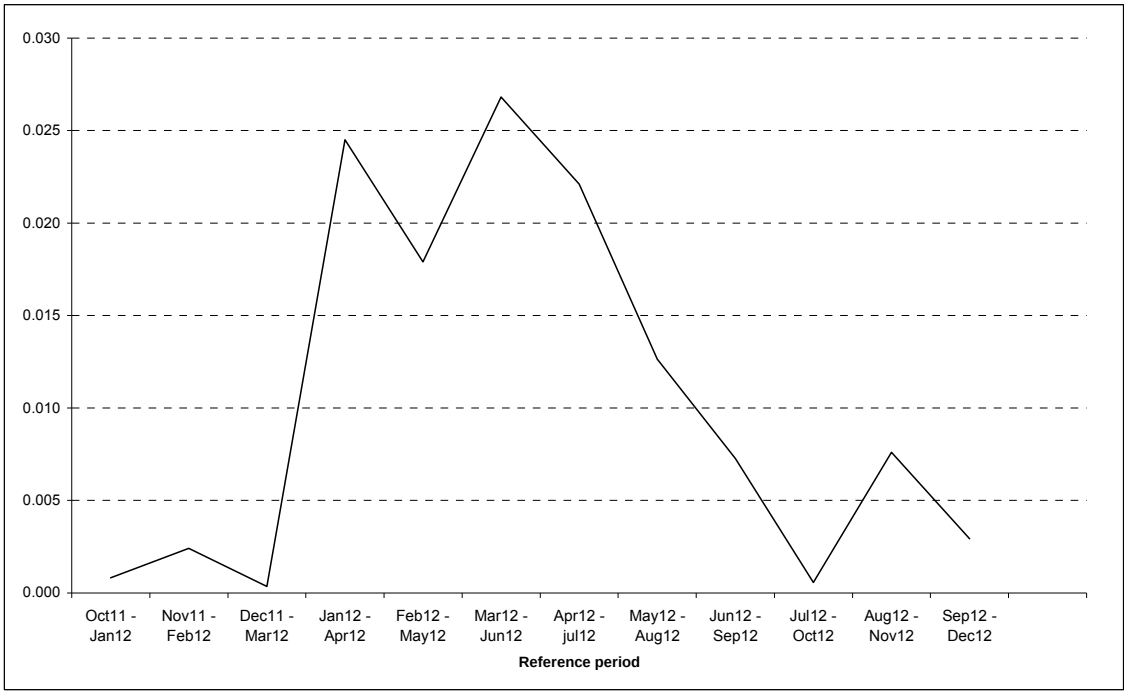


Table 2. RMSE of the qualitative series and the correlation between the expectation (prospective) and the performance (retrospective)

RMSE of output expectation	0.113
Correlation between output expectation made at time t and performance reported at time t+3	0.906
RMSE of employment expectation	0.036
Correlation between employment expectation made at time t and performance reported at time t+3	0.914

We have also computed the root mean squared errors (RMSE)[7] for the output expectation relative to the output performance. This statistic is reported in Table 2. Such statistics are useful when comparing the accuracy of the forecast of interest to a naïve rule such as a forecast derived from a random walk. The sample period is too small to make such an assessment meaningful at this stage. It is because no long term pattern of fluctuation/changes, and no trend and cycle can be observed from a short time series. This hinders any general conclusion to be drawn about the forecasting 'power' of the expectation data. Of course one can still draw a conclusion of how well the expectation series has predicted the output performance over the short period we are examining. But

[7] The RMSE is $\sqrt{\frac{1}{T}\sum\left(A_t - F_t\right)^2}$, where A is the outturn (performance) and F is the forecast (expectation).

one cannot tell, for example, under what economic condition can the output expectation better predict the output performance, nor one can observe under what economic conditions its predictive powers are worse. The value of the correlation coefficient, as also reported in Table 2, between the aggregate qualitative expectation and the aggregate qualitative performance is large, which indicates a high correlation between these two series[8]. However, one should note that such high values could be biased due to a short sample period.

Aggregate qualitative employment indicators

The performance question asks the respondent at each workplace whether the average number of people working in the reference month was higher, the same or lower than 3 months ago. While the expectation question asks about whether the respondent expects the average number of people working 3 months later to be higher, the same or lower than the reference month. Similar to the questions regarding output, the retrospective answers already reflect the actual change in the reference month as compared to 3 months ago, and prospective answers reflect the expected change 3 months later as compared to the reference month. We again compare the expectation made for reference month t relative to month t+3 with the performance reported for reference month t+3 relative to month t.

Figure 3. Employment performance and expectation balance statistics

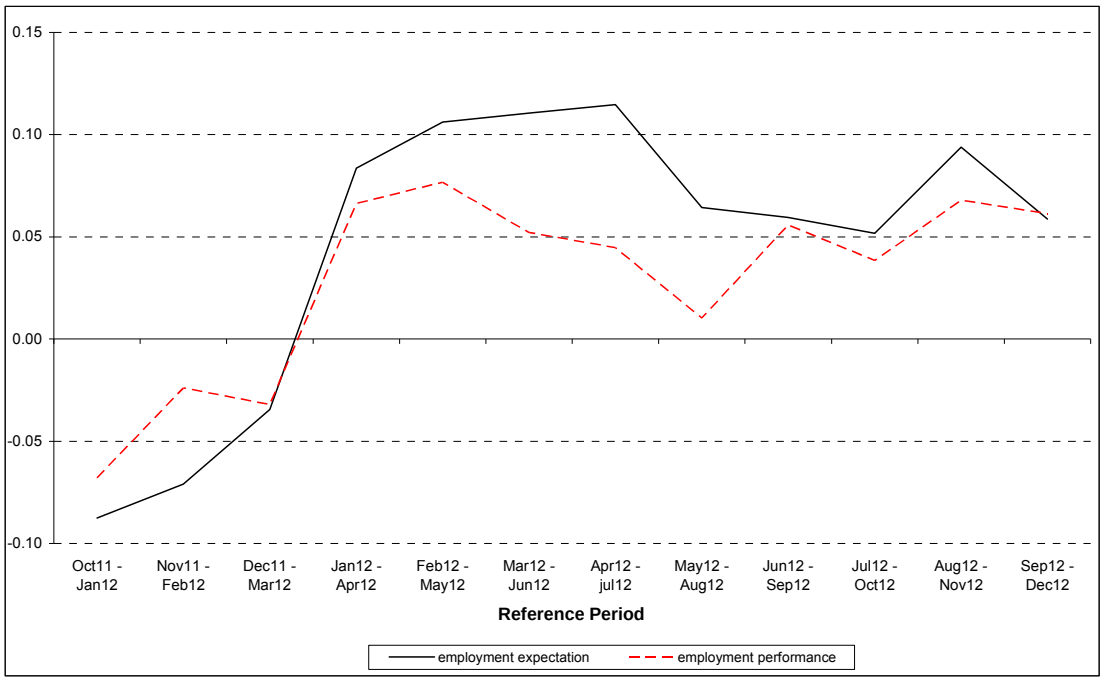
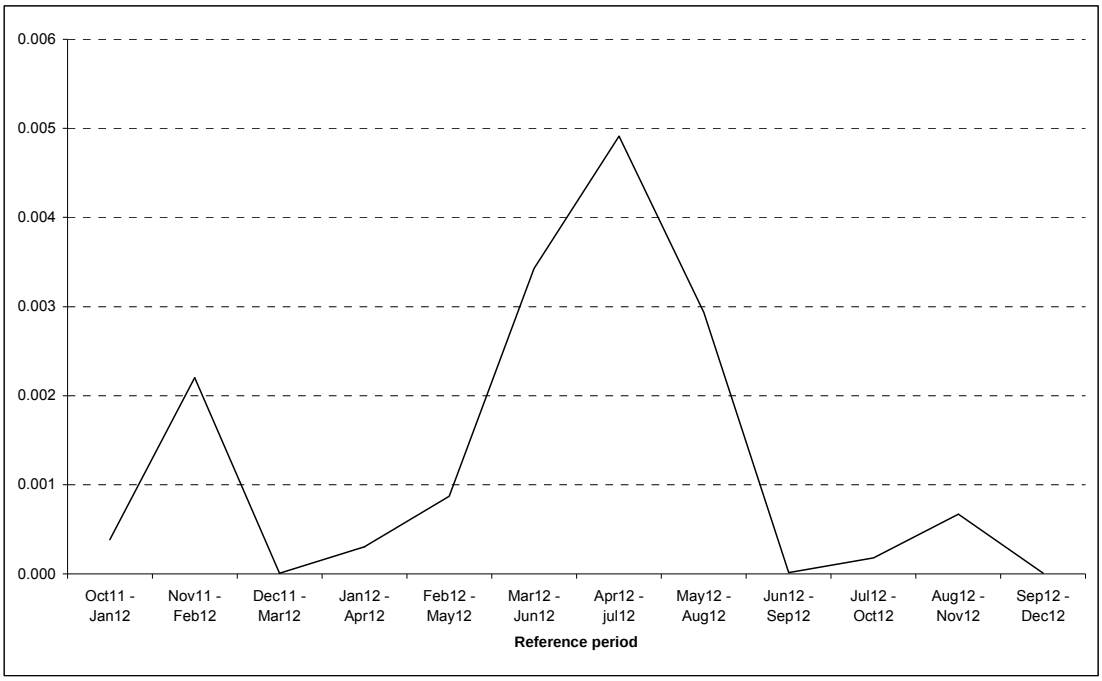


Figure 3 plots the balance of employment expectation alongside the balance statistics of the employment performance. The employment expectation balance statistic seems to track the actual employment performance well. In a similar fashion to the qualitative output

[8] The estimated correlation coefficient lies within the range ± 1, with the positive bound representing perfect positive correlation and the negative bound representing perfect negative correlation. A figure of 0 represents no correlation between the two variables.

expectations, the expectation of employment change appears to have over-estimated the actual employment performance from the reference period January 2012-April 2012. However, expectations made prior to that, i.e. for the first two reference periods October 2011-January 2012 and November 2011-February 2012, appear to have underestimated the actual change. However, the graphical illustration does show that for some periods in particular, the qualitative employment expectation is highly consistent with the qualitative employment performance. These periods can be clearly seen in Figure 4. Figure 4 plots the squared error of the employment forecast error with respect to the actual qualitative employment performance. There is a noticeable spike in the forecast error for the reference period April 2012-June 2012.

Figure 4. Squared error of employment expectation



In fact, in Table 3 the RMSE of the qualitative employment forecast relative to the qualitative outturn appears to be smaller than the output expectation. It provides evidence that the aggregate qualitative employment forecasts are more accurate than the qualitative output forecast. The aggregate qualitative employment expectation also appears to be highly correlated with the aggregate qualitative employment performance.

Table 3. Correlation between the performance and expectation indicators

Output performance at time t and Employment performance at time t	0.749
Output expectation and employment expectation	0.862
Output expectation at time t and employment performance at time t+3	0.860
Output performance at time t+3 and employment expectation at time t	0.620

The relationship between qualitative output and qualitative employment series

Put simply, economic theory suggests that changes in the demand for products and services produced by a workplace should cause changes in the demand for labour at that workplace. Given that the EBS data provides us with only near-term developments in output and employment, it might well be that we are measuring data over too short a time period to identify these features. However, at an aggregate level it may well be possible to identify at least a correlation between output and employment changes. We use the performance and expectation balance statistics for both output and employment in order to investigate the presence of correlation.

All available data points are used in evaluating the correlation between the two performance series. However, three data points are lost in evaluating the expectation variables with respect to the performance series. Since for a particular reference month, the performance variables are reported 3 months after the expectation is made, the first three months of the EBS do not have corresponding expectations with which to map onto from earlier months. The computed correlation coefficients are for (1) output performance and employment performance; (2) output expectation and employment expectation; (3) output expectation and employment performance; (4) output performance and employment expectation. The values of all 4 correlation coefficients are greater than zero, indicating positive relationships between the qualitative output and employment series. The final third correlation is difficult to interpret. The strong positive correlations could just well be a feature of the small sample period with which we have to compute the correlation. To some extent, it is a useful reminder that we should not place too much weight on results that are the result of a very limited dataset. The final correlation could well be related to output leading employment in standard economic theory. That is positive output performance causes the expectation of increasing future employment. However, the missing link in this process is the expectation for future output. If output performance were expected to deteriorate, an increase in employment would not be expected, all else equal.

Figure 5 plots the balance of the output expectation and the balance of employment expectation. While Figure 6 plots the balance statistics of the output performance and the balance of employment performance. The employment expectation appears to follow the same pattern of the output expectation. The same finding applies to the output and employment performances. However, in both plots the employment series appear to be less volatile (flatter) than the output series. This finding is supported by a larger standard deviation of the output expectation/performance than the employment expectation/performance. This is broadly consistent with what official statistics suggest, where the standard deviation of output growth has exceed the variance of employment change over the sample period.

Figure 5. Output and employment expectation balance statistics

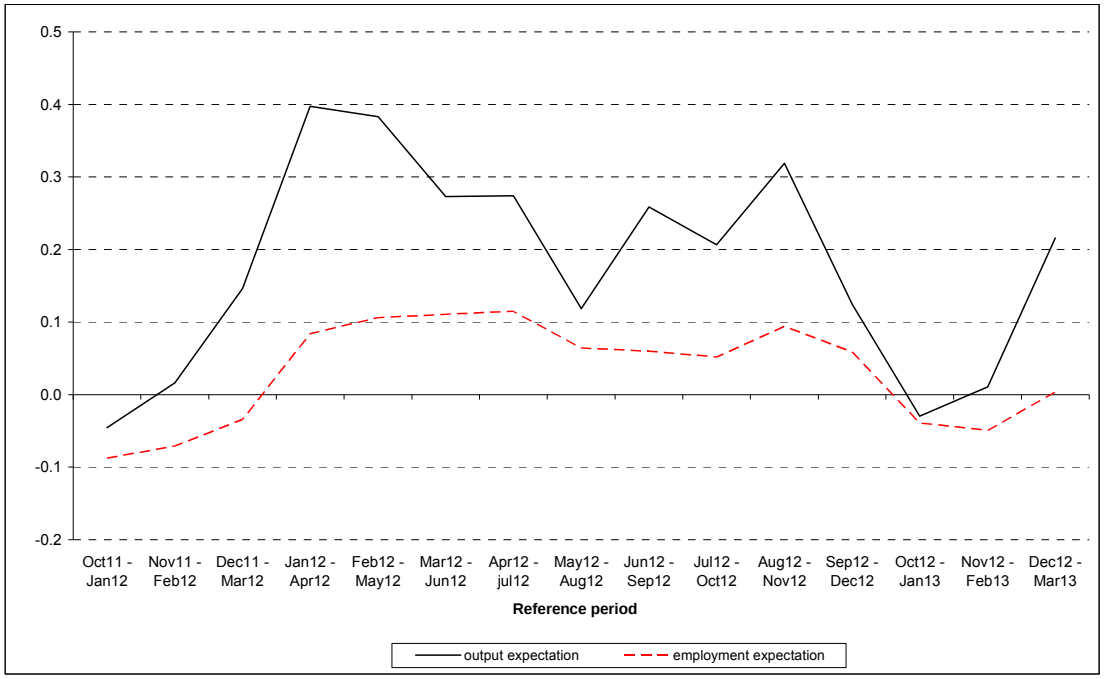


Figure 5 plots the balance of the output expectation and the balance of the employment performance. The two series appear to follow the same trend in general, while the employment performance series appears to be flatter than the output expectation series. It suggests that while expectation of output changes were made in advance the actual change in employment, which is reported 3 months later, are consistent with the former. However, as noted previously there is no intuitive reason as to why the output expectations and employment performance should be correlated to the degree that they are. As Figure 6 suggests, the strong correlation coefficient reported in Table 3 is simply related to the fact that both have consistent positive balances over the sample period.

Figure 6. Output and employment performance balance statistics

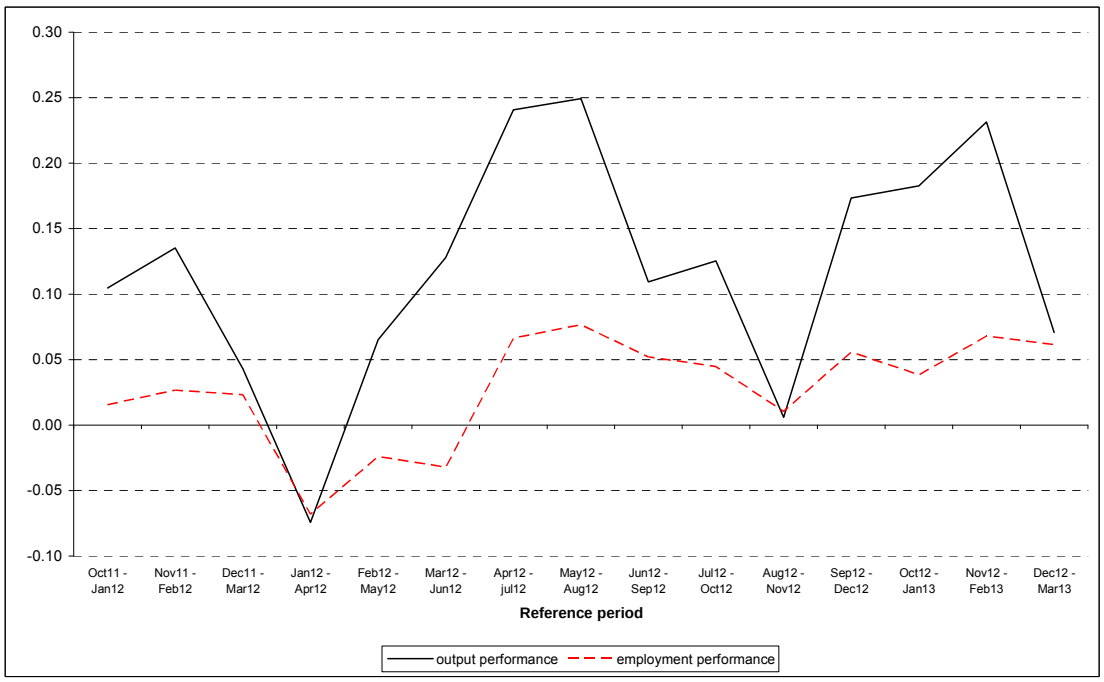


Figure 7. Output expectation and employment performance balance statistics

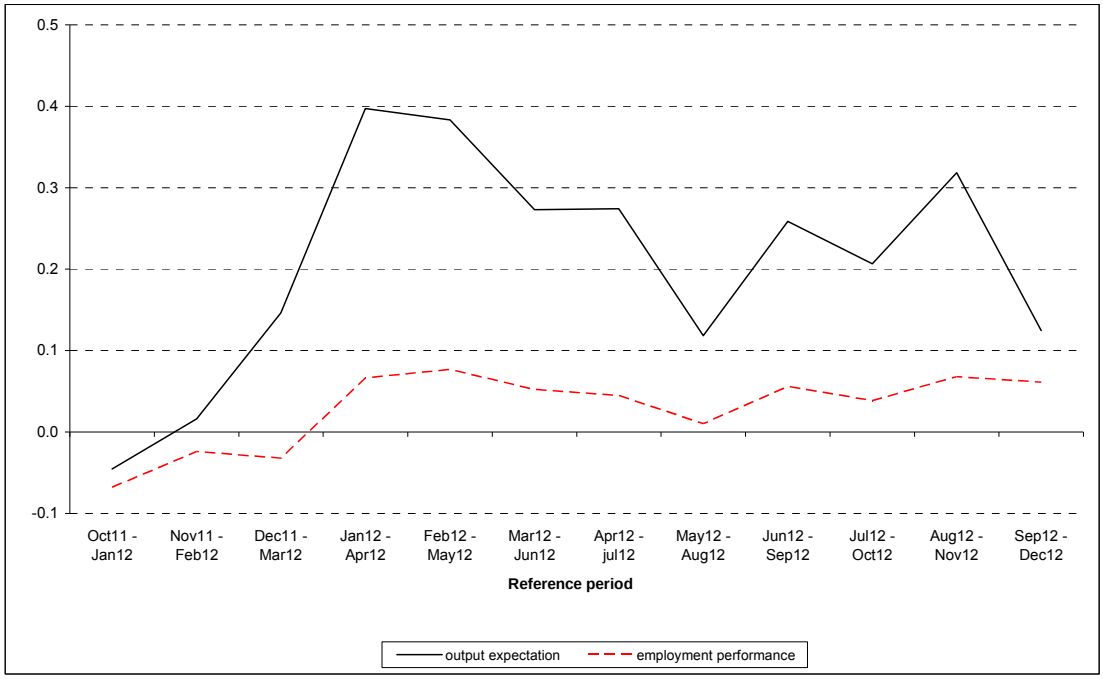
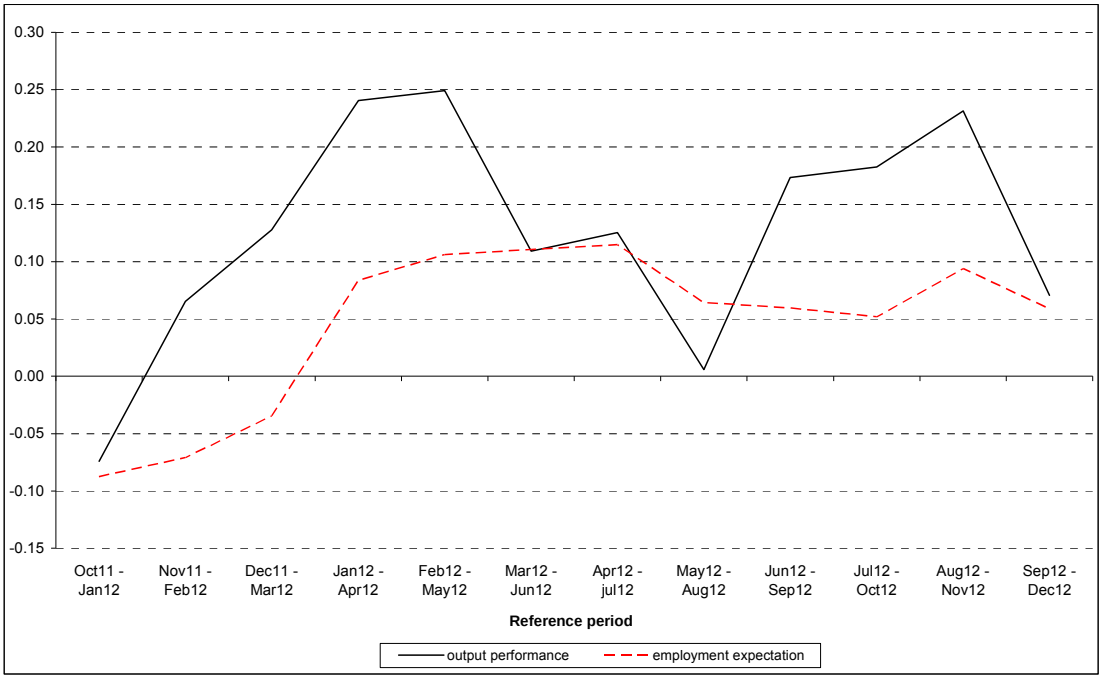


Figure 8 plots the balance statistics for output performance and the employment expectation. The correlation between the two is relatively high. The normal relationship between output and employment is one of employment lagging output. Such a high correlation could be interpreted as a relationship consistent with this. However, the short sample period again, limits such a strong interpretation of the data. In addition, the underlying assumption was that employment lagged changes in output by 3 quarters (see for example, HM Treasury, 2009). However, over the course of the crisis employment developments have surprised on the upside. For example, between the first quarter of 2008 and first quarter of 2013, employment had increased by 0.7 per cent, while output was 3.9 per cent lower[9]. Between the fourth quarter of 2011 and first quarter of 2013, approximating our sample period, the increases are 1.9 per cent and 0.3 per cent, for employment and output respectively.

[9] Using official statistics available at the end of June 2013. These data are seasonally adjusted.

Figure 8. Output performance and employment expectation balance statistics



Adjusting the grossing factor

As opposed to the existing grossing factor that weights the data using only employment information, we have also applied an additional grossing factor when producing the balance statistics output series. This additional grossing factor builds on the existing employment weighted data by adjusting the grossing up of the balance statistic to take account of the industry gross value added (GVA) shares for each region[10]. The principle underpinning this is that employment weights implicitly assume labour productivity is equal across industries and regions. Given that ONS data shows this is not the case, adjusting the grossing factor for the output series with using region and industry specific GVA should minimise any bias that the underlying productivity assumption introduced[11].

In order to investigate how sensitive the results we have presented for analysing the correlation between different balance statistics to this additional grossing factor, we have replicated the analysis presented above, but with the new grossing factor.

Before we move to further analysis, we first look at the change the standard deviations of the aggregate output series computed using the new grossing factor, as reported in Table 4. Both the performance and expectation output series, derived using the alternative grossing factor, appear to have higher standard deviations than the series that are derived with the employment based weights. This suggests that application of the alternative grossing factor has increased the volatility of the series. This is intuitive. The use of employment weights, by definition, under-weights the output contribution of higher than

[10] We call this new grossing factor "GVA adjusted" as opposed to the existing grossing factor which relies on employment weights. The GVA adjustment is based on the GVA data for 2010 published in the *Regional Accounts*. We use the December 2012 vintage of the *Regional Accounts*.
[11] Note the new grossing factor is not applicable to the employment variables.

average productivity sectors, such as the broad production sector and construction. These series have been volatile over the course of the crisis and as such should lead to a heightened degree of volatility in any balance statistic for the EBS.

Table 4. Standard deviation of the output series derived with different grossing factors

Variable	Employment weight	GVA adjusted grossing factor
Output performance	0.090	0.101
Output expectation	0.144	0.164

Figure 9 then plots the balance of output expectation alongside the balance of output performance, when both series are computed with the alternative grossing factor. It is not surprising to see that both series appear to follow the same pattern as that in Figure 1. The alternative grossing factor does not change the trend of the output balance series as the grossing factor is not time varying. Figure 10 then plots the squared error of the output expectation computed with the additional grossing factor. Once again, this plot follows the same pattern through time as that reported in Figure 2.

