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Abstract

Since the autumn of 1997, the regional offices of the Bank of Canada have conducted quarterly consultations with businesses across Canada. These consultations, summarized in the *Business Outlook Survey* (BOS), are structured around a survey questionnaire that covers topics of importance to the Bank, notably business activity, pressures on production capacity, prices and inflation, and credit conditions. The author aims to enhance our understanding of the survey's information content by extending the early work of Martin and Papile (2004) in two key ways. First, since all BOS questions are designed to capture some aspect of economic activity and are therefore interrelated, various approaches were considered to extract the common underlying variations among the indicators: a subjective approach (a simple average), principal-component analysis and factor analysis. Second, the information content of these common movements is assessed, using regression analysis and a forecasting assessment. The results suggest that all approaches to extract the information from the BOS provide very similar measures of underlying common variations. This underlying variable appears to be a useful indicator of economic activity, particularly for providing information on investment spending. However, the balance of opinion on future sales growth remains a better indicator than any measures of common movements for the growth of real GDP.

JEL classification: C43, C82, E37
Bank classification: Business fluctuations and cycles; Regional economic developments

Résumé

Depuis l'automne 1997, les bureaux régionaux de la Banque du Canada mènent chaque trimestre une enquête auprès d'entreprises d'un bout à l'autre du pays. Cette enquête, dont les résultats sont résumés dans le bulletin *Enquête sur les perspectives des entreprises*, s'appuie sur un questionnaire portant sur des sujets importants pour la Banque, notamment l'activité économique, les pressions sur la capacité de production, les prix et l'inflation ainsi que les conditions du crédit. L'objectif de l'auteure est de faciliter notre compréhension du contenu informatif de l'enquête en prolongeant la recherche de Martin et Papile (2004) de deux grandes manières. Tout d'abord, comme toutes les questions de l'enquête sont destinées à capter un aspect de l'activité économique et que, dans ces conditions, elles se recoupent, l'auteure utilise diverses méthodes pour extraire les variations sous-jacentes communes aux indicateurs, soit une approche subjective (moyenne simple), une analyse en composantes principales et une analyse factorielle. Elle évalue ensuite le contenu informatif de ces mouvements en se livrant à une analyse de régression ainsi qu'à un exercice de prévision. Les résultats de ce travail donnent à

penser que toutes les méthodes servant à extraire l'information de l'enquête fournissent des mesures très similaires des variations sous-jacentes communes. Cette variable sous-jacente semble être un indicateur utile de l'activité économique, surtout pour ce qui est des dépenses d'investissement. Toutefois, le solde des opinions concernant la progression future des ventes demeure un meilleur indicateur de la croissance du PIB réel que n'importe quelle mesure des variations communes.

Classification JEL : C43, C82, E37
Classification de la Banque : Cycles et fluctuations économiques; Évolution économique régionale

1. Introduction[1]

Since the autumn of 1997, the regional offices of the Bank of Canada have conducted quarterly consultations with businesses across Canada. These consultations, summarized in the *Business Outlook Survey* (BOS), are structured around a survey questionnaire that covers topics of importance to the Bank, notably business activity, pressures on production capacity, prices and inflation, and credit conditions.[2] The responses to these qualitative questions (e.g., whether sales volumes will increase at a greater, lesser or the same rate over the next 12 months as over the past 12 months), together with the explanations that accompany them, allow senior economic staff at the Bank's regional offices to provide a macro-level assessment of the economy. This assessment supplements the more quantitative approaches used by the Bank to evaluate the economic situation and outlook by providing insights into what businesses are seeing and planning.[3]

A key advantage of the BOS is its timeliness: the BOS has become a well-monitored information source for the media and the financial community since the Bank began its quarterly publication in 2004. The objective of this paper is to enhance our understanding of the survey's information content by extending the early work of Martin and Papile (2004) in two key ways. First, since all BOS questions are designed to capture some aspect of economic activity and are therefore interrelated, various approaches were considered to extract the common underlying variations among the indicators: a subjective approach (a simple average), principal-component analysis (PCA) and factor analysis (FA). Second, the information content of these common movements is assessed, using regression analysis and a forecasting assessment. The longer sample period now available for the survey data allows this type of statistical assessment. The first test of these measures' usefulness is whether they can help predict growth in real GDP, and if yes, whether they outperform the survey question on future sales expectations—the question most closely tied to measuring GDP. The second test is whether the common movements of indicators provide clearer signals for any one component of economic activity.

This paper is organized as follows. Section 2 reviews other business surveys' measures of underlying movements, which are commonly called indexes, and section 3 describes the BOS data. Section 4 describes the various approaches considered in this paper to extract the common movements from the BOS indicators. Section 5 assesses the information content of these measures using correlation and regression analysis, as well as a forecasting exercise. Section 6 offers some concluding comments.

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[1] Some results reported in this paper were published in the Autumn 2011 *Bank of Canada Review* (Pichette and Rennison 2011).

[2] For a detailed description of the survey, see Martin (2004) and the "Backgrounder on Questions in the *Business Outlook Survey* Concerning Past Sales and Credit Conditions" (http://www.bankofcanada.ca/wp-content/uploads/2011/07/bos_backgrounder_jan2008.pdf).

[3] See Macklem (2002) and Jenkins and Longworth (2002) for a description of how the BOS fits into the Bank's monetary policy decision-making process.

2. Extracting Information from Business Surveys: Other Experiences

While there are several business surveys conducted around the world, few institutions produce an index from the results of these surveys. In fact, results from business surveys are usually reported using balances of opinion or diffusion indexes for individual questions. Surveys for which results from multiple questions have been combined in a summary measure of underlying movements, a simple average or a weighted average are the most commonly used approach to extract this information. Well-known examples in the United States are the Manufacturing ISM *Report on Business*, in which the Purchasing Managers' Index (PMI) is defined as a composite index based on seasonally adjusted diffusion indexes for five of the indicators with equal weights, and the Conference Board's Measure of Business Confidence. In the latter case, the index is an average of the scores for three questions of the survey. The scores for each question are determined by assigning a value to the replies and calculating an average.

Most of the business survey indexes are similarly constructed using a simple or a weighted average of balances of opinion for different questions. Other examples are the Ifo Business Climate Index in Germany, the euro area Purchasing Managers' Index, the National Bank of Belgium's synthetic economic barometer and the NAB Business Confidence in Australia. The Conference Board of Canada publishes the Index of Business Confidence on a quarterly basis. As with the United States, this is an average of the balances of opinion for three questions of the survey. Twice a year, Export Development Canada also produce an index called the Trade Confidence Index, which is a composite score based on the responses to five questions on future global and domestic economic conditions and trade opportunities.

