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Survey-derived proxies for uncertainty: the case of Cyprus

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Δείκτες αβεβαιότητας από στοιχεία ερευνών οικονομικής συγκυρίας: η περίπτωση της Κύπρου

Νικολέττα Πασιουρτίδου

ΠΕΡΙΛΗΨΗ

Χρησιμοποιούνται στοιχεία επιχειρήσεων από τις Έρευνες Οικονομικής Συγκυρίας για να κατασκευαστούν δείκτες οικονομικής αβεβαιότητας για την Κύπρο σε επίπεδο τομέων και οικονομίας. Κατασκευάζονται δύο κατηγορίες δεικτών χρησιμοποιώντας ατομικά στοιχεία επιχειρήσεων. Η πρώτη κατηγορία βασίζεται στη διαφοροποίηση των απόψεων των επιχειρήσεων για τη μελλοντική πορεία διαφόρων οικονομικών μεγεθών τους, χρησιμοποιώντας τη διασπορά των αισιόδοξων και των απαισιόδοξων απαντήσεων σε ερωτήσεις προσδοκιών. Η δεύτερη κατηγορία δεικτών βασίζεται στα σφάλματα πρόβλεψης των επιχειρήσεων, συγκρίνοντας τις προσδοκίες με τις πραγματοποιήσεις που δηλώθηκαν εκ των υστέρων από κάθε επιχείρηση. Οι δείκτες στη δεύτερη κατηγορία υποδιαιρούνται σε δείκτες «αρνητικής» και «θετικής» αβεβαιότητας, ανάλογα με την κατεύθυνση των σφαλμάτων. Τα σοκ αβεβαιότητας που μετρούνται μέσω των δύο κατηγοριών δεικτών επιφέρουν αρνητικές και στατιστικά σημαντικές επιπτώσεις στην εμπιστοσύνη, στην απασχόληση και στην οικονομική δραστηριότητα σε επίπεδο τομέων. Οι αρνητικές επιπτώσεις είναι πιο έντονες και παρατεταμένες στους τομείς των κατασκευών και της μεταποίησης. Σε συνολικό επίπεδο, οι δείκτες κατασκευάζονται αθροίζοντας κλαδικούς δείκτες και συγκρίνονται με εναλλακτικούς δείκτες αβεβαιότητας από στοιχεία ερευνών επιχειρήσεων και χρηματιστηριακά στοιχεία. Ανεξάρτητα από τον συνολικό δείκτη που χρησιμοποιείται, ένα σοκ αβεβαιότητας προκαλεί αρνητικές και στατιστικά σημαντικές επιπτώσεις στη συνολική απασχόληση και στο ΑΕΠ, οι οποίες είναι παρατεταμένες.

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Survey-derived proxies for uncertainty: the case of Cyprus*

Nicoletta Pashourtidou **

Abstract

This paper uses business survey data to construct proxies for economic uncertainty for Cyprus at the sectoral and aggregate levels. The proxies considered are in the form of ex ante disagreement and ex post forecast errors. Proxies based on ex ante disagreement are estimated using the dispersion of optimistic and pessimistic responses provided by firms to expectation questions. Ex post forecast errors are derived by comparing expectations and realisations stated by individual respondents; the proxies are computed using the dispersion of ex post forecast errors. The proxies in the latter group are further decomposed into negative and positive uncertainty measures, depending on the direction of the errors. Uncertainty shocks measured by either ex ante disagreement or ex post negative forecast errors result in significant negative effects on sectoral confidence, employment and output; the negative effects are more pronounced and protracted in the sectors of construction and industry. At the aggregate level, proxies are constructed using the most informative sectoral proxies and are compared to alternative measures from survey and non-survey data. Shocks to aggregate uncertainty proxies generate negative and significant effects on total employment and aggregate output, which are rather protracted.

Keywords: Uncertainty; Business and Consumer Surveys; Cyprus

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1. Introduction

The recent global financial crisis has spurred interest in measuring economic uncertainty and assessing the impact of uncertainty surprises on economic activity, employment and other macroeconomic variables. Moreover, the COVID-19 pandemic has underscored the importance of timely available proxies for uncertainty, which can be fed into models for quantifying the short- and medium-run macroeconomic effects of uncertainties arising from such extraordinary circumstances (e.g. Baker et al. 2020).

A wide range of uncertainty proxies has been proposed in the literature. The proxies differ depending on the data sources used in their construction, for example, stock market returns, surveys of professional forecasters, and business and consumer surveys. Bloom (2009, 2014) uses the value of options on the Standard and Poor's index as a proxy for uncertainty, which signals expectations of stock market volatility in the very short run. The diversity of respondents' opinions in surveys, represented by the dispersion of the cross-sectional responses (usually the standard deviation) in a given time period has yielded various uncertainty proxies in the literature. Some papers measure uncertainty through respondents' disagreement about the future evolution of firm-specific or economy-wide variables; these works employ the dispersion in firms' and/or consumers' expectations stated in surveys (e.g. Bachmann et al. 2013; Girardi and Reuter 2017). Others focus on the dispersion of forecast errors computed from firm-level data of qualitative expectations and realisations (e.g. Arslan et al. 2015; Bachmann et al. 2013). The above-mentioned survey-based proxies capture uncertainty experienced by businesses and households, while disagreement among experts about the future course of macroeconomic variables, and forecast errors by professional forecasters have also been exploited for measuring uncertainty (e.g. Abel et al. 2016; Dovern et al. 2012, Rossi and Sekhposyan 2015). Other data sources used in the literature for the development of uncertainty indices include newspaper archives, and data rich environments employed to compute diffusion index forecasts. For example, Baker et al. (2016) exploit the frequency of words relating to uncertainty in newspaper articles to construct measures of economic policy uncertainty for major economies. Jurado et al. (2015) use the conditional volatility of forecast errors obtained from forecasting via a factor augmented vector autoregression to produce individual uncertainty estimates, which are subsequently aggregated to form a macro uncertainty estimate.

In this paper we tap business survey data collected through the Joint Harmonised EU Programme of Business and Consumer Surveys to construct uncertainty proxies for Cyprus

and investigate their relation with output and employment.¹ Data from Business and Consumer Surveys contain information on perceptions and expectations of firms and consumers on a range of economic variables. The paper aims to assess the usefulness of data from Business Surveys for constructing informative proxies for economic uncertainty at the sectoral level, which can then be used for estimating uncertainty proxies at the aggregate level. Cyprus is a small, open economy which is susceptible to regional and global shocks. As there are no time series of uncertainty proxies available for Cyprus that can provide timely information about the level of economic uncertainty, this work aspires to fill this gap. Business Survey data are used to compute uncertainty proxies in the form of ex ante disagreement and ex post forecast errors. The ex ante disagreement proxies are estimated using the dispersion of optimistic and pessimistic responses to expectation questions. Ex post forecast errors are derived by comparing expectations and realisations stated by individual respondents; the proxies are computed using the dispersion of ex post forecast errors. The latter group of proxies exploits the individual responses given by firms and the panel nature of the Cypriot survey data. Activity and employment expectations of the firms in the panel for a three-month horizon are compared with realisations reported by the same firms three months later, to derive forecast errors. Uncertainty proxies are then computed using the cross-sectional dispersion of firms' forecast errors. The dynamic relationships between uncertainty proxies, output and employment are explored using vector autoregressions (VAR).

Using uncertainty measures based on the different data sources and methodologies, the empirical literature documents the countercyclical relationship between uncertainty and real activity, and finds significant negative effects of uncertainty shocks on output and employment. Nevertheless, there are variations in the findings regarding the shape of the output and employment responses to uncertainty surprises, as well as the persistence of the effects triggered by uncertainty shocks on output and employment. Bloom (2009) uses stock market volatility as a proxy for a macro uncertainty shock which leads to a fast reduction and rebound in output and employment; in the medium term, output and employment overshoot as a result of the higher volatility caused by the shock. Bachmann et al. (2013) construct a proxy from expectation disagreement in business surveys and find large and persistent reductions in US production and employment without overshooting effects. Jurado et. al. (2015) find that their uncertainty estimates signal fewer important uncertainty episodes in the US economy than other popular proxies, and that macro uncertainty shocks lead to larger and more persistent effects on output and employment. Rossi and Sekhposyan (2015) separate their overall

¹ Information on the harmonised surveys conducted by the Directorate General for Economic and Financial Affairs can be found at:
https://ec.europa.eu/info/business-economy-euro/indicators-statistics/economic-databases/business-and-consumer-surveys_en

uncertainty index into an upside and a downside uncertainty measure; they find that the downside uncertainty measure leads to larger negative effects on US GDP than the overall index. Moreover, the effects of an uncertainty innovation on output, using their downside uncertainty measure, are larger than those estimated by the stock market volatility (VXO) index in Bloom (2009), but smaller than the effects generated by the macroeconomic uncertainty index in Jurado et. al. (2015).

Focusing on uncertainty proxies derived from business and consumer surveys conducted in the EU, empirical findings for EU member states and the euro area show that these surveys can be used to derive meaningful proxies for the level of uncertainty in an economy. Using data for Germany, Bachmann et al. (2013) find that surprises in measures based on firms' ex ante disagreement or ex post forecast errors generate declines in production followed by a quick rebound; the negative effects on employment are more persistent. Girardi and Reuter (2017) make a thorough use of both business and consumer survey data for constructing composite uncertainty measures for the euro area. Shocks to their survey-based measures are found to lead to significant declines in real GDP, which die away over time. Moreover, the proposed survey-based measures in Girardi and Reuter (2017) account for a larger proportion of the variability in GDP than other available uncertainty indicators derived from different data sources. Van Aarle and Moons (2017) utilise the sectoral dimension of business and consumer surveys to study the role of sentiment and uncertainty in the fluctuations of economic activity in the euro area as a whole, as well as in its two largest economies; the most negative response to an uncertainty shock is associated with output in the services sector in both the euro area and France. Claeys and Vasicek (2019) also exploit the richness of business and consumer survey data to derive uncertainty proxies for individual EU member states and to estimate the effects of uncertainty on macro variables using a panel Bayesian VAR. They find that uncertainty shocks at the EU country level result in significant but temporary negative effects on GDP, consumption and investment, with the response of the latter being the most pronounced. The authors use the country-specific measures to estimate a common EU-wide uncertainty component; the responses of GDP and investment to shocks to the common component are more persistent compared to the reactions induced by country-specific surprises. The common uncertainty component explains a large fraction of the variation (over 70%) across EU countries and the authors conclude that uncertainty in the EU is driven by common rather than country-specific developments. Nevertheless, they mention that Cyprus is among the euro area countries with the strongest idiosyncratic component, a finding that reinforces the need for proxies for Cyprus.