Figure 9. Output expectation and performance balance statistics (GVA grossing factor)

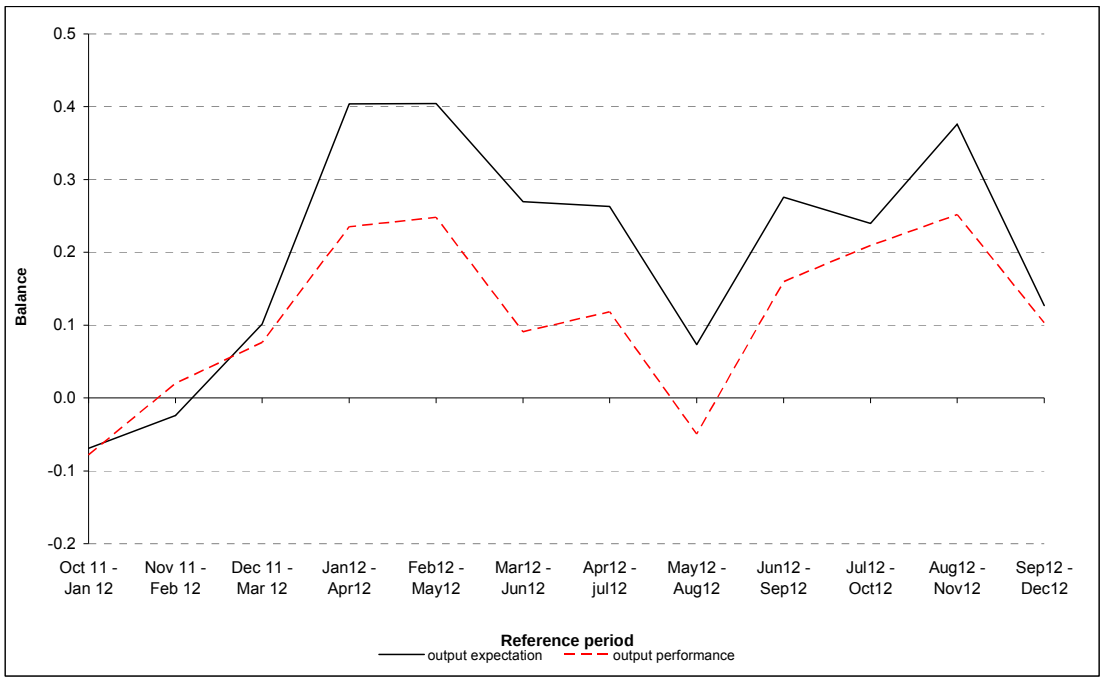


Figure 10. Squared errors of output expectation (GVA grossing factor)

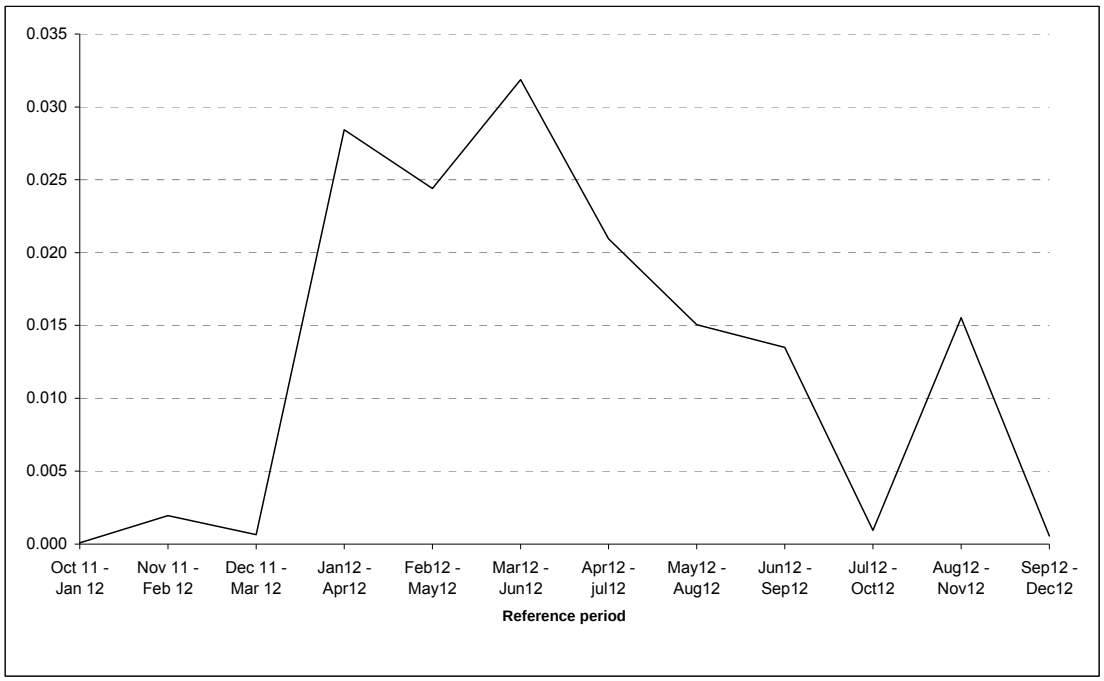


Table 5 presents the RMSE of the output expectation and the correlation of the output expectation and the output performance statistics. Compared with Table 2, output expectations remain the same. It suggests the alternative grossing factor does not change the predictive power of the prospective series. In other words, over the sample period the forecasting performance of the output expectations series is invariant to grossing factor applied. The correlation between the retrospective and prospective output remains very large; compared with Table 2, accounting for the additional regional-industry output information in aggregation increases the correlation between the two output series very marginally. However, as noted previously, the correlation coefficient can be biased due to the short sample period.

Table 5. RMSE of output expectation and correlation between output expectation and performance (GVA grossing factor)

RMSE of output expectation	0.113
Correlation between output expectation at time t and performance at time t+3	0.912

Analysis of the employment indicators and the GVA adjusted output indicators

To assess whether the application of additional grossing factor changes the relationship between output and employment, we have re-computed the correlation coefficients between these series and these are reported in Table 6. As aforementioned, we use the maximum number of data points available to derive the correlation between the two performance series. As previously, the sample is reduced by three data points when it

comes to deriving and evaluating the performance and expectation series. This is due to the reporting of performance 3 months after the expectation is made. We can see that the application of the additional grossing factor to the output series have only marginally increased the correlation coefficients.

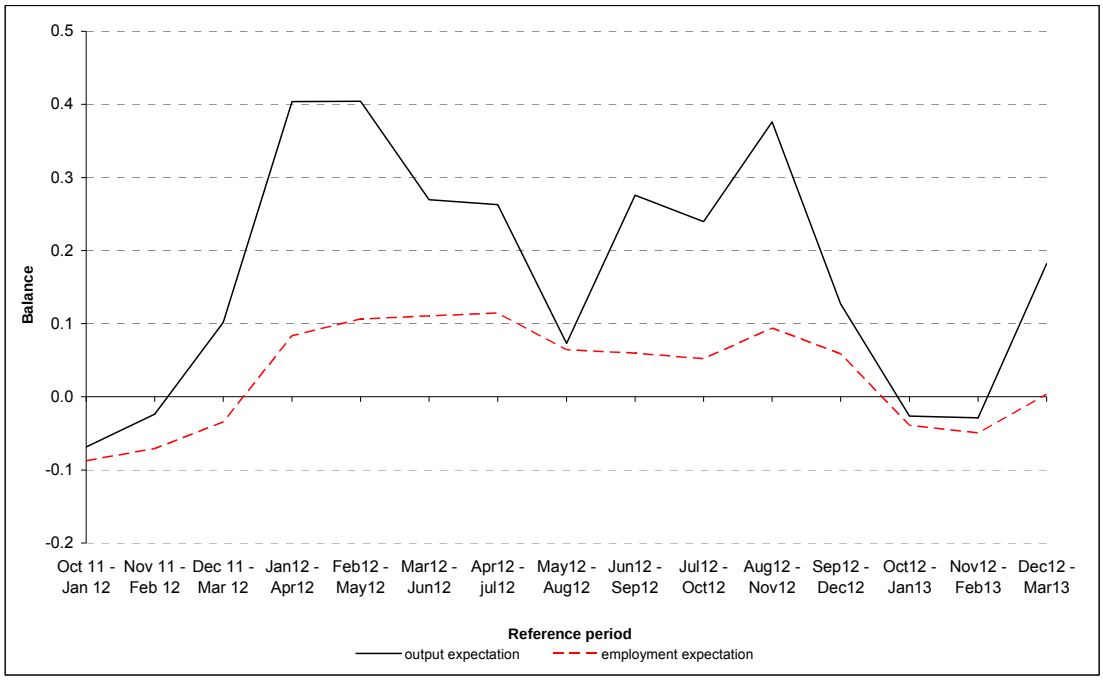
Table 6. Correlation between the performance and expectation balance statistics (output series have GVA adjusted weight applied)

Output performance at time t and Employment performance at time t	0.795
Output expectation at time t and employment expectation at time t	0.869
Output expectation at time t and employment performance at time t+3	0.885
Output performance at time t+3 and employment expectation at time t	0.641

In fact, if we examine the relationship between the GVA adjusted output series and the employment series, we can see that their relationship does not appear to be sensitive to whether the alternative grossing factor is applied to the output balance statistics.

Figure 11 plots the balance statistics of the GVA adjusted output expectation and the employment expectation. Figure 12 plots the GVA adjusted output performance and the employment performance balance statistics. Figure 13 plots the balance of the GVA adjusted output expectation and the balance of the employment performance. Figure 14 plots the balance of the GVA adjusted output performance balance statistic and the balance statistic of the employment expectation. All four graphs present patterns that are consistent with their pairwise comparator reported in Figure 5 to Figure 8.

Figure 11. Output (GVA adjusted) and employment expectation balance statistics



However, Figure 11 shows that the GVA adjusted output expectation series appears to be 'flatter' than the output expectation weighted with the standard grossing factor between the reference period Oct 2012-Jan 2013 and Dec 2012-Mar 2013. Comparing Figure 12 with Figure 6, for the reference period Aug 2012-Nov 2012, suggests that there was a sharper drop in the GVA adjusted output performance balance statistic appears to be sharper than that of the standard weighted output performance. Such developments are not a significant surprise given the larger standard deviation associated with the GVA adjusted balance statistic than the standard weighted balance statistic of output performance. Figure 6 and Figure 12, both highlight the fact that the sample standard deviation of the employment performance balance statistic is of a smaller magnitude than either weighted output balance statistic series. Given the greater volatility of the GVA adjusted output performance balance statistic, it is perhaps unsurprising it appears to have sharper changes to its level, as Figure 11 to Figure 14 suggest.

Figure 12. Output (GVA adjusted) and employment performance balance statistics

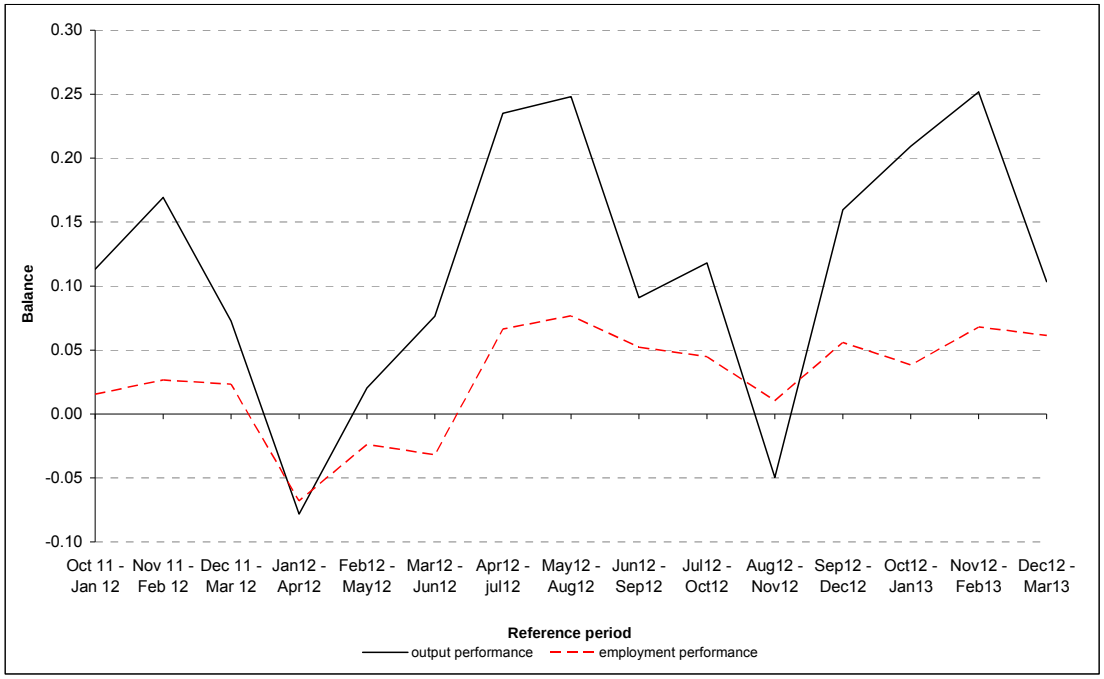


Figure 13. Output (GVA adjusted) expectation and employment performance balance statistics

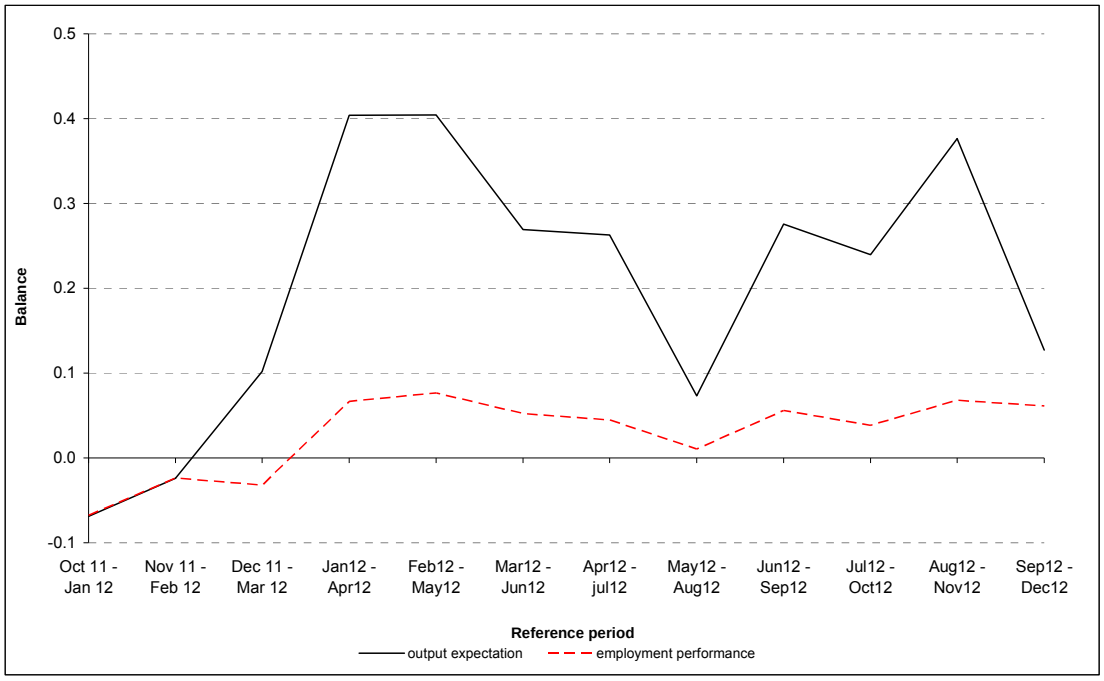
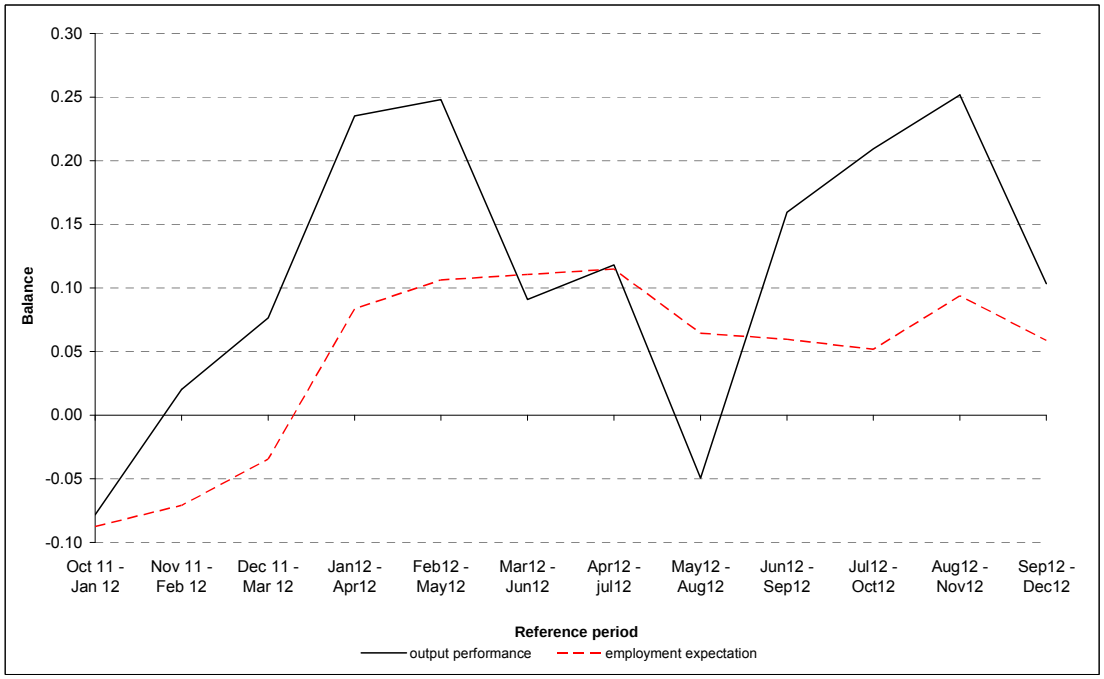


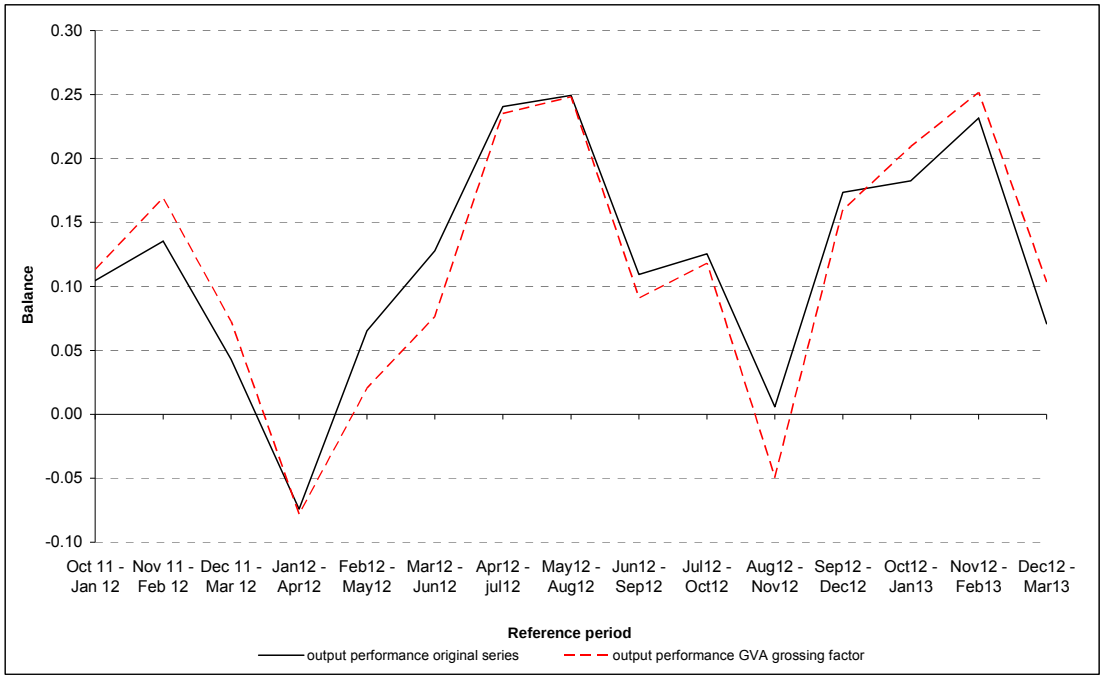
Figure 14. Output (GVA grossing factor) performance and employment expectation balance statistics



The above findings suggest that the results are invariant to the grossing factor applied to the output balance statistics. As Figure 15 shows, the balance statistic differs marginally using the GVA grossing factor, for the sample period available. Nevertheless, as Figure 15 shows, there is tentative evidence that the GVA adjusted grossing factor results in more volatile output balance statistics. We reiterate the point that sample sizes are small in this analysis, while it is also possible that the estimated relationships are a feature of the specific time period of the analysis, and may change as the UK economy moves towards a

period of more robust output growth. With regards to the volatility of the output balance statistics, it will be of interest for the EBS research team to investigate the effect of using NUTS 2 level grossing factors as well as to investigate the impact of varying these weights through time[12]. In the subsequent analysis we use the GVA adjusted grossing factor for output balance statistics as this is assumed to derive a more precise approximation of the state of output growth in the economy.

Figure 15. Output performance using different grossing factors



Part 2: An analysis of the relationship between the qualitative and quantitative indicators

Analysis of output

The preceding analysis shows that results are insensitive to different grossing factors. Since we assume that the GVA adjusted output balance statistics are a closer approximation of the state of output growth in the English economy[13], and it is these output series that we use through the remainder of this aggregate level analysis[14].

For quantitative output, since GDP is published quarterly, monthly GDP values are unobserved. To facilitate comparison between the qualitative and quantitative aggregate

[12] The suggested convention would be to weight the balance statistics in previous years using the historical regional accounts, but to impose the grossing factor from the last available year to subsequent years in the EBS. However, this will expose EBS balance statistics to revision as and when the ONS revise the *Regional Accounts*.
[13] This is due to the variation in industry-region productivity that the GVA grossing factor incorporates.
[14] With a longer time series in place such a hypothesis can be tested, and we recommend that BIS review this in due course.

while using the maximum number of data points, we use NIESR's monthly estimates of GDP[15]. These monthly GDP estimates are consistent with the latest vintage of the official GDP figures published by the ONS[16].

Month-to-month movements in economic aggregates are particularly volatile. We focus on the growth rates of three month rolling averages for the monthly GDP series and three month rolling averages for the balance statistics in the following analysis. However, this does restrict our monthly sample by two data points, leaving us with a total of 13 for the analysis. 'Pooling' the balance statistics will also minimise the variation caused by sampling variability in the EBS.

There are some additional caveats concerning the analysis of the output indicators. The monthly GDP estimates are seasonally adjusted, but, as noted previously, the balance statistics from the derived from the EBS are not seasonally adjusted. The EBS also asks respondents to report the annual change in output. We utilise this information to check the sensitivity of our results are to the inability to adjust the EBS balance statistics for seasonal factors. Note that while using the three month rolling averages for the balance statistics in the analysis already allows one to smooth out the volatility in the series. The annual change in output series should be largely immune to the effect of seasonality. Therefore, as well as presenting the results that focus on comparing the growth rates of three month rolling averages for the monthly GDP series and the three month rolling averages for the balance statistics; we also present a comparison of the three month rolling averages of the balance statistics from the annual change in output with the annual rate of growth derived from the NIESR's monthly GDP estimate. Presenting two sets of comparisons should allow us to see how sensitive the outcomes are to seasonality.

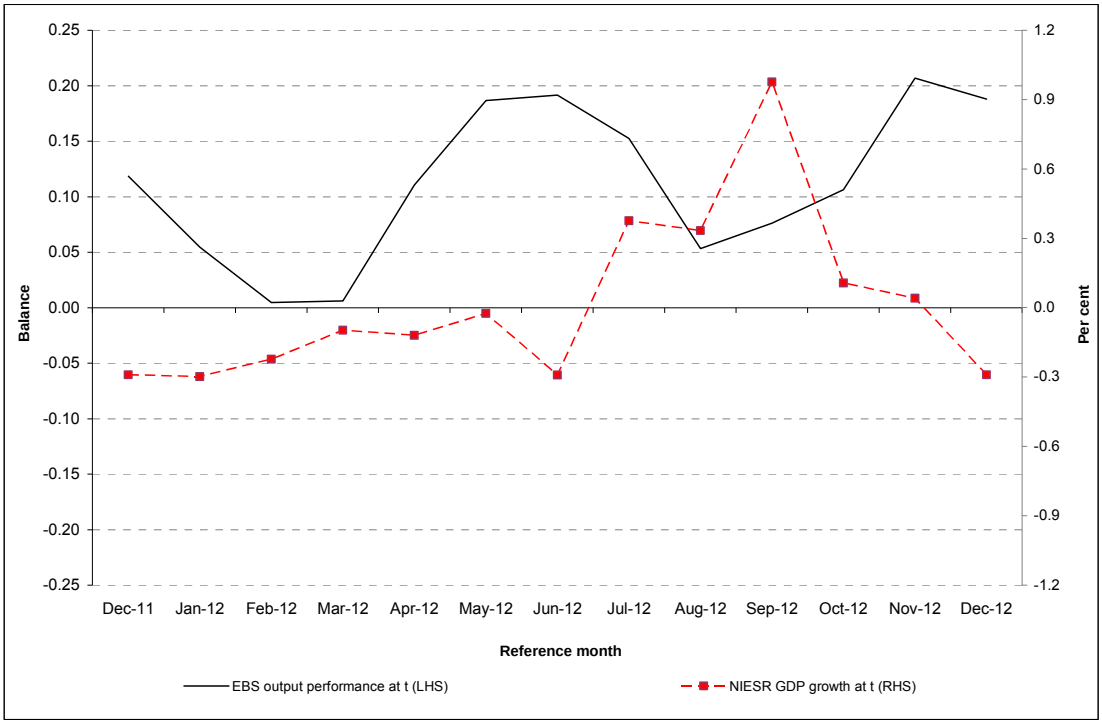
While both the quantitative and qualitative indicators measure change in output, they are not on an equivalent scale. As such the charts below should not be interpreted as an under- or over-estimation on the part of a balance statistic. We use two vertical axes for the graphical illustrations. However the patterns of the qualitative and quantitative aggregates can still be observed.

We compute the correlation between the rolling three-month average of the balance of output performance at reference month t and the growth rate of the three-month averages of monthly GDP at reference month t as reported in Table 6. The value of this correlation coefficient is negative. That is, the three month rolling average of the output performance balance statistic is inversely related to economic growth, as measured by monthly GDP. However, the magnitude of this correlation is close to zero (-0.109), suggesting little correlation between the two indicators. Figure 16 plots the trends of the two series, which do not appear to be very consistent over time.

[15] Note the EBS measures output changes for England in our analysis. Monthly GDP measures output change for the UK. We are implicitly assuming that the inclusion of the other three home nations in the monthly GDP estimate (Wales, Scotland and Northern Ireland) does not bias the results. In the long run this may not be much of a concern. As Armstrong (2012) shows, the economic cycles of the UK and Scotland are closely correlated. Over the short-run, such as our sample period, such patterns may not hold.

[16] We use GDP at basic prices as this is likely to closely represent the answers by respondents on the changes in the volume of their output. Details of underpinning NIESR's monthly GDP estimates methodology are published in Mitchell, Smith, Weale, Wright and Salazar (2005).

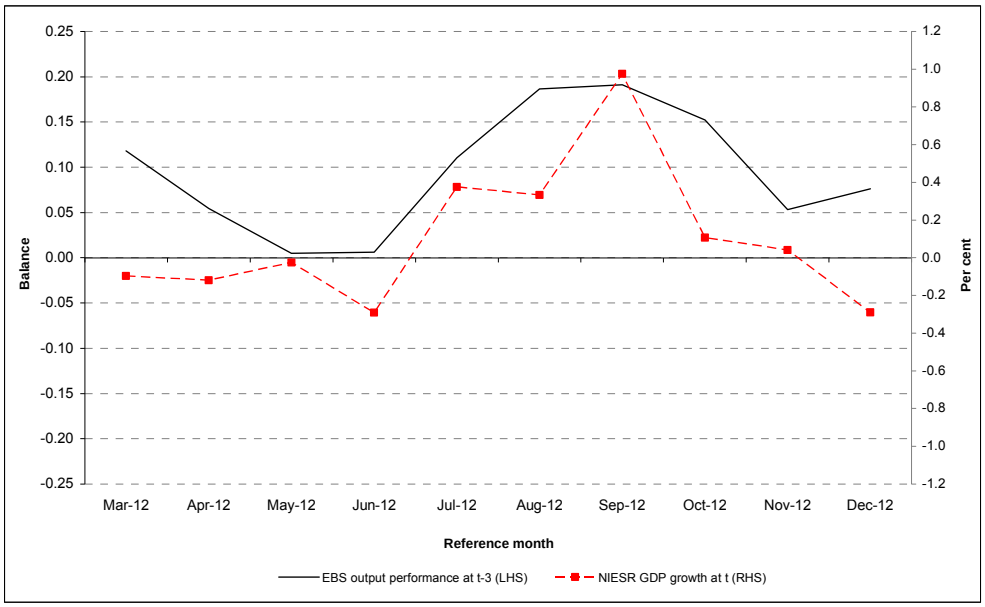
Figure 16. EBS output performance at time t and GDP growth at time t



Note: three month rolling averages.

However, lagging the output performance balance statistic by three periods (i.e. at reference month t-3), and re-computing the correlation coefficient with the monthly GDP growth rate at reference month t, as reported in Table 7, leads to a sharp rise in the value of the correlation coefficient (to 0.732). This relationship is plotted in Figure 17. While there is little contemporaneous correlation between the EBS output performance balance statistic and GDP growth, there is tentative evidence of positive association between contemporaneous GDP and the EBS output performance balance statistic from three months previous: the EBS output performance balance statistic is a leading indicator of GDP growth.