Useful business survey indexes are available in France. Each month, the Banque de France publishes a Business Sentiment Indicator on industry and services. This indicator is constructed using PCA to combine the replies of business managers to the monthly survey, extracting common movements from the balances of opinion. More details on the approach are provided in Darné and Brunhes-Lesage (2008). The National Institute of Statistics and Economic Studies (INSEE) also publishes a monthly indicator on the French economy, the Industrial Economic Climate (Synthetic Index) (Doz and Lenglart 1995, 1999; Cornec and Deperraz 2006). The INSEE survey includes eight questions, but two on prices are excluded from the indicator. This synthetic index is calculated using dynamic factor analysis.

In the literature, other papers assess the information content of business surveys using measures of common movements. Chamberlin (2007) uses PCA to construct an indicator from four survey measures of activity in the United Kingdom, which he then uses to forecast GDP. Using dynamic factor analysis, Bruno and Malgarini (2002) build synthetic indicators for the Italian economy based on four qualitative surveys, by the Institute for Studies and Economic Analysis (ISAE), of consumers and the manufacturing, retail and construction sectors. They compare these indicators with the usual ISAE consumer confidence indicator and with short-term movements of a quantitative variable related to their specific sector, respectively. The authors also construct an aggregate indicator using the four ISAE surveys, and they test its ability to track the cyclical features of Italy's GDP. Similarly, Hansson,

Jansson and Lof (2003) examine the usefulness of data from business tendency surveys in Sweden for forecasting short-run developments in a number of economic variables. They use a dynamic factor model to extract the underlying movements from the survey, which are assessed for forecasting using a vector autoregressive approach. This procedure outperforms the competing alternatives, which use the survey variables directly, macro variables only or other popular indexes of economic activity to forecast GDP growth. For the other macro variables, the results are more mixed.

3. *Business Outlook Survey* Data

Each quarter, staff in the Bank's regional offices assess and amalgamate the signals from the survey regarding aggregate demand, aggregate supply and financial markets, informed by the broader discussions that take place with firms during interviews. Table 1 lists the BOS indicators that are useful for interpreting the survey results. While data for most BOS indicators are available from 1997Q3, the questions on credit conditions and on the ability of firms to meet an unexpected increase in demand were added more recently. In fact, the question on the ability to meet demand was added in 1999Q3 and the question on credit conditions in 2000Q3. The question on credit was modified in 2001Q4 to reduce its horizon from the past 12 months to the past 3 months. Extracting information from the published BOS indicators therefore requires that the length of the sample be limited to 2001Q4 to 2011Q4.[4] Martin and Papile (2004) provide an assessment of the survey for those questions that were available for a sample beginning in at least 1999Q3.

For analytical and communication purposes, the responses to most BOS questions are expressed in terms of a balance of opinion, which is calculated by subtracting the proportion of negative responses from the proportion of positive responses. The balance of opinion can vary between -100 and +100. For questions on firms' ability to meet demand and on labour shortages, the proportion of respondents experiencing constraints is used.

Since this study aims to develop a measure of the common movements that summarizes the information published in the BOS, it seems natural to incorporate as many indicators as possible from the survey.[5,6] The National Bank of Belgium has identified its criteria for the selection of the survey questions that compose the indicator: "an optimal business survey indicator is defined as an indicator having: 1) a high correlation with year-over-year GDP

[4] While the information content analysis uses the sample spanning 2001Q4 to 2011Q2, the sample was also extended back to 2000Q3 using the first formulation of the credit-conditions question. Since results were very similar, this extended sample is used for the charts to illustrate the behaviour of the underlying variable through the 2001 slowdown.

[5] The BOS asks a number of supplemental questions that are useful in interpreting the survey results. The results from these questions are not available to the public, either because the information content is not considered to be significant (Martin 2004) or the sample is not long enough to assess the information content. Still, some questions were added to the dataset (e.g., probing questions that aim to identify the proportion of respondents expecting a decline in their sales or prices, and a question on the perceived intensity of labour shortages), but the measure of common movements was not significantly different from the one using only published information.

[6] The question relating to firms' expectations regarding consumer price index inflation over the next two years is excluded from this analysis, since it does not pertain to firms' views on their own business situation or plans.

growth, 2) a low degree of short-term variation, and 3) leading indicator properties."[7] This approach is very appealing, since the aim of an indicator would be to best reflect economic activity. However, frequent revisions to the GDP data would lead to an indicator that might not be optimal after the economic series is fully revised. This problem could be avoided by assessing the index on a truncated GDP series that would include only final data, but the history for the survey is still too short to allow this type of forecasting analysis. Instead, BOS questions are selected independent of any economic variables. This is consistent with simply summarizing the information from the survey, and it might be possible to reassess the combination of questions in the future, as was done at the National Bank of Belgium (De Greef and Van Nieuwenhuyze 2009).

4. Methodology

There are various methodologies to extract information common to multiple indicators. The idea is to determine the weights for each series that will compose the indicator. The most widely used approach is the subjective method, which consists of choosing weights arbitrarily. These indexes are usually the weighted average of a set of survey questions. The main advantage of this method is its simplicity, but any choice of weights could be questionable, because they are subjective. Since the objective is to construct an index that summarizes firms' sentiments about their recent developments and future prospects, two other approaches, which estimate weights using an optimization process rather than assigning them arbitrarily, are appealing: PCA and FA. In this paper, each of these statistical methods is considered, as well as some subjective indexes, since most business survey indexes are built using this simple methodology.

4.1 Principal-component analysis

"The central idea of principal component analysis (PCA) is to reduce the dimensionality of a data set consisting of a large number of interrelated variables, while retaining as much as possible of the variation present in the data set." (Joliffe 2002, 1)

This method generates a new set of variables—principal components—that are linear combinations of the original variables. Principal components are artificial variables that account for most of the variance in the observed variables contained in the dataset, and they are all orthogonal to each other.

The first principal component is obtained by maximizing its contribution to the variance of a set of p variables (x). It is expressed as follows:

$$\propto_1' x = \propto_{11} x_1 + \propto_{12} x_2 + \cdots + \propto_{1p} x_p = \sum_{j=1}^{p} \propto_{1p} x_p,$$

[7] De Greef and Van Nieuwenhuyze (2009, 37).

where x has a covariance matrix Σ. To derive this first principal component, the vector α_1 maximizes $var(\alpha_1' x) = \alpha_1' \Sigma \alpha_1$ subject to $\alpha_1' \alpha_1 = 1$.[8]

By definition, the number of principal components that can be found is the same as the number of variables considered, but, in general, most of the variance in the dataset will be accounted by fewer principal components. For this analysis, only the first principal component (PC1) is retained.