Our results suggest that business survey data constitute a valuable source in the construction of economic uncertainty proxies for Cyprus, at the sectoral and aggregate levels. Ex ante

disagreement proxies, which are timely available and less data-demanding, are strongly correlated with ex post forecast errors proxies, obtained from panels of individual data and are therefore free from firm heterogeneity. Thus, fluctuations in ex ante disagreement proxies reflect changes in the level of uncertainty rather than firm heterogeneity, and ex ante disagreement proxies can form valid measures of uncertainty. At the sectoral level, uncertainty shocks measured by ex ante disagreement in employment or price expectations generate significant negative effects on confidence, employment and output, which are more pronounced and protracted in construction and industry. Significant effects on sectoral confidence, employment and output are estimated when uncertainty is measured separately by ex post negative and positive forecast errors, reflecting negative and positive surprises, respectively. At the aggregate level, proxies are constructed using the most informative sectoral measures and are compared to alternative proxies from survey and non-survey data. All proxies at the aggregate level result in similar employment and GDP responses to uncertainty shocks. The ex ante disagreement proxy is flatter and more slow-moving compared to the negative and positive forecast error proxies, as employment expectations do not exhibit large swings mainly due to institutional factors.

Section 2 describes the business survey data and discusses the construction of uncertainty proxies employed in the paper. Section 3 computes uncertainty proxies for sectors of economic activity, estimates their relationships with confidence indicators, output and employment, and evaluates their usefulness for forecasting output and employment. Section 4 presents uncertainty proxies for the economy derived from the sectoral proxies given in Section 3; section 4 also investigates the dynamic relationships between aggregate uncertainty proxies and macro variables. Section 5 concludes.

2. Uncertainty proxies from survey data

2.1 Survey data

This paper uses individual and aggregate data from business surveys in Cyprus collected through the Joint Harmonised EU Programme of Business and Consumer Surveys, over the period May 2008 – December 2019.² Business surveys in Cyprus are conducted on a monthly basis using panels of firms in industry, construction, retail trade and services, with monthly sample sizes of 120, 120, 250 and 250 firms, respectively.³

² Individual firm data start in May 2008, when the University of Cyprus (Economics Research Centre) began its participation in the Joint Harmonised EU Programme of Business and Consumer Surveys. Survey data for Cyprus in the form of proportions also start in May 2008.

³ For the period May 2008 – April 2015, the monthly sizes for the surveys in industry, construction, retail trade and services are 100, 100, 200 and 200 firms, respectively.

In the surveys carried out under the Joint Harmonised EU Programme of Business and Consumer Surveys (European Commission, 2020), managers are asked, inter alia, to assess recent trends in their firms' production (industry), demand (services), sales (retail trade), building activity (construction), employment (services), order books (industry and construction) and stocks (industry and retail trade). Managers are also requested to state their expectations concerning their firms' production (industry), demand (services), sales (retail trade), orders to suppliers (retail trade), selling prices and employment. Firms' assessments refer to the past three months, while their expectations cover the next three months. The answers are qualitative, according to a three-option scale: "increase" (+), "no change" (=) and "decrease" (-). Aggregate data at the sector level in a given month are computed as the weighted percentages of replies in each answering category, using weights that reflect the size of each stratum in the population.

Uncertainty proxies proposed in the literature can be derived either from the weighted proportions of optimistic and pessimistic responses, or from firm-specific forecast errors, i.e. the discrepancy between a respondent's expectations about an economic variable of the firm and the corresponding realisations.

Table 1 provides more details about the monthly survey questions on expectations, along with the monthly questions on realisations. As seen from Table 1 not all expectation questions have a realisation counterpart. Where possible, a forward-looking question can be matched to a realisation question on an identical or closely related economic concept. In the industry, retail trade and services surveys, there are questions on activity developments over the past and next three months. In the construction survey, there is a question on activity developments over the past three months, but no question on expected activity developments. Hence, the question on expected employment is matched to the realisation question on past activity developments; the former could convey information on future activity as construction is a labour-intensive sector.

TABLE 1
Monthly survey questions

Survey/Sector	Expectation question	Realisation question
Industry	How do you expect your production to develop over the next 3 months?	How has your production developed over the past 3 months?
	How do you expect your firm's total employment to change over the next 3 months?	–
	How do you expect your selling prices to change over the next 3 months?	–
Construction	How do you expect your firm's total employment to change over the next 3 months?	How has your building activity developed over the past 3 months?
	How do you expect the prices you charge to change over the next 3 months?	–
Retail trade	How do you expect your business activity (sales) to change over the next 3 months?	How has (have) your business activity (sales) developed over the past 3 months?
	How do you expect your orders placed with suppliers to change over the next 3 months?	–
	How do you expect your firm's total employment to change over the next 3 months?	–
	How do you expect the prices you charge to change over the next 3 months?	–
Services	How do you expect the demand (turnover) for your company's services to change over the next 3 months?	How has demand (turnover) for your company's services changed over the past 3 months?
	How do you expect your firm's total employment to change over the next 3 months?	How has your firm's total employment changed over the past 3 months?
	How do you expect the prices you charge to change over the next 3 months?	–

2.2 Ex ante disagreement and ex post forecast errors

Following Bachmann et al. (2013), ex ante forecast disagreement measured by the dispersion of firms' responses to forward-looking questions can be used as a proxy for uncertainty. Let the numerical values 1, 0 and –1 denote the qualitative responses “increase”, “no change” and “decrease”, respectively, to a survey question. An uncertainty proxy for sector s , in month t , is given by the weighted cross-sectional standard deviation of survey responses to a forward-looking question, say q ,

$$U_{s(q)t}^a = \sqrt{P_{s(q)t} + M_{s(q)t} - (P_{s(q)t} - M_{s(q)t})^2}, \quad (1)$$

where $P_{s(q)t}$ and $M_{s(q)t}$ are the weighted proportions of firms that answered “increase” and “decrease”, respectively. The proxy in (1) ranges from 0, indicating identical responses by all firms, to 1, suggesting maximum disagreement in firms’ expectations. Thus, when firms express more diverse views about the future, the proxy takes larger values, signalling higher uncertainty, and the opposite happens when firms tend to hold more similar opinions about the future.

A shortcoming of the above uncertainty proxy is that its fluctuations over time could reflect heterogeneity among firms that affects their expectations, without the firms necessarily being more/less uncertain about their future prospects. Another uncertainty proxy which is not affected by firm heterogeneity is based on ex post forecast errors made by firms. Given the panel nature of business survey data in Cyprus, a qualitative measure of a firm’s ex post forecast error is constructed by comparing the answer to an expectation question with the response provided to the corresponding realisation question three months later.

Comparing the response to an expectation question q , given by firm i , operating in sector s , in month t , with the answer provided by the same firm to the corresponding realisation question three months later ($t + 3$), we obtain the forecast error shown in Table 2 as follows:

$$e_{s,i(q)t+3} = \text{realisation}_{s,i(q)t+3} - \text{expectation}_{s,i(q)t}. \quad (2)$$

In both expectation and realisation questions shown in Table 2, the three response options “increase”, “no change” and “decrease” are coded as 1, 0 and -1 , respectively, and therefore the value of the forecast error ranges from -2 to 2 .

TABLE 2
Qualitative forecast error

Expectations stated in month t	Realisations stated in month $t+3$		
	Increase: 1	No change: 0	Decrease: -1
Increase: 1	0	-1	-2
No change: 0	1	0	-1
Decrease: -1	2	1	0

Following Bachmann et al. (2013), uncertainty proxies can be constructed by computing the standard deviation of expectation errors, or the mean of absolute errors across firms:

$$U_{s(q)t}^b = \sqrt{\frac{1}{N} \sum_{i=1}^N (e_{s,i(q)t+3} - \bar{e}_{s(q)t+3})^2}, \quad (3)$$

$$U_{s(q)t}^c = \frac{1}{N} \sum_{i=1}^N |e_{s,i(q)t+3}|, \quad (4)$$

where $\bar{e}_{s(q)t+3}$ denotes the average error across firms in month t , and N is the number of firms that stated both their expectations in month t and the corresponding realisations three months

later.⁴ Furthermore, $U_{s(q)t}^c$ can be decomposed into two components, $U_{s(q)t}^{c,n}$ and $U_{s(q)t}^{c,p}$ associated with negative and positive forecast errors, respectively. Therefore, $U_{s(q)t}^c$ can be expressed as the sum of negative and positive surprises faced by firms,

$$U_{s(q)t}^c = U_{s(q)t}^{c,n} + U_{s(q)t}^{c,p}, \quad (5)$$

where $U_{s(q)t}^{c,n} = \frac{1}{N} \sum_{i=1}^{N_n} |e_{s,i(q)t+3}|$, $U_{s(q)t}^{c,p} = \frac{1}{N} \sum_{i=1}^{N_p} |e_{s,i(q)t+3}|$; N_n , and N_p denote the number of firms who made negative and positive errors, respectively. The two components $U_{s(q)t}^{c,n}$ and $U_{s(q)t}^{c,p}$ can form proxies of ‘negative’ or ‘downside’ and ‘positive’ or ‘upside’ uncertainty. When more firms experience a worse outcome than what they anticipated, downside uncertainty increases and upside uncertainty decreases. When realisations are better than expected, upside uncertainty rises and downside uncertainty declines.

Proxies based on the standard deviation, such as $U_{s(q)t}^a$ and $U_{s(q)t}^b$ point to low uncertainty when the dispersion among firms’ expectations or among forecast errors is low. However, this may occur if, for example, many firms are simultaneously pessimistic or make negative errors, as a result of a negative shock, which should lead to a rise in uncertainty. The proxy given in equation (4), $U_{s(q)t}^c$, and its components shown in equation (5), $U_{s(q)t}^{c,n}$ and $U_{s(q)t}^{c,p}$, do not suffer from this shortcoming.