Figure 17. EBS output performance at time t-3 and GDP growth at time t



We repeat the above exercise, but exploring the relationship between the EBS output expectation balance statistic and GDP growth. The correlation coefficients are reported in Table 7. The expectation made at time t for three months into the future has a positive correlation with GDP growth in the three months to time t (a correlation of 0.254). Figure 18 plots this relationship. While the pattern is relatively similar divergence towards the start and end of the sample period have helped depress the overall correlation. Expectations made three-months prior to the current month (t-3) do not appear to have a significant correlation with GDP growth in the three months to month t (a correlation of -0.051). The pattern of the expectation balance statistic and the GDP growth rate are plotted in Figure 19.

Table 7. Correlation coefficients between output balance statistics and GDP growth

Correlation between the output performance balance statistic at month t and GDP growth at month t	-0.109
Correlation between the output performance balance statistic at month t-3 and GDP growth at month t	0.732
Correlation between the output expectation balance statistic at month t and GDP growth at month t	0.254
Correlation between the output expectation balance statistic at month t-3 and GDP growth at month t	-0.051

Figure 18. EBS output expectation at time t and GDP growth at time t

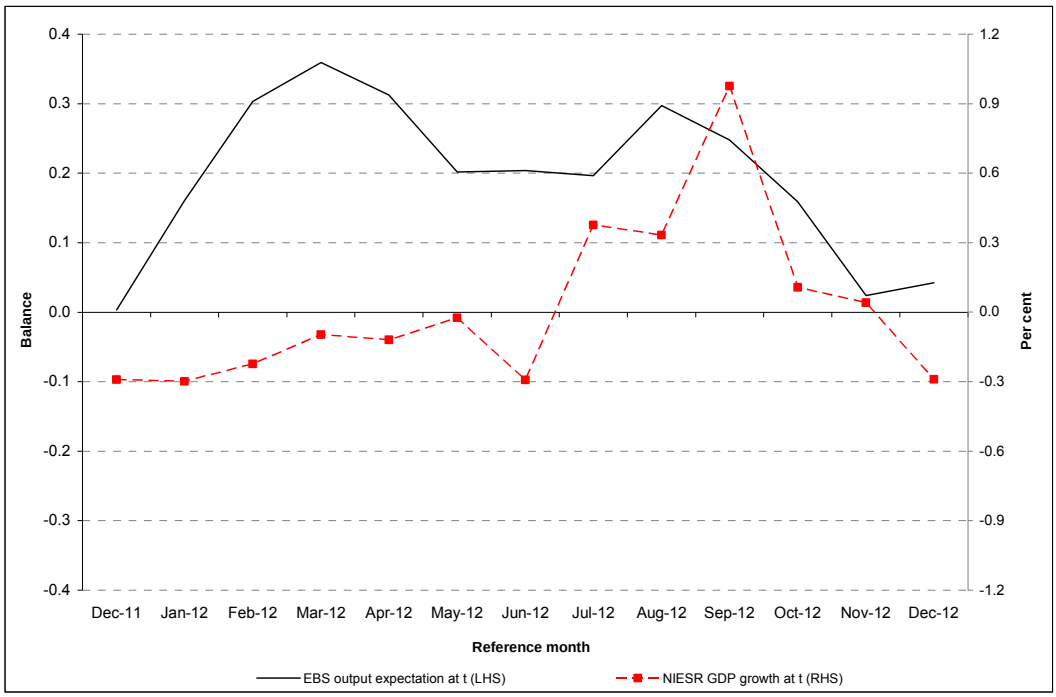


Figure 19. EBS output expectation at time t-3 and GDP growth at time t

These results suggest an association between GDP growth and both past performance and expectation balance statistics from the EBS. For the sample period under scrutiny the expectation balance statistic appears to have a contemporaneous association with GDP growth, even though it is forward looking from the reference month. The statistics suggest the performance balance statistic is a leading indicator of GDP growth. Overall, there is tentative evidence of a relationship between EBS balance statistics and GDP growth. As the sample period available for analysis is extended, such a relationship can be tested more fully. A larger sample will allow for robust tests of the significance of findings, while also providing us with an understanding of whether the relationships we observe are

simply a feature of the specific sample period. The results suggest a role for both balance statistics and a larger sample period will allow the use of multivariate analysis to estimate this more complex relationship and determine the information content of the EBS with regards to nowcasting the UK economy. One question of interest this would allow is to determine the information of the EBS alongside a set of indicators in determining the current rate of economic growth in the economy.

Analysis of output: annual rates of change

The EBS also asks about the annual change in output. Such responses should be largely immune to the effects of seasonality even though the series of the balance statistics derived from these responses, i.e. the balance of annual output performance, are not seasonally adjusted. We investigate the correlation between a three-month rolling averages of balance statistics from this series and the annual rate of growth derived from the NIESR's monthly GDP estimate.

We analyse the relationship between the balance statistic for the output performance over the past year and the annual change in the monthly GDP estimate. We analyse the association where each data point is an individual month and also for those for rolling three month averages.

Table 8 reports the correlations for each of these dimensions. Both correlations suggest a positive relationship between the balance statistics and GDP growth (0.387 for the monthly data points and 0.128 for the rolling three month averages). However, the correlation for the rolling three month average is around a third of that where each data point is a single month. Figure 20 presents the monthly data. The EBS balance statistic does not appear to capture the sharp monthly movements in GDP in June and July 2012. The sharp drop in GDP in June is associated with the changes to Bank Holidays for the Queen's Jubilee Celebrations. The month of July saw a sharp rebound in output as the economy returned to a 'normal' month of working days. The EBS does not appear to have captured such developments. It is such developments that likely depress the magnitude of the correlation between the two series. Such events are specific to certain periods and as the sample period for analysis extends it is possible that the correlation between the two series will increase.

Table 8. Correlation coefficients for annual changes in output

Correlation between balance statistics for annual output change at month t and the annual change in monthly GDP	0.387
Correlation between balance statistics for annual output change at month t and the annual change in monthly GDP (rolling three month averages)	0.128

Figure 20. The balance statistic of the annual change in output and annual rate of growth of monthly GDP

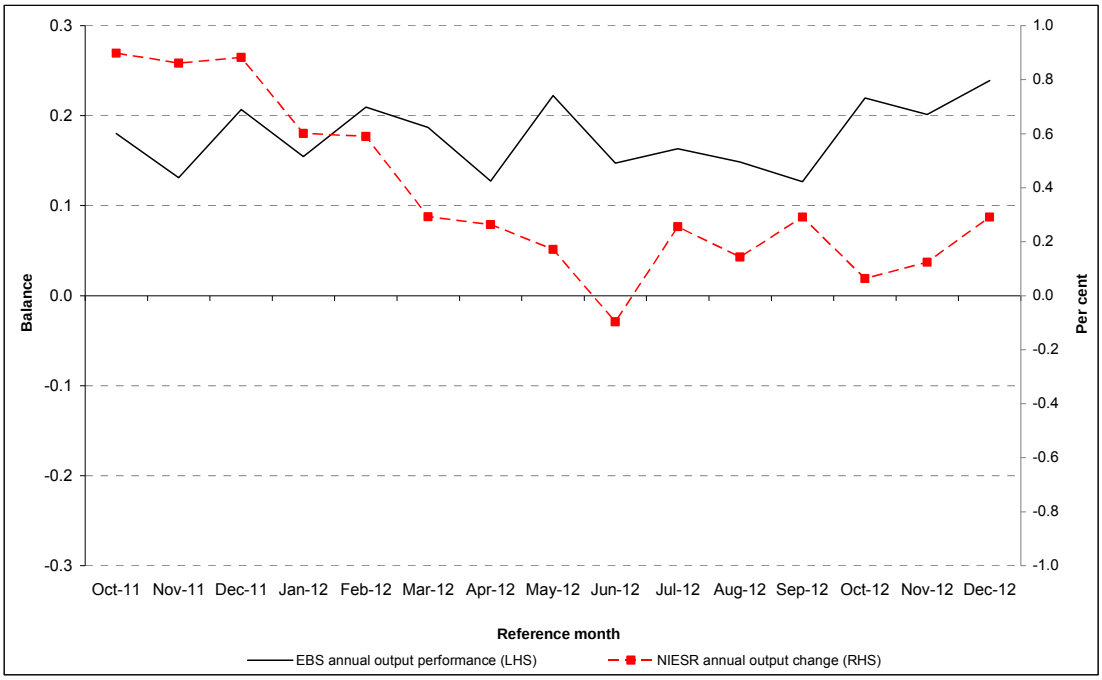
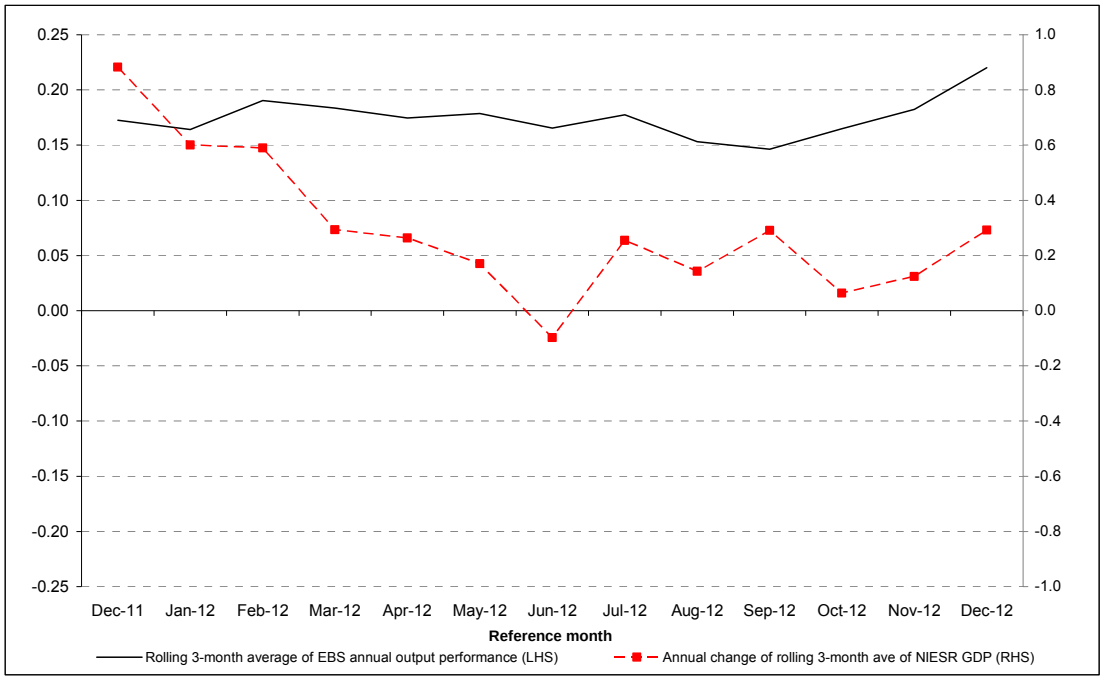


Figure 21 plots the annual changes for rolling three month averages of both variables. As in the case of the single month data points plotted in Figure 20, the drop in output in June is not captured in the EBS balance statistic. However, the chart also highlights the divergence between the two series over the first and second half of the sample period, explaining why the correlation coefficient is around a third of the single month data points. Nevertheless, the correlation is still positive and it is possible that a greater positive relationship would be found between the two series. Certainly, the evidence is not enough to reject the evidence of positive correlations between GDP growth and EBS balance statistics.

With the arrival of more data points, it would be a useful exercise to experiment with the variations in the leads and lags of this series. It may well be with less than three years of data the annual rate of change may allow some simple nowcasting models to be derived for the English economy.

Figure 21. The balance statistic of the annual change in output and annual rate of growth of monthly GDP (rolling 3 month averages)



Analysis of employment

The analysis of employment follows a similar approach to the previous analysis of output. We investigate the relationship between balance statistics derived from the EBS and the rate of growth in the official estimate of employment. There are, however, some important differences with the preceding analysis of output. The official employment series is derived from the Labour Force Survey (LFS) and is available for England, rather than the UK; is not seasonally adjusted, but available only on rolling three month average basis[17]. Overall, therefore the quantitative data is a closer approximation to the latent variable the EBS balance statistics are predicting.

We investigate the relationship between the balance statistics from the EBS with their quantitative counterpart. Table 9 reports the correlation coefficients from this analysis. The results suggest a relatively robust correlation between the performance balance statistic and the employment growth rate at time t (0.722). This correlation coefficient is noticeably greater than the association between the employment expectation balance statistic and employment growth at time t (0.233). In other words, employment growth has a high degree of association with past employment change balance statistic covering the same rolling three-month moving average period. Such a result is promising. The sign of the correlation coefficient is correct, and the strength of the relationship suggests the EBS balance statistic may well be a timely indicator for employment developments in England. The positive correlation between employment growth and employment expectations

[17] This restricts the analysis to 13 data points.

Table 9. Correlation coefficients of the employment indictors

Correlation between the employment performance balance statistic at month t and employment growth at month t	0.722
Correlation between the employment expectation balance statistic at month t and employment growth at month t	0.233
Correlation between the employment performance balance statistic at month t-3 and employment growth at month t	0.040
Correlation between the employment expectation balance statistic at month t-3 and employment growth at month t	0.830

suggests that both EBS balance statistics may well be useful predictors for employment, a test of which can be performed when more waves of the EBS have been undertaken. Of course, there is also the risk that these relationships, for which we have provided tentative evidence, are simply a product of this particular juncture for employment, and that they will not hold in the coming years. Figure 22 and Figure 23 plot the performance and expectation balance statistics, respectively, against employment growth. As Figure 22 shows, employment performance has tracked employment growth relatively closely, with the three months to March 2012 the exception. This outlier could simply be to sampling variability. Figure 24, on the other hand, shows the difference between employment growth and the employment expectation balance statistic is much more widespread, consistent with a lower correlation coefficient.

Figure 22. EBS employment performance at time t and employment growth at time t

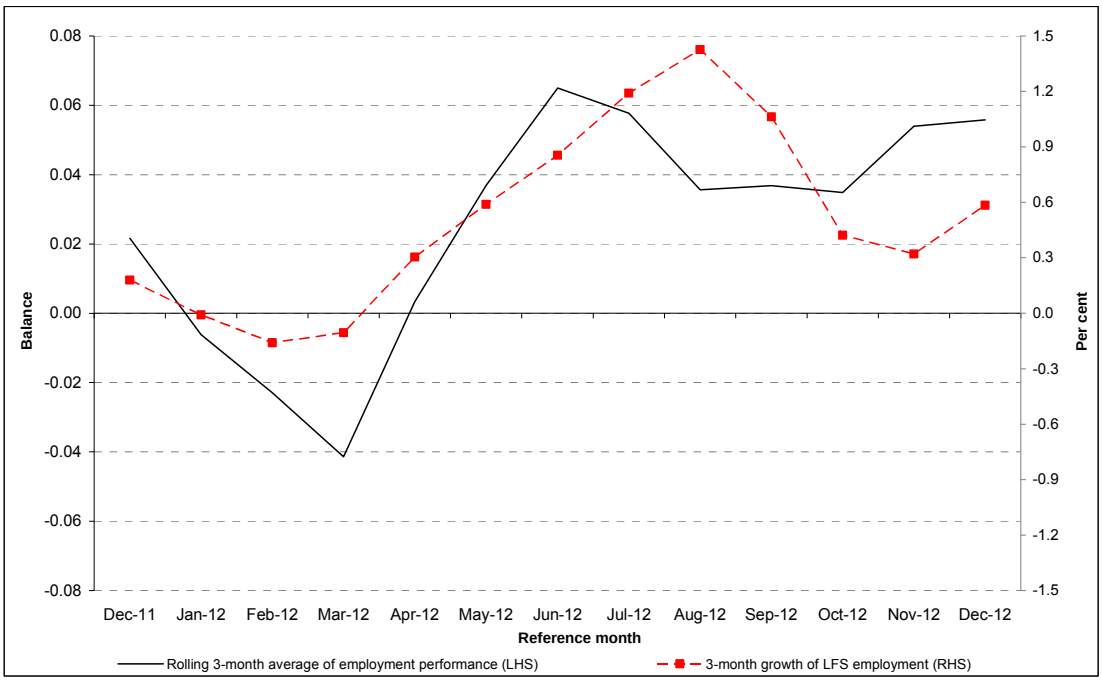
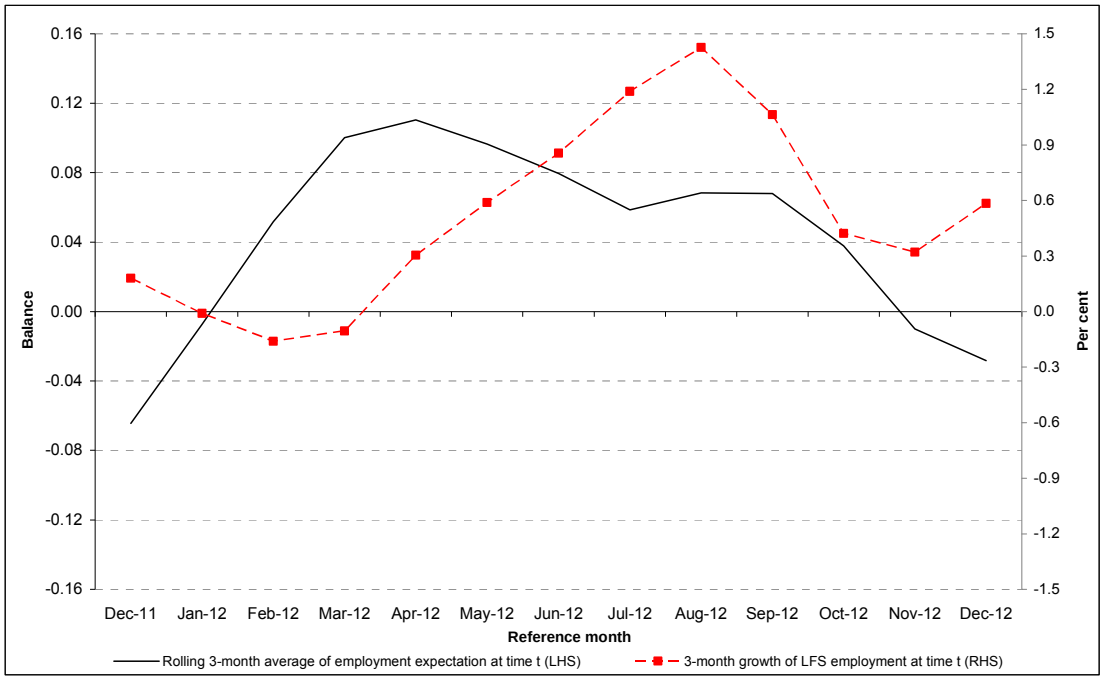


Figure 23. EBS employment expectation made at time t and employment growth at time t



There is no reason to assume that there is no lead or lag relationship between the balance statistics and employment growth. To investigate this we repeat the process undertaken with output above, and look at the relationship between the balance statistics and employment growth, where the balance statistics are lagged by three months (t-3). As the results in Table 9 suggest, there is almost no relationship between the performance balance statistic and employment growth (a correlation coefficient of 0.040, see Figure 24). However, quite the reverse occurs for the employment expectation balance statistic. There estimated correlation coefficient is high (0.830) when the employment expectation is lagged by 3 months (see figure 24). This is perhaps tentative evidence that respondents' expectations of what is to happen over the next three months are reasonable forecasts of outturns. These results are also in-line with those reported in Table 2, above, which suggests the expectation balance statistic for employment is highly correlated with the subsequent outturn in employment as measured by the performance balance statistic. With a significant increase in sample points a formal model based on these data could be developed and tested to see if such properties are realised.

Figure 24. EBS employment performance at time t-3 and employment growth at time t

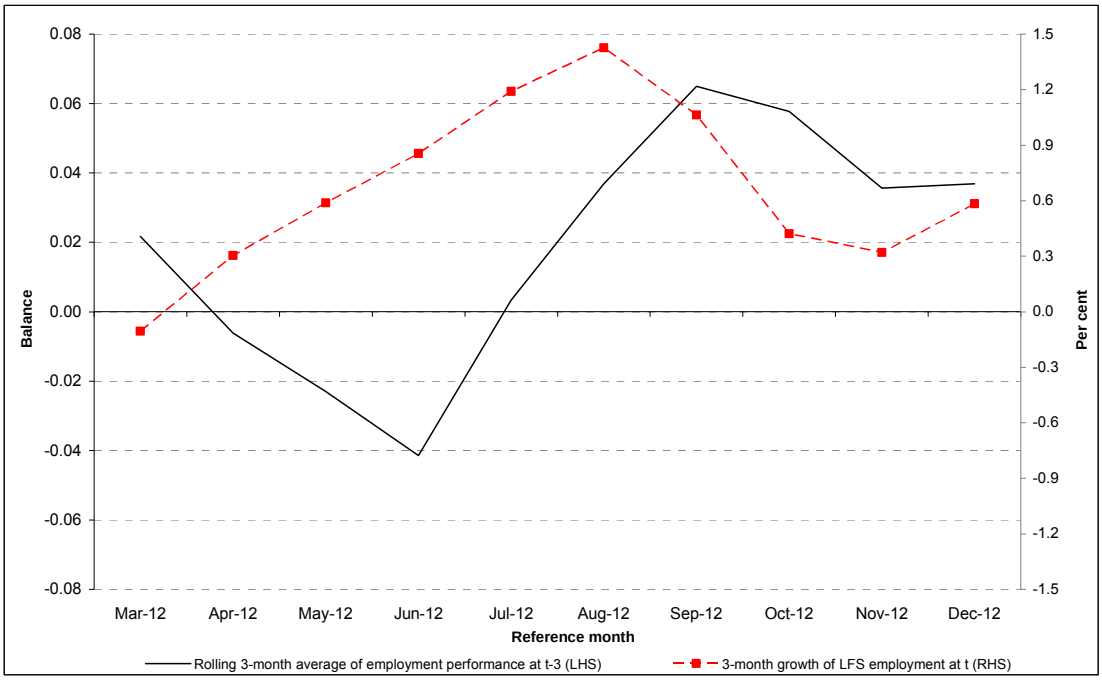
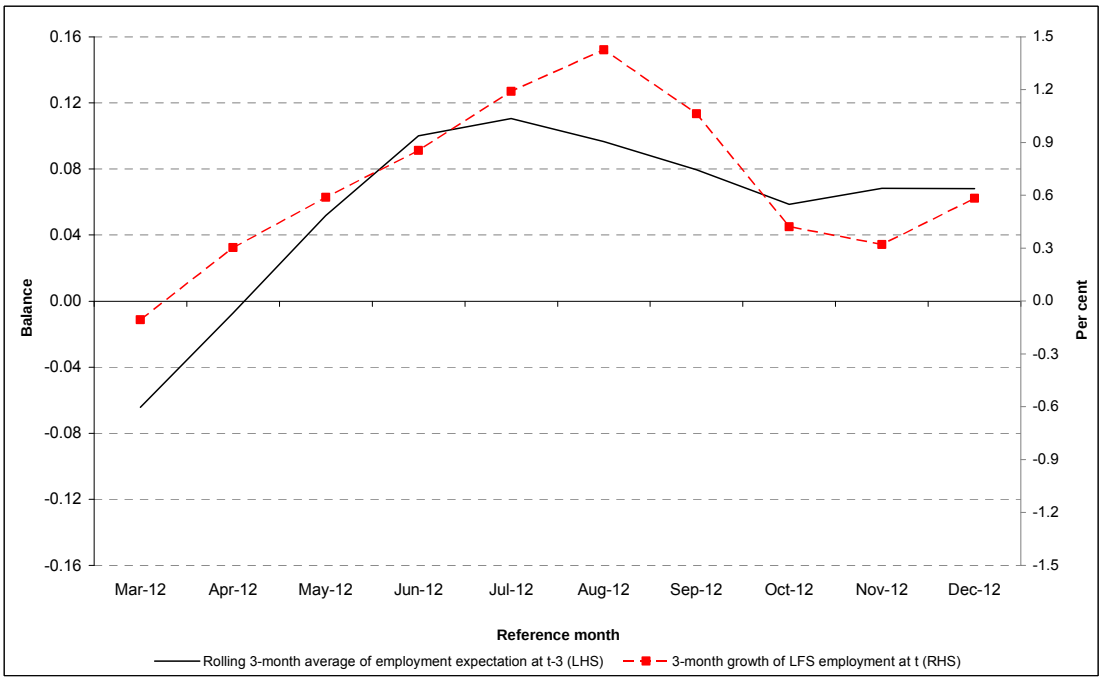


Figure 25. EBS employment expectation at time t-3 and employment growth at time t



It is perhaps not surprising, that the employment balance statistics appear to be 'more accurate predictors of their quantitative outturn than the output balance statistics are. Decisions to increase or shrink a workforce take time to feed through, and should be accurately reflected in the responses to the question about expectations of employment change, more so than for output. In these questions, we are effectively asking questions related to a workplaces demand for employment and their view on how demand for their products and services is expected to change in the near-term. Overall, however, the tentative evidence is promising. There certainly appears to be the potential for

complementing the existing data which can be used to determine recent developments as well as contribute to the derivation of forecasts for the near term.

Part 3: Cross-correlation analysis

In this section, we examine the properties of different series used for our analysis via an analysis of the cross-correlation function[18]. Once again due to the small sample period, the coefficients presented here should be interpreted with caution. To investigate the correlation between different series at different lags, we conduct an analysis based on cross-correlation function. For series X and Y, we report below the cross-correlation between X at time t, i.e. X(t) and Y at time t-k, i.e. Y(t-k) for k=0,1,2,3. The results are reported in Table 10 and Table 11.

Table 10. Cross-correlation coefficient of GDP growth (variable X(t)) with EBS balance statistics (variable Y(t-k))

Lag k	Output performance	Output expectation
-3	0.5041	0.0252
-2	0.3554	0.0431
-1	-0.1037	0.3663
0	-0.1085	0.2542

The cross-correlation function suggests that monthly GDP growth at month t is most positively correlated with the output performance balance statistic at time t-3, lending further support to the notion of the balance statistic as a leading indicator of output growth. The output expectation balance statistic is most positively correlated with GDP growth at month t-1, suggesting less of a leading indicator role for output expectations. However, as we have noted previously, the issues related to a small sample size and seasonal adjustment mean that we should not preclude further analysis as more months become available, particularly when the time series is long enough to allow seasonal adjustment procedures to be applied.

[18] See appendix B, for an analysis of the autocorrelation function of each of the variables of interest.

Table 11. Cross-correlation coefficient of employment growth (variable X(t)) with EBS balance statistics (variable Y(t-k))

Lag k	Employment performance	Employment expectation
-3	-0.0219	0.6315
-2	0.3955	0.6073
-1	0.6550	0.4370
0	0.7216	0.2313

The cross-correlation function suggests that employment growth is most highly correlated with the employment performance balance statistic at time t, implying a contemporaneous relationship between employment growth and the balance statistic, reinforcing the employment analysis previously. Consistent with the results above which show the employment expectation balance statistics to have potential leading indicator properties; employment growth is most highly correlated with the employment expectation balance statistic at month t-3.

Analytical Framework

There are a number of limitations to the testing of economic theories with the EBS data. Much of the analysis of output and investment decisions makes the clear distinction between the short and long-run. For example, Mairesse et al. (1999) use a longitudinal panel of workplaces to estimate the simple investment decisions in error-correction format. That is deriving estimates of a long-run relationship while accounting for the dynamics of any investment decision. Such a framework implicitly requires data on key long-run drivers, for example the capital-output ratio of a workplace or firm. The EBS is neither a longitudinal dataset, while the available variables for this analysis are limited. For example, capital stocks estimates are not recorded. As such it makes estimating any relationships at a workplace level which extend beyond the short term impossible.

However, this is not to say that the EBS cannot be utilised to investigate some economic relationships. To this end we will start the workplace level analysis with the measurement of the correlation between different variables. Unconditional (partial) correlations of qualitative variables can be measured by computing the polychoric correlation (see Olsson (1979)). While conditional correlations can be measured via multivariate models in the second stage of the analysis. In the workplace level analysis the data should be adjusted to control for the complex survey design. Ignoring the complex survey, or at minimum the unequal probability of selection could lead to bias in our estimated standard errors and consequent significance of the estimated coefficients.

