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Survey-derived proxies for uncertainty: the case of Cyprus

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Abstract

This paper uses survey data on business expectations to construct proxies for economic uncertainty at the sectoral and aggregate levels. The proxies are in the form of ex ante disagreement