3. Uncertainty proxies for sectors of economic activity

Uncertainty proxies for the sectors of economic activity covered by the surveys are derived using ex ante disagreement among firms and ex post forecast errors made by respondents. More specifically, uncertainty proxies are computed using monthly data from business surveys and the formulae given in equations (1), (3) and (4). The proxies given by the mean absolute forecast error are further decomposed into negative and positive uncertainty components as shown in equation (5). The monthly proxies are transformed into quarterly frequency by averaging. Quarterly data on sectoral confidence indicators, output and employment are also used. In particular, the analysis in this section uses data on confidence indicators for the sectors covered by the surveys, sectoral gross value added (chain-linked volume measures), production/turnover indices, and the number of persons employed in each sector.⁵ The sample covers the period from 2008q2 to 2019q4. The statistical properties of the constructed

⁴ In computing the standard deviation or the mean of absolute errors across firms in a sector survey, errors can be weighted according to the size of the population stratum to which the firm belongs.

⁵ The sectoral confidence indicators are produced for industry, construction, retail trade and services, using business survey data collected under the European Commission’s Joint Harmonised EU Programme of Business and Consumer Surveys. Data on output measures and employment were obtained from the Statistical Service of Cyprus and Eurostat. The data used are seasonally adjusted. Output and employment variables are expressed in quarter-on-quarter percentage changes.

uncertainty proxies, as well as their interrelationships with employment and output in each sector are explored.

3.1 Statistical properties of proxies

Table 3 presents some unconditional descriptive statistics for the uncertainty proxies computed using the dispersion in firms' expectations and forecast errors derived from the business survey data. Measures based on the standard deviation of ex post forecast errors show relatively low volatility, similar to that of proxies obtained from the dispersion of expectations about activity. Measures computed using either the disagreement in employment expectations in industry, construction and retail trade, or employment expectation errors in services are associated with higher volatility. The proxies based on either negative or positive forecast errors are the most volatile among the ex post forecast error measures. Many of the proxies in Table 3 exhibit skewness and kurtosis that are not statistically different from those of the normal distribution. Ex ante disagreement proxies show larger deviations from normality compared to forecast error proxies. Almost all uncertainty proxies based on ex ante disagreement are negatively and significantly correlated with the corresponding confidence indicator, as well as with sectoral employment and output measures. The proxies computed from ex post forecast errors, typically result in weaker correlations with confidence, employment and output vis-à-vis expectation disagreement measures. As expected, proxies based on positive forecast errors exhibit positive correlation with confidence, employment and output measures.

Although proxies based on disagreement in business and consumer survey expectations have been widely used in the literature (e.g. Claeys and Vasicek, 2019; Bachmann et al. 2013, Girardi and Reuter, 2017; Ghirelli et al. 2019; van Aarle and Moons, 2017; Meinen and Roehle 2017), it was noted that such proxies could also reflect heterogeneity due to differences in agents' characteristics and information sets, as well as noise (see e.g. Claeys and Vasicek, 2019; Bachmann et al. 2013, Girardi and Reuter, 2017). Uncertainty proxies based on ex post forecast errors are not flawed by heterogeneity, as they are drawn from panels of firm-level data. According to Bachmann et al. (2013), proxies derived from ex post forecast errors constitute a natural measure of uncertainty since their fluctuations reflect changes in the dispersion of shocks experienced by firms; this measure resembles the view of uncertainty in the theoretical literature. Hence, Table 4 presents the correlations between proxies based on ex post forecast errors and the corresponding proxies computed from expectation disagreement. In the majority of cases, the two types of proxies are significantly correlated with the right sign, which suggests that fluctuations in proxies based on ex ante disagreement reflect changes in uncertainty rather than effects due to firm heterogeneity.

TABLE 3
Statistical properties of uncertainty proxies

	Volatility	Skewness	Kurtosis	Correlation			
				Confidence indicator	Value added	Other output measure	Employment
Proxies based on ex ante disagreement							
Industry: production	0.07	-0.79	3.06	-0.66	-0.37	-0.45	-0.47
Industry: prices	0.26	0.04	1.90	-0.48	-0.69	-0.80	-0.65
Industry: employment	0.36	-0.11	1.53	-0.57	-0.71	-0.81	-0.69
Construction: employment	0.22	-0.15	1.95	-0.32	-0.51	-0.42	-0.56
Construction: prices	0.17	-0.45	2.29	-0.37	-0.47	-0.47	-0.59
Retail trade: orders to suppliers	0.06	0.27	2.49	0.07	0.17	-0.07	0.15
Retail trade: sales	0.05	-0.16	1.85	-0.48	-0.35	-0.50	-0.29
Retail trade: employment	0.42	-0.08	1.40	-0.71	-0.58	-0.55	-0.70
Retail trade: prices	0.19	-0.17	1.53	-0.70	-0.59	-0.57	-0.61
Services: turnover	0.08	0.23	1.94	-0.55	-0.26	–	-0.44
Services: employment	0.13	0.08	3.09	-0.27	-0.27	–	-0.33
Services: prices	0.22	0.02	1.93	-0.70	-0.44	–	-0.66
Proxies based on ex post forecast errors							
Industry: production, standard deviation	0.06	0.18	3.05	0.02	0.16	0.05	0.14
Industry: production, mean absolute error	0.10	-0.17	2.55	-0.12	-0.10	-0.19	-0.04
Industry: production, negative errors	0.22	0.23	1.91	-0.41	-0.52	-0.62	-0.47
Industry: production, positive errors	0.29	0.32	2.83	0.45	0.65	0.69	0.63
Construction: employment, standard deviation	0.07	0.02	2.18	-0.12	-0.26	-0.34	-0.35
Construction: employment, mean absolute error	0.16	0.22	2.16	-0.41	-0.45	-0.50	-0.56
Construction: employment, negative errors	0.37	0.14	1.90	-0.60	-0.57	-0.55	-0.68
Construction: employment, positive errors	0.33	0.32	2.25	0.71	0.58	0.46	0.64
Retail trade: sales, standard deviation	0.05	-0.66	3.72	0.26	0.25	0.13	0.16
Retail trade: sales, mean absolute error	0.09	-0.61	3.68	0.26	0.26	0.01	0.18
Retail trade: sales, negative errors	0.16	-0.18	2.62	-0.04	-0.05	-0.35	-0.07
Retail trade: sales, positive errors	0.21	-0.60	3.78	0.43	0.48	0.62	0.38
Services: turnover, standard deviation	0.06	0.00	2.03	-0.48	-0.33	–	-0.47
Services: turnover, mean absolute error	0.09	0.22	2.62	-0.48	-0.35	–	-0.24
Services: turnover, negative errors	0.17	0.22	2.79	-0.51	-0.41	–	-0.45
Services: turnover, positive errors	0.17	0.11	2.40	0.22	0.24	–	0.16
Services: employment, standard deviation	0.12	0.73	3.77	-0.31	-0.18	–	-0.24
Services: employment, mean absolute error	0.22	0.99	4.34	-0.31	-0.19	–	-0.23
Services: employment, negative errors	0.28	1.08	4.61	-0.01	-0.14	–	-0.03
Services: employment, positive errors	0.31	0.33	3.41	-0.56	-0.16	–	-0.37

Notes: Following Bachmann et al. (2013), volatility is measured by the coefficient of variation, i.e. the ratio of the standard deviation to the mean of the proxy. The values for skewness and kurtosis in bold indicate that the hypothesis of normality is not rejected at the 5% significance level (D'Agostino et al. 1990 and Royston 1991). The correlation coefficients in bold indicate statistical significance at the 5% level. The volume index of manufacturing production, the volume index of production in construction and the index of deflated turnover in retail trade are used as alternative output measures for the corresponding sectors.

TABLE 4
Correlations between uncertainty proxies, sectors

Proxies based on ex post forecast errors	Proxies based on ex ante disagreement	
	Activity	Employment
Industry: production, standard deviation	0.12	0.05
Industry: production, mean absolute error	0.23	0.22
Industry: production, negative errors	0.35	0.62
Industry: production, positive errors	-0.25	-0.66
Construction: employment, standard deviation	–	0.60
Construction: employment, mean absolute error	–	0.58
Construction: employment, negative errors	–	0.64
Construction: employment, positive errors	–	-0.52
Retail trade: sales, standard deviation	0.48	0.12
Retail trade: sales, mean absolute error	0.52	0.17
Retail trade: sales, negative errors	0.62	0.44
Retail trade: sales, positive errors	-0.32	-0.53
Services: turnover, standard deviation	0.71	0.49
Services: turnover, mean absolute error	0.66	0.44
Services: turnover, negative errors	0.60	0.47
Services: turnover, positive errors	-0.12	-0.22
Services: employment, standard deviation	0.68	0.63
Services: employment, mean absolute error	0.67	0.66
Services: employment, negative errors	0.46	0.61
Services: employment, positive errors	0.64	0.40

Note: The correlation coefficients in bold indicate statistical significance at the 5% level.

3.2 Uncertainty, employment and output in sectors of economic activity

The dynamic relationships between uncertainty and the real economy are explored using a separate VAR for each sector. The VARs include the confidence indicator, an uncertainty proxy (one at a time), as well as employment and real gross value added expressed in quarterly growth rates. To investigate the dynamic effects of uncertainty shocks on employment and output, holding everything else in the models constant, the variables in the VARs are ordered as follows: uncertainty proxy, confidence indicator, employment growth, output growth. This ordering assumes that shocks to uncertainty impact confidence, employment and output instantaneously. Thus, this ordering is equivalent to a recursive orthogonalization of the VAR innovations using the Cholesky decomposition of the variance-covariance matrix of the VAR residuals. The Cholesky decomposition is used for the estimation of orthogonalized impulse response functions and forecast error variance decompositions. The VARs are estimated over the period 2008q2–2019q4.⁶ In most empirical studies, the uncertainty measure is ordered before employment and output; also, the confidence indicator, or the stock market index, is ordered before the uncertainty proxy (e.g. Bachmann et al. 2013; Bloom 2009; Claeys and Vasicek 2019; Girardi

⁶ The lag length in the VARs was selected using the Bayesian Information Criterion. In the estimation of the variance-covariance matrix of the VAR residuals, a small-sample adjustment for the degrees of freedom was applied.

and Reuter 2017). However, Granger causality tests reveal that causality tends to run from uncertainty to confidence but not vice versa (Appendix, Table A1).⁷

First, the estimated conditional effects of uncertainty on confidence, employment and output in the four sectors, quantified by the estimated VAR coefficients, are summarised in the Appendix (Table A2). The conditional effects have the expected signs, similarly to the unconditional correlations, with only minor exceptions. Uncertainty proxies based on ex ante disagreement, as well as measures derived from either negative or positive ex post forecast errors tend to generate more pronounced effects vis-à-vis other proxies considered. Uncertainty measured by the extent of disagreement in employment expectations and, to a lesser degree, price expectations result in more negative effects on confidence, employment and output, compared to proxies based on the dispersion of firms' expectations about their activity (i.e. production, sales, turnover).