We can infer consistencies with theory via the estimated coefficients. The dataset may well be analysed in a panel format, but at the workplace level this is only a pooled set of repeated cross-sections. By definition it is difficult to test hypotheses with such data. As such the inference is derived from tests of association rather than causation. However, one needs to bear in mind that for some variables the direction of causation is not theoretically clear. For example, it is not clear whether past labour utilisation drives past employment or the other way round. There is no clear direction of which of these two variables leads the other unless past output is taken into account.

In the multivariate analysis we need to control for unidentified shocks that could bias our results. Shocks can manifest themselves in a wide variety of forms at different levels of the economy. A variety of macroeconomic variables could be included for control for aggregate level shocks that pervade the whole economy. But there is always a risk that the included macro variables do not capture a specific shock. As such, a common approach is to include dummy variables as time fixed effects. Such variables also control for the presence of any time trends that would be otherwise captured by the estimated residuals.

We have already identified the issue of seasonality in data. A typical control would be to include dummy variables to control for seasonal fixed effects. However, at present the short time series precludes the inclusion of such control variables.

Other fixed effects that should be included as standard in a model such as this is through the inclusion of industry and regional fixed effects. Throughout one must be careful with regards to the cell sizes for each of these groups.

Output

The EBS data allows us to observe qualitative responses with regards to the activities of a particular workplace. We are able to observe responses with regards to changes in factor inputs, be they capital (investment decisions) or labour (employment and hours worked decisions). We are also able to observe responses concerning output changes. At its core we have subjective responses that can be aligned as a workplace production function, where output (q) is a function of capital (investment) and labour (employment, hours worked). In this context we are able to observe two flow variables (output and investment) and one set of stock variables (employment or hours worked). We will utilise the theoretical construct of a production function to guide the analytical framework of our analysis.

The production function determines the maximum level of output that a workplace can produce for a given set of factor inputs[19]. The first difference of such a relationship relates changes in output to the change in factor inputs. The EBS data enables us to establish short-run changes in the factor inputs and output of a workplace. To this end we are able to estimate the simple relationship:

$$\Delta q = \beta_1 \Delta l + \beta_2 \Delta i + \mathbf{x}\boldsymbol{\beta} + \varepsilon \qquad (1)$$

Where the change in output (Δq q) is a function of the change in labour input (Δl) and change in investment (Δi), the factor inputs. β_1 and β_2 are the respective parameters to be estimated, and ε is the estimated error term. In equation 1, $\mathbf{x}$ is a vector of explanatory variables (time, industry, region and workplace size dummy variables) and $\boldsymbol{\beta}$ is vector of unknown parameters. We estimate a model based on the first difference of this equation. We are able to estimate ordered probit regressions where we experiment with output performance and output expectations as the dependent variable. It is observed that the level of the labour input varies in the short as well as the long-run. We will investigate the use of performance and expectations employment change variables as well as the retrospective change in hours worked for our labour input variable. We are not able to observe the level or change in workplaces' capital stock through the EBS; rather the EBS includes data that provide a partial view of the flow of capital in the form of questions on gross capital investment.

Labour demand

We can derive a workplace labour demand equation to estimate with the EBS data:

$$\Delta l = \beta_1 \Delta q + \beta_2 lu + \beta_3 \Delta lc + \mathbf{x}\boldsymbol{\beta} + \varepsilon \qquad (2)$$

where Δl is the change in employment (or hours worked), *lu* is labour utilisation, Δlc is the change in labour costs and other variables are as specified above. As is clear this is a relatively simple specification. For a survey of a more sophisticated approach to modelling labour demand see Bond and Van Reenen (2007).

Investment decision

We can derive an investment decision equation to estimate with the EBS data:

$$\Delta i = \beta_1 \Delta q + \beta_2 cu + \mathbf{x}\boldsymbol{\beta} + \varepsilon \qquad (3)$$

where *cu* is capital utilisation and other variables are as specified above. We will experiment with the retrospective and expectations variables for both investment and

[19] This equally applies to the firm, industry and economy level.

output. A key determinant of the investment decisions is the real user cost of capital[20]. However, we do not have data with which to derive a user cost of capital estimate for each workplace. Implicitly we are estimating the dynamics of an investment demand equation at the workplace level. In some sense it is similar to the investment demand model of Bean (1981), but without an embedded steady-state.

Workplace level analysis

Introduction

This microeconomic level analysis presents the results of the workplace level analysis of the relationships of interest highlighted in the analytical framework. The first stage of this analysis is to explore the data using bivariate correlation analysis. Given the categorical nature of the data the underlying assumptions of Pearson's correlation estimates are violated. To address this we estimate polychoric correlations[21]. The second stage of the analysis is via the use of multivariate techniques, notably estimating ordered probit and probit models[22]. The cross-sectional nature of the data means that questions of causality cannot be easily addressed. Rather the multivariate results should be viewed in the context of conditional correlations[23].

Part 1: Correlation analysis[24]

To assess the relationship between the micro-level qualitative variables within the survey, we compute the polychoric correlation (see Olsson (1979)) between the variables. We examine the correlations between these variables using pooled workplace data, across time. We focus on the investigation of the following relationships[25]:

- Correlation between output performance and:
    a. employment performance
    b. employment expectations
    c. total number of hours worked

[20] The user cost of capital is a weighted average of the cost of equity and debt finance and is influenced by corporate taxes, depreciation (consumption of fixed capital) and risk premia.
[21] See Appendix C for details.
[22] See Appendix C for details.
[23] The descriptive statistics for each of the variables of interest can be found in Appendix D.
[24] This analysis is focused around the use of the polychoric command in Stata.
[25] The number of correlations shrinks as we move down the list, since swapping the z_1 and z_2 variables does not change the outcome of the estimation (see Appendix C for the derivation of the correlation). The list is effectively a list of the permutations from the set of variables of interest.

   d. labour costs
   e. capital investment performance
   f. labour utilisation in reference month
   g. capital utilisation in reference month

- Correlation between labour utilisation in reference month and:
   a. output expectation
   b. employment performance
   c. past total number of hours worked
- Correlation between capital utilisation in reference month and:
   a. capital investment expectation
   b. employment expectation
- Correlation between capital investment expectation and:
   a. Output performance
   b. Labour utilisation in reference month

The analysis presented in this section is based on unconditional (partial) correlations of the qualitative variables[26]. We can infer consistencies with theory via the estimated coefficients. However, for some variables, the direction of causation is not theoretically clear. For each estimated correlation apply a Likelihood Ratio (LR) test to determine whether the estimated correlation is significant. The null hypothesis underpinning the test is for no correlation between the two series. We report the p-values from this test in each instance.

When computing the correlation coefficients on pooled data, for each wave and for each region, we take into account the workplace level survey weight. Applying this weight adjusts our estimates for the unequal probability of selection given that survey respondents are not selected by simple random sample with replacement[27].

We first examine the different relationships between variables in general (pooled sample). This should give us indication of how the variables of interest from the survey relate to each other, and thus can provide some reference to whether such relationships coincide with general economic theories. We then move on to investigate whether these

[26] Conditional correlations measured via multivariate methods are presented in the subsequent section.
[27] This is applied as the pweight option in Stata. Details on the weight variable are available in TNS-BMRB (2012).

relationships appear stable or changing over time (for each wave); and whether these relationship appear stable or vary across regions (for each region).

Polychoric correlations on the pooled sample

1. Correlation between output performance and other variables (weighted)

Table 12 reports the polychoric correlation analysis between output performance and other qualitative variables in the survey using a pooled sample. All values of the coefficients are greater than zero. The p-values for the LR test suggest the correlations are all significant at the 1 per cent level. These results show that output performance is positively and significantly correlated with both employment performance and expectation variables, number of hours worked, labour costs, and investment performance. Output performance has a stronger correlation with employment performance than with employment expectations.

These findings are consistent with economic theory. Output performance is also found to be positively and significantly correlated with both labour and capital utilisation in the reference month. While output performance indicates workplaces' output growth over the three months to the reference month, labour and capital utilisation questions are asking about workplaces' experience in the reference month. Such relationships are theoretically consistent: increases in output over a short-time period are associated with an increase in utilisation of factor inputs. Over such a short period of time it is unlikely that a workplace can respond by increasing factor inputs, with the exception of increasing the number of hours worked by those employed at the workplace. A result reinforced by the higher correlation between past output and the past total number of hours worked.

Table 12. Polychoric correlation between output performance and other variables (weighted)

Variable	Correlation coefficient	Std. error	p-value of LR test	No. of observations
Employment performance	0.3932	0.0095	0.0000	46684
Employment expectation	0.0899	0.0108	0.0000	46459
Total no. of hours worked	0.5938	0.0073	0.0000	46336
Labour costs	0.3019	0.0105	0.0000	45111
Capital investment performance	0.1222	0.0117	0.0000	44168
Labour utilisation in ref. month	0.3755	0.0092	0.0000	46216
Capital utilisation in ref. month	0.3676	0.0106	0.0000	45906

2. Correlation between labour utilisation in reference month and other variables

Table 13 presents the polychoric correlation analysis between labour utilisation in reference month and other qualitative variables in the survey using a pooled sample. Labour utilisation is found to be positively correlated with employment performance and total number of hours worked, but negatively correlated with output expectations. All p-values from the LR tests suggest the correlations are significant at the 1 per cent level.

Table 13. Polychoric correlation between Labour utilisation and other variables (weighted)

Variable	Correlation coefficient	Std. error	p-value of LR test	No. of observations
Output expectation	-0.0495	0.0106	0.0000	45739
Employment performance	0.1504	0.0109	0.0000	47374
Total no. of hours worked	0.3432	0.0094	0.0000	46981

A negative correlation between labour utilisation and output expectation may indicate that if the labour force is under-utilised in the reference month, then we expect future output to increase. The reverse interpretation would be that if labour is over-stretched we expect future output to be weaker, possibly implying a return to levels of output consistent with a full level of utilisation. However, despite a significant result, the correlation is close to zero. In other words, there is little to no correlation between current labour utilisation and future output. This conclusion does not apply to the correlations between current labour utilisation and both employment performance and total number of hours worked. The sign of the correlation coefficient appears consistent with what we would expect: a rise in labour input is associated with greater utilisation of labour in the reference month

3. Correlation between capital utilisation in reference month and other variables

Table 14 reports the polychoric correlation analysis between capital utilisation in reference month and employment expectations and capital investment expectations using a pooled sample. Both coefficients are greater than zero, and the LR test suggests these significant at the 1 per cent level. Although the correlation between capital utilisation in reference month and employment expectations is significant, it is particularly close to zero, suggesting little of the variation in capital utilisation is associated with the variation in employment expectations.

Table 14. Polychoric correlation between capital utilisation and other variables (weighted)

Variable	Correlation coefficient	Std. error	p-value of LR test	No. of observations
Employment expectations	0.0375	0.0122	0.0000	46823
Capital investment expectations	0.1067	0.0135	0.0000	43679

4. Correlation between capital investment expectations and other variables

Table 15 presents the polychoric correlation analysis between capital investment expectations and, output expectations and labour utilisation in reference months using a pooled sample. Firstly, the results show positive correlation between capital investment expectations and output expectations. It means if workplace expect output and their capital investment to move to the same direction. As in earlier results, the correlation coefficients are all significant, at the 1 per cent level.

Table 15. Polychoric correlation between capital investment expectations and other variables (weighted)

Variable	Correlation coefficient	Std. error	p-value of LR test	No. of observations
Output expectations	0.1046	0.0122	0.0000	42859
Labour utilisation in ref month	0.1107	0.0124	0.0000	43784

The correlation between capital investment expectations and labour utilisation in the reference month also appear to be positive, and significant as shown by the LR test. This is a difficult correlation to interpret. One possible interpretation is that lower labour utilisation is associated with lower capital investment expectations because a workplace will wait to see labour more utilised before further investment is introduced. But investment is lumpy and can require quite significant lead times (for example the decision and then implementation of an extension to a workplace). It is another example of a correlation that is specific to the current economic environment. One hypothesis put forward to explain the current productivity puzzle is the substitution of labour for capital (see Disney et al., 2013). In the presence of uncertainty, investment in labour, either through increasing hours worked by existing staff or the hiring of additional staff is a decision that workplaces can more easily reverse than a capital investment if a pick-up in demand is not realised. In this context, it could well be that workplaces would wait to see labour fully utilised before even considering more investment. As such we could well see a positive correlation dissolve as the economy returns to rates of economic growth consistent with a period of economic recovery. However, the correlation coefficient reported above is relatively low and should certainly not be interpreted as evidence to support such a hypothesis.

Polychoric correlation analysis by wave

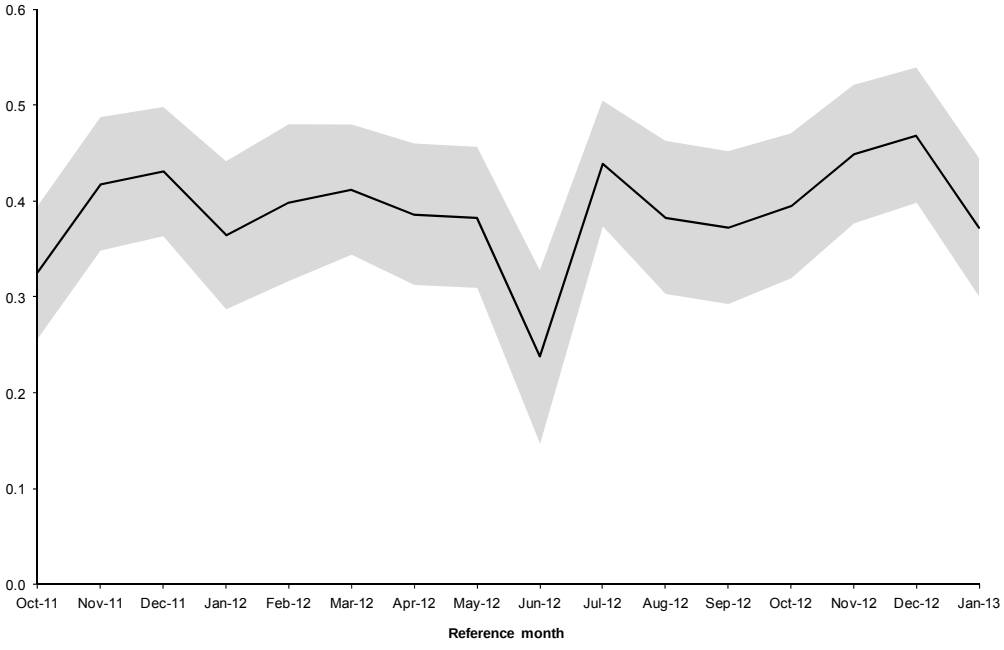
The analysis in Part 1 used a pooled sample. It therefore gives us a general picture of the unconditional relationships between variables, as measured by the polychoric coefficients, without taking into account possible variation over time. In this section, we conduct the analysis by wave i.e. for each cross-section. As well as computing the correlations between variables, we also measure the uncertainty around the computed coefficients via a 95 per cent confidence interval.

There are sixteen waves in total, starting from reference month October 2011 through to January 2013. The polychoric correlation analysis by wave and the uncertainty around such correlations is illustrated in Figure 26 to Figure 39.

1. Correlation between output performance and other variables

Figure 26 to Figure 31 plot the polychoric correlations between output performance and different variables in the survey across each wave (reference month). In each case the 95 per cent confidence interval is also reported. In those instances where the confidence interval includes zero, the correlation coefficient is not significantly different from zero[28].

Figure 26. Polychoric correlations between output performance and employment performance, by reference month



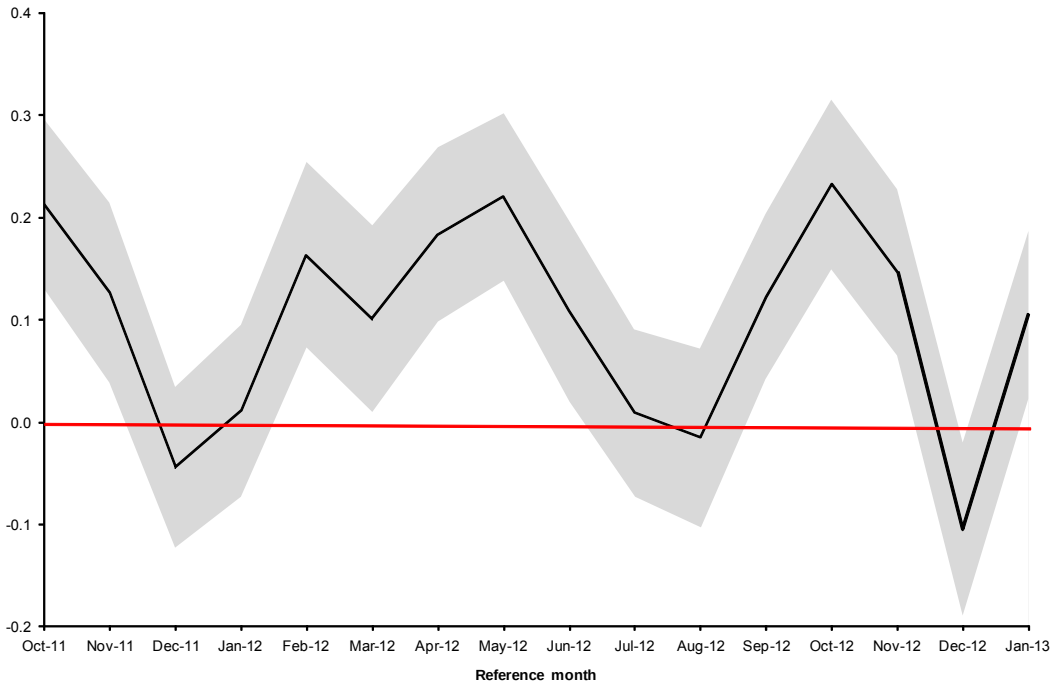
Note: Shaded area is 95 per cent confidence interval.

[28] In other words, we have failed to reject the null hypothesis of zero correlation.

The plot of correlation coefficients across waves between output performance and employment performance in Figure 26 appears relatively flat in general despite occasional small ups and downs. Only one obvious decrease is observed for the reference month June 2012. This month is notable for the occurrence of the Queen's Jubilee celebrations which resulted in the movement of a bank holiday from May to June and the addition of a bank holiday (see Hardie and Perry, 2013). Official statistics suggest output was particularly weak in this month, with employment levels remaining reasonably stable. As such the correlation reported in Figure 26 is entirely consistent with this period.

The correlation between past output and future employment in Figure 27 appears to be more volatile across waves. Negative correlations between the two variables are observed in three reference months throughout the entire period. Two out of these three reference months are not significantly different from zero. Output performance also appears to be less correlated with employment expectations than with employment performance (comparing Figure 26 with Figure 27).

Figure 27. Polychoric correlations between output performance and employment expectations, by reference month



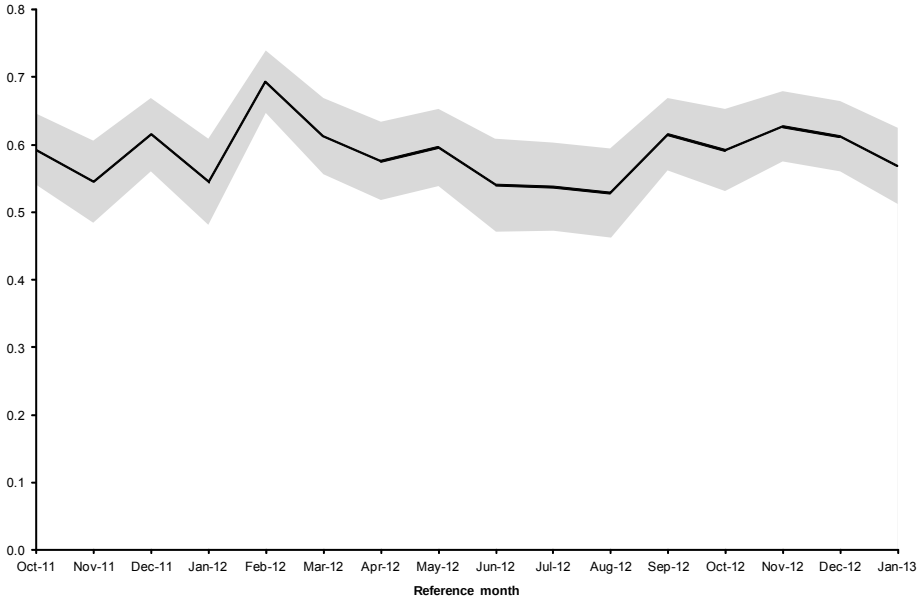
Note: Shaded area is 95 per cent confidence interval.

An alternative measure of labour input is total hours worked. The correlation between output performance and total hours worked does appear to be more highly correlated than employment performance (Figure 28). This is perhaps not surprising given that the total number of hours worked captures both the change in the number of employees as well as the hours each of them works. There is no drop in the correlation in June 2012, in sharp contrast to the correlation between past output and past employment. Given that the changes to the bank holidays in that month resulted in an adjustment in hours worked rather than headcount; the reduction in labour input occurred through less hours worked

rather than a reduction in the numbers employed. This result is consistent with developments in actual hours worked over this period as derived from the LFS[29].

Figure 29 shows the correlation between output performance and labour costs. The plot follows similar pattern as the relationship between output performance and employment performance shown in Figure 26, with an obvious downturn in reference month June 2012. The peaks in July 2012 and December 2012 coincided with that in Figure 26.

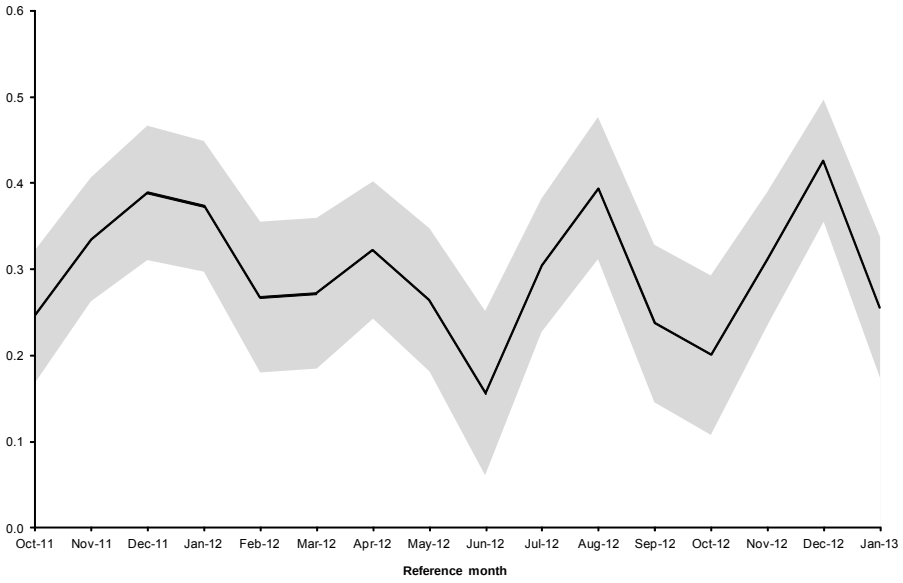
Figure 28. Polychoric correlations between output performance and total number of hours worked, by reference month



Note: Shaded area is 95 per cent confidence interval.

[29] See the *Labour Market Statistics, March 2013* release from the ONS.

Figure 29. Polychoric correlations between output performance and labour costs, by reference month

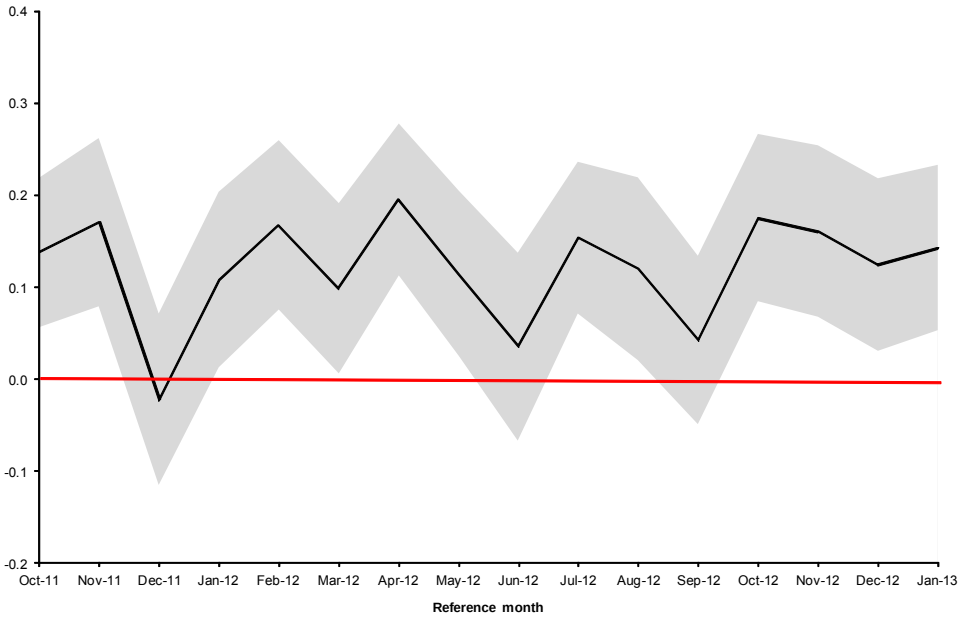


Note: Shaded area is 95 per cent confidence interval.

The correlation between output performance and capital investment performance appears relatively volatile over time as shown in Figure 30. The value of the coefficients, although significant, do not appear to be as large as that of employment performance and total number of hours worked. There are negative correlations in three reference months but the correlations in these three months appears to be insignificant as confirmed by the LR test results.

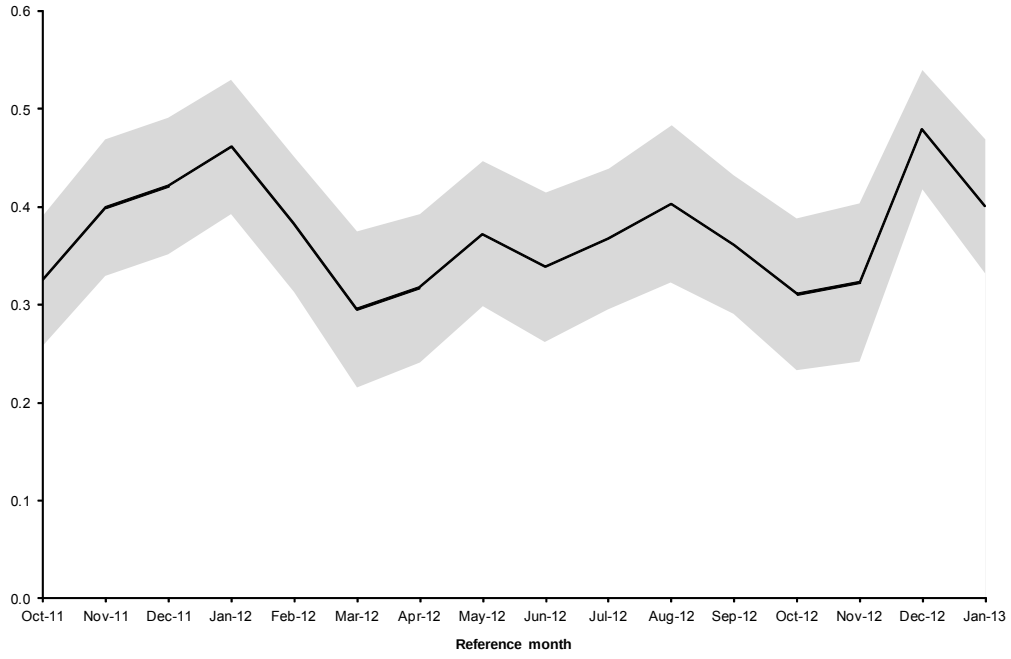
The correlation between output performance and labour utilisation in reference month appears to be relative stable over time as shown in Figure 31. The hypothesis of no correlations between the two variables can be rejected. However, the correlation between output performance and capital utilisation in reference month appear to be more volatile over time, as shown in Figure 32, when compared to that with labour utilisation. The LR test results also confirm evidence of the statistical significance of the correlations between the two variables over time as the reported p-value in Table 13 is zero, indicating a clear reject of the null hypothesis of insignificance.