Two sets of BOS indicators are used to construct $PC1_{ALL}$ and $PC1_{GDP}$. The former is extracted from all of the questions, while the latter excludes the questions pertaining to price development.[9] Each BOS indicator is normalized by its standard deviation.

4.2 Factor analysis

The main idea behind FA is the same as for PCA to the extent that it aims to reduce the dimensionality of a dataset, but instead of retaining as much as possible of the variation in the dataset, FA extracts the common movements. Another difference is that FA invokes a model relating the variables of the dataset to a reduced number of factors (or latent variables).[10]

As for PCA, two factors ($F1_{ALL}$ and $F1_{GDP}$) are estimated using the sets of variables described in Appendix A.

4.3 Subjective methodology

To compare the performance of the underlying variables constructed using PCA and FA, some indexes are calculated using a subjective approach. These types of indexes are used widely around the world to summarize information from business surveys. Most subjective indexes are simple or weighted averages of the balances of opinion for more than one question.

This study starts with the simplest option—applying an equal weight to each BOS question. Ultimately, there are an infinite number of possible combinations of weights, and all subjective methods to determine weights could be argued to be arbitrary. However, simple averages have performed well in other situations (e.g., while not optimal, simple averages of forecasts from alternative models are often the most successful, even in comparison to estimated optimal combinations of those same forecasts [Stock and Watson 2004]). In addition, as will be shown below, the constructed index tends to be rather robust to modest changes in weights.

Several indexes are created using selected questions: an activity index (AI), which includes four questions pertaining to business activity; a production capacity index (PCI), which

[8] See Appendix B for more details.
[9] See Appendix A for a detailed list of questions included in each dataset.
[10] See Appendix B for technical details.

includes two questions aiming to assess pressures on production capacity;[11] and a price index (PI), which includes questions only on input and output price growth.

Composite indexes (CI and CIxP) are then constructed as a simple average of these subindexes:

$$\boldsymbol{CI} = \frac{\boldsymbol{AI+PCI+PI}}{\boldsymbol{3}},$$

$$\boldsymbol{CIxP} = \frac{\boldsymbol{AI+PCI}}{\boldsymbol{2}}.$$

This approach implies that the indicators included in the AI will have a smaller weight than the others. Therefore, other summary indexes are developed using a simple average (AVE and AVExP), so that all single questions have the same weight.

The subjective approach has the advantage over the other two methods of not being subject to historical revisions, since the weights are fixed and BOS data are never revised. On the other hand, PCA and FA, while more complex, each provide optimal weights in that no other set of weights could produce a set of components that are more successful in accounting for variance in the observed variables. Consequently, an appealing strategy would be to use one of these methods for a first estimate of the weights, and then fix them. For simplicity, PCA is retained,[12] but before doing so, a robustness test is performed to determine how the weights evolve over time. Because weights may fluctuate when the sample is changing, real-time estimates of the first principal component are examined. The first principal component is calculated using a sample ending in 2005Q2, and then a rolling estimation adding one quarter at a time is computed, extracting the weights (α_1 from the equation in section 4.1) for each sample. Chart C-1 in Appendix C shows the results. Some estimates of weights have fluctuated non-trivially. For example, the one on the balance of opinion on future sales growth experienced marked swings over the 2008–09 recession. However, to the extent that the balance of opinion on future sales growth moved in the same direction as most other BOS indicators, the underlying variable extracted using PCA remains virtually the same. Chart C-2 shows that historical revisions to the estimates of PC1 would be relatively small were weights to be re-estimated as additional observations of the BOS indicators became available, and that estimates of PC1 are highly correlated for all weightings. Thus, the estimate of PC1 is largely insensitive to the choice of sample for estimating the weights.

[11] Note that the weight on the percentage of firms that indicated they would have serious difficulties meeting an unexpected increase in demand is twice the weight on the percentage of those that indicated they would have some difficulties.

[12] Because of FA's model structure, more work would be necessary to obtain the weights of each question in the index.

5. Results Analysis

5.1 Robustness

As a first step, estimates of the summary index for the various approaches to extract common movements described in the previous section are compared, to determine whether the underlying indicator is robust across methodologies. Table 2 shows the cross-correlations between the indexes in both levels and first differences.[13] The very strong correlations suggest that all statistical methods generate very similar series. This means that whatever the chosen approach to summarize the survey results, it would rarely indicate a different signal about firms' views.

5.2 Correlations with economic variables

Tables 3 and 4 show the results from the correlation analysis of the various indexes, capturing the common source of variation from the BOS indicators, and real economic variables. Two measures of economic activity are examined: real GDP growth (Table 3, Panel A) and real business sector GDP growth (Table 3, Panel B). As in Martin (2004), the latter measure is considered because the BOS sample comprises only private sector firms. A glance at Chart 1 indicates that all measures of common movements track developments in aggregate economic activity relatively well. The most important turning points, the 2001 slowdown and the 2008–09 recession, have been picked up. In general, the correlation results reported in Table 3 are moderate to moderately strong.[14] In all cases, the strongest correlation with quarterly GDP growth is reached contemporaneously (in *t*), except for the balance of opinion on future sales growth, for which the highest correlation coefficient is obtained one quarter ahead (*t*+1). While the question on future sales asks firms to characterize their expected change in sales growth over the next 12 months (i.e., momentum as opposed to growth), it is reasonable to expect that firms' predictions about future momentum could also contain information about current or near-term growth. This result is consistent with the results from other business surveys. For example, Wheeler (2010, 191) argues that "businesses may be more uncertain about the economic situation further ahead and so place more weight on near-term expectations when answering the survey. . . . So the horizon over which the surveys provide information may be shorter than that implied by the questions."

Given the 12-month horizon of many BOS questions, it is worth noting that the correlation for the question on sales outlook with the year-over-year growth of real GDP reaches a peak three quarters ahead, while it is only one quarter ahead for most underlying variables, extracting common movements from multiple BOS indicators. This might be due to the fact that these underlying variables include questions asking for contemporaneous or even past information.

[13] The subindexes (AI, PI, PCI and PPI) are not reported in Table 2 because they include a different set of BOS indicators.

[14] The same scale of assessment as in Martin (2004) is used to evaluate the correlation coefficients: strong, > 0.80; moderately strong, 0.60 to 0.80; moderate, 0.40 to 0.60; weak, 0.20 to 0.40; insignificant, < 0.20.