The estimates of the VAR coefficients show that changes in the level of uncertainty in the four sectors considered give useful signals about movements in employment and output, particularly when uncertainty is measured using ex ante disagreement in employment and price expectations. Thus, the impact of uncertainty shocks on confidence, employment and output is explored using impulse response functions. Shocks to uncertainty measured through proxies based on the dispersion of firms' employment or price expectations trigger significant negative effects on confidence, employment and output in the four sectors, particularly in construction and industry. These impulse responses are plotted in Figure 1; panels A and B plot the impulse responses in the case of proxies based on employment and price expectations, respectively. The solid line shows the estimated response to a shock of magnitude equal to one standard deviation of the innovations in the uncertainty proxy equation. The shaded region around the estimated response gives the 95% bootstrap confidence interval. The impulse responses of confidence, employment and output to proxies derived from employment or price expectation disagreement are similar in terms of shape and magnitude. The negative effects of an uncertainty shock tend to be more persistent in the sectors of construction and industry. Long-lasting negative effects are also estimated in retail trade when uncertainty is measured by disagreement in price expectations. As a result of the uncertainty shock, the confidence indicator registers reductions for up to 12 quarters after the shock. The largest decline in the confidence indicator ranges between 3 (industry) to 7 (services) balance points; afterwards confidence starts rebounding rather slowly. The maximum decline in employment and output growth due to an uncertainty shock occurs within at most four quarters of the shock; subsequently the effects begin to fade out. The largest

⁷ The results of variance decomposition and impulse response analysis presented in this section are not sensitive to alternative orderings of the variables in the VARs.

reduction in employment growth varies between 0.2 percentage points in retail trade and 0.8 percentage points in construction. The maximum decrease in output growth ranges between 0.3 in retail trade to about 1.0 percentage points in construction and industry, occurring within less than a year after the shock.

Similar responses to those described above are found when negative and positive forecast errors are used separately as proxies for uncertainty. The responses of confidence, employment and output to positive surprises have the opposite sign to, but are of similar size as the responses to negative uncertainty shocks. The impulse responses are shown in Figure 2; panels A and B plot the impulse responses in the case of a negative and a positive uncertainty surprise, respectively. In the sector of construction, an uncertainty innovation has more persistent and larger effects on employment and output vis-à-vis other sectors. A negative uncertainty shock leads to a maximum reduction in confidence that ranges between 3 (industry) and 6 (services) balance points. A positive uncertainty shock can lead to a boost in confidence that varies from 3 (industry) to 7 (services) at its peak. The effects of uncertainty shocks on employment and output are maximised within four and one quarters after shock, respectively. The largest effect of a negative or positive shock on employment varies from 0.3 (retail trade) to 0.8 (construction) percentage points. The largest change in output growth induced by a negative or positive surprise is estimated between 0.3 (services) and 2 (construction) percentage points.

Proxies based on ex ante disagreement of firms' expectations about activity (e.g. production in industry, turnover in services, sales in retail trade) result in weaker responses. Furthermore, uncertainty shocks modelled using proxies based on the standard deviation of ex post forecast errors do not seem to trigger significant effects on confidence, employment and output. Some significant responses to uncertainty shocks are found when the average of the absolute forecast errors is used; however, the effects on macro variables are smaller compared to the case when its components based on negative and positive forecast errors are used as separate uncertainty proxies.⁸

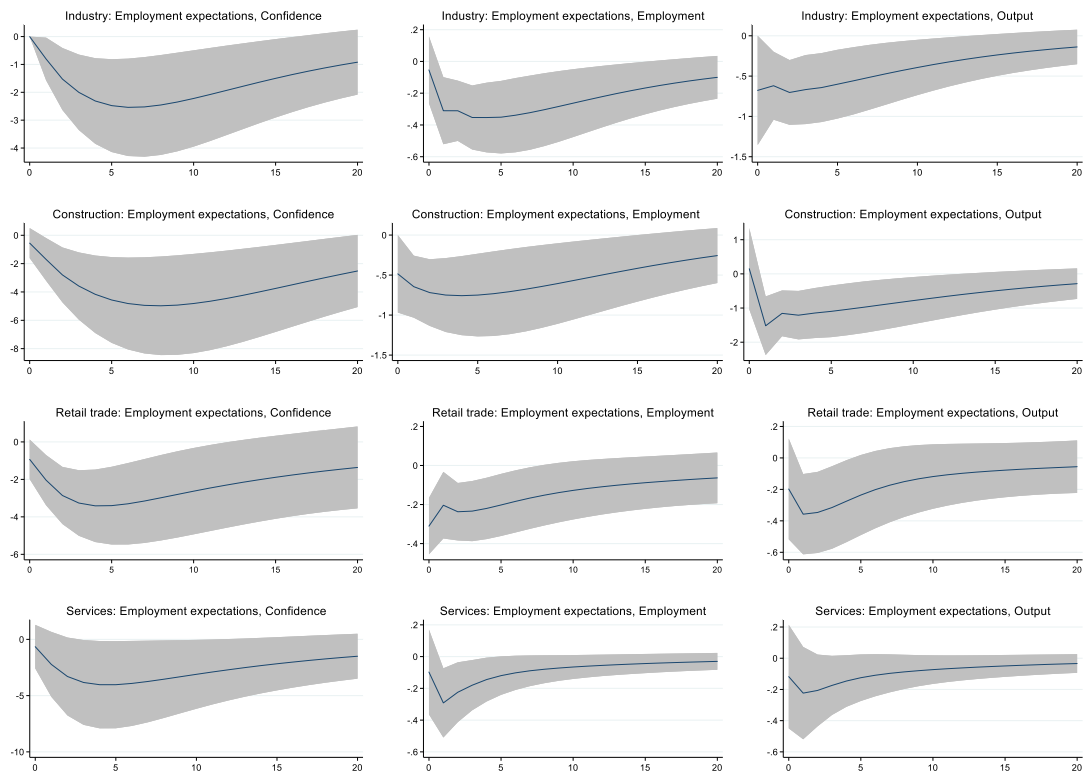
Table 5 shows the forecast error variance decomposition for employment and output. More specifically, the values in Table 5 show the contribution of an uncertainty shock (measured via different proxies) to the forecast error variance of employment and output. The contribution of uncertainty shocks tends to be higher in the case of employment forecasts. For both employment and output, the proportion of the forecast error variance attributed to uncertainty shocks rises significantly at the four-quarter horizon and continues to increase, but at a slower

⁸ The results obtained using proxies based on ex ante disagreement about activity and the dispersion of ex post forecast errors (i.e. the standard deviation and the mean of absolute errors) are omitted for brevity.

rate, at longer horizons. Within the group of ex ante disagreement proxies, measures derived from employment and price expectations account for a larger fraction of the forecast error variance than proxies using disagreement in expectations about activity. In most cases, the contribution of shocks induced by employment and price expectations proxies at the 20-quarter horizon exceeds 40% for employment and 30% for output. Within the ex post forecast error group, negative and positive uncertainty proxies fare better in terms of variance contribution than proxies calculated using the mean of the absolute ex post forecast errors or the standard deviation of firms' errors. The contribution of negative and positive uncertainty surprises at the end of the horizon, ranges between 20% and 40%.

Figure 1: Response of confidence, employment and output to uncertainty shocks, ex ante disagreement

A. Uncertainty proxy based on employment expectations



B. Uncertainty proxy based on price expectations

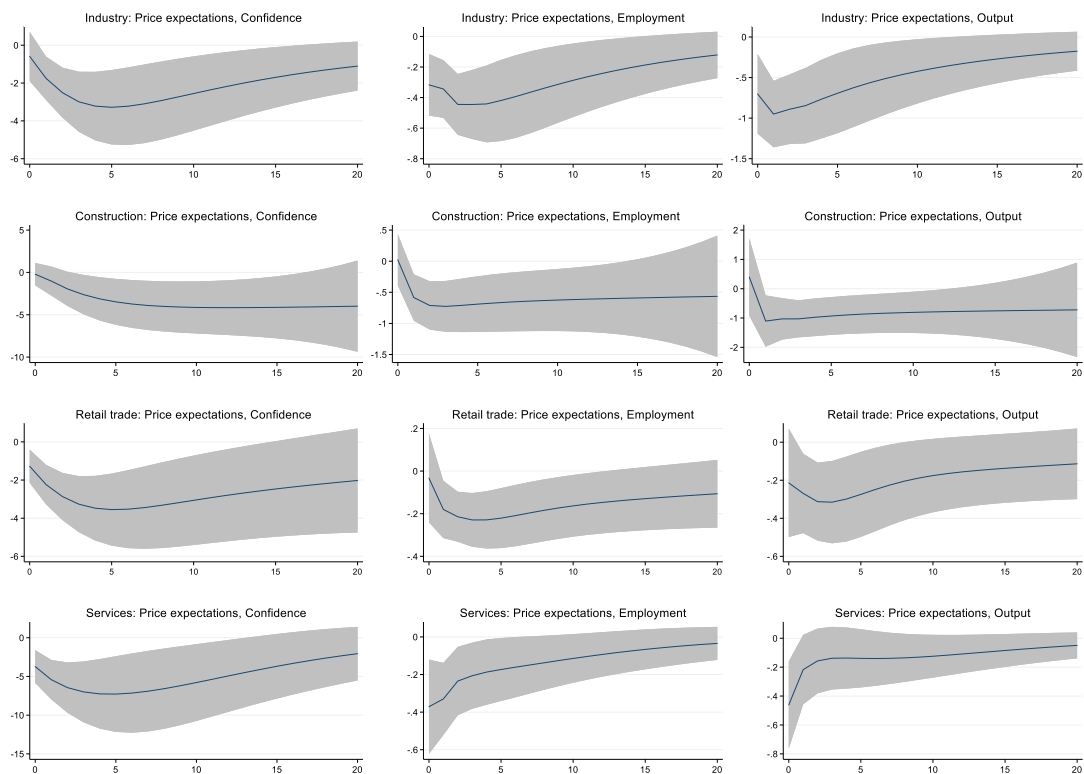
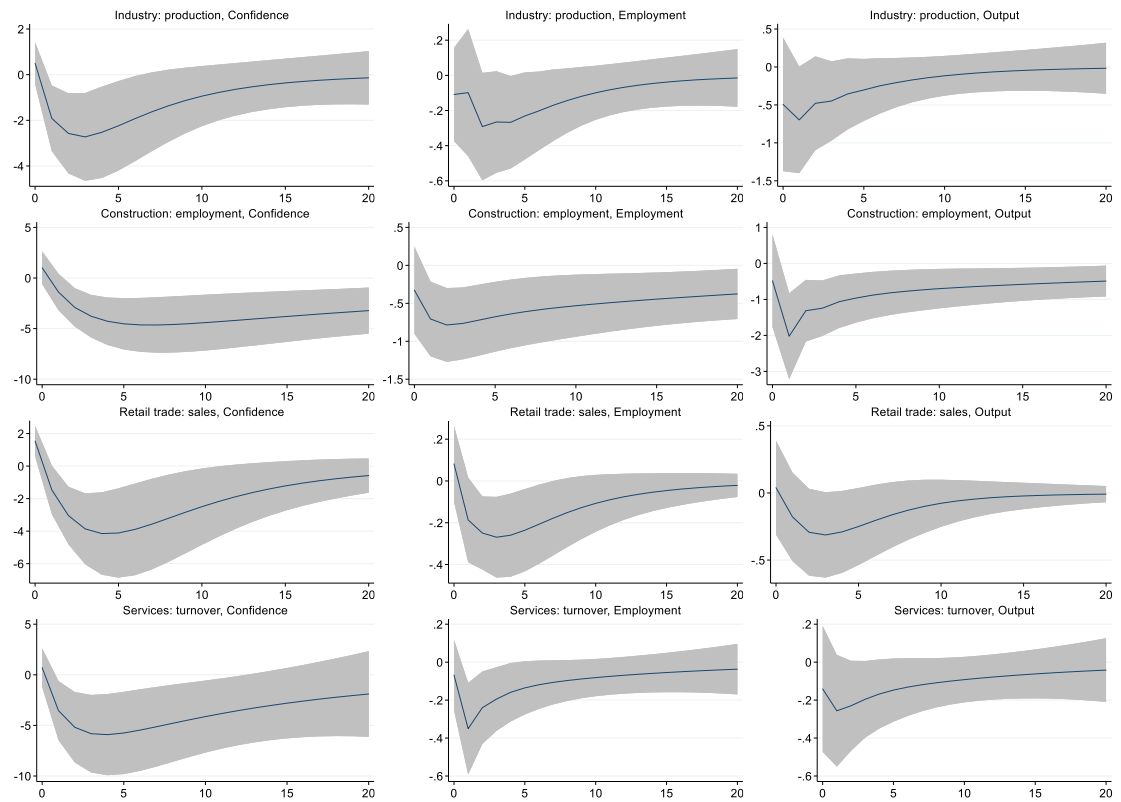