Figure 30. Polychoric correlations between output performance and capital investment performance, by reference month



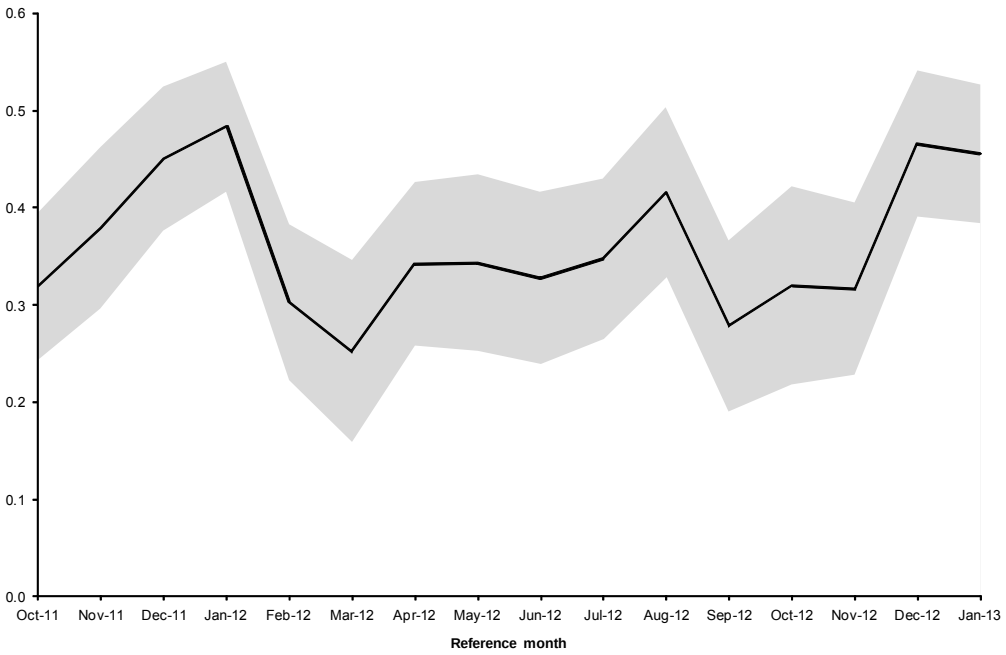
Note: Shaded area is 95 per cent confidence interval.

Figure 31. Polychoric correlations between labour utilisation and output performance, by reference month



Note: Shaded area is 95 per cent confidence interval.

Figure 32. Polychoric correlations between capital utilisation and output performance, by reference month



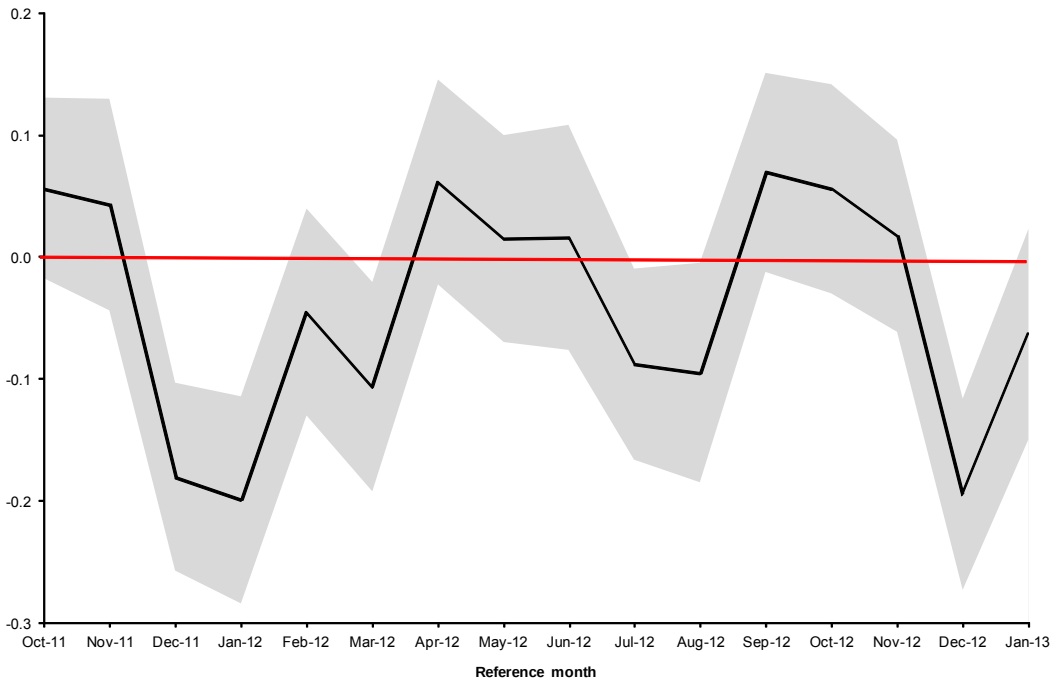
Note: Shaded area is 95 per cent confidence interval.

2. Correlation between labour utilisation in reference month and other variables

Figure 33 to Figure 35 plot the polychoric correlations between labour utilisation in reference month and (i) output expectations, (ii) employment performance and (iii) total number of hours worked.

The correlations between labour utilisation and output expectations appear to be low and volatile across waves, as shown in Figure 13. Although the correlations between the two variables appear to be negative in the pooled sample, the confidence interval suggests for the majority of months there is no statistically significant difference from zero. However, what the estimates do suggest is that there is no evidence of a positive correlation between the two series. Such estimates are consistent with those reported in Table 14.

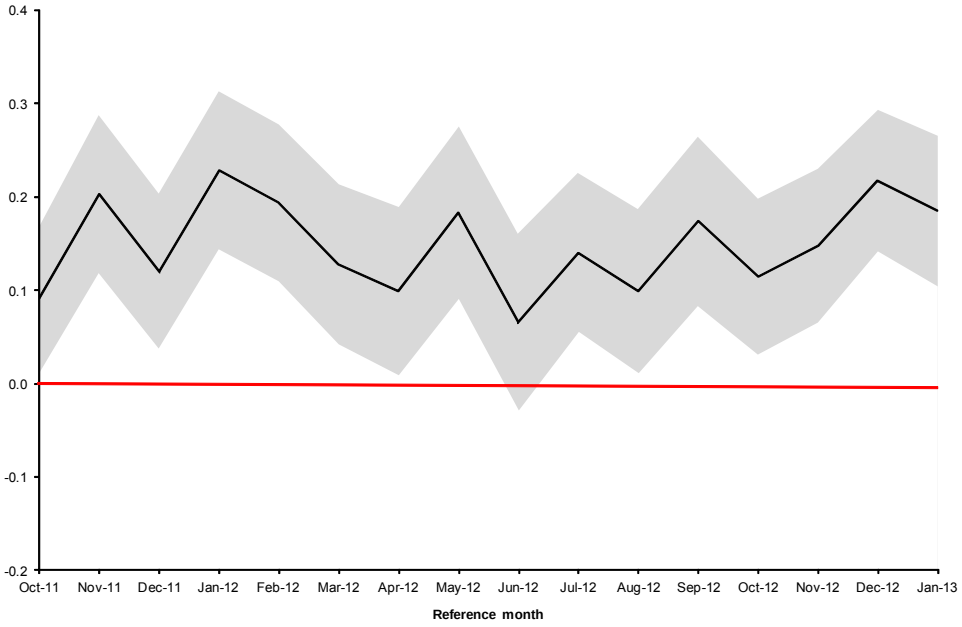
Figure 33. Polychoric correlations between labour utilisation and output expectations, by reference month



Note: Shaded area is 95 per cent confidence interval.

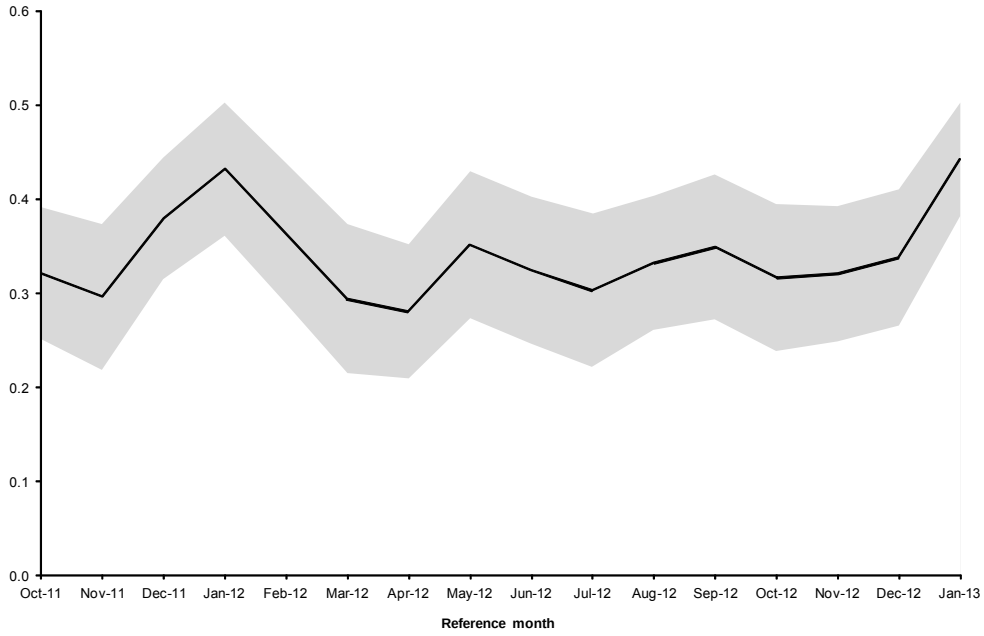
Comparing Figure 34 and Figure 35, the correlation between labour utilisation appear to be higher and more stable with total number of hours worked than with employment performance. The LR test results show the hypothesis of no correlation can be rejected at all significance levels for both relationships across all waves. The confidence bounds around the correlations between labour utilisation in past employment are also wider than those around the correlation between labour utilisation and total number of hours worked, signalling a greater degree of uncertainty around the estimated association.

Figure 34. Polychoric correlations between labour utilisation and employment performance, by reference month



Note: Shaded area is 95 per cent confidence interval.

Figure 35. Polychoric correlations between labour utilisation and total number of hours worked, by reference month

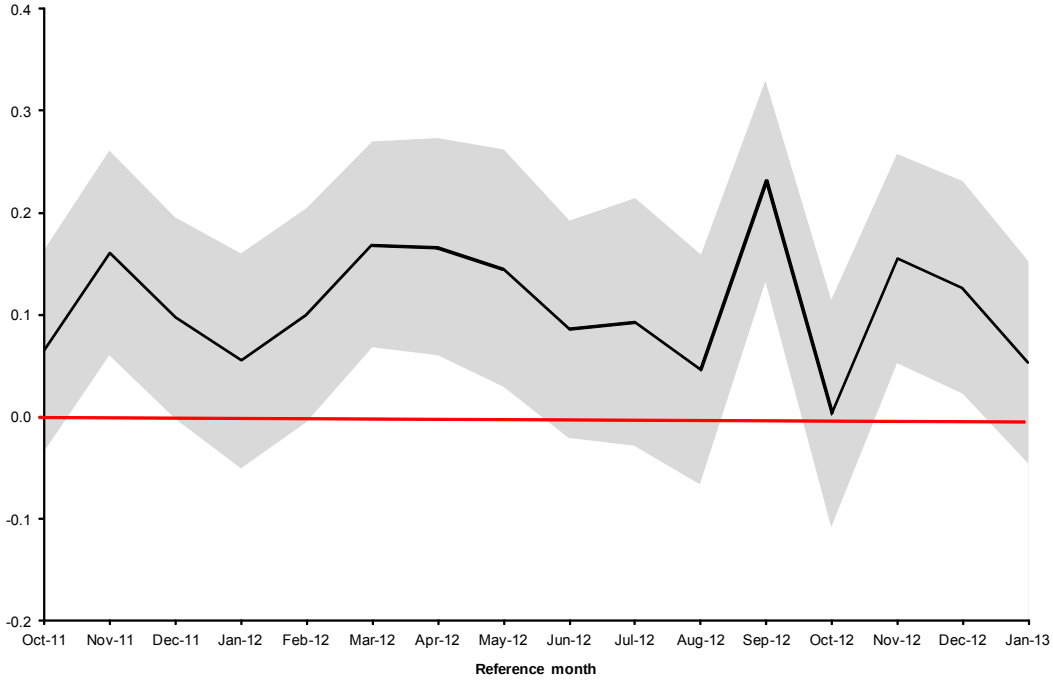


Note: Shaded area is 95 per cent confidence interval.

3. Correlation between capital utilisation and other variables

Figure 36 and Figure 37 plot the polychoric correlations between capital utilisation, and employment expectations and capital investment expectations, respectively. Figure 36 shows the correlation between capital utilisation in reference month and capital investment expectations. The correlation peaked in the reference month September 2012. The correlation may not be very high, but it is significantly positive for much of the sample period. The positive relationship is what we would expect. For example, this result suggests a lack of underutilisation is associated with the intention to increase investment. As we have noted previously, the recent downturn has been associated with a sharp drop in investment volumes that have yet to recover their pre-recession peak. If workplaces are hesitant with regards to investment due to heightened uncertainty then it is possible that the correlation coefficients we see in Figure 36 will rise as recovery takes hold of the UK economy. Furthermore, these lower correlation coefficients are also consistent with one of the hypotheses put forward to solve the UK's productivity puzzle: the substitution of labour for capital. However, we must stress that this not a confirmation that this behaviour is actually occurring.

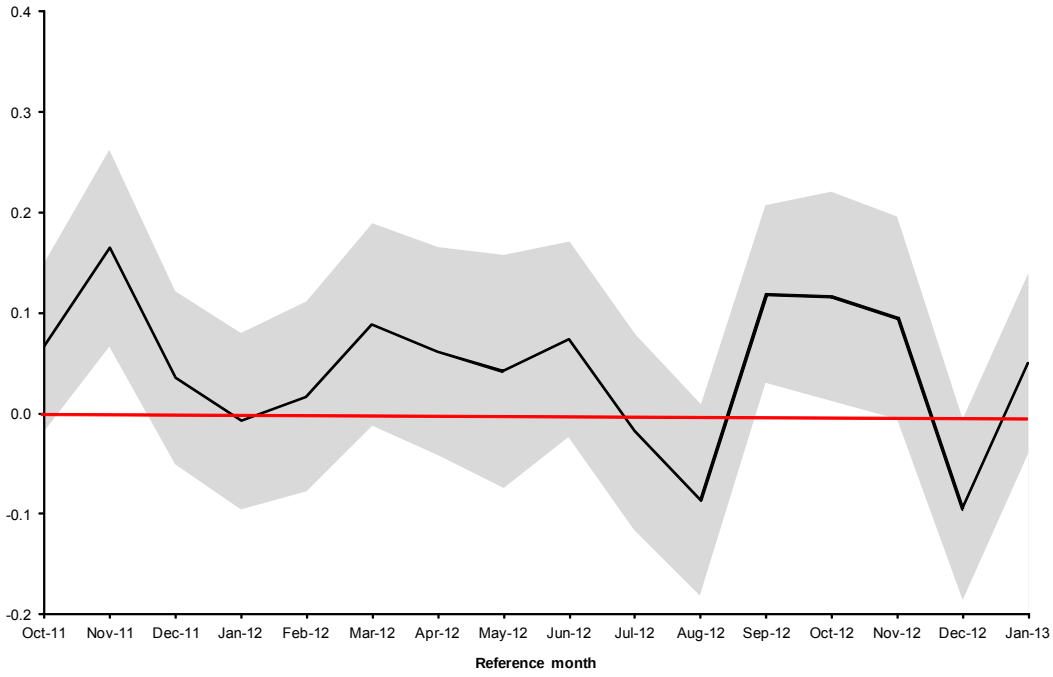
Figure 36. Polychoric correlations between capital utilisation and capital investment expectations, by reference month



Note: Shaded area is 95 per cent confidence interval.

Figure 37 shows the correlation between capital utilisation in reference month and employment expectations over time. The correlation does not appear to be large. Although the correlation between the two variables does appear to be positive, there is evidence of negative correlations, albeit insignificant, in some reference months.

Figure 37. Polychoric correlations between employment expectations and capital utilisation, by reference month



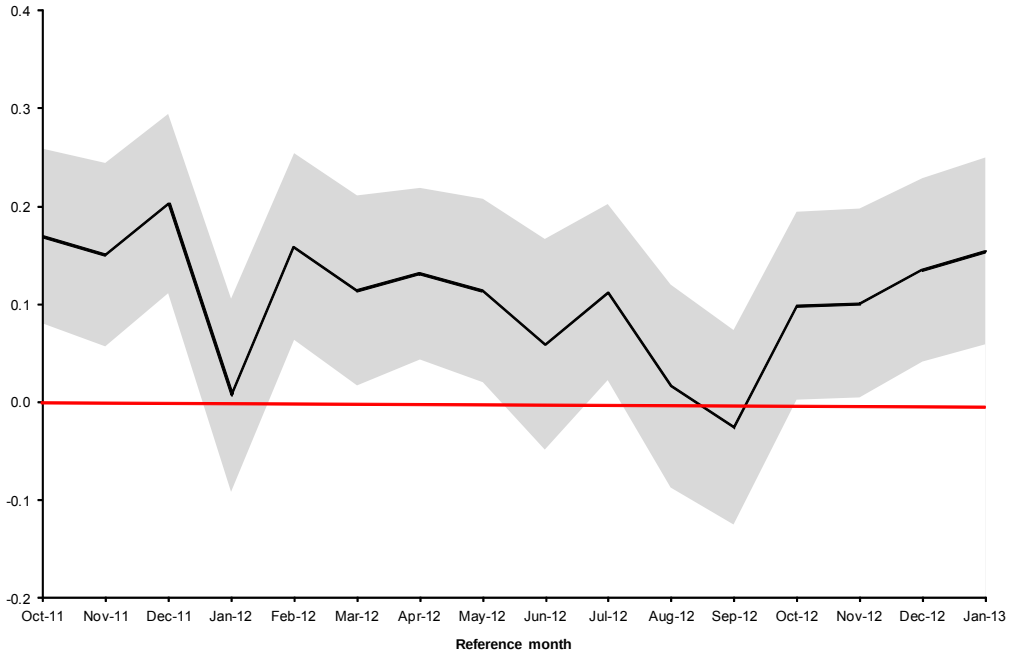
Note: Shaded area is 95 per cent confidence interval.

4. Correlation between capital investment expectations and other variables

Figure 38 and Figure 39 plots the polychoric correlations between capital investment expectations, and output expectations and labour utilisation for each reference month, respectively.

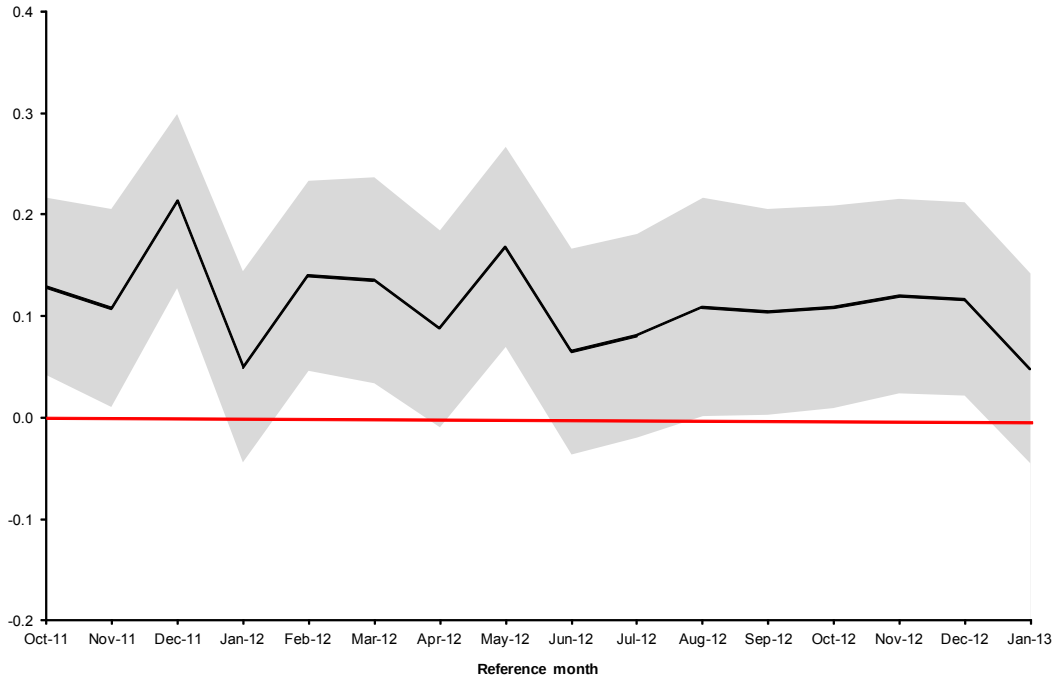
The two relationships both appear to be bounded by higher level of uncertainty over time as both plots are associated with wider confidence bounds. Both relationships peaked in reference month December 2011, and then followed by a downturn in January 2012. Capital investment expectations and output expectations appear to be positively correlated, despite not being large, over time. There is a negative correlation found in reference month September 2012, but the LR test shows this to be statistically insignificant. While the relationship between capital investment expectations and labour utilisation, presented in Figure 39, appears to have stabilised since reference months June 2012. The correlation between capital investment expectations and labour utilisation could simply be capturing the correlation between investment expectations and capital utilisation.

Figure 38. Polychoric correlations between future output and future capital investment, by reference month



Note: Shaded area is 95 per cent confidence interval.

Figure 39. Polychoric correlations between output expectations and capital investment expectations, by reference month



Note: Shaded area is 95 per cent confidence interval.

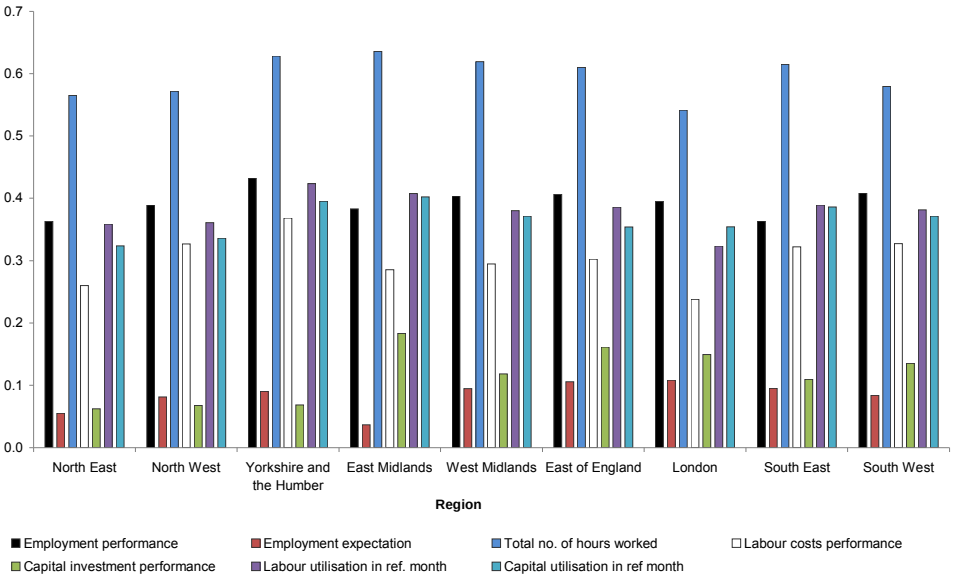
Polychoric correlation analysis by region

We further our analysis to investigate if the unconditional (partial) correlations between different variables in the survey vary across region by re-computing the above correlation for each region. There are nine English regions in total[30]. We illustrate the comparison across regions in Figure 40 to Figure 43.

1. Correlation between past output and other variables:

Figure 40 shows the polychoric correlations between output performance and other variables in the survey across different regions. Number of hours worked out of all the qualitative variables examined is most highly correlated with output performance (consistent with the English level correlations reported in Table 12. While output performance is least correlated with capital investment performance, as compared to other variables. These results hold for all regions. In fact the relationships between past output and other variables appear to be quite similar across region. Although these correlations only provide a limited picture about the relationships between variables given these estimates are unconditional, this results may imply there is not much regional variation in these relationships[31]. It is interesting to note that the lack of regional variation is borne out in the multivariate analysis, where regional control variables prove to be statistically insignificantly different from zero.

Figure 40. Polychoric correlations between output performance and other region variables, by region

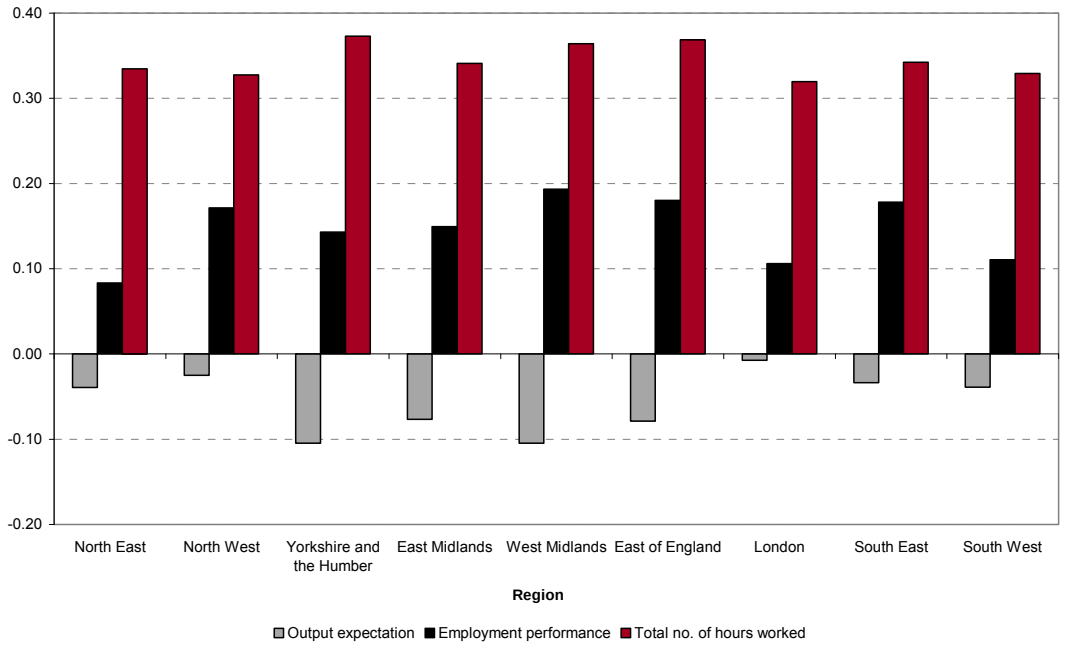


[30] These are Government Office Regions.
[31] The null hypothesis can generally be rejected for all regions for each of these bivariate relationships, except for three cases.

2. Correlation between labour utilisation and other variables

Figure 41 shows the polychoric correlations between labour utilisation and other variables in the survey across different regions. Output expectations are negatively related to labour utilisation in all regions. The values of the coefficients are small in general. In three of the nine regions (North East, North West and London) we find no statistically significant correlation.