Table 4 reports the correlation results for specific components of the GDP: consumption (Panel A) and business investment (Panel B). The results for quarterly growth in real consumption are weak, while those for growth in real business investment are moderately strong to strong. The weak correlation with consumption may be partly explained by the survey sample, which comprises the business sector rather than the consumer sector, and even within the business sector, not only firms selling to consumers, but also firms selling to other businesses or exporting. All indexes have a higher correlation with business investment than the survey question on the expected direction of change in investment in machinery and equipment over the next 12 months. This suggests that extracting the common movements from all the survey questions might lead to a better indicator of quarterly growth in business investment than this single question on investment intentions. Chart 2 shows that the indexes closely track fluctuations in business investment over the sample period. The strong correlation between the underlying variables derived from the BOS results and business investment is interesting, since very few indicators of investment are available ahead of official statistical data. Moreover, the correlation coefficient continues to be moderately strong one quarter ahead, suggesting that the BOS also contains forward-looking information regarding business investment.

5.3 Forecasting performance

Regression analysis and a forecasting exercise are carried out in this section to evaluate (i) whether the underlying variables extracted from the BOS indicators, using the simple average and PCA, can provide information beyond that contained in the past values of the economic variables, and (ii) whether they provide more information than is contained in the answers to the individual survey questions on future sales growth and investment intentions. In light of the correlation results reported in the previous section, the economic variables that are considered are real GDP growth and real business investment growth. Various models are examined and compared based on the root mean square errors (RMSE) computed using a series of one-step-ahead forecasts for each equation.[15] Specifically, each equation is estimated for a sample spanning the period 2001Q4 to 2006Q1, and a forecast is produced for 2006Q2.[16] One observation is then added to the estimation period for the next-quarter forecast, and this is repeated up to 2011Q3. The ratio of the RMSE for each equation, relative to a benchmark case that includes only the lags of the dependent variable, is reported. For example, an RMSE ratio below one implies that the inclusion of the common component obtained from BOS results improves the forecast derived from an equation that takes into account only the latest information on the variable of interest.

Table 5 summarizes the estimation results for quarterly real GDP growth. The first six rows report results for four different specifications (equations 1 to 4) estimated on the full sample (2001Q4 to 2011Q3). In equations 2 and 3, the coefficients on AVE and PC1 are both significant, and in both cases the adjusted R^2 increases compared with equation 1, which includes only lagged GDP. AVE and PC1 are incorporated only at time t in these equations, because lags were not statistically significant. Nonetheless, since data from the BOS are available almost two months before the release of the national accounts, the results can be

[15] The prediction is for the current quarter before the release of the national accounts.
[16] The data used in this exercise were published on 30 November 2011.

useful for forecasting. The results for equation 4, however, indicate that the balance of opinion on future sales remains a better indicator than any measures of common movements, with the adjusted R^2 increasing to 0.51. The balance of opinion on future sales is significant only contemporaneously, despite correlation results suggesting that expectations of future sales contained more forward-looking information.

The last row of Table 5 reports the results of the out-of-sample forecast exercise. The RMSE ratios for equations 2, 3 and 4 are all below one, indicating that the inclusion of information from the BOS improves the forecast from that of equation 1. However, the improvement is only marginal for the measures of common movements, and, according to the Diebold-Mariano test, the results from equation 4 are statistically different from those of both equations 2 and 3 at the 5 per cent significance level. Thus, the underlying variables extracted from the BOS responses do not outperform the balance of opinion on future sales in forecasting real economic activity.

Table 6 reports the estimation results for growth in real business investment, using the same approach. The values of the adjusted R^2 and the RMSE are quite impressive when an underlying variable extracted from the BOS results is included as an explanatory variable. Based on the estimates from equations 3 and 5, AVE or PC1 alone, without the lagged growth of business investment, produce results very similar to those of equations 2 and 4, respectively. While the survey question on investment intentions for machinery and equipment is found to have explanatory power (equation 6), results for equations 2 to 5 indicate that both AVE and PC1 outperform the survey question.[17] From these results, it appears that a measure of the underlying information from all BOS indicators provides more useful signals for monitoring the growth of near-term investment than the question regarding investment intentions for machinery and equipment over the next 12 months.

6. Discussion

This paper examines various statistical approaches to extract the common underlying variations among the BOS indicators. Three methodologies are considered: a subjective approach (simple average), principal-component analysis and factor analysis. The information content of these measures of common movements is assessed relative to that of individual survey questions using correlation analysis and a forecasting exercise. This paper is the first empirical assessment of the BOS information content since the initial correlation analysis by Martin and Papile (2004), and it makes several notable contributions.

First, the results suggest that all approaches to extract the information from the BOS provide very similar measures of underlying common variations. Second, this underlying variable appears to be a useful indicator of economic activity, particularly for providing information on investment spending—a variable that is typically difficult to predict and for which there are very few indicators. This may not be surprising, since the BOS is a survey of firms, and all its questions provide some signals relating to the probability of investing. For instance, it is reasonable to expect higher investment activity if the outlook of firms regarding sales,

[17] The RMSE from equations 2 to 5 are all statistically different from those of equation 6 at the 5 per cent significance level, according to the Diebold-Mariano test.

employment and investment improves; if more firms are operating at or above their production capacity; and if more firms report an easing in credit conditions. The outlook for prices can also play a role in firms' near-term investment spending; for example, if firms are expecting higher input costs and are therefore spending to become more efficient, or if higher prices are stimulating activity in particular sectors where investment projects become profitable (as was the case with the boom in commodity prices in the 2000s). Overall, when all survey indicators are taken together, they provide information about the business investment climate. When the business climate is positive, firms are better disposed to increase their investment spending.

Third, this analysis has found that responses to the individual survey questions on future sales growth and intentions for investment in machinery and equipment provide useful information in a forecasting context for real GDP growth and growth of real business investment, respectively. The inclusion of these variables in their respective regressions improved upon a simple autoregressive model. In the case of business investment, however, the single question was found to be less informative than the measure of common movements.

Given that the BOS covers other topics such as pressures on production capacity and price developments, it might be of use in future work to examine whether an underlying variable constructed using relevant survey indicators could help a monetary authority to assess the degree of excess demand or supply in the economy. Martin and Papile (2004) have shown that responses to the question on the ability of firms to meet an unexpected increase in demand provide a good indicator of current pressures on production capacity. A measure of common variations extracted from selected BOS indicators could perhaps provide even more information about the output gap, a concept that is estimated with a lot of uncertainty and is subject to substantial revisions as more observations become available. Using a methodology similar to that reported in this paper, another extension might be to develop a measure of business inflation expectations. This would also be helpful in the current monetary policy framework.