Figure 2: Response of confidence, employment and output to uncertainty shocks, ex post forecast errors

A. Uncertainty proxy based on negative forecast errors



B. Uncertainty proxy based on positive forecast errors

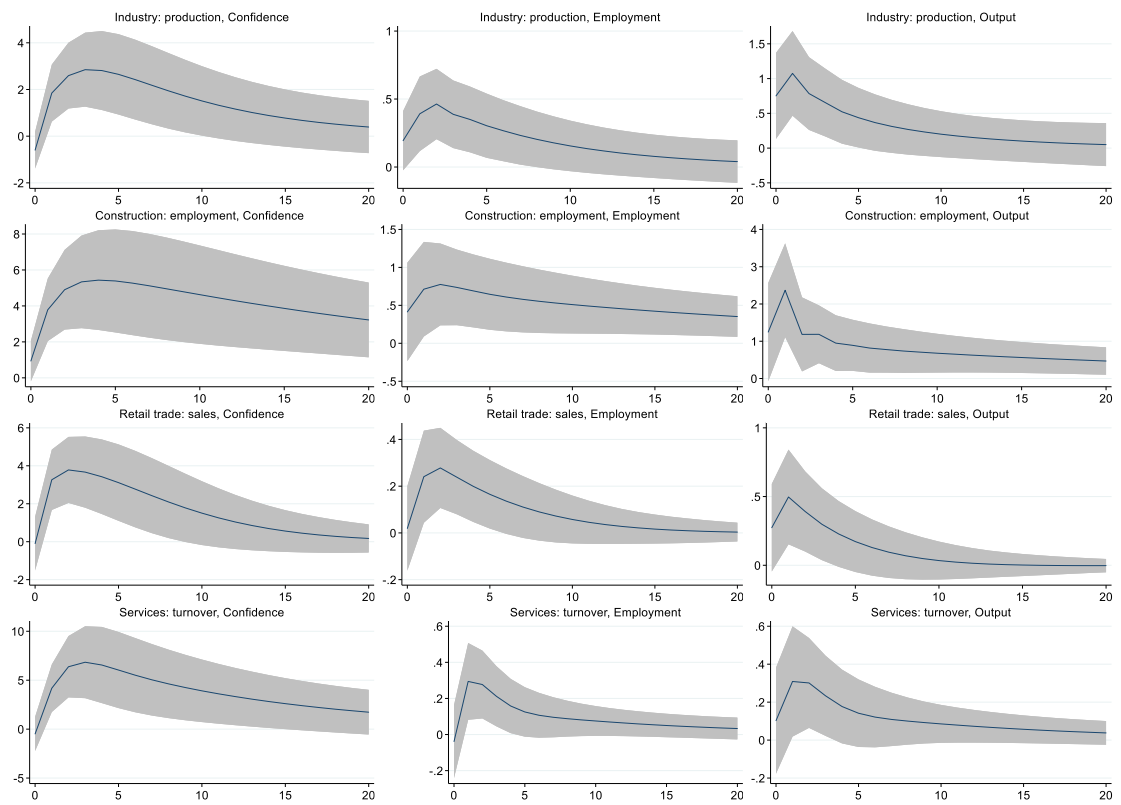


TABLE 5
Forecast error variance decomposition, sectors

Horizon (quarters)	Employment				Output			
	1	4	8	20	1	4	8	20
Proxies based on ex ante disagreement								
Industry: production	0.01	0.04	0.04	0.04	0.04	0.03	0.03	0.03
Industry: prices	0.16	0.41	0.56	0.63	0.12	0.44	0.54	0.58
Industry: employment	0.00	0.24	0.42	0.55	0.11	0.29	0.42	0.50
Construction: employment	0.08	0.33	0.51	0.64	0.00	0.18	0.29	0.38
Construction: prices	0.00	0.30	0.43	0.52	0.01	0.12	0.21	0.31
Retail trade: orders to suppliers	0.03	0.04	0.07	0.08	0.02	0.02	0.02	0.03
Retail trade: sales	0.13	0.26	0.39	0.46	0.05	0.12	0.21	0.24
Retail trade: employment	0.23	0.33	0.43	0.50	0.03	0.19	0.26	0.30
Retail trade: prices	0.00	0.19	0.35	0.48	0.04	0.17	0.28	0.36
Services: turnover	0.09	0.12	0.12	0.13	0.06	0.05	0.05	0.06
Services: employment	0.02	0.20	0.23	0.24	0.01	0.10	0.13	0.14
Services: prices	0.25	0.37	0.44	0.48	0.19	0.21	0.25	0.30
Proxies based on ex post forecast errors								
Industry: production, standard deviation	0.01	0.05	0.04	0.04	0.04	0.03	0.03	0.03
Industry: production, mean absolute error	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00
Industry: production, negative errors	0.02	0.10	0.16	0.18	0.05	0.15	0.17	0.17
Industry: production, positive errors	0.06	0.33	0.41	0.43	0.13	0.36	0.40	0.41
Construction: employment, standard deviation	0.07	0.17	0.18	0.18	0.01	0.12	0.13	0.13
Construction: employment, mean absolute error	0.02	0.26	0.34	0.38	0.01	0.17	0.21	0.24
Construction: employment, negative errors	0.03	0.31	0.45	0.56	0.01	0.25	0.32	0.40
Construction: employment, positive errors	0.05	0.26	0.38	0.48	0.08	0.30	0.35	0.41
Retail trade: sales, standard deviation	0.00	0.02	0.03	0.03	0.03	0.02	0.02	0.02
Retail trade: sales, mean absolute error	0.02	0.06	0.12	0.14	0.03	0.03	0.05	0.05
Retail trade: sales, negative errors	0.02	0.20	0.32	0.35	0.00	0.09	0.16	0.17
Retail trade: sales, positive errors	0.00	0.21	0.25	0.26	0.07	0.24	0.25	0.25
Services: turnover, standard deviation	0.04	0.08	0.07	0.07	0.02	0.02	0.02	0.02
Services: turnover, mean absolute error	0.04	0.10	0.10	0.10	0.01	0.03	0.03	0.04
Services: turnover, negative errors	0.01	0.25	0.29	0.32	0.02	0.13	0.17	0.20
Services: turnover, positive errors	0.00	0.23	0.27	0.30	0.01	0.18	0.22	0.24
Services: employment, standard deviation	0.01	0.12	0.15	0.18	0.06	0.07	0.08	0.11
Services: employment, mean absolute error	0.00	0.08	0.12	0.16	0.04	0.05	0.07	0.10
Services: employment, negative errors	0.01	0.11	0.15	0.18	0.04	0.08	0.11	0.14
Services: employment, positive errors	0.05	0.05	0.05	0.05	0.00	0.02	0.02	0.02

Survey data are routinely used for forecasting macro variables in the short run because of the timely and forward-looking nature of these data. As part of the investigation of the time series properties of survey-based proxies, it is examined whether they can signal future developments in sectoral employment and output. The VARs described above are used to compute pseudo-out-of-sample forecasts for the growth rate of employment and output in

industry, construction, retail trade and services. The mean squared forecast error (square root) is compared to that from the corresponding VAR model that includes only the confidence indicator, employment growth and output growth, and therefore excluding the uncertainty proxy. The mean squared forecast errors in relative terms are shown in Table 6.