Figure 41. Polychoric correlations between labour utilisation and other variables, by region



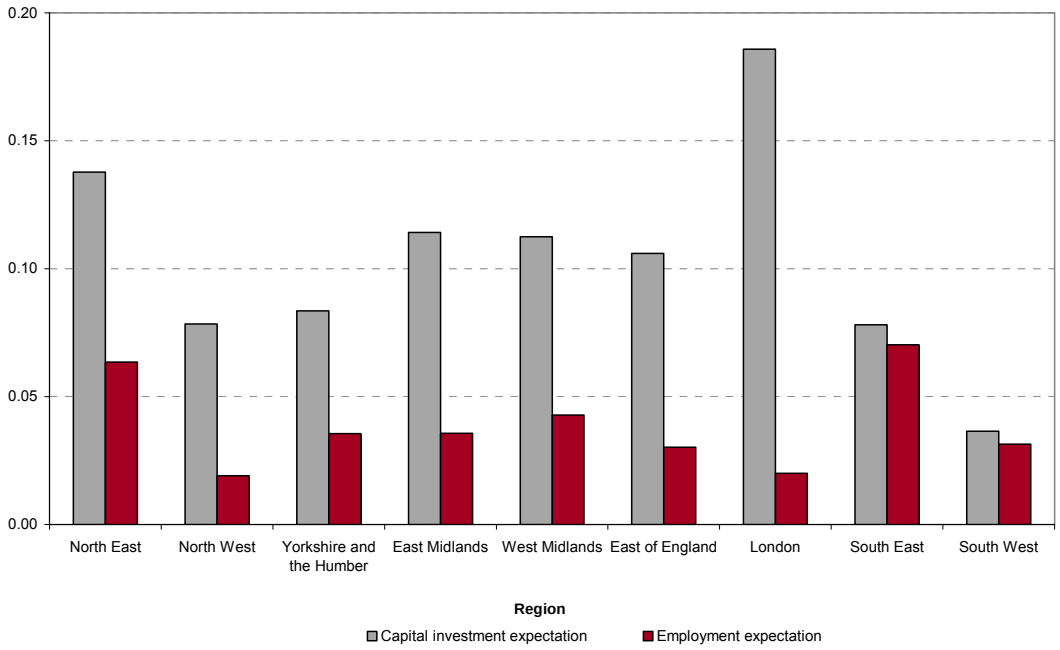
Labour utilisation is more highly correlated with the number of total hours worked than with employment performance in all regions. These correlations are significant in all of the English regions. Such results are consistent with the correlations for the English level.

3. Correlation between capital utilisation and other variables

Figure 42 shows the polychoric correlations between capital utilisation, and employment expectations and capital investment expectations across different regions. Capital utilisation is shown to be more highly correlated with capital investment expectations than with employment expectations in all regions. The highest correlation with capital investment expectations is in London, and least so in the South West (SW). The result for the South West is actually insignificant. The correlation between employment expectations and capital utilisation was found to be insignificant in eight of the nine regions[32].

[32] The correlation was significant in the South East region.

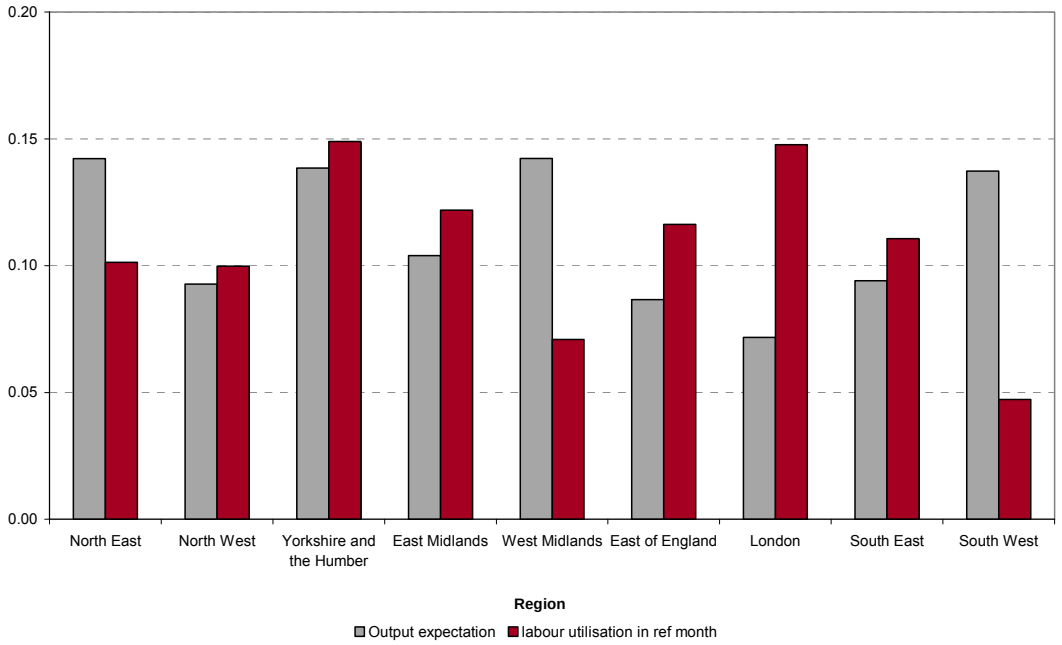
Figure 42. Polychoric correlations between capital utilisation and other variables, by region



4. Correlation between capital investment expectations and other variables

Figure 43 plots the polychoric correlations between capital investment expectations, and output expectations and labour utilisation for each of the English regions. The correlations are relatively small. Nevertheless, these correlation coefficients are statistically significant. Again, regional variation is relatively limited. While in principal this might not be the case once other variables are controlled for in multivariate analysis, in practice the results in the next section suggest that there is little regional variation to be explained once other factors are controlled for. In that sense this reinforces the limited information content from the regional decomposition of bivariate associations. However, the limited regional variation is in itself an important result. The results should not be viewed as the final word on any regional variation. These associations are likely to evolve as the English economy recovers, for example. Future, more detailed analysis with longer periods of time underpinning the analysis will allow us to see how these relationships do evolve.

Figure 43. Polychoric correlations between capital investment expectations and other variables, by region



Part 2: Multivariate analysis

While the correlation analysis conducted above can provide a picture of how different variables within the survey relate, such measurement is partial. It is because there are other factors that are not controlled for in the analysis. To formally assess the relationship between various sets of variable in the survey, we estimate ordered probit and probit models on the pooled dataset (across respondents and across time)[33].

When analysing repeated cross-section data, we need to control for shocks that could bias our results. Such shocks could be on a macroeconomic level. That is shocking the country as a whole. Approaches to control for such events can be via the inclusion of macro level variables, such as the change in the level of GDP. But there is always a risk that the included macro variables do not capture a specific shock. For example, trade shocks propagate through the economy with a lag[34]. As such the GDP variables included may not capture the shock at the appropriate point in time for the analysis. We therefore adopt a more typical approach by including sets of dummy variables to control for each month in the sample period. The inclusion of monthly dummy variables also allows us to control for upward trends in the data that are unrelated to workplace specific factors (see Sakellaris, 2004 for example).

Another possible shock to the UK economy is the deterioration in credit conditions for SMEs that is beyond what economic fundamentals can explain (see Armstrong et al, 2013). Such a shock is likely captured by a set of dummy variables that control for

[33] The analysis is undertaken using the svy suite of commands in stata, which allow us to control for the complex survey design of the EBS.
[34] A feature of the Great Recession of 2008-9 was a negative trade shock at a global level.

workplace size. But shocks can manifest at a variety of different levels (even workplace level). We also introduce a series of control variables for industry and region to control for shocks at these particular levels as well as any fixed variation explained by these factors[35].

The models we estimate in this part of our analysis are as follow:

Output:

1. Output performance on employment performance, total number of hours worked, and capital investment performance
2. Output expectations on employment expectations, capital investment expectations

Labour demand:

3. Employment performance on output performance, labour utilisation in reference month and labour cost performance
4. Total number of hours worked on output performance, labour utilisation in reference month and labour cost
5. Employment expectations on output expectations, labour utilisation in reference month and labour cost expectations

Investment decision:

6. Investment performance on output performance and capital utilisation in reference month
7. Investment expectations on output expectations and capital utilisation in reference month

For 1 to 5, the models we estimate are ordered probit as the dependent variables are of categorical order[36]. While for 6 and 7, the models we estimate are probit model since the dependent variable is binary[37]. We also estimate for each of the models a version including and a version excluding the dummy variables for employment size[38], industry and region. We also perform F-test to test for the joint significance of each set of dummies separately[39].

In these models the variable underlying the responses are latent. As such, the estimated thresholds (or cut-points) are the values such that when the latent variable y* passes them, the observed category changes. In other words, it is the value in the unobserved y*

[35] Due to small sample sizes we have merged the capital intensive industries: mining and quarrying; electricity, gas, steam and air condition; and water supply, sewage and waster management.
[36] We use the oprobit command in Stata.
[37] We use the probit command in Stata.
[38] Workplace size is measured by the number of employees.
[39] The full estimation results are presented in the Appendix E. The F-test referred to is an adjusted Wald test implemented with the Stata command testparm.

that distinguish the observed categories when the explanatory variables are evaluated at zero. In the case of our ordered probits when there are 3 categories (lower, same, higher), threshold 1 refers to the point in the latent variable y* that separates "lower" and "the same" categories, while threshold 2 is the point in the latent variable y* that separates "the same" and "higher". Therefore, when y* is less than the value of threshold 1, we observe "lower"; between thresholds 1 and 2, we observe "the same"; but if it is greater than threshold 3, we observe "higher"[40].

Model 1: Output performance

Table 16 presents the ordered probit estimation result of output performance on employment performance, total number of hours worked and capital investment performance[41]. All three explanatory variables are highly significant whether the model includes the dummies that control for employment size, industry, region and month. When these control dummies are included in the model, the values of the estimated coefficients are marginally reduced. The coefficients of all three dependent variables are greater than zero, indicating their positive relationships with output performance. The magnitude of the coefficient of total number of hours worked appear to be greater than that of the employment performance. The number of hours worked variable also has a larger t-statistic associated with it than the employment performance variables, signalling a more significant impact on output performance. This finding is in line with that in Table 12.

Results of the F-test for joint significant show that the employment size, industry and month dummy variables are all significant, indicating these control variables are correlated with explaining past output performance. However, there is no evidence of regional control variables providing a significant contribution to explaining past output performance. A separate specification that includes the standard explanatory variables but only the regional dummy variables still resulted in no significant regional fixed effects[42]. Interestingly, there does not appear to be a Jubilee effect in these results. The June 2012 fixed effect (relative to the November 2011 reference category) is positive. This may be due to seasonal factors, in that seasonally adjusting the data would lead to a negative effect for June 2012. But it is noticeable in contrast to the bivariate correlation, in particular those reported in Figure 26, which seem to suggest a Jubilee effect.

[40] See Appendix C for more details and relevant references.
[41] Detailed results from the estimation with employment size, industry, region and wave controls can be found in Table E1.
[42] These results are available from the authors upon request.

Table 16. Summary of ordered probit of output performance

Dependent variable: output performance	Without set of additional dummy variables			With set of additional dummy variables		
Explanatory Variables	estimated coefficient	Standardised coeff.	t-statistic	Estimated coefficient	Standardised coeff.	t-statistic
Employment performance	0.318 (0.022)	0.309	14.43	0.311 (0.022)	0.295	14.03
Total number of hours worked	0.871 (0.018)	0.846	47.95	0.856 (0.018)	0.811	46.84
Capital investment performance	0.125 (0.021)	0.121	5.86	0.094 (0.022)	0.089	4.30
Threshold 1	1.850 (0.047)	1.797	39.56	1.752 (0.067)	1.660	26.07
Threshold 2	2.942 (0.050)	2.858	58.40	2.859 (0.070)	2.707	40.81
Results of joint significant test on the set of additional dummy variables						
	F-test stat	Degrees of freedom	p-value of F-test			
Employment size	15.03	6	0.00			
Industry	7.71	16	0.00			
Region	0.70	8	0.69			
Wave (time dummy variables)	6.73	15	0.00			
Number of observations	43763					

Notes: standard errors in parentheses; derivation of standardised coefficients defined in appendix C, the additional set of dummy variables control for the employment size of the workplace, industry, region and wave (time dummy variables).

Model 2: Output expectations

Table 17 shows the ordered probit estimation result of output expectations on employment expectations and capital investment expectations[43]. Both explanatory variables are shown

Table 17. Summary of ordered probit of output expectations

Dependent variable: output expectations	Without set of additional dummy variables			With set of additional dummy variables		
Explanatory Variables	estimated coefficient	Standardised coeff.	estimated coefficient	Standardised coeff.	estimated coefficient	Standardised coeff.
Employment expectations	0.841 (0.020)	0.825	41.03	0.817 (0.021)	0.757	39.12
Capital investment expectations	0.064 (0.022)	0.063	2.93	0.057 (0.022)	0.053	2.56
Threshold 1	0.937 (0.041)	0.919	22.61	1.178 (0.062)	1.092	19.06
Threshold 2	1.990 (0.044)	1.951	45.53	2.267 (0.063)	2.102	35.70
Results of joint significant test on the set of additional dummy variables						
	F-test statistic	Degrees of freedom	p-value of F-test			
Employment size	4.09	6	0.00			
Industry	4.13	16	0.00			
Region	0.17	8	0.99			
Wave (time dummy variables)	47.91	15	0.00			
Number of observations	42700					

Notes: standard errors in parentheses; derivation of standardised coefficients defined in appendix C; the additional set of dummy variables control for the employment size of the workplace, industry, region and wave (time dummy variables).

[43] Detailed results from the estimation with employment size, industry, region and wave controls can be found in Table E2.

to be highly significant in relation to output expectations, whether the model include the set of dummies capturing different fixed effects or not. Though the values of the coefficients are reduced when fixed effects are included, the decrease is only marginal.

Joint significance tests on the dummies show employment size, industry and time fixed effects significant, the regional fixed effects are shown to be insignificant. A separate specification that includes the standard explanatory variables but only the regional dummy variables still resulted in no significant regional fixed effects[44].

Model 3: Employment performance

Table 18 reports the ordered probit estimation results where employment performance is regressed on output performance, labour utilisation and labour cost performance[45]. All estimated coefficients are greater than zero, indicating their positive conditional relationships with employment performance. Individual z-test shows they are also individually highly significant in explaining employment performance. These results hold regardless of whether the set of control dummy variables are included in the model. In fact when dummies are included, the magnitudes of the coefficients become marginally smaller.

The positive association between employment performance and labour cost performance is perhaps surprising. In a standard labour demand function you would expect a negative relationship between labour costs (mainly gross wages) and employment. The crucial difference is that we do not have estimates of the magnitude of any changes in employment nor labour costs. If nominal wages are downward sticky we should expect them to rise as employment does[46]. Without observing the magnitude of change this would plausibly result in a positive association in a model based on ordinal data. Overall, output performance changes dominate the estimated results, suggesting a close association with output performance and employment performance. Such results are consistent with empirical evidence, such as Hamermesh (1989) which showed a close degree of association between output and employment fluctuations in US manufacturing plants.

Over the past two years both nominal wages and employment have expanded, a result consistent with the above estimated equation. In fact, over the past two years nominal wages have expanded at a slower pace than producer prices, and relative to the price of investment goods. One of the proposed solutions to the productivity puzzle is that employees have been pricing themselves into work[47]. It is possible that the relationship we are observing is related to this. If UK productivity performance returns to 'normal' then the parameters in any such estimated equation (as in table 18) may well shift.

[44] These results are available from the authors upon request.
[45] Detailed results from the estimation with employment size, industry, region and wave controls can be found in Table E3.
[46] Yates (1998) suggests the empirical evidence for downward nominal wage rigidities is mixed.
[47] Crawford et al (2013) have provided some empirical evidence of this for SMEs, using firm level data.

Table 18. Summary of ordered probit of employment performance

Dependent variable: employment performance	Without set of additional dummy variables			With set of additional dummy variables		
Explanatory Variables	estimated coefficient	Standardised coeff.	Estimated coefficient	Standardised coeff.	estimated coefficient	Standardised coeff.
Output performance	0.408 (0.014)	0.397	29.02	0.401 (0.014)	0.389	28.15
Labour utilisation	0.048 (0.018)	0.047	2.63	0.050 (0.019)	0.049	2.69
Labour cost performance	0.433 (0.023)	0.422	18.70	0.425 (0.023)	0.413	18.37
Threshold 1	0.577 (0.056)	0.562	10.24	0.405 (0.076)	0.393	5.36
Threshold 2	3.017 (0.062)	2.941	48.45	2.864 (0.080)	2.780	35.75
Results of joint significant test on the set of additional dummy variables						
	F-test statistic	Degrees of freedom	p-value of F-test			
Employment size	7.05	6	0.00			
Industry	11.54	16	0.00			
Region	1.41	8	0.19			
Wave (time dummy variables)	1.69	15	0.05			
Number of observations	44584					

Notes: standard errors in parentheses; derivation of standardised coefficients defined in appendix C; the additional set of dummy variables control for the employment size of the workplace, industry, region and wave (time dummy variables).

Results of the F-test for joint significance show the employment size and industry dummy variables are highly significant in explaining employment performance change. The null hypothesis of joint insignificance is rejected for both sets of dummy variables. The regional fixed effects, again, are found to be insignificant. However, when only the regional dummy variables are included alongside the standard explanatory variables, there is some evidence of regional fixed effects. These fixed effects are jointly significant at only the 10 per cent level. The inclusion of the employment size and industry fixed effects suggests that perhaps the regional dummy variables are capturing some small regional variation in these fixed effects and so are significant when these other fixed effects are not included[48]. The dummy variables for months can be rejected only marginally; the set is jointly significant at the 5 per cent level.

Model 4: Total number of hours worked

Table 19 reports the estimation results of the ordered probit of total number of hours worked[49]. Output performance, labour utilisation in reference month and labour cost performance are all found to be highly significant in explaining the total number of hours worked. Among the three explanatory variables, performance output are found to be more significant in explaining the total number of hours worked as signalled by a larger value of t-statistics; while labour utilisation in the reference month is found to be the least significant among the three. The estimated coefficients on the explanatory variables are also found to be greater than zero, signalling positive relationships with the number of total hours worked.

The results are similar to those reported for employment performance (see Table 18). We observe the same positive relationship between labour cost performance and total hours worked, all else equal. Again, this is likely due to the categorical nature of the data, whereas replicating the analysis with continuous variables could well lead to a negative relationship. Of note in the comparison with model 3 is the higher t-statistics for output performance and labour utilisation in the total hours worked regression than in the employment performance regression. Workplaces can more readily respond to changes in demand through changing the working hours of those currently employed, especially in a period of heightened uncertainty. The fact that these t-statistics are greater in the past hours regression may be an indication of this. These results are also consistent with the findings from the polychoric correlations estimated in the first part of this section. There the correlation between total number of hours worked and output performance was greater than between past employment and past output performance. This association holds, even when we estimate conditional correlations via this multivariate analysis. The degree to which this pattern persists as the economy recovers will be of particular interest.

F-test for joint significance shows that the industry and time dummy variables are highly significant in explaining total number of hours worked. However, the evidence for regional variation still proved to be insignificant, as the results from the reported F-test show. A separate specification that includes the standard explanatory variables but only the

[48] These results are available from the authors upon request.
[49] Detailed results from the estimation with employment size, industry, region and wave controls can be found in table E4.

regional dummy variables still resulted in no significant regional fixed effects[50]. The employment size dummy variables were significant at 5 per cent but not at 1 per cent level.

Table 19. Summary of ordered probit of total number of hours worked

Dependent variable: Hours worked	Without set of additional dummy variables			With set of additional dummy variables		
Explanatory Variables	estimated coefficient	Standardised coeff.	estimated coefficient	Standardised coeff.	estimated coefficient	Standardised coeff.
Output performance	0.679 (0.014)	0.633	46.97	0.672 (0.015)	0.615	46.22
Labour utilisation	0.290 (0.018)	0.271	16.23	0.297 (0.018)	0.272	16.34
Labour cost performance	0.468 (0.023)	0.437	20.20	0.469 (0.023)	0.429	20.17
Threshold 1	1.933 (0.060)	1.802	32.11	1.837 (0.077)	1.682	23.84
Threshold 2	3.857 (0.068)	3.596	57.03	3.777 (0.083)	3.459	45.68
Results of joint significant test on the set of additional dummy variables						
	F-test statistic	Degrees of freedom	p-value of F-test			
Employment size	2.54	6	0.019			
Industry	2.98	16	0.000			
Region	0.8	8	0.600			
Wave (time dummy variables)	8.33	15	0.000			
Number of observations	44353					

Notes: standard errors in parentheses; derivation of standardised coefficients defined in appendix C; the additional set of dummy variables control for the employment size of the workplace, industry, region and wave (time dummy variables).

[50] These results are available from the authors upon request.

Model 5: Employment expectations

Table 20 reports the ordered probit estimation result of employment expectations on output expectations, labour utilisation in reference month and labour cost expectations[51]. Again, all coefficients of the explanatory variables are proved to be highly significant in explaining employment expectations, as well as positively (conditionally) correlated with employment expectations. These results hold regardless of which fixed effect dummies are included in the model to capture variation due to different sources. Inclusion of dummies reduces the magnitude and the significance of the coefficients, but the reduction is once again marginal, consistent with the findings from other models above. Output expectations and labour cost expectations are found to be more significant in explaining employment expectations, as indicated by larger values of the t-statistics, than labour utilisation in reference month.

Again labour costs, at first glance, should not be positively associated with employment expectations, if a workplace is operating with a downward sloping labour demand curve. However, we should note that the cross-sectional nature of the data limits us from estimating a dynamic labour demand curve for these workplaces. The results presented are effectively estimates of a static relationship.

Employment size dummies, industry dummies and time dummies are found to be significant in explaining future employment as the hypothesis of joint insignificant is rejected for the F-tests conducted for the three sets of dummies. Regional variation are still found to be insignificant in explaining the dependent variable as the hypothesis that the regional dummies jointly equal to zero cannot be rejected. As in the case of employment performance (reported in Table 18) a separate specification that included the standard explanatory variables but only the regional dummy variables did suggest that there were some significant regional fixed effects in explaining the probability of employment change expectations[52].

[51] Detailed results from the estimation with employment size, industry, region and wave controls can be found in Table E5.
[52] These results are available from the authors upon request.

Table 20. Summary of ordered probit of employment expectations

Dependent variable: Employment expectations	Without set of additional dummy variables			With set of additional dummy variables		
Explanatory Variables	estimated coefficient	Standardised coeff.	estimated coefficient	Standardised coeff.	estimated coefficient	Standardised coeff.
Output expectations	0.517 (0.015)	0.486	35.43	0.507 (0.015)	0.457	33.82
Labour utilisation	0.151 (0.018)	0.142	8.57	0.150 (0.018)	0.135	8.22
Labour cost expectations	0.567 (0.022)	0.533	25.61	0.562 (0.022)	0.507	25.05
Threshold 1	1.272 (0.063)	1.196	20.30	1.370 (0.077)	1.235	17.82
Threshold 2	3.812 (0.072)	3.582	53.09	3.930 (0.084)	3.543	46.54
Results of joint significant test on the set of additional dummy variables						
	F-test statistic	Degrees of freedom	p-value of F-test			
Employment size	4.35	6	0.000			
Industry	7.15	16	0.000			
Region	1.6	8	0.119			
Wave (time dummy variables)	3.35	15	0.000			
Number of observations	44322					

Notes: standard errors in parentheses; derivation of standardised coefficients defined in appendix C; the additional set of dummy variables control for the employment size of the workplace, industry, region and wave (time dummy variables).

Model 6: Capital investment performance

Table 21 reports the probit estimation of capital investment performance on output performance and capital utilisation in the reference month, with a constant[53]. Both explanatory variables are found to be positively (conditionally) related to capital investment performance regardless of the model conditional on the sets of dummies. The t-statistics of output performance is larger than that of capital utilisation in reference month, indicating a stronger impact of the former on capital investment performance. Both signs on the coefficients are what we broadly expect. Increases in output performance are associated with increases in investment performance. Higher current utilisation of capital is associated with increases in investment performance. We need to be somewhat careful with the interpretation of the relationship between utilisation and investment performance. For example, if the utilisation still high even though the capital investment has happened. It could be that the investment has not yet been involved in the production process[54]. The capital investment might already be in use in the production process by the time the reference month with which the utilisation question refers, but utilisation remains high. Alternatively, current capital utilisation may be little related to investment performance. The coefficient on utilisation is small in magnitude, and less than half of that associated with investment expectations (Table 22).

The inclusion of the set of control dummy variables reduces the significance of the explanatory variables somewhat, while reducing the magnitude of the coefficients further. F-tests reveal significant employment size and industry fixed effects to be significant at the 1 per cent level, but with again no significance for regional fixed effects. A separate specification that includes the standard explanatory variables but only the regional dummy variables still resulted in no significant regional fixed effects[55]. Interestingly, there is no evidence of the significance of including the wave dummy variables. This could well be related to the absence of any meaningful investment growth over the period the EBS has been running for. While, we make no allowance for the magnitude of investment, which is likely to vary significantly by workplace, this should at least be captured by the employment size, and in particular the industry fixed effects. Indeed, Table E6, shows this to be the case, with investment increasing alongside workplace size and production based industries investing more than the wholesale and retail sector.

[53] Detailed results from the estimation with employment size, industry, region and wave controls can be found in Table E6.
[54] For example, the delivery of a new set of computers to an office, but they have yet to be set up for staff to use.
[55] These results are available from the authors upon request.

Table 21. Summary of probit of capital investment performance

Dependent variable: Capital investment performance	Without control variables for employment size, industry, region and wave		With control variables	
Explanatory Variables	estimated coefficient	t-statistic	estimated coefficient	t-statistic
Output performance	0.122 (0.014)	8.88	0.098 (0.014)	6.92
Capital utilisation	0.080 (0.025)	3.28	0.055 (0.025)	2.16
Constant	-1.040 (0.050)	-20.69	-1.045 (0.077)	-13.56
Results of joint significant test on dummies				
	F-test statistic	Degrees of freedom	p-value of F-test	
Employment size	69.36	6	0.000	
Industry	20.41	16	0.000	
Region	0.46	8	0.886	
Wave (time dummies)	1.41	15	0.134	
Number of observations	43591			

Notes: standard errors in parentheses; the additional set of dummy variables control for the employment size of the workplace, industry, region and wave (time dummy variables).

Model 7: Summary of probit of capital investment expectations

Table 22 presents the probit estimation of capital investment expectations on output expectations and capital utilisation in the reference month[56]. Both explanatory variables are found to be positively and significantly related to capital investment expectations, regardless of whether the model includes the sets of dummy variables to capture different fixed effects. Though similar to all other models presented above, inclusion of dummies reduce the level of significance of the explanatory variables but only very marginally. As we have noted above, current capital utilisation has a greater positive association with output expectations than output performance. One would expect such a relationship to

[56] Detailed results from the estimation with employment size, industry, region and wave controls can be found in Table E7.

exist, whereby, current capacity constraints induce investment in order for a workplace/firm to meet future increases in demand.

The absence of an economic recovery, to date, and uncertainty about future demand are likely infecting investment decisions. As business confidence returns and uncertainty diminishes we should expect to see a pick-up in investment. This will coincide and likely support a sustained economic recovery. As the economy changes up a gear or two, we may well see the coefficients in this estimated equation rise. It will be useful to test different parameter estimates over different sample periods in light of this potential outcome.

Joint significance test results reveal significant employment size, industry and time fixed effect in future capital investment. But regional fixed effects are once again found to be insignificant. A separate specification that includes the standard explanatory variables but only the regional dummy variables still resulted in no significant regional fixed effects[57]. In contrast to the estimated model for capital investment performance, there is a significant role for the wave dummy variables in explaining the probability of expecting future capital investment. Only three waves are significantly different from the reference category, but they are all negative effects, perhaps suggesting a drop in business optimism that affected investment decisions in comparison to the reference month. However, these negative months are May, September and October 2012 (see Table E7) and it is difficult to see what might have infected this business optimism relative to November 2011 when domestic and global economic prospects had already deteriorated markedly.

[57] These results are available from the authors upon request.

Table 22. Summary of probit of capital investment expectations

Dependent variable: Capital investment expectations	Without control variables for employment size, industry, region and wave		With control variables	
Explanatory Variables	estimated coefficient Standard error	t-statistic	estimated coefficient	t-statistic
Output expectations	0.125 (0.014)	8.78	0.119 (0.015)	7.91
Capital utilisation	0.190 (0.024)	7.96	0.154 (0.025)	6.23
Constant	-1.338 (0.058)	-22.89	-1.391 (0.084)	-16.59
Results of joint significant test on dummies				
	F-test statistic	Degrees of freedom	p-value of F-test	
Employment size	67.71	6	0.000	
Industry	12.39	16	0.000	
Region	0.58	8	0.798	
Wave (time dummies)	1.91	15	0.018	
Number of observations	42340			

Notes: standard errors in parentheses; the additional set of dummy variables control for the employment size of the workplace, industry, region and wave (time dummy variables).

Conclusions

As our results show the balance statistics provide a particular interesting source of information and analysis. As the EBS extends its time series it has the potential to be a very useful source of real-time data on the state of the economy. A survey of this coverage and sample size is a very welcome complement to the existing data published by a variety of organisations.