While this work contributes to our understanding of the survey's information content, the reliability and robustness of the results will need to be evaluated over time as the sample period grows. Moreover, promising statistical assessments do not preclude careful examination of the movements in each BOS indicator every quarter, or the qualitative assessment of the messages that accompany firms' responses, both of which make a valuable contribution to monetary policy. Whether in terms of common movements or individual indicators, information gathered from business surveys is often best used with informed judgment rather than according to mechanical rules. The information obtained from individual survey indicators and from the qualitative assessment carried out by the Bank's regional offices remains an important element in BOS analysis. As emphasized in Martin (2004, 10), "The BOS interview format allows for a broader understanding of current business perceptions through confidential discussions with business representatives, which provide invaluable information that cannot be measured quantitatively."

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Table 1: BOS indicators

Survey question	Horizon	Type of signal
Balance of opinion[a] on past sales growth	Past 12 months	Demand-side
Balance of opinion on future sales growth	Next 12 months	Demand-side
Balance of opinion on investment in machinery and equipment	Next 12 months	Demand-side
Balance of opinion on employment	Next 12 months	Supply-side, indirect demand-side
Ability to meet an unexpected increase in demand[b]	Current	Supply-side, cost structure
Percentage of firms facing labour shortages	Current	Supply-side, cost structure
Balance of opinion on input prices	Next 12 months	Supply-side, cost structure
Balance of opinion on output prices	Next 12 months	Supply-side, margins
Balance of opinion on credit conditions	Past 3 months	Financial markets, demand-side

a. Percentage of firms responding "greater" or "higher" less percentage of firms reporting "lesser" or "lower."
b. Percentage of firms responding "some" or "significant" difficulty.

Table 2: Cross-correlations between selected indexes

(Sample: 2001Q4 to 2011Q4)
(white cells: in level; grey cells: in first difference)

	Composite	Average	PCA	FA
Panel A: Indexes including all published BOS indicators				
Composite	1.00			
	1.00			
Average	0.97	1.00		
	0.96	1.00		
PCA	0.97	**0.99**	1.00	
	0.96	**0.99**	1.00	
FA	0.95	**0.99**	**1.00**	1.00
	0.92	**0.98**	**0.99**	1.00
Panel B: Indexes including all published BOS indicators excluding those pertaining to prices				
Composite	1.00			
	1.00			
Average	0.92	1.00		
	0.93	1.00		
PCA	0.97	0.96	1.00	
	0.95	0.97	1.00	
FA	0.89	0.99	0.96	1.00
	0.90	0.98	0.96	1.00

Table 3: Correlation analysis: Real GDP growth and real business GDP growth

(Sample: 2001Q4 to 2011Q3)

Indexes	*t*	*t*+1	*t*+2	*t*+3	*t*	*t*+1	*t*+2	*t*+3
	Panel A: Real GDP growth							
	Year-over-year				**Quarter-over-quarter**			
Activity index	0.67	**0.75**	0.69	0.45	**0.60**	0.55	0.20	-0.12
Composite index	0.67	**0.72**	0.57	0.23	**0.56**	0.43	0.02	-0.41
Composite ex. prices	**0.72**	0.68	0.49	0.20	**0.51**	0.35	-0.03	-0.30
Average	0.65	**0.75**	0.68	0.41	**0.59**	0.55	0.18	-0.22
Average ex. prices	0.67	**0.75**	0.68	0.45	**0.58**	0.56	0.21	-0.11
$PC1_{ALL}$	0.63	**0.72**	0.63	0.35	**0.56**	0.50	0.13	-0.26
$PC1_{GDP}$	**0.70**	0.69	0.53	0.25	**0.49**	0.38	0.04	-0.24
$F1_{ALL}$	0.64	**0.72**	0.64	0.37	**0.57**	0.51	0.14	-0.22
$F1_{GDP}$	0.66	**0.72**	0.63	0.39	**0.55**	0.49	0.15	-0.16
Future sales growth (BoO)[a]	-0.07	0.30	0.61	**0.68**	0.48	**0.69**	0.53	0.24
	Panel B: Real business GDP growth							
	Year-over-year				**Quarter-over-quarter**			
Activity index	0.71	**0.78**	0.69	0.46	**0.68**	0.53	0.14	-0.07
Composite index	0.69	**0.72**	0.56	0.25	**0.62**	0.40	-0.02	-0.34
Composite ex. prices	**0.72**	0.66	0.46	0.17	**0.53**	0.29	-0.09	-0.29
Average	0.69	**0.77**	0.68	0.43	**0.66**	0.53	0.14	-0.17
Average ex. prices	0.71	**0.76**	0.67	0.44	**0.64**	0.52	0.15	-0.09
$PC1_{ALL}$	0.67	**0.74**	0.64	0.37	**0.63**	0.48	0.09	-0.21
$PC1_{GDP}$	**0.72**	0.69	0.51	0.23	**0.52**	0.34	-0.02	-0.23
$F1_{ALL}$	0.68	**0.75**	0.64	0.39	**0.64**	0.48	0.09	-0.17
$F1_{GDP}$	0.69	**0.74**	0.63	0.38	**0.61**	0.47	0.09	-0.13
Future sales growth (BoO)[a]	-0.03	0.34	0.63	**0.73**	0.58	**0.69**	0.49	0.33

[a]BoO = Balance of opinion

Table 4: Correlation analysis: Real consumption growth and real business investment growth

(Sample: 2001Q4 to 2011Q3)

Indexes	*t*	*t*+1	*t*+2	*t*+3	*t*	*t*+1	*t*+2	*t*+3
	Panel A: Real consumption growth							
	Year-over-year				**Quarter-over-quarter**			
Activity index	**0.59**	**0.59**	0.50	0.34	**0.36**	0.21	0.11	0.04
Composite index	**0.68**	0.60	0.39	0.13	**0.31**	0.08	-0.05	-0.15
Composite ex. prices	**0.77**	0.69	0.53	0.34	**0.40**	0.25	0.12	0.05
Average	**0.61**	0.59	0.46	0.27	**0.33**	0.15	0.08	-0.03
Average ex. prices	**0.64**	**0.64**	0.56	0.42	**0.40**	0.26	0.21	0.11
$PC1_{ALL}$	**0.61**	0.58	0.44	0.24	**0.31**	0.13	0.05	-0.04
$PC1_{GDP}$	**0.71**	0.64	0.52	0.35	**0.34**	0.21	0.15	0.07
$F1_{ALL}$	**0.61**	0.58	0.46	0.27	**0.32**	0.15	0.07	-0.01
$F1_{GDP}$	**0.63**	0.61	0.52	0.36	**0.35**	0.21	0.15	0.07
Future sales growth (BoO)[a]	-0.04	0.22	**0.33**	0.30	**0.33**	0.26	0.11	0.08
	Panel B: Real business investment growth							
	Year-over-year				**Quarter-over-quarter**			
Activity index	0.63	**0.80**	**0.81**	0.68	**0.81**	0.71	0.36	0.14
Composite index	0.62	**0.77**	0.75	0.55	**0.82**	0.63	0.24	-0.07
Composite ex. prices	0.70	**0.74**	0.64	0.44	**0.69**	0.51	0.13	-0.06
Average	0.62	**0.80**	0.82	0.67	**0.83**	0.71	0.35	0.09
Average ex. prices	0.67	**0.80**	**0.79**	0.66	**0.78**	0.67	0.34	0.15
$PC1_{ALL}$	0.62	**0.79**	**0.79**	0.63	**0.81**	0.67	0.31	0.06
$PC1_{GDP}$	0.73	**0.79**	0.70	0.50	**0.72**	0.55	0.19	0.00
$F1_{ALL}$	0.63	**0.79**	**0.79**	0.64	**0.80**	0.67	0.32	0.07
$F1_{GDP}$	0.67	**0.80**	0.78	0.62	**0.77**	0.65	0.30	0.10
Investment in M&E (BoO)[a]	0.56	**0.71**	0.65	0.48	**0.66**	0.53	0.20	0.03