TABLE 6
Relative mean squared forecast error, sectors

Horizon (quarters)	Employment				Output			
	1	2	3	4	1	2	3	4
Proxies based on ex ante disagreement								
Industry: production	1.01	0.92	1.01	1.04	1.06	1.03	1.04	1.02
Industry: prices	0.95	0.81	0.82	0.80	1.03	0.94	0.83	0.79
Industry: employment	0.94	0.78	0.68	0.66	0.78	0.79	0.69	0.73
Construction: employment	0.92	0.82	0.89	0.82	0.87	0.79	0.86	0.91
Construction: prices	0.93	1.06	1.29	1.13	0.94	0.82	0.91	0.81
Retail trade: orders to suppliers	1.13	1.17	1.26	1.17	1.38	1.34	1.38	1.41
Retail trade: sales	1.12	1.13	1.13	0.93	1.08	1.00	0.94	1.21
Retail trade: employment	1.08	1.01	0.83	0.71	0.95	0.79	0.79	0.82
Retail trade: prices	1.03	1.02	0.89	0.80	1.04	0.91	0.83	0.81
Services: turnover	0.95	1.04	1.07	1.10	1.03	1.05	1.31	1.19
Services: employment	0.90	0.90	0.92	0.84	0.98	1.01	1.09	1.16
Services: prices	0.89	0.98	0.94	0.92	1.02	1.01	1.08	1.14
Proxies based on ex post forecast errors								
Industry: production, standard deviation	1.07	0.95	0.98	0.99	1.02	1.03	1.06	1.07
Industry: production, mean absolute error	1.04	0.95	0.97	0.99	1.01	1.02	1.05	1.05
Industry: production, negative errors	1.03	0.89	0.95	0.99	0.93	0.96	1.03	1.06
Industry: production, positive errors	0.95	0.88	1.06	0.98	0.98	1.01	1.03	0.99
Construction: employment, standard deviation	1.13	1.21	1.30	1.23	1.03	0.99	1.05	1.04
Construction: employment, mean absolute error	0.93	0.95	1.10	1.04	0.96	0.91	1.00	0.96
Construction: employment, negative errors	0.94	0.87	0.87	0.93	0.82	0.84	0.92	0.90
Construction: employment, positive errors	1.17	1.16	0.93	1.06	0.82	0.92	0.92	0.95
Retail trade: sales, standard deviation	1.05	1.20	1.21	1.17	1.38	1.39	1.36	1.35
Retail trade: sales, mean absolute error	1.04	1.19	1.11	0.99	1.24	1.22	1.23	1.27
Retail trade: sales, negative errors	1.07	1.17	1.06	0.96	1.11	1.04	1.10	1.18
Retail trade: sales, positive errors	1.15	1.20	1.21	1.23	1.24	1.27	1.31	1.29
Services: turnover, standard deviation	0.95	1.07	1.06	1.10	1.15	1.15	1.49	1.35
Services: turnover, mean absolute error	0.96	1.02	0.97	0.97	1.04	1.01	1.06	1.11
Services: turnover, negative errors	0.85	0.96	0.90	0.93	1.02	0.98	1.08	1.13
Services: turnover, positive errors	0.87	0.91	0.96	1.11	1.06	1.02	1.37	1.26
Services: employment, standard deviation	0.90	1.01	0.98	0.94	1.01	1.01	1.07	1.13
Services: employment, mean absolute error	0.91	0.98	0.94	0.90	1.02	1.01	1.07	1.12
Services: employment, negative errors	0.93	0.90	0.86	0.86	1.04	1.06	1.08	1.10
Services: employment, positive errors	0.94	1.00	1.02	1.03	0.97	0.97	1.08	1.09

Notes: The entries refer to the square root of mean squared forecast error relative to that from a VAR model which includes the confidence indicator, employment growth and output growth. Entries in bold denote statistical significance at 10% level of the modified Diebold-Mariano test of equal forecast accuracy (Diebold and Mariano 1995; Harvey et al. 1997).

A number of uncertainty proxies contain information about future movements in employment and output beyond that contained in sectoral confidence indicators and past growth rates of employment and output; nevertheless, the gains are significant only in a limited number of cases. Proxies based on ex ante disagreement about employment and prices, as well as proxies derived from negative or positive forecast errors appear to be informative for forecasting employment and output growth. Although proxies based on ex post forecast errors are available with a delay vis-à-vis ex ante disagreement proxies, the timely availability of survey data can render them useful in signalling future fluctuations in hard data, which are available with a delay vis-à-vis the reference quarter.

4. *Uncertainty proxies for the economy*

The analysis at the sectoral level in the previous section revealed that uncertainty shocks modelled via proxies based on firms' disagreement about employment and price expectations lead to significant declines in employment and output, as well as in confidence. Similarly, negative and positive uncertainty surprises derived from firms' ex post forecast errors are found to significantly affect the above-mentioned macro variables. We explore various combinations of sectoral proxies presented in the previous section to compute uncertainty proxies for the economy as a whole. The effects of uncertainty shocks on aggregate employment and output are investigated.

We focus on simple combinations of sectoral proxies based on: (i) ex ante disagreement about employment and price expectations, and (ii) ex post forecast errors. Aggregate uncertainty proxies are constructed by computing the simple average across sectoral proxies.⁹ Moreover, we explore economy-wide uncertainty proxies that utilise the dispersion of the changes in the balances of survey questions, referred to as inter-question dispersion proxies in Girardi and Reuter (2017). Following Girardi and Reuter (2017), an inter-question dispersion proxy is derived by, first, computing the three-month changes in the balances of survey questions and, second, calculating the standard deviation of (standardised) changes across questions.¹⁰ The rationale for this measure is that higher (lower) uncertainty can be reflected in the balances changing very differently (little) across survey questions. In other words, firms may have more dispersed expectations over some business aspects (e.g. activity, orders, etc.), whereas they may express less diverse views about the future evolution of other aspects (e.g. prices, employment, etc.). This measure can be viewed as supplementary to proxies derived as the dispersion of firms' expectations about a single business aspect (i.e. proxies based on ex ante

⁹ Other aggregate uncertainty proxies using the weighted average instead of the simple average, or common factors of all sectoral proxies yield significant but less pronounced negative effects on employment and output, and their information content is inferior to those of the proxies discussed in this section.

¹⁰ We present the results for the proxy based on the set of forward-looking survey questions only, as opposed to the full set of survey questions, as the former has a higher information content.

disagreement). For example, in the case of an exogenous negative shock (e.g. the COVID-19 pandemic), there might not be a high degree of disagreement among firms as they converge to negative assessments, but there might be a large variation in the extent of balance changes across questions, as the percentage of pessimistic responses rises due to the shock. Finally, a proxy based on stock market volatility is derived from the daily returns of the Cyprus Stock Exchange Index. As shown in Table 7, all of the above proxies are highly correlated, suggesting that the different measures convey similar signals about uncertainty.

TABLE 7
Correlations between uncertainty proxies, economy

	Proxy based on ex ante disagreement	Proxy based on inter-question dispersion	Proxy based on non-survey data
	Simple average of sectoral proxies: employment & prices	Standard deviation of 3-month changes: forward-looking questions	Stock market volatility
Proxy based on ex ante disagreement			
Simple average of sectoral proxies: employment & prices	–	0.70	0.83
Proxies based on ex post forecast errors			
Simple average of sectoral proxies: negative errors	0.79	0.58	0.68
Simple average of sectoral proxies: positive errors	-0.71	-0.43	-0.72

Note: The correlation coefficients are statistically significant at the 5% level.

The empirical analysis at the aggregate level is carried out in four-variable VARs, similarly to the sectoral analysis in section 3. The endogenous variables consist of an aggregate uncertainty proxy (one at a time), the economic sentiment indicator, which is an aggregate measure of economic confidence, and total employment and real GDP expressed as quarter-on-quarter growth rates.¹¹ All uncertainty proxies are standardised. In the VARs the uncertainty proxy is ordered first and the economic sentiment indicator is ordered second, followed by employment growth and GDP growth. The uncertainty proxy is ordered before the economic sentiment indicator as the latter is not found to Granger cause the former, while the hypothesis that the uncertainty proxy does not cause the sentiment indicator is strongly rejected (Appendix, Table A3).^{12,13} This recursive identification results in orthogonal innovations via the Cholesky decomposition of the variance-covariance matrix, hence it is

¹¹ The economic sentiment indicator is constructed in the same way as the indicator published by the European Commission; however, the sectoral weights applied reflect the contribution of each sector to the GDP of Cyprus. Data on the total number of persons employed (employment) and GDP (chain-linked volume measures) were obtained from the Statistical Service of Cyprus. The data used are seasonally adjusted. Employment and GDP are expressed in quarter-on-quarter percentage changes.

¹² The lag length in the VARs was determined by the Bayesian Information Criterion. In the estimation of the variance-covariance matrix of the VAR residuals, a small-sample adjustment for the degrees of freedom was applied.

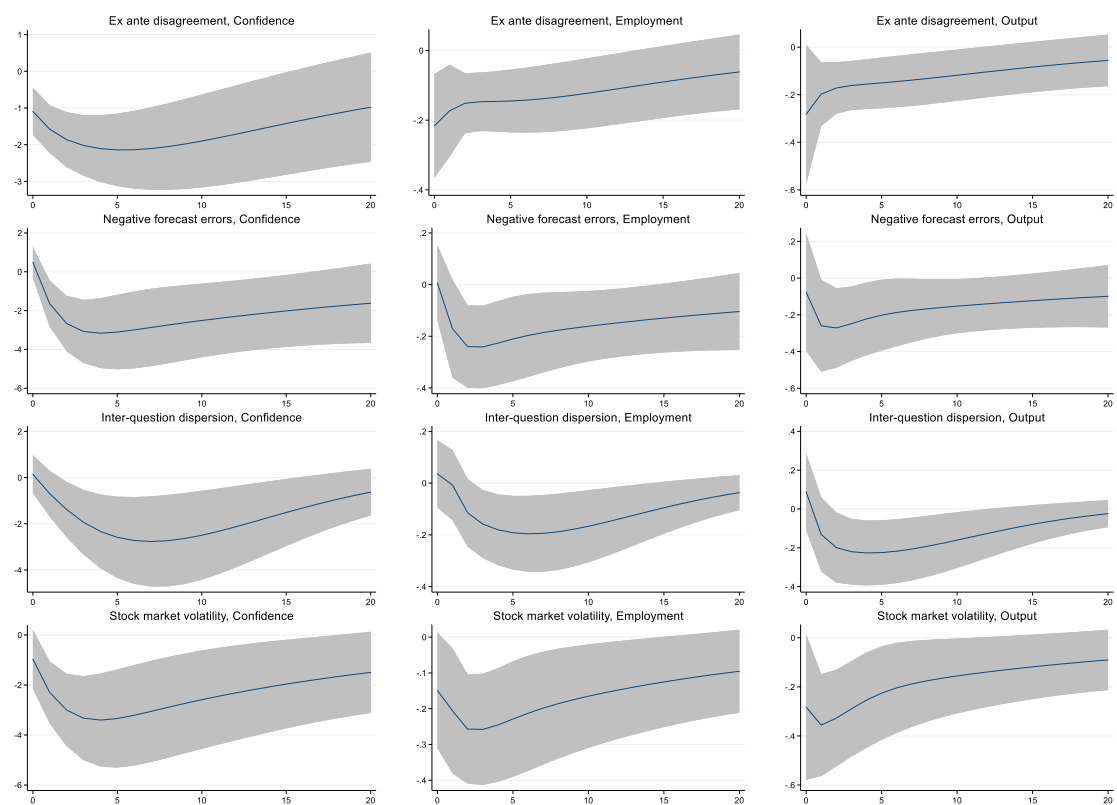
¹³ The results presented in this section are not sensitive to alternative orderings of the variables in the VARs.

used to estimate the causal effects of an uncertainty shock on economic sentiment, employment and output. The VARs are estimated over the period 2008q2–2019q4.