The EBS compares favourably to the currently available business surveys in terms of sample size and coverage of the economy. The sampling frame used in the EBS allows the sample selected to be far more representative of the English population of workplaces.

Our aggregate level analysis provides some tentative evidence of the real time information content of the EBS with regards to the 'current' state of the English economy. Issues such as a small sample size and the seasonally unadjusted nature of the output data, make us somewhat cautious with regards to over-interpreting the results. Nevertheless, this initial foray into the EBS balance statistics is promising. As we have shown, there is some tentative evidence of the output performance balance statistic leading GDP developments.

The results for the analysis of the employment balance statistics were even more promising. Seasonal factors are not an issue in this analysis, which strengthens the case for the information content of the EBS balance statistics in providing real-time information about the state of the English economy. Again, a small time series means we must remain cautious over the robust interpretations of our results, but the results are supportive of further investigation as we cumulate yet more waves into the time series.

The workplace level analysis estimated the relationships between, in turn, output, labour input (employment and hours worked) and investment with a set of explanatory variables. Polychoric correlations formed the basis of the bivariate exploration. Within this, there was some noticeable time variation, possibly due to special events such the reduction in working days associated with the Queen's Jubilee Celebrations. While there was wide variation in the correlation between different pairwise subsets of variables, there appeared to be little in the way of regional variation.

This lack of regional variation was also an outcome of the results from the multivariate analysis. Here we estimated conditional correlations using ordered probit models (probit models in the case of the investment series). The magnitudes of the estimated coefficients and their associated t-statistics changed little with or without controls for workplace size, industry, region and month. But when the other control variables were included there was no evidence of any regional fixed effects in any of the seven models estimated.

The categorical nature of the data can at times lead to what appear to be the opposite sign on a coefficient from what might be expected. The core example of this in our results is the positive coefficient for labour cost in the past employment, past number of hours and future employment models. In labour demand models what matters is the real producer wage[58]. In the current economic environment, where there is the absence of productivity

[58] Wages deflated by output prices.

growth, nominal wages would need to be growing at a slower rate than producer prices in order for employees to 'price' themselves into employment. Dale (2012) shows how this fall in the real producer wage has evolved over the past few years, and certainly over the course of the existence of the EBS.

The scope of the analysis is deliberately broad. The results published in this report are just the initial foray into the EBS. As more data is released, more detailed and sophisticated analysis can be undertaken. More detailed analysis of key economic and policy relevant questions is the logical next step. Focusing on specific questions rather than taking a broad approach, such as in this report. The timely nature of the data means that BIS analysts can inform policy teams in near real time about developments at a subnational level using the workplace data.

Suggestions for future analysis of the EBS

While exploration analysis reveals some useful informational content that can be useful for policy-making, the analysis undertaken also reveals some drawbacks of data available for this analysis in its current form, and hence there is room for improvements in future research.

Future detailed analysis of the properties of the data would be a useful exercise. With the exception of the EBS, the publically available information on business surveys is somewhat limited. It would be useful to arrange a series of interviews with survey managers to enable a detailed comparison of methodologies used in the different business surveys.

The EBS is a not seasonally adjusted. With only 16 months of data available it is not yet possibly to apply seasonal adjustment. The ONS follows Eurostat guidelines with respect to seasonal adjustment. These state that at least three years of a time series are required before seasonal adjustment can be applied via a standard procedure such as X-12-ARIMA. Until there are 7 years of data, a 'health' warning needs to be attached as the seasonal adjustment parameters can be unstable. Prior to the three year period, Eurostat advice is to avoid seasonal adjustment (Eurostat, 2009).

Once three years of data are available, it would be useful for BIS to begin to explore seasonal adjustment of the headline EBS balance statistics. In the interim, one possible approach for BIS would be to consider is to use existing business surveys to backcast the EBS, in order to provide a time series of enough length to seasonally adjust. These synthetic EBS balance statistics would also likely enable to exploitation of the EBS in the derivation of nowcasting models for the English economy. One obvious flaw to this is the absence of GDP volume data for England. However, this is not an issue for employment, where a time series of reasonable length for England is already published by the ONS.

Further exploration would formally investigate alternative grossing factors, not just for output, but for balance statistics such as investment as well. While our results were insensitive to the choice of grossing factor, we should not assume that this will hold for all data periods. This would, however, open the EBS up to revision, as adjustments to the historical data in the Regional Accounts due to revisions to the Quarterly National Accounts, for example, would mean adjustments to the grossing factors. The EBS is sampled on a NUTS2 geographical basis and it would be useful to examine the sensitivity of these alternative grossing factors to the choice of geographical level.

As well as the above suggestion to further analysis, the business survey could be further improved by revising the survey design. Respondents report their qualitative answers accordingly to their subjective probability distribution. This applies, especially, to expectational data as expectations are respondents' subjective beliefs about the uncertainty of the future. If respondents answer according to their subjective beliefs, there is no reason to assume the same thresholds apply to all survey respondents and across time. The level of change that is regarded as "higher" to respondent A, may just be "the same" to respondent B. This is true not only for answers to questions on expectations but also to answers on questions about performance.

Das et al. (1999) discuss three distinct situations that survey respondents report their answers based on the mode, the median or the mean of the subjective density of their expectation. Lui et al. (2011b) follow their approach and non-parametric test and also introduce a weaker test on whether qualitative expectational data is informative about their quantitative counterpart at a firm-level. They argue there is an information loss when firms discretise their answers to the expectational question, and discretisation into different categories assumes firms' subjective density forecasts to be symmetric and unimodal. Their findings reveal that qualitative expectations are, although able to predict firms' qualitative realisations, fail to predict their quantitative realisations. Their paper explains this is due to the "discretisation errors" in addition to the "forecast errors". The two sources of errors weaken the signal of firms' qualitative expectations. Their paper suggests that indication to quantitative, especially probabilistic information in the answers could improve the survey. In other words, careful design of survey questions and especially the survey answers is essential in reducing the amount of information loss.

Furthermore, evidence in existing literature has shown that business survey data contains informational content about the state of economy. As a further analysis, it will be very useful to evaluate the forecasting and nowcasting power of the EBS. A natural way to conduct such evaluation would be, analogous to the analysis in Lui et al. (2011a), to carry out a micro-level comparison of qualitative answers provided to the business survey with the answers provided to other official surveys that collects quantitative answers. So as to assess its reliability and its predictive power. However, given the current design of EBS, there are two limitations that make such evaluation difficult. First of all, the survey consists of repeated cross-sections. Answers to the same workplaces are not traced, therefore it is impossible to trace the behavioural pattern. Any improvement of the survey should consider the implementation of a panel design to collect longitudinal data, as this would allow for more interesting and in-depth analysis of the business survey to be conducted. Secondly, the EBS samples workplaces; while existing quantitative surveys usually sample firms. There are likely to be solutions to such an issue, but this issue is rendered redundant until a survey of longitudinal design becomes available.

References

Armstrong, A. (2012) 'Scotland's currency and fiscal choices', *National Institute Economic Review*, No. 219, F4-F9.

Armstrong A, Davis E P, Liadze I and Rienzo C (2013), "Evaluating changes in bank lending to UK SMEs over 2001-12 – ongoing tight credit?", NIESR Discussion Paper No 408.

Ashley, J., Driver, R., Hayes, S. & Jeffery, C. (2005) 'Dealing with data uncertainty', *Bank of England Quarterly Bulletin*, Vol. 45, No. 1, pp. 23–29.

Bean, C. (1981) 'An Econometric Model of Manufacturing Investment in the UK', *Economic Journal*, Vol. 91, No. 361 (Mar., 1981), pp. 106-121.

Bond, S. and Van Reenen, J. (2007) 'Microeconometric models of investment and employment', In Heckman, J. and Leamer, E. (eds) *Handbook of econometrics: Volume 6A*, London: North-Holland.

Crawford, C., Jin, W. and Simpson, H. (2013) 'Productivity, investment and profits during the Great Recession: evidence from the UK firms and workers', *Fiscal Studies*, Vol. 34, No. 2, pp. 153-77.

Dale, S. (2012) *Sticky inflation*, Speech given at the Stationers' Hall, London, hosted by Market News International, 12 December.

Das, M., Dominitz, J. and van Soest, A. (1999), "Comparing predictions and outcomes: Theory and application to income changes", Journal of the American Statistical Association, Vol. 94, No. 445, p.75-85

Disney, R., Jin, W. and Miller, H. (2013) 'The productivity puzzles', in Emmerson, C., Johnson, P. and Miller, H. (eds), *IFS Green Budget: February 2013*, IFS: London.

Driver, C. and Urga, G. (2004), "Transforming qualitative survey data: performance comparison for the UK", *Oxford Bulletin of Economic Statistics*, 66, p.71-90

Eurostat (2009) *EES Guidelines on Seasonal Adjustment*, Eurostat methodologies and working papers.

Hamermesh, D. (1989) 'Labor Demand and the Structure of Adjustment Costs', *The American Economic Review*, Vol. 79, No. 4, pp. 674-689.

Hardie, M. and Perry, F. (2013) 'Special events in 2012: Impact of the Diamond Jubilee and London 2012 Olympics on the UK economy', available at: http://www.ons.gov.uk/ons/dcp171766_311487.pdf.

HMT (2009) *Pre-Budget Report 2009. Securing the recovery: growth and opportunity*, Cm 7747.

Lui, S., Mitchell, J. and Weale, M. (2011a), "Qualitative business surveys: Signal or Noise?", *Journal of the Royal Statistical Society Series A*, 174, 2, p.327-348

Lui, S., Mitchell, J. and Weale, M. (2011b), "The Utility of Expectational Data: Firm-Level Evidence Using Matched Qualitative-Quantitative UK Surveys", *International Journal of Forecasting*, 27, 1128-1146

Long, J. S. (1997), Regression Models for Categorical and Limited Dependent Variables, *Advanced Quantitative Techniques in the Social Sciences Volume 7*, SAGE Publications.

Long, J. S., and Freese, J. (2006), *Regression Models for Categorical Dependent Variables Using Stata*, Second Edition, Stata Press.

Mairesse, J., Hall, B. H. and Mulkay, B. (1999) *Firm-level investment in France and the United States: an exploration of what we have learned in twenty years*, NBER Working Paper 7437.

Mitchell, J., Matheson, T.D. and Silverstone, B. (2010) 'Nowcasting and predicting data revisions using panel survey data', *Journal of Forecasting*, 29, pp. 313-330.

Mitchell, J., Smith, R.J. and Weale, M. R. (2005) 'Forecasting manufacturing output growth using firm-level survey data', *Manchester School*, 73, pp. 479-499.

Mitchell, J. Smith, R. J., Weale, M. R., Wright, S. and Salazar, E. L. (2005) 'An Indicator of Monthly GDP and an Early Estimate of Quarterly GDP Growth', *Economic Journal*, No. 551, pp. F108-F129.

Kolenikov, S. and Angeles, G. (2004), *The Use of Discrete Data in PCA: Theory, Simulations, and Applications to Socioeconomic Indices*, CPC/MEASURE Working paper No. WP-04-85.

OECD (2013) *OECD Economic Surveys: United Kingdom*, Paris: OECD.

Olsson, U. (1979) "Maximum likelihood estimation of the polychoic correlation coefficient", *Psychometrika*, 44, No. 4, p.443-460.

Pesaran, M. H. and Weale, M. (2006), "Survey expectations". In *Handbook of Economic Forecasting*, vol.1 (eds G. Elliott, C.W.J. Granger and A. Timmermann), p.27-55. Oxford: Blackwell

Sakellaris, P. (2004) 'Patterns of plant adjustment', *Journal of Monetary Economics*, Vol. 51, No. 2, pp. 425-450.

TNS-BMRB (2012) *English Business Survey Technical Annex*.

Wooldridge J. M. (2002) *Econometric Analysis of Cross Section and Panel Data*, MIT Press.

Yates, A. (1998) 'Are prices and wages sticky downwards?', *Bank of England Quarterly Bulletin*, Vol. 38, No. 3, pp. 233-47.

Appendix A – Qualitative business surveys

The English Business Survey (EBS) [59]

(i) Sample frame, sample unit, sample coverage, sample method and response rate

The EBS sampling frame is the Inter-departmental Business Register (IDBR). The sample unit is the workplace (single local unit). All industries are covered, including the public sector. A stratified sampling method is used, where strata are based on NUTS2 geographies and the employment size of the workplaces. Sampling is a two-stage process: stage one is to select an annual sample, including all workplaces with 250+ employees. The second stage is to select a quarterly sample from this annual sample. Around 3,000 workplaces are covered every month.

The survey is carried out via telephone each month.

The response rate for the October 2011 reference month was 43.5 per cent of the sample with a matched telephone number. The response rate increased to 53 per cent in October 2012.

(ii) Period covered and publication frequency

The survey is conducted and published on a monthly basis by BIS. BIS also publish on a quarterly basis where using three months of pooled data to provide estimates at a sub-regional level (NUTS2)[60]. Time series starts from 2011m10 (the reference month, referred to as 2011m11 in TNS-BMRB (2012)).

(iii) Methodologies

The percentage balance statistic for most variables is computed as the weighted percentage of firms reporting "higher" (positive) less the weighted percentage of firms reporting "lower" (negative) responses. User missing values are coded as ‘no change’ for the purposes of deriving the balance statistic. The balance statistics derived from the EBS are bounded by per cent.

[59] TNS-BMRB (2012) *English Business Survey Technical Annex*.
[60] BIS in conjunction with TNS-BMRB provide a reporting tool that allows interested parties to produce LEP level estimates from the EBS: http://dservuk.tns-global.com/English-Business-Survey-Reporting-Tool/

(iv) Weighting

Responses to the EBS are weighted to represent the total employment in England. This is referred to as the 'economic importance' weight. It adjusts for NUTS2 geography, industry and workplace employment size.

(v) Seasonal adjustment method

Respondents to the EBS are not asked to take into account expected seasonal variation when providing their answers.

Purchasing Manager Index (PMI)

(i) Sample frame, sample unit, sample coverage, sample method and response rate

UK regional PMI covers manufacturing and service sectors. The survey is conducted for UK and 9 English regions, with additional series for Scotland, Wales and Northern Ireland. Over 1800 companies are covered[61].

The survey is carried out via mail, email, web, fax and phone in the second half of each month[62].

PMI aims to achieve a monthly response rate of about 80 per cent[63].

(ii) Period covered and publication frequency

The survey is conducted and published on a monthly basis.

(iii) Methodologies

A diffusion index, which is bounded between the values of 0 to 100, is computed for each variable in the survey. The value of 50 corresponds to no change on the previous month. A value that is greater (lower) than 50 means an increase (decrease) on the previous month. The extent of the deviation from the value of 50 indicates the magnitude of the rate of change[64].

[61] Markit UK Regional PMIs August 2012, Markit.
[62] PMI Survey Methodology, Markit
[63] PMI Survey Methodology, Markit
[64] Markit UK Regional PMIs August 2012, Markit

(iv) Weighting

Responses to the PMI are weighted according to industry group broken down into three employment size bands. Industry groups represent main activity within the sector, while employment sizes are classified into small, medium and large[65].

(v) Seasonal adjustment method

Respondents to the PMI are asked to take into account expected seasonal variation when providing their answers[66].

Regional Trends Survey (RTS)

Note that the results of RTS are no longer published. The time series is still updated by the CBI and published through data delivery services such as Datastream.

(i) Sample frame, sample unit, sample coverage, sample method and response rate

RTS is derived from the Industrial Trends Survey (ITS) of the CBI. It is the regional manufacturing dimension of the ITS. The ITS is conducted both monthly and quarterly, with the RTS available on a quarterly basis. The same sample of firms in manufacturing is used every month[67].

The survey covers UK manufacturing firms and it is carried out among CBI's members only. It covers UK and Standard Statistical Regions of the UK. There are in total 11 regions, including Scotland and Ireland[68].

Postal questionnaires are sent to survey participants. Online ad hoc survey is also used. Telephoning significant participants is conducted to deal with unit non-response. Imputation method (when appropriate), telephoning, or referring to publically available sources is used to deal with item non-response if the item non-response is about the number of employees or other more static non-trend question[69].

[65] Markit UK Regional PMIs August 2012, Markit
[66] PMI Survey Methodology, Markit
[67] http://www.cbi.org.uk/business-issues/economy/business-surveys/industrial-trends-survey/
[68] Technical Note, CBI/Experian Regional Trends Survey No.72- August 2008
[69] http://www.cbi.org.uk/business-issues/economy/business-surveys/survey-methodology/

(ii) Period covered and publication frequency

RTS was published quarterly, starting in 1992Q2. The publication months are February, May, August and November.

(iii) Methodologies

The percentage balance statistic of the ITS, and thus should be same for RTS, is computed as the weighted percentage of firms reporting "up" (positive) less the weighted percentage of firms reporting "down" (negative) [70]. The balance statistics derived from the RTS are bounded by ± 100 per cent.

(iv) Weighting

Follows the same weighting method used by the CBI Survey for weighting the results. Respondents' industrial sector, net output and employment size are used to weight the results. The weights are computed from the value-added data produced by the ONS[71].

(v) Seasonal adjustment method

Respondents to the ITS are asked to take into expected seasonal variation when providing their answers[72].

Quarterly Economic Survey (QES)

(i) Sample frame, sample unit, sample coverage, sample method and response rate

The QES is conducted by the British Chamber of Commerce (BCC). The QES covers the UK and 12 UK regions in total, including Scotland and Northern Ireland. It is carried out among manufacturing firms and services firms[73].

More than 7500 businesses respond to the QES each quarter[74]. Survey is conducted by questionnaires via the post and online[75].

[70] http://www.cbi.org.uk/business-issues/economy/business-surveys/industrial-trends-survey/
[71] Technical Note, CBI/Experian Regional Trends Survey No.72- August 2008.
[72] Technical Note, CBI/Experian Regional Trends Survey No.72- August 2008
[73] British Chambers of Commerce, Quarterly Economic Survey, 3rd Quarter 2012
[74] http://www.britishchambers.org.uk/policy-maker/economic-data/quarterly-economic-survey/
[75] British Chambers of Commerce, Quarterly Economic Survey, 3rd Quarter 2012

(ii) Period covered and publication frequency

QES is published quarterly.

Time series coverage of the survey is back to 1989Q1.

(iii) Methodologies

Balance statistics are computed as the percentage of companies reporting increases less the percentage of companies reporting decreases[76].

(iv) Weighting

Responses to the QES are weighted according to the actual distribution of companies by employment size[77].

(v) Seasonal adjustment method

No seasonal adjustment is made to the data.

Business Confidence Monitor (BCM)

(i) Sample frame, sample unit, sample coverage, sample method and response rate

The BCM survey is carried out among The Institute of Chartered Accountants in England and Wales (ICAEW) members' working in industry and commerce. The survey covers all production industries (Energy, Water and Mining; Manufacturing and Engineering); construction; and all service industries (Retail and Wholesale; Transport and Storage; IT and Communications; Banking, Finance and Insurance; Property; Business Services)[78].

The survey covers 9 English regions, English total, and Scotland, Wales and Northern Ireland[79].

[76] British Chambers of Commerce, Quarterly Economic Survey, 3rd Quarter 2012
[77] British Chambers of Commerce, Quarterly Economic Survey, 3rd Quarter 2012
[78] UK Business Confidence Monitor Report Q1 2013, Appendices and Tables, ICAEW/Grant Thornton; http://www.icaew.com/~/media/Files/About-ICAEW/What-we-do/business-confidence-monitor/2013/7176bcmq113appendixv3pdf.pdf
[79] UK Business Confidence Monitor Report Q1 2013, Appendices and Tables, ICAEW/Grant Thornton; http://www.icaew.com/~/media/Files/About-ICAEW/What-we-do/business-confidence-monitor/2013/7176bcmq113appendixv3pdf.pdf

Quarterly aggregate data are obtained from the latest 1000 interviews for the quarter. About 4000 telephone interviews are conducted every year with ICAEW members in the industry and commerce[80].

(ii) Period covered and publication frequency

BCM is published quarterly.

Time series of BCM starts from 2005Q3.

(iii) Methodologies

A scoring method is used to compute the Business Confidence Index (BCI) from the responses to the question that asks about respondents' confidence in the economic prospect over the next 12 months as compared to the previous 12 months. Each response to this question is given a score: score of +100, +50, 0, -50 and -100 correspond to "Much more confident", "Slightly more confident", "As confident", "Slightly less confident", "Much less confident", respectively. An average score is then computed. Using this scoring method, the BCI is therefore bounded between -100 to +100[81].

(iv) Weighting

Responses to the BCM are weighted according to regional location, company size (number of employees) and industry sector. The 2009 GVA data published by the ONS is used to derive the target weights for sector and region. While the turnover data for the start of 2011 published by the Small Business Analytical Unit of the Department for Business, Innovation and Skills are used to derive the weights for company size[82].

(v) Seasonal adjustment method

No seasonal adjustment is made to the data.

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[80] UK Business Confidence Monitor Report Q1 2013, Appendices and Tables, ICAEW/Grant Thornton; http://www.icaew.com/~/media/Files/About-ICAEW/What-we-do/business-confidence-monitor/2013/7176bcmq113appendixv3pdf.pdf

[81] UK Business Confidence Monitor Report Q1 2013, Appendices and Tables, ICAEW/Grant Thornton; http://www.icaew.com/~/media/Files/About-ICAEW/What-we-do/business-confidence-monitor/2013/7176bcmq113appendixv3pdf.pdf

[82] UK Business Confidence Monitor Report Q1 2013, Appendices and Tables, ICAEW/Grant Thornton; http://www.icaew.com/~/media/Files/About-ICAEW/What-we-do/business-confidence-monitor/2013/7176bcmq113appendixv3pdf.pdf

Appendix B – Autocorrelations of the aggregate series

To examine whether different series exhibit auto (or serial) correlation i.e. whether the current value of a series is correlated with its past value, we compute the autocorrelation coefficients. The Portmanteau Q-statistics and the corresponding p-value for testing the hypothesis of no presence of autocorrelation are also presented. We use the maximum number of observations (i.e. 15). We compute the autocorrelation for up to 5 lags. The results are reported in Table B1 to Table B4.

Table B1. Autocorrelation of the output performance balance statistic

Lag	Auto-correlation	Portmanteau Q	Prob>Q
1	0.306	1.7052	0.1916
2	-0.1704	2.2745	0.3207
3	-0.5856	9.5617	0.0227
4	-0.3118	11.816	0.0188
5	0.1834	12.674	0.0266

Table B2. Autocorrelation of the output expectation balance statistic

Lag	Auto-correlation	Portmanteau Q	Prob>Q
1	0.451	3.704	0.0543
2	-0.0612	3.7775	0.1513
3	-0.4606	8.2861	0.0405
4	-0.2189	9.3971	0.0519
5	0.0559	9.4767	0.0915

Table B3. Autocorrelation of the employment performance balance statistic

Lag	Auto-correlation	Portmanteau Q	Prob>Q
1	0.4517	3.7162	0.0539
2	0.1779	4.3367	0.1144
3	-0.2167	5.3347	0.1489
4	-0.2208	6.4645	0.167
5	0.0604	6.5575	0.2557

Table B4. Autocorrelation of the employment expectation balance statistic

Lag	Auto-correlation	Portmanteau Q	Prob>Q
1	0.6484	7.6586	0.0057
2	0.1628	8.1785	0.0168
3	-0.1804	8.8698	0.0311
4	-0.2319	10.116	0.0385
5	-0.2151	11.296	0.0458

The null hypothesis (H0) of the Portmanteau Q-test is the series appears to have no autocorrelation. If the p-value corresponds to the test statistics is less than 0.05, we reject the null hypothesis of no autocorrelation at 5 per cent significance level. i.e. the series exhibit autocorrelation.

Rejection of the null hypothesis of no autocorrelation in prospective series means output/employment expectation made at current reference month is correlated with expectation made at past reference months. While rejection of the null hypothesis in retrospective series means current output/employment trend is correlated to past output/employment trend.

We should note that the presence of autocorrelation does not imply workplaces based their current answers on their past answers. The sample is a repeated cross-section rather than a longitudinal survey.

For the balance of output performance, we cannot reject H0 at the first 2 lags. However, H0 is rejected from at higher lags (lag 3 to lag 5). It means the current values of balance of past output appear to be correlated with its values 3 to 5 periods ago, although such correlation appear to be negative at lag 3 and 4.

However for the balance of output expectation, there is evidence that its current value is correlated with its first lag but not the second lag, and hardly correlated with its values at higher lags.

Current value of the balance of past employment does not appear to be correlated with its lagged values at all as H0 of no autocorrelation cannot be rejected for all 5 lags. While for the balance of employment expectation, there is evidence that its current value is correlated with its first 5 lags, although the correlations appears to be negative between its current value and its lagged 3 to 5 values.

We have also tested for the presence of autocorrelation in the two quantitative aggregate series we use for the above analysis, for completeness. The results are reported in Table B5 and Table B6.

Table B5. Autocorrelation of GDP growth

Lag	Auto-correlation	Portmanteau Q	Prob>Q
1	0.3593	2.3517	0.1251
2	0.1986	3.125	0.2096
3	-0.3509	5.7421	0.1249
4	-0.1065	6.0053	0.1988
5	-0.1756	6.7916	0.2366

Note: Series is a quarterly growth rate of the 3-month rolling average of employment; seasonally adjusted; GDP at basic prices.

Table B6. Autocorrelation of employment growth

Lag	Auto-correlation	Portmanteau Q	Prob>Q
1	0.7997	11.648	0.0006
2	0.4426	15.491	0.0004
3	0.1535	15.991	0.0011
4	-0.0888	16.174	0.0028
5	-0.3125	18.664	0.0022

Note: Series is a quarterly growth rate of the 3-month rolling average of employment; not seasonally adjusted.

The null hypothesis of no autocorrelation cannot be rejected for the growth rate of the rolling 3-month average of monthly GDP at all lags. However, autocorrelation in the 3-month growth of the LFS employment is clearly rejected at all lags, indicating the current value of the series is correlated with its past values.

Appendix C – The estimation methods

In each wave of the EBS survey, each workplace, *i*, is asked to give answers to the qualitative questions set out in the survey questionnaire. Depending on the questions, almost all of the questions of our interests that have been analysed using statistical models involve three categorical answers. These questions include past and future output, past and future employment, and past total number of hours worked. For example, the survey asks about workplaces' level of business activity or volume of output in the reference month as compare to three months prior to the reference month. Workplaces are required to give categorical answers whether it is "higher", "the same" or "lower".[83] To analyse the conditional relationships between this set of variables with a set of explanatory variables (also from the EBS), we adopt the ordered probit models. Whereas for past and future capital investment, in which the categorical answers to the questions is binary, that is "Yes" or "No", we adopt probit models.

An ordered probit model

We denote workplace's categorical response to a survey question as *j*, where *j = 0, 1, 2*; in which a higher value of j corresponds to a "higher" outcome. We assume there is a continuous latent variable, y_i^* that triggers workplace *i*'s categorical response. Let y_i be a categorical response of workplace *i* that takes on the values of *j = 0, 1, 2*. The latent variable model underlying an ordered probit model is given by

$$y_i^* = x_i\beta + \varepsilon_i \qquad \text{(A1)}$$

where x_i contains *k* explanatory variables that are related to y_i^* but does not contain a constant, β is a $k\times 1$ vector of parameters, and $\varepsilon \mid x \sim N(0, 1)$. The categorical response y_i follows the observation rule

$$y_i = j \quad if \ \mu_j \prec y_i^* \prec \mu_{j+1}; \qquad j = 0,1,2 \qquad \text{(A2)}$$

Let μ_j denote the unknown thresholds that the latent variable y_i^* crosses to change the value of the observed y_i, with $\mu_0 = -\infty$, $\mu_j \leq \mu_{j+1}$, and $\mu_3 = \infty$. The thresholds are to be estimated. The conditional distribution of y_i on x_i is given by each response probability (see e.g. Wooldridge (2002)):

[83] Workplace can also, and very small number do, respond “don’t know”. We ignore these responses in our analysis.

$$
\begin{aligned}
P(y_i = 0 \mid x_i) &= \Phi(\mu_1 - x_i\beta) \\
P(y_i = 1 \mid x_i) &= \Phi(\mu_2 - x_i\beta) - \Phi(\mu_1 - x_i\beta) \\
P(y_i = 2 \mid x_i) &= 1 - \Phi(\mu_2 - x_i\beta)
\end{aligned}
\tag{A3}
$$

These conditional probabilities should sum to unity. Maximum likelihood is used to estimate the unknown thresholds and the parameter β. The log-likelihood function for each workplace *i* is given by

$$
\begin{aligned}
&\log L_i(\mu, \beta) = I(y_i = 0) \times \log[\Phi(\mu_1 - x_i\beta)] \\
&+ I(y_i = 1) \times \log[\Phi(\mu_2 - x_i\beta) - \Phi(\mu_1 - x_i\beta)] \\
&+ I(y_i = 2) \times \log[1 - \Phi(\mu_2 - x_i\beta)]
\end{aligned}
\tag{A4}
$$

where $I(y_i = j)$ denotes the indicator function, and it takes the value of 1 if $y_i = j$, and *0* otherwise. Note that when *j* takes on only two values (two outcomes i.e. if $j = 0, 1$ only), the model reduces to a binary probit. In this case we estimate an intercept instead by setting the single threshold in the probit model to zero. The ordered probit models are estimated using Stata, with data pooled across all cross-sections. Models are estimated using the **svy** suite of commands to account for the complex survey design.