[a]BoO = Balance of opinion

Table 5: Estimation results: Real GDP growth (q/q)

(Sample: 2001Q4 to 2011Q3)

Variables	Equation 1	Equation 2	Equation 3	Equation 4
Constant	0.91 (2.15)*	-0.24 (-0.41)	1.22 (2.89)	-0.13 (-0.30)
GDP (*t*-1)	0.58 (4.42)	0.37 (2.57)	0.39 (2.68)	0.55 (4.99)
AVE (*t*)		0.10 (2.67)		
PC1 (*t*)			0.44 (2.36)	
Future sales (*t*)				0.07 (4.01)
Adjusted R2	0.32	0.42	0.40	0.51
RMSE	1.00	0.91	0.94	0.82

**t*-statistics are in parentheses.

Table 6: Estimation results: Real business investment growth (q/q)

(Sample: 2001Q4 to 2011Q3)

Variables	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
Constant	1.47 (0.87)	-10.50 (-4.88)	-13.09 (-6.29)	2.70 (2.21)	3.72 (3.17)	-2.36 (-1.22)
Investment (*t*-1)	0.63 (4.99)	0.22 (2.04)		0.24 (2.12)		0.40 (2.92)
AVE (*t*)		0.86 (6.60)	0.79 (5.07)			
AVE (*t*-1)			0.30 (2.00)			
PC1 (*t*)				4.18 (6.12)	4.05 (4.81)	
PC1 (*t*-1)					1.28 (1.57)	
Invest. in M&E (*t*)						0.39 (3.31)
Adjusted R2	0.38	0.71	0.71	0.68	0.67	0.53
RMSE	1.00	0.70	0.72	0.74	0.78	0.91