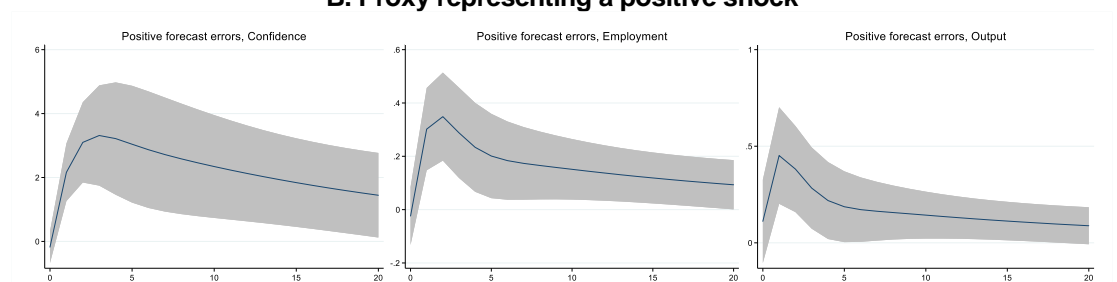
Figure 3 presents the impulse responses of economic sentiment, employment and GDP to an uncertainty shock of one standard deviation, when the different aggregate proxies are used in the VAR model. Panel A plots the responses to negative uncertainty shocks in the case of proxies derived from ex ante disagreement, negative ex post forecast errors, inter-question dispersion, and stock market volatility. Panel B shows the responses to positive uncertainty surprises measured by positive ex post forecast errors. The shaded areas surrounding the estimated responses (solid lines) indicate the 95% bootstrap confidence intervals.

Figure 3: Response of confidence, employment and output to uncertainty shocks, economy

A. Proxies representing a negative shock



B. Proxy representing a positive shock



In panel A, an uncertainty shock triggers negative and significant effects on the overall confidence, as well as on total employment and aggregate output. The estimated responses of employment and GDP are very similar in shape and magnitude across the above-mentioned proxies. On impact, the declines in confidence and output are rather weak, but subsequently the negative effects of the shock build up. The negative responses of economic sentiment and employment tend to be more protracted than the negative reaction of GDP. The economic sentiment indicator loses 1 to 2 points within the first quarter and continues to decline up to four to seven quarters after the shock, depending on the proxy, with maximum losses ranging from 2 to 3 points across proxies; subsequently the declines in confidence abate. The largest decrease in employment growth ranges between 0.2 to 0.3 percentage points across proxies and occurs on impact or up to six quarters after the shock, depending on the proxy. The negative effect of an uncertainty shock on GDP growth varies across proxies between 0.2 and 0.4 percentage points; the maximum effect is observed as early as the first quarter, or as late as four quarters following the shock. The negative effects on employment and output build up early on in the case of the ex ante disagreement proxy, while the effects accumulate more slowly when the inter-question dispersion proxy is used. A positive uncertainty surprise in panel B generates positive and significant effects on confidence, employment and output. The responses to the positive innovation are more persistent than those estimated for a negative shock. The effects of a positive uncertainty surprise on sentiment are of similar magnitude as those of a negative shock, but of the opposite sign. The positive effects on employment and output growth peak early on, reaching 0.4 and 0.5 percentage points respectively, and subsequently taper off.

Table 8 shows the forecast error variance decomposition for aggregate employment and output from the VARs, using the different uncertainty proxies. The table entries show the proportion of the forecast error variance of employment and GDP which arises from an uncertainty shock, measured by the different proxies, over the forecast horizon. The contribution of an uncertainty surprise to the VAR forecast error variance of both employment and output rises as the horizon increases. The fraction of error variance accounted for by uncertainty shocks is larger in the case of employment than for GDP, especially for longer horizons. The ex ante disagreement proxy is associated with the largest variance contribution in the first quarter after the shock. As the horizon increases, the contribution of shocks measured by the remaining proxies grows, particularly for the proxies based on positive forecast errors and stock market volatility. At the end of the horizon, the contribution associated with most proxies rise to above 40% for employment and above 30% for GDP.

TABLE 8
Forecast error variance decomposition, economy

Horizon (quarters)	Employment				Output			
	1	4	8	20	1	4	8	20
Proxy based on ex ante disagreement								
Simple average of sectoral proxies: employment & prices	0.20	0.26	0.37	0.48	0.10	0.18	0.25	0.32
Proxies based on ex post forecast errors								
Simple average of sectoral proxies: negative errors	0.00	0.27	0.42	0.53	0.01	0.18	0.28	0.37
Simple average of sectoral proxies: positive errors	0.00	0.54	0.62	0.67	0.02	0.39	0.45	0.50
Proxy based on inter-question dispersion								
Standard deviation of 3-month changes: forward-looking questions	0.01	0.08	0.25	0.38	0.01	0.11	0.23	0.31
Proxy based on non-survey data								
Stock market volatility	0.09	0.34	0.50	0.59	0.10	0.34	0.43	0.49

Figure 4 plots the various uncertainty proxies for the economy as a whole, in quarterly frequency and in standardised form. The sample is extended beyond the estimation period to include the first two quarters of 2020 when the economy has experienced the effects of the COVID-19 pandemic. The upper graph shows the proxies derived from ex ante disagreement, negative ex post forecast errors, inter-question dispersion and stock market volatility; the lower graph depicts the proxy based on positive ex post forecast errors, reflecting upside uncertainty.

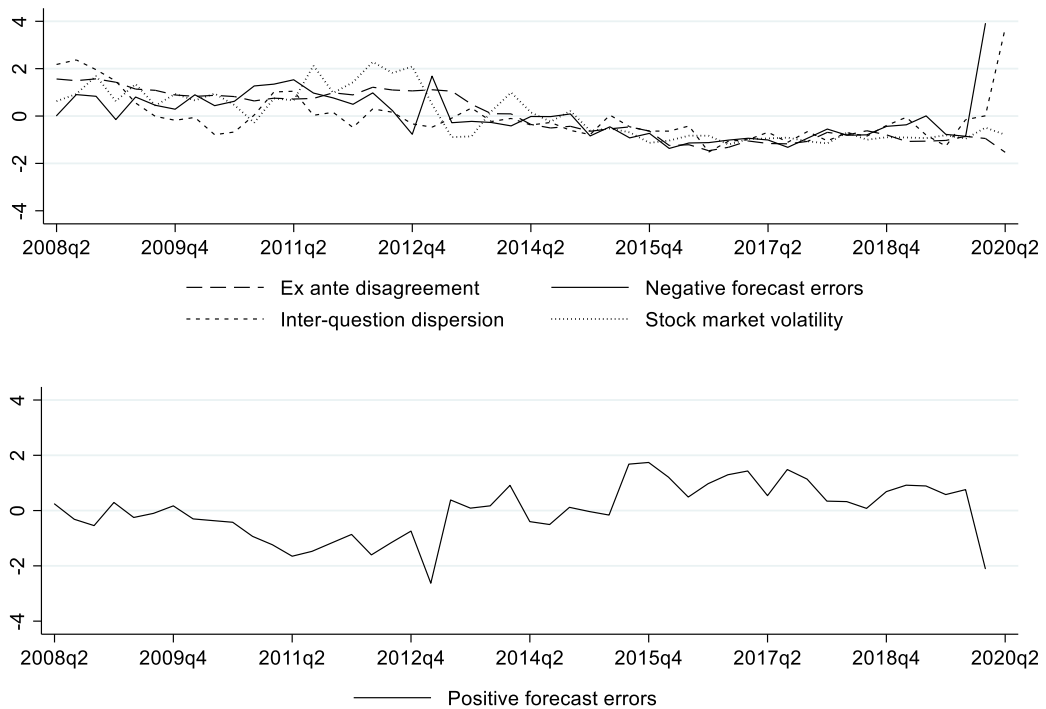
All proxies exhibit increases/decreases in uncertainty around dates of major economic and political developments. All proxies in the upper graph point to increased uncertainty during the period 2008 – 2013; this period was marked by the global financial crisis, the European debt crisis, particularly the Greek crisis, and subsequently the 2013 crisis in Cyprus. Uncertainty declined substantially after 2014 and fluctuated at low levels until 2019. The ex ante disagreement proxy estimates the highest levels of uncertainty in 2008 amid the financial crisis, in particular around the time of the Lehman Brothers bankruptcy. The inter-question dispersion proxy also points to especially elevated uncertainty levels at the time of the global financial crisis. The stock market volatility proxy signalled the highest uncertainty levels in 2012 when the Greek debt crisis, particularly the Greek debt restructuring, affected Cypriot banks due to the strong financial links between the two countries at the time. The year 2012 was particularly turbulent as one of Cyprus's largest banks was recapitalised by the state, Cyprus's credit rating was downgraded to non-investment grade, and the government began negotiations for a bailout with international lenders. The ex post forecast error proxy estimates

a distinct peak in the first quarter of 2013, at the height of the crisis in Cyprus that led to a bailout request from the European authorities and the International Monetary Fund, and the closure of one of the largest banks in the country. The uncertainty levels estimated by all proxies are especially high during the period 2011 – 2013, which coincides with the Greek crisis and the economic crisis in Cyprus.