Since the probability model is nonlinear, the estimated coefficients, $\hat{\beta}$ does not allow a straight interpretation of the impact on the dependent variable from a unit change in the independent variables as in the linear models. To understand the estimated relationship, one can derive standardised coefficients that allow interpretation (See Long (1997) and Long and Freese (2006)). The marginal change in the latent variable with respect to $x_{i,k}$ is given by the derivative

$$
\frac{\partial y^*}{\partial x_k} = \beta_k \tag{A5}
$$

Due to the fact that y_i^* is unobserved, it is unclear what is the impact on y_i^* due to a unit change in $x_{i,k}$. β_k cannot be interpreted without being rescaled by the standard deviation of y_i^*. The variance of the latent variable, $\sigma^2_{y^*}$ is given by

$$
VAR(y^*) = \sigma^2_{y^*} = \hat{\beta}' VAR(x)\hat{\beta} + VAR(\varepsilon) \tag{A6}
$$

The y^* -standardised coefficent of variable x_k, denoted as β_{k^*} , is therefore

$$
\beta_k^* = \frac{\beta_k}{\sigma^2_{y^*}} \tag{A7}
$$

β_{k^*} thus measures the change in y^* due to a unit change in x_k, when all other variables are held constant.

Polychoric correlation

The variables in the EBS survey are ordinal. The usual Pearson moment correlation coefficient, which is used to measure the correlation between continuous variables, is not an appropriate measure to compute the (unconditional) correlation between the categorical variables. We adopt the polychoric correlation of Olsson (1979). The polychoric correlation coefficient is a maximum likelihood estimate. Following Olsson (1979), suppose two latent variables z_1^* and z_2^*, that underlie two categorical variables z_1 and z_2 follow a bivariate normal distribution. Further assuming the thresholds of the two variables are denoted by $a_{1,i}$, $i = 0,\cdots,s$ and $a_{1,j}$, $j = 0, \cdots, r$; where $a_{1,0} = a_{2,0}=-\infty$ and $a_{1,s}=a_{2,r}=\infty$. s and r are the number of categories taken by z_1 and z_2. So $z_1 = i$ when $a_{1,i-1} < z_1^* < a_{1,i}$, and correspondingly for z_2. The probability that $z_1 = i$ and $z_2 = j$, $P(i, j, \rho, a)$, denoted as π_{ij} is given by

$$\pi_{i,j} = \Phi_2\left(a_{1,i}, a_{2,j}, \rho\right) - \Phi_2\left(a_{1,i-i}, a_{2,j}, \rho\right) - \Phi_2\left(a_{1,i}, a_{2,j-2}, \rho\right) + \Phi_2\left(a_{1,i-1}, a_{2,j-1}, \rho\right) \quad \text{(A8)}$$

where ρ denotes the correlation and Φ_2 denotes the bivariate normal distribution function. The log-likelihood function is given by

$$\ln L(\rho) = \ln A + \sum_{i=1}^{s}\sum_{j=1}^{r} n_{i,j} \ln \pi_{i,j} \quad \text{(A9)}$$

where A is a constant, n_{ij} is the observed frequencies when $z_1 = i$ and $z_2 = j$. The estimates of ρ and a's can be obtained by maximising the likelihood function. The estimated ρ is the polychoric correlation coefficient. The Stata command polychoric is used to compute the correlation coefficient[84].

[84] See Kolenikov and Angeles (2004) for further discussion of the polychoric correlation.

Appendix D – Descriptive statistics

Table D1. Descriptive statistics

Variable	Frequency	Percentage of total
Employment size		
Employs 1 to 9	9,924	20.58
Employs 10 to 49	16,866	34.98
Employs 50 to 99	9,739	20.20
Employs 100 249	6,937	14.39
Employs 250 to 499	2,907	6.03
Employs 500 to 999	1,211	2.51
Employs > 1000	634	1.31
Total number of observations	48,218	100.00
Industry		
Agriculture, Forestry And Fishing	900	1.87
Mining and Quarrying; Electricity, Gas, Steam and Air Conditioning; Water supply, sewage, waste management	350	0.73
Manufacturing	4,408	9.14
Construction	2,130	4.42
Wholesale and Retail Trade; Repair Of Motor Vehicles	8,913	18.48
Transportation and Storage	1,555	3.22
Accommodation and Food Service Activities	4,486	9.30
Information and Communication	998	2.07
Financial and Insurance Activities	737	1.53

Table D1 (continued). Descriptive statistics

Variable	Frequency	Percentage of total
Real Estate Activities	822	1.70
Professional, Scientific and Technical	2,997	6.22
Administrative and Support Service	3,206	6.65
Public administration and Defence	1,070	2.22
Education	6,867	14.24
Human Health and Social Work Activities	6,133	12.72
Arts, Entertainment and Recreation	1,474	3.06
Other Service Activities	1,172	2.43
Total number of observations	48,218	100.00
Regions		
North East	3,802	7.89
North West	6,152	12.76
Yorkshire & the Humber	5,153	10.69
East Midlands	4,613	9.57
West Midlands	5,867	12.17
East of England	4,848	10.05
London	5,262	10.91
South East	6,326	13.12
South West	6,195	12.85
Total number of observations	48,218	100.00

Table D1 (continued). Descriptive statistics

Variable	Frequency	Percentage of total
Wave		
Nov-11	3,081	6.39
Dec-11	2,991	6.20
Jan-12	2,976	6.17
Feb-12	3,014	6.25
Mar-12	3,040	6.30
Apr-12	3,000	6.22
May-12	3,009	6.24
Jun-12	3,012	6.25
Jul-12	3,037	6.30
Aug-12	3,025	6.27
Sep-12	3,019	6.26
Oct-12	3,007	6.24
Nov-12	3,000	6.22
Dec-12	3,001	6.22
Jan-13	3,001	6.22
Feb-13	3,005	6.23
Total number of observations	48,218	100.00

Table D1 (continued). Descriptive statistics

Variable	Frequency	Percentage of total
Output performance		
Lower	12,360	25.63
The same	17,463	36.22
Higher	16,936	35.12
Don't know	1,459	3.03
Total number of observations	48,218	100.00
Employment performance		
Lower	6,992	14.50
The same	32,583	67.57
Higher	8,456	17.54
Don't know	187	0.39
Total number of observations	48,218	100.00
Total number of hours worked		
Lower	9,663	20.04
The same	25,567	53.02
Higher	12,341	25.59
Don't know	647	1.34
Total number of observations	48,218	100.00

Table D1 (continued). Descriptive statistics

Variable	Frequency	Percentage of total
Capital investment performance		
No	31,057	64.41
Yes	14,173	29.39
Don’t know	2,988	6.20
Total number of observations	48,218	100.00
Output expectations		
Lower	9,810	20.35
The same	17,577	36.45
Higher	18,901	39.20
Don't know	1,930	4.00
Total number of observations	48,218	100.00
Employment expectations		
Lower	6,272	13.01
The same	32,896	68.22
Higher	8,656	17.95
Don't know	394	0.82
Total number of observations	48,218	100.00

Table D1 (continued). Descriptive statistics

Capital investment expectations		
No	31,345	65.01
Yes	12,929	26.81
Don’t know	3,944	8.18
Total number of observations	48,218	100.00
Labour utilisation in reference month		
Underutilised	4,804	9.96
Used at a satisfactory level	31,095	64.49
Overstretched	11,593	24.04
Don’t know	726	1.51
Total number of observations	48,218	100.00
Labour costs expectations		
Lower	3,320	6.89
The same	31,601	65.54
Higher	11,584	24.02
Don't know	1,432	2.97
Not applicable	281	0.58
Total number of observations	48,218	100.00

Table D1 (continued). Descriptive statistics

Capital utilisation in reference month		
Underutilised	5,382	11.16
Used at a satisfactory level	37,135	77.01
Overstretched	4,612	9.56
Don't know	1,089	2.26
Total number of observations	48,218	100.00

Appendix E – Detailed results from multivariate analysis

Table E1. Summary of ordered probit of output performance

Explanatory variables	Coefficients
Employment performance	0.311 (0.022)***
Change in total hours worked	0.856 (0.018)***
Capital investment performance	0.094 (0.022)***
Reference category: workplace employs 10 to 49	
Employs 1 to 9	-0.164 (0.022)***
Employs 50 to 99	0.01 (0.03)
Employs 100 249	0.032 (0.03)
Employs 250 to 499	0.181 (0.054)***
Employs 500 to 999	0.017 (0.064)
Employs > 1000	0.074 (0.113)
Reference category: Wholesale and Retail Trade; Repair Of Motor Vehicles	
Agriculture, Forestry and Fishing	0.057 (0.053)
Mining and Quarrying; Electricity, Gas, Steam and Air Conditioning;	0.082 (0.104)
Manufacturing	-0.002 (0.037)
Construction	-0.032 (0.037)
Transportation and Storage	-0.075 (0.053)
Accommodation and Food Service Activities	-0.089 (0.035)***
Information and Communication	0.132 (0.054)**
Financial and Insurance Activities	0.018 (0.066)
Real Estate Activities	0.206 (0.061)***
Professional, Scientific and Technical	0.036 (0.035)
Administrative and Support Service	0.097 (0.04)**
Public Administration and Defence	0.27 (0.053)***
Education	0.129 (0.032)***
Human Health and Social Work Activities	0.171 (0.03)***
Arts, Entertainment and Recreation	0.067 (0.054)
Other Service Activities	0.089 (0.049)*
Reference category: South West	
North East	-0.024 (0.041)
North West	-0.049 (0.036)
Yorkshire & the Humber	-0.02 (0.036)
East Midlands	-0.024 (0.037)
West Midlands	-0.013 (0.035)
East of England	0.005 (0.037)
London	-0.057 (0.037)
South East	-0.048 (0.035)

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E1 (continued). Summary of ordered probit of output performance

Explanatory variables	Coefficients
Reference category: Nov-11	
Dec-11	-0.019 (0.05)
Jan-12	0.009 (0.051)
Feb-12	-0.144 (0.051)***
Mar-12	0.078 (0.049)
Apr-12	0.089 (0.051)*
May-12	0.185 (0.048)***
Jun-12	0.155 (0.049)***
Jul-12	-0.072 (0.052)
Aug-12	0.02 (0.049)
Sep-12	-0.018 (0.053)
Oct-12	0.073 (0.049)
Nov-12	0.066 (0.051)
Dec-12	0.117 (0.051)**
Jan-13	-0.057 (0.051)
Feb-13	-0.138 (0.05)***
Lower threshold	1.752 (0.067)***
Upper threshold	2.859 (0.07)***
Number of observations	43763
F (48, 43715)	81.3
Prob > F	0.000

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E2. Summary of ordered probit of output expectations

Explanatory variables	Coefficients
Employment expectations	0.817 (0.021)***
Capital investment expectations	0.057 (0.022)***
Reference category: workplace employs 10 to 49	
Employs 1 to 9	-0.088 (0.022)***
Employs 50 to 99	-0.004 (0.029)
Employs 100 249	-0.02 (0.033)
Employs 250 to 499	-0.015 (0.048)
Employs 500 to 999	0.134 (0.076)**
Employs > 1000	0.207 (0.15)
Reference category: Wholesale and Retail Trade; Repair Of Motor Vehicles	
Agriculture, Forestry and Fishing	-0.142 (0.053)***
Mining and Quarrying; Electricity, Gas, Steam and Air Conditioning;	-0.342 (0.103)***
Manufacturing	-0.096 (0.036)***
Construction	-0.121 (0.038)***
Transportation and Storage	-0.124 (0.052)**
Accommodation and Food Service Activities	-0.109 (0.035)***
Information and Communication	0.073 (0.053)
Financial and Insurance Activities	0.046 (0.064)
Real Estate Activities	-0.012 (0.055)
Professional, Scientific and Technical	-0.079 (0.035)**
Administrative and Support Service	-0.01 (0.04)
Public Administration and Defence	0.057 (0.054)
Education	-0.124 (0.031)***
Human Health and Social Work Activities	-0.002 (0.03)
Arts, Entertainment and Recreation	-0.066 (0.049)
Other Service Activities	0.018 (0.051)
Reference category: South East	
North East	0.003 (0.039)
North West	0.004 (0.036)
Yorkshire & the Humber	-0.017 (0.036)
East Midlands	-0.018 (0.038)
West Midlands	-0.022 (0.035)
East of England	-0.023 (0.037)
London	-0.009 (0.036)
South West	-0.001 (0.035)

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E2 (continued). Summary of ordered probit of output expectations

Explanatory variables	Coefficients
Reference category: Nov-11	
Dec-11	0.15 (0.05)***
Jan-12	0.469 (0.052)***
Feb-12	0.807 (0.051)***
Mar-12	0.735 (0.051)***
Apr-12	0.549 (0.051)***
May-12	0.49 (0.048)***
Jun-12	0.286 (0.051)***
Jul-12	0.502 (0.051)***
Aug-12	0.41 (0.05)***
Sep-12	0.481 (0.054)***
Oct-12	0.202 (0.052)***
Nov-12	0.034 (0.051)
Dec-12	0.172 (0.049)***
Jan-13	0.596 (0.051)***
Feb-13	0.786 (0.05)***
Lower threshold	1.178 (0.062)***
Upper threshold	2.267 (0.063)***
Number of observations	42700
F(47, 42653)	54.1
Prob > F	0.000

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E3. Summary of ordered probit of employment performance

Explanatory variables	Coefficients
Output performance	0.401 (0.014)***
labour utilisation	0.050 (0.019)***
Labour cost performance	0.425 (0.023)***
Reference category: Workplace employs 10 to 49	
Employs 1 to 9	-0.09 (0.022)***
Employs 50 to 99	0.048 (0.037)
Employs 100 249	0.121 (0.040)***
Employs 250 to 499	-0.011 (0.065)
Employs 500 to 999	-0.027 (0.099)
Employs > 1000	-0.203 (0.143)
Reference category: Wholesale and Retail Trade; Repair Of Motor Vehicles	
Agriculture, Forestry and Fishing	-0.108 (0.055)**
Mining and Quarrying; Electricity, Gas, Steam and Air Conditioning;	-0.191 (0.085)**
Manufacturing	0.097 (0.033)***
Construction	0.043 (0.040)
Transportation and Storage	0.058 (0.048)
Accommodation and Food Service Activities	-0.08 (0.033)**
Information and Communication	0.1 (0.056)*
Financial and Insurance Activities	0.093 (0.067)
Real Estate Activities	-0.024 (0.054)
Professional, Scientific and Technical	0.143 (0.034)***
Administrative and Support Service	0.003 (0.04)
Public Administration and Defence	-0.601 (0.06)***
Education	-0.016 (0.033)
Human Health and Social Work Activities	-0.025 (0.031)
Arts, Entertainment and Recreation	-0.14 (0.052)***
Other Service Activities	-0.03 (0.049)
Reference category: South East	
North East	-0.056 (0.039)
North West	-0.051 (0.036)
Yorkshire & the Humber	-0.029 (0.036)
East Midlands	-0.042 (0.037)
West Midlands	0.01 (0.035)
East of England	-0.088 (0.037)**
London	-0.048 (0.038)
South West	-0.006 (0.036)

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E3 (continued). Summary of ordered probit of employment performance

Explanatory variables	Coefficients
Reference category: Aug-12	
Nov-11	-0.124 (0.051)**
Dec-11	-0.102 (0.053)*
Jan-12	-0.08 (0.052)
Feb-12	-0.146 (0.054)***
Mar-12	-0.122 (0.051)**
Apr-12	-0.14 (0.053)***
May-12	-0.078 (0.052)
Jun-12	-0.059 (0.053)
Jul-12	-0.031 (0.058)
Sep-12	-0.083 (0.058)
Oct-12	-0.038 (0.055)
Nov-12	-0.136 (0.056)**
Dec-12	-0.144 (0.056)***
Jan-13	-0.03 (0.053)
Feb-13	-0.165 (0.053)***
Lower threshold	0.405 (0.076)***
Upper threshold	2.864 (0.08)***
Number of observations	44584
F(48, 44536)	38.2
Prob > F	0.000

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E4. Summary of ordered probit of total number of hours worked

Explanatory variables	Coefficients
Output performance	0.672 (0.015)***
Labour utilisation	0.297 (0.018)***
Labour cost performance	0.469 (0.023)***
Reference category: Workplace employs 10 to 49	
Employs 1 to 9	0.041 (0.022)*
Employs 50 to 99	0.033 (0.032)
Employs 100 249	0.049 (0.032)
Employs 250 to 499	-0.126 (0.052)**
Employs 500 to 999	0.011 (0.083)
Employs > 1000	-0.127 (0.11)
Reference category: Wholesale and Retail Trade; Repair Of Motor Vehicles	
Agriculture, Forestry and Fishing	-0.072 (0.064)
Mining and Quarrying; Electricity, Gas, Steam and Air Conditioning;	-0.055 (0.103)
Manufacturing	0.038 (0.036)
Construction	-0.06 (0.039)
Transportation and Storage	0.058 (0.052)
Accommodation and Food Service Activities	-0.011 (0.032)
Information and Communication	-0.007 (0.052)
Financial and Insurance Activities	0.103 (0.061)*
Real Estate Activities	-0.015 (0.056)
Professional, Scientific and Technical	0.117 (0.035)***
Administrative and Support Service	0.077 (0.038)**
Public Administration and Defence	-0.105 (0.053)**
Education	-0.006 (0.032)
Human Health and Social Work Activities	-0.051 (0.028)*
Arts, Entertainment and Recreation	-0.073 (0.052)
Other Service Activities	-0.062 (0.045)
Reference category: South East	
North East	-0.063 (0.039)
North West	-0.029 (0.035)
Yorkshire & the Humber	-0.045 (0.037)
East Midlands	-0.058 (0.036)
West Midlands	-0.015 (0.035)
East of England	-0.055 (0.038)
London	-0.005 (0.036)
South West	-0.012 (0.036)

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E4 (continued). Summary of ordered probit of total number of hours worked

Explanatory variables	Coefficients
Reference category: Aug-12	
Nov-11	-0.064 (0.05)
Dec-11	-0.01 (0.054)
Jan-12	-0.3 (0.053)***
Feb-12	-0.163 (0.052)***
Mar-12	-0.226 (0.05)***
Apr-12	-0.008 (0.053)
May-12	-0.018 (0.049)
Jun-12	0.036 (0.05)
Jul-12	-0.011 (0.053)
Sep-12	-0.092 (0.055)*
Oct-12	-0.031 (0.049)
Nov-12	-0.087 (0.052)*
Dec-12	-0.054 (0.052)
Jan-13	-0.247 (0.054)***
Feb-13	-0.258 (0.051)***
Lower threshold	1.837 (0.077)***
Upper threshold	3.777 (0.083)***
Number of observations	44353
F(48, 44305)	79.3
Prob > F	0.000

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E5. Summary of ordered probit of employment expectations

Explanatory variables	Coefficients
Output expectations	0.507 (0.015)***
Labour utilisation	0.15 (0.018)***
Labour cost expectations	0.562 (0.022)***
Reference category: Workplace employs 10 to 49	
Employs 1 to 9	-0.031 (0.023)
Employs 50 to 99	0.080 (0.036)**
Employs 100 249	-0.039 (0.042)
Employs 250 to 499	-0.116 (0.061)*
Employs 500 to 999	-0.305 (0.105)***
Employs > 1000	-0.389 (0.174)**
Reference category: Wholesale and Retail Trade; Repair Of Motor Vehicles	
Agriculture, Forestry and Fishing	0.028 (0.056)
Mining and Quarrying; Electricity, Gas, Steam and Air Conditioning;	-0.051 (0.113)
Manufacturing	0.052 (0.035)
Construction	0.062 (0.041)
Transportation and Storage	0.038 (0.051)
Accommodation and Food Service Activities	0.075 (0.033)**
Information and Communication	0.126 (0.058)**
Financial and Insurance Activities	0.335 (0.069)***
Real Estate Activities	0.093 (0.056)*
Professional, Scientific and Technical	0.187 (0.035)***
Administrative and Support Service	0.205 (0.04)***
Public Administration and Defence	-0.326 (0.067)***
Education	0.01 (0.033)
Human Health and Social Work Activities	0.13 (0.032)***
Arts, Entertainment and Recreation	0.09 (0.049)*
Other Service Activities	0.053 (0.051)
Reference category: South East	
North East	-0.055 (0.041)
North West	-0.045 (0.036)
Yorkshire & the Humber	-0.09 (0.038)**
East Midlands	-0.03 (0.038)
West Midlands	-0.028 (0.036)
East of England	-0.002 (0.039)
London	-0.02 (0.038)
South West	-0.092 (0.035)***

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E5 (continued). Summary of ordered probit of employment expectations

Explanatory variables	Coefficients
Reference category: Nov-11	
Dec-11	0.034 (0.051)
Jan-12	-0.033 (0.054)
Feb-12	0.118 (0.054)**
Mar-12	0.133 (0.052)**
Apr-12	0.204 (0.055)***
May-12	0.195 (0.051)***
Jun-12	0.231 (0.052)***
Jul-12	0.131 (0.058)**
Aug-12	0.08 (0.053)
Sep-12	0.106 (0.057)*
Oct-12	0.1 (0.052)*
Nov-12	0.077 (0.056)
Dec-12	0.058 (0.053)
Jan-13	0.074 (0.053)
Feb-13	0.124 (0.05)**
Lower threshold	1.37 (0.077)***
Upper threshold	3.93 (0.084)***
Number of observations	44322
F(48, 44274)	51.2
Prob > F	0.000

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E6. Summary of probit of capital investment performance

Explanatory variables	Coefficients
Output performance	0.098 (0.014)***
Capital utilisation	0.055 (0.025)**
Reference category: Workplace employs 10 to 49	
Employs 1 to 9	-0.176 (0.026)***
Employs 50 to 99	0.272 (0.034)***
Employs 100 249	0.404 (0.037)***
Employs 250 to 499	0.505 (0.055)***
Employs 500 to 999	0.562 (0.078)***
Employs > 1000	0.751 (0.113)***
Reference category: Wholesale and Retail Trade; Repair Of Motor Vehicles	
Agriculture, Forestry and Fishing	0.574 (0.06)***
Mining and Quarrying; Electricity, Gas, Steam and Air Conditioning;	0.167 (0.11)
Manufacturing	0.418 (0.04)***
Construction	0.19 (0.046)***
Transportation and Storage	0.193 (0.056)***
Accommodation and Food Service Activities	0.123 (0.038)***
Information and Communication	0.525 (0.059)***
Financial and Insurance Activities	0.216 (0.076)***
Real Estate Activities	0.201 (0.069)***
Professional, Scientific and Technical	0.381 (0.041)***
Administrative and Support Service	0.324 (0.045)***
Public Administration and Defence	-0.013 (0.073)
Education	0.373 (0.038)***
Human Health and Social Work Activities	0.046 (0.037)
Arts, Entertainment and Recreation	0.323 (0.058)***
Other Service Activities	0.108 (0.059)*
Reference category: South East	
North East	0.005 (0.047)
North West	-0.008 (0.041)
Yorkshire & the Humber	-0.007 (0.043)
East Midlands	-0.03 (0.045)
West Midlands	-0.014 (0.041)
East of England	-0.013 (0.043)
London	-0.054 (0.043)
South West	-0.05 (0.041)

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E6 (continued). Summary of probit of capital investment performance

Explanatory variables	Coefficients
Reference category: Nov-11	
Dec-11	-0.094 (0.06)
Jan-12	-0.076 (0.06)
Feb-12	-0.071 (0.06)
Mar-12	-0.182 (0.06)***
Apr-12	-0.091 (0.06)
May-12	-0.134 (0.058)**
Jun-12	-0.081 (0.06)
Jul-12	-0.068 (0.063)
Aug-12	-0.063 (0.059)
Sep-12	-0.096 (0.063)
Oct-12	-0.07 (0.062)
Nov-12	-0.076 (0.062)
Dec-12	-0.151 (0.061)**
Jan-13	-0.196 (0.061)***
Feb-13	-0.161 (0.059)***
Constant	-1.045 (0.077)***
Number of observations	43591
F(47, 43544)	22.7
Prob > F	0.000

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E7. Summary of probit of capital investment expectations

Explanatory variables	Coefficients
Output expectations	0.119 (0.015)***
Capital utilisation	0.154 (0.025)***
Reference category: Workplace employs 10 to 49	
Employs 1 to 9	-0.242 (0.027)***
Employs 50 to 99	0.173 (0.035)***
Employs 100 249	0.377 (0.037)***
Employs 250 to 499	0.460 (0.056)***
Employs 500 to 999	0.541 (0.079)***
Employs > 1000	0.732 (0.114)***
Reference category: Wholesale And Retail Trade; Repair Of Motor Vehicles	
Agriculture, Forestry and Fishing	0.6 (0.062)***
Mining and Quarrying; Electricity, Gas, Steam and Air Conditioning;	0.172 (0.111)
Manufacturing	0.354 (0.04)***
Construction	0.163 (0.048)***
Transportation and Storage	0.178 (0.057)***
Accommodation and Food Service Activities	0.151 (0.039)***
Information and Communication	0.451 (0.06)***
Financial and Insurance Activities	0.17 (0.075)**
Real Estate Activities	0.232 (0.071)***
Professional, Scientific and Technical	0.296 (0.043)***
Administrative and Support Service	0.278 (0.046)***
Public Administration and Defence	0.05 (0.079)
Education	0.245 (0.038)***
Human Health and Social Work Activities	0.095 (0.038)**
Arts, Entertainment and Recreation	0.244 (0.059)***
Other Service Activities	0.187 (0.059)***
Reference category: South East	
North East	0.011 (0.049)
North West	0.006 (0.043)
Yorkshire & the Humber	-0.045 (0.044)
East Midlands	0.011 (0.045)
West Midlands	-0.009 (0.042)
East of England	0.022 (0.045)
London	0.039 (0.044)
South West	0.029 (0.042)

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

Table E7 (continued). Summary of probit of capital investment expectations

Explanatory variables	Coefficients
Reference category: Nov-11	
Dec-11	-0.033 (0.063)
Jan-12	0.061 (0.062)
Feb-12	-0.002 (0.063)
Mar-12	-0.021 (0.063)
Apr-12	-0.064 (0.063)
May-12	-0.106 (0.063)*
Jun-12	-0.018 (0.063)
Jul-12	-0.076 (0.066)
Aug-12	-0.062 (0.063)
Sep-12	-0.139 (0.067)**
Oct-12	-0.135 (0.066)**
Nov-12	-0.014 (0.065)
Dec-12	0.052 (0.064)
Jan-13	-0.076 (0.063)
Feb-13	0.059 (0.062)
Constant	-1.391 (0.084)***
Number of observations	42340
F(47, 42293)	18.9
Prob > F	0.000

Notes: standard errors in parentheses; *** indicates significant at the 1 per cent level; ** indicates significant at the 5 per cent level; * indicates significant at the 10 per cent level.

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