**t*-statistics are in parentheses.

Chart 1: BOS Indexes and Real GDP Growth

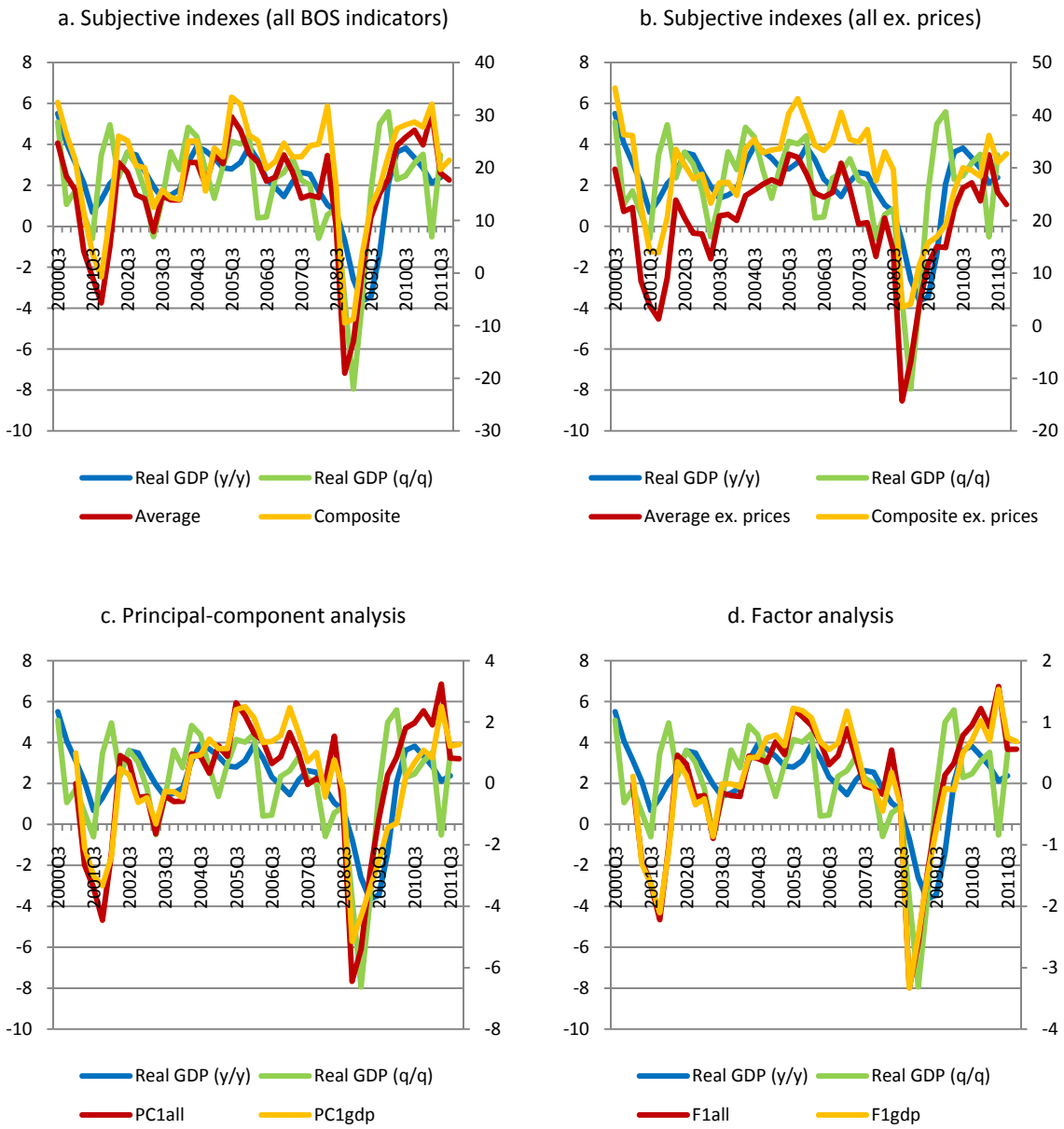
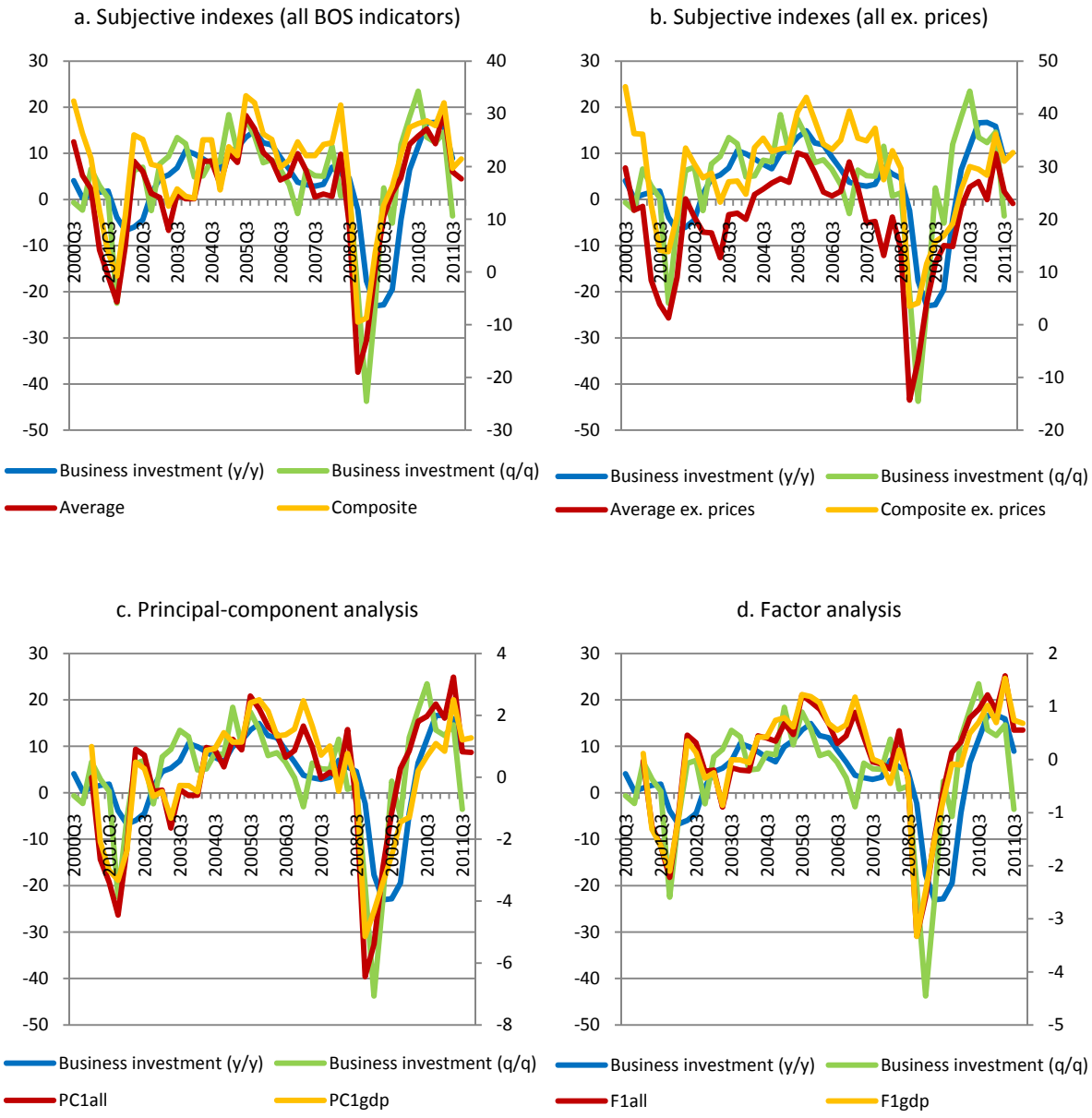


Chart 2: BOS Indexes and Real Business Investment



Appendix A: The BOS Data

BOS questions	Underlying variables				
	AI	PCI	PI	AVE, $PC1_{ALL}$, $F1_{ALL}$	AVExP, $PC1_{GDP}$, $F1_{GDP}$
Past sales growth[a]	x			x	x
Future sales growth[a]	x			x	x
Difficulty in meeting demand[b]		x		x	x
Investment in M&E[a]	x			x	x
Employment[a]	x			x	x
Labour shortages[b]		x		x	x
Input prices growth[a]			x	x	
Output prices growth[a]			x	x	
Credit conditions[a]				x	x

[a]Balance of opinion
[b]Proportion of respondents

Appendix B: Technical Details of Statistical Approaches

Principal-Component Analysis

The first principal component is obtained by maximizing its contribution to the variance of a set of p variables (x). It is expressed as follows:

$$\propto_1' x = \propto_{11} x_1 + \propto_{12} x_2 + \cdots + \propto_{1p} x_p = \sum_{j=1}^{p} \propto_{1p} x_p,$$

where x has a covariance matrix Σ. To derive this first principal component, the vector $\alpha_1$maximizes $var(\alpha_1' x) = \alpha_1' \Sigma \alpha_1$ subject to $\alpha_1' \alpha_1 = 1$. Using the technique of Lagrange multipliers,

$$\max_{\alpha_1} \alpha_1' \Sigma \alpha_1 - \lambda(\alpha_1' \alpha_1 - 1) = 0.$$

The first-order condition is

$$(\Sigma - \lambda I_p)\alpha_1 = 0,$$

where I_p is the $(p \times p)$ identity matrix, λ is an eigenvalue of Σ, and α_1 is the corresponding eigenvector. To maximize $var(\alpha_1' x)$, the vector of coefficients in the first principal component, α_1, is the eigenvector associated with the largest eigenvalue:

$$var(\alpha_1' x) = \alpha_1' \Sigma \alpha_1 = \alpha_1' \lambda \alpha_1 = \lambda \alpha_1' \alpha_1 = \lambda.$$

The *k*th principal component is derived by maximizing $var(\alpha_k' x)$ subject to $\alpha_k' \alpha_k = 1$ and $\text{cov}(\alpha_k' x, \alpha_l' x) = 0$ for all $k \neq l$.