The COVID-19 pandemic and the containment measures that followed both locally and globally, led to spikes in uncertainty in the first and second quarters of 2020, as indicated by the ex post forecast error and inter-question dispersion proxies, respectively. In the first half of 2020 the inter-question dispersion and ex post forecast error proxies more than doubled from their previous peaks, recorded during the global financial crisis in 2008 and the Cyprus economic crisis in 2013, respectively. The stock market volatility proxy rose by 50% and climbed to a five-year high in the first quarter of 2020, but remained well-below the levels reached during the previous crises. The proxy on ex ante disagreement remained unaffected upon impact as the vast majority of firms did not foresee changes in their employment in the short run, due to state programmes to support employment in response to the pandemic. Moreover, in the first half of 2020, firms did not anticipate prices to change in the very near future, although expectation disagreement about prices signalled higher uncertainty in services and construction, as a result of the COVID-19 pandemic.

The proxy in the lower graph, reflecting upside uncertainty, follows a course opposite to that of the proxies in the upper graph, indicating low levels of positive uncertainty between 2008 and 2014, and higher levels of positive uncertainty from 2015 to 2019, a period of strong growth in Cyprus. Consistent with the negative uncertainty proxy, positive uncertainty declined at its lowest point in the first quarter of 2013 and plummeted again in the first quarter of 2020.

Figure 4: Uncertainty proxies, economy



5. Conclusions

This paper uses business survey data collected through the Joint Harmonised EU Programme of Business and Consumer Surveys to construct proxies of economic uncertainty for Cyprus at the sectoral and aggregate levels. The proxies considered are in the form of ex ante disagreement and ex post forecast errors. The ex ante disagreement proxies are estimated using the dispersion of optimistic and pessimistic responses provided by firms to expectation questions. Ex post forecast errors are derived by comparing expectations and realisations stated by individual respondents; the proxies are computed using the dispersion of ex post forecast errors. Proxies in the latter group are further decomposed into negative and positive uncertainty measures, depending on the direction of the errors. The derived proxies are used to investigate the effects of uncertainty shocks on confidence, employment and output at the sectoral and aggregate levels.

Uncertainty shocks measured by the dispersion in employment or price expectations result in significant negative effects on sectoral confidence, employment and output; the negative effects are more pronounced and protracted in construction and industry. Similar effects on sectoral variables are found when uncertainty is measured separately by ex post negative forecast errors, reflecting negative surprises, while effects of the opposite sign, but of similar

magnitude and duration, are estimated when ex post positive forecasts errors are used as a proxy for positive surprises. Using the most informative sectoral proxies we construct aggregate uncertainty measures which are compared to alternative proxies from survey and non-survey data. At the aggregate level, negative uncertainty shocks result in significant and rather persistent reductions in employment and GDP, and account for a sizeable proportion of the forecast error variance. A positive uncertainty surprise generates significant increases in economic sentiment, aggregate employment and GDP.

The results of the analysis are along the lines of those in other studies, namely that uncertainty shocks lead to significant declines in employment and output. The negative effects of an uncertainty shock on output peak within a year of the shock as in, for example, Bachmann et al. (2013), Girardi and Reuter (2017) and Ghirelli et al. (2019). Neither output nor employment show overshooting while adjusting to their pre-shock levels, similarly to other studies that use European data (e.g. Claeys and Vasicek 2019; Girardi and Reuter 2017; Ghirelli et al. 2019). We find that the negative response of employment to an uncertainty shock is more protracted than the reaction of output, as in Bachmann et al. (2013) and Ghirelli et al. (2019). When uncertainty is decomposed into negative and positive components, based on the direction of ex post forecast errors, we find that the two proxies for downside and upside uncertainty have larger effects on the macro variables than those estimated using the combined measure of mean absolute forecast errors. A similar result is reported by Rossi and Sekhposyan (2015) who distinguish between upside and downside uncertainty.

Fluctuations in ex ante disagreement proxies are found to reflect changes in the level of uncertainty rather than firm heterogeneity, and ex ante disagreement proxies can form valid measures of uncertainty. The ex ante disagreement proxy is flatter and more slow-moving compared to the negative and positive forecast error proxies, as employment expectations do not exhibit large swings mainly due to institutional factors. Therefore, the different proxies can form a set of complementary uncertainty measures for Cyprus.

Our results suggest that business survey data constitute a valuable source for the development of economic uncertainty proxies for Cyprus at the sectoral and aggregate levels. Uncertainty proxies based on business survey data can offer timely signals about the direction and magnitude of fluctuations in economic activity and employment, facilitate informed policy decisions, and lead to comparable uncertainty measures across countries.

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Appendix

TABLE A1
Granger causality tests, p-values (sectors)

	Null hypotheses	
	Confidence indicator does not Granger cause uncertainty proxy	Uncertainty proxy does not Granger cause confidence indicator
Proxies based on ex ante disagreement		
Industry: production	0.37	0.04
Industry: prices	0.15	0.03
Industry: employment	0.87	0.13
Construction: employment	0.92	0.00
Construction: prices	0.21	0.03
Retail trade: orders to suppliers	0.34	0.00
Retail trade: sales	0.83	0.00
Retail trade: employment	0.55	0.00
Retail trade: prices	0.92	0.00
Services: turnover	0.75	0.19
Services: employment	0.78	0.14
Services: prices	0.46	0.01
Proxies based on ex post forecast errors		
Industry: production, standard deviation	0.33	0.29
Industry: production, mean absolute error	0.52	0.04
Industry: production, negative errors	0.63	0.00
Industry: production, positive errors	0.90	0.00
Construction: employment, standard deviation	0.71	0.41
Construction: employment, mean absolute error	0.82	0.03
Construction: employment, negative errors	0.38	0.00
Construction: employment, positive errors	0.11	0.00
Retail trade: sales, standard deviation	0.92	0.14
Retail trade: sales, mean absolute error	0.83	0.00
Retail trade: sales, negative errors	0.93	0.00
Retail trade: sales, positive errors	0.96	0.00
Services: turnover, standard deviation	0.76	0.98
Services: turnover, mean absolute error	0.64	0.20
Services: turnover, negative errors	0.39	0.00
Services: turnover, positive errors	0.30	0.00
Services: employment, standard deviation	0.17	0.10
Services: employment, mean absolute error	0.40	0.04
Services: employment, negative errors	0.89	0.00
Services: employment, positive errors	0.03	0.87

Notes: The VARs also include employment growth and output growth as endogenous variables. The variance - covariance matrix of the VAR residuals and the test statistics were adjusted for small samples by using a degrees-of-freedom correction and F or t distributions for hypothesis tests.

TABLE A2
Estimated effects of uncertainty proxies

	Confidence indicator		Employment		Output	
	Estimated effect	P-value	Estimated effect	P-value	Estimated effect	P-value
Proxies based on ex ante disagreement						
Industry: production	-1.73	0.04	-0.02	0.92	0.43	0.36
Industry: prices	-1.95	0.03	-0.29	0.11	-1.50	0.00
Industry: employment	-1.44	0.13	-0.38	0.04	-1.30	0.01
Construction: employment	-3.06	0.00	-1.07	0.00	-3.04	0.00
Construction: prices	-2.27	0.03	-1.42	0.00	-2.54	0.01
Retail trade: orders to suppliers	-2.56	0.00	-0.19	0.07	-0.16	0.36
Retail trade: sales	-3.17	0.00	-0.32	0.01	-0.34	0.08
Retail trade: employment	-4.30	0.00	-0.34	0.02	-0.51	0.04
Retail trade: prices	-3.71	0.00	-0.34	0.02	-0.63	0.01
Services: turnover	-1.94	0.19	-0.14	0.33	0.28	0.14
Services: employment	-1.86	0.14	-0.32	0.01	-0.22	0.18
Services: prices	-4.49	0.01	-0.43	0.02	0.07	0.78
Proxies based on ex post forecast errors						
Industry: production, standard deviation	-0.67	0.29	0.19	0.13	-0.16	0.64
Industry: production, mean absolute error	-1.30	0.04	0.19	0.11	-0.08	0.81
Industry: production, negative errors	-2.58	0.00	0.05	0.71	-0.59	0.13
Industry: production, positive errors	2.59	0.00	0.28	0.09	1.03	0.02
Construction: employment, standard deviation	-0.74	0.41	-0.38	0.24	-1.35	0.11
Construction: employment, mean absolute error	-2.10	0.03	-0.83	0.02	-2.12	0.02
Construction: employment, negative errors	-3.85	0.00	-1.05	0.01	-3.53	0.00
Construction: employment, positive errors	4.60	0.00	0.70	0.11	3.85	0.00
Retail trade: sales, standard deviation	-1.14	0.14	-0.19	0.08	-0.03	0.87
Retail trade: sales, mean absolute error	-2.48	0.00	-0.28	0.01	-0.11	0.51
Retail trade: sales, negative errors	-3.36	0.00	-0.29	0.00	-0.26	0.11
Retail trade: sales, positive errors	3.46	0.00	0.18	0.14	0.39	0.04
Services: turnover, standard deviation	-0.03	0.98	-0.19	0.17	0.10	0.57
Services: turnover, mean absolute error	-1.78	0.20	-0.22	0.10	-0.07	0.71
Services: turnover, negative errors	-5.08	0.00	-0.39	0.00	-0.27	0.14
Services: turnover, positive errors	5.17	0.00	0.30	0.01	0.32	0.05
Services: employment, standard deviation	-2.11	0.10	-0.25	0.05	0.00	0.99
Services: employment, mean absolute error	-2.56	0.04	-0.25	0.05	-0.06	0.74
Services: employment, negative errors	-3.53	0.00	-0.25	0.04	-0.20	0.21
Services: employment, positive errors	0.25	0.87	-0.14	0.37	0.27	0.18

Note: the variance - covariance matrix of the VAR residuals and the test statistics were adjusted for small samples by using a degrees-of-freedom correction and F or t distributions for hypothesis tests.

TABLE A3
Granger causality tests, p-values (economy)

	Null hypotheses	
	Confidence indicator does not Granger cause uncertainty proxy	Uncertainty proxy does not Granger cause confidence indicator
Proxy based on ex ante disagreement		
Simple average of sectoral proxies: employment & prices	0.75	0.00
Proxies based on ex post forecast errors		
Simple average of sectoral proxies: negative errors	0.13	0.00
Simple average of sectoral proxies: positive errors	0.12	0.00
Proxy based on inter-question dispersion		
Standard deviation of 3-month changes: forward-looking questions	0.49	0.00
Proxy based on non-survey data		
Stock market volatility	0.14	0.00

Notes: The VARs also include employment growth and output growth as endogenous variables. The variance - covariance matrix of the VAR residuals and the test statistics were adjusted for small samples by using a degrees-of-freedom correction and F or t distributions for hypothesis tests.