Factor Analysis

The estimation method maximizes the correlations between the series in the dataset by focusing on the off-diagonal elements of the correlation matrix. All common factors must contribute to at least two of the variables. This means the number of factors will be less than the number of variables ($\boldsymbol{m} < p$). To perform factor analysis, the optimal number of factors to be extracted has to be specified. A conventional rule of thumb is that the number of factors should equal the number of eigenvalues of the sample correlation matrix larger than 1. The choice of $\boldsymbol{m}$ remains subjective; it may depend on what is making sense given what has to be measured.

The factor model can be presented as follows:

$$\begin{aligned} \boldsymbol{x_1} &= \lambda_{11}\boldsymbol{f_1} + \lambda_{12}\boldsymbol{f_2} + \cdots + \lambda_{1m}\boldsymbol{f_m} + \boldsymbol{e_1} \\ \boldsymbol{x_2} &= \lambda_{21}\boldsymbol{f_1} + \lambda_{22}\boldsymbol{f_2} + \cdots + \lambda_{2m}\boldsymbol{f_m} + \boldsymbol{e_2} \\ &\vdots \\ \boldsymbol{x_p} &= \lambda_{p1}\boldsymbol{f_1} + \lambda_{p2}\boldsymbol{f_2} + \cdots + \lambda_{pm}\boldsymbol{f_m} + \boldsymbol{e_p} \end{aligned}$$

$$\boldsymbol{X} = \Lambda\boldsymbol{f} + \boldsymbol{e}.$$

Each variable $\boldsymbol{x_k}$, for $\boldsymbol{k} = \boldsymbol{1}, \dots, \boldsymbol{p}$, is expressed as a function of the unknown factors, $\boldsymbol{f_j}$, for $\boldsymbol{j} = \boldsymbol{1}, \dots, \boldsymbol{m}$. $\boldsymbol{\Lambda}$ is a $\boldsymbol{p} \times \boldsymbol{m}$ matrix of factor loadings and $\boldsymbol{e}$ is a $\boldsymbol{p}$-vector of specific disturbances, and unique or idiosyncratic factors. Some assumptions are associated with this model:

(i) $\boldsymbol{E(e) = 0}$
(ii) $\boldsymbol{E(f) = 0}$
(iii) $\boldsymbol{E(x) = 0}$
(iv) $\boldsymbol{E[ee'] = \Psi}$ (diagonal)
(v) $\boldsymbol{E[fe'] = 0}$ (a matrix of zeros)
(vi) $\boldsymbol{E[ff'] = I}$ (an identity matrix).

Assumption (i) is standard in most statistical models; (ii) and (iii) are convenient for the estimation of the model; (iv) and (v) are fundamental assumptions for any factor models. Finally, (vi) can be relaxed, since common factors do not necessarily need to be orthogonal; they can be correlated once a rotation is applied. This is explained in the next few lines.

The estimation of the factor model is usually done in two steps using the maximum likelihood method. First, we estimate the parameters of $\boldsymbol{\Lambda}$ and $\boldsymbol{\Psi}$ by calculating the covariance matrix for both sides of the model above:

$$\boldsymbol{\Sigma = \Lambda\Lambda' + \Psi}.$$

It is clear from this equation that there is no unique solution. Both $\boldsymbol{\Lambda}$ and $\boldsymbol{\Lambda}^*$ are possible solutions for $\boldsymbol{\Lambda}^* = \boldsymbol{\Lambda T}$ and any orthogonal matrix T:

$$\begin{aligned} \boldsymbol{\Lambda}^*\boldsymbol{\Lambda}^{*'} &= (\boldsymbol{\Lambda T})(\boldsymbol{\Lambda T})' \\ &= \boldsymbol{\Lambda TT'\Lambda'}, \\ &= \boldsymbol{\Lambda\Lambda'}. \end{aligned}$$

Restrictions are then imposed on $\boldsymbol{\Lambda}$ to find a unique initial solution, and then a rotation is applied using the matrix T. The rotation changes the factor loadings, but it does not affect the statistical properties of the model. Again, the choice of the rotation criteria involves some subjectivity. In general, one looks for factors that are the easiest to interpret.

Appendix C: Additional Charts

Chart C-1: Weights Obtained from PCA

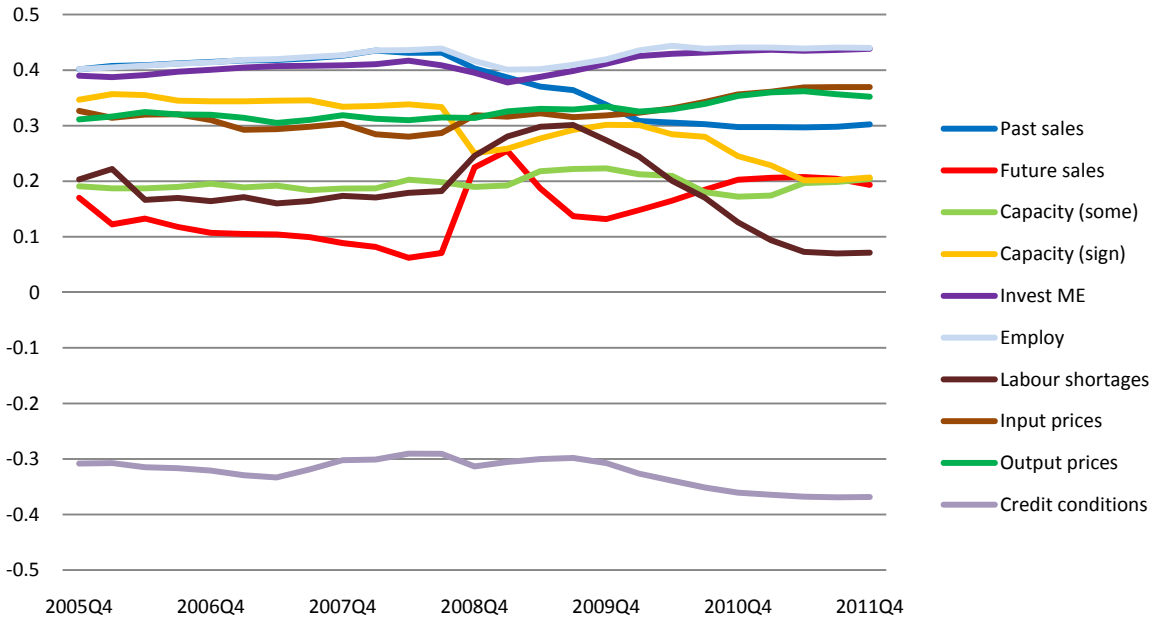


Chart C-2: The Index Using Various Vintages of Weights Estimated with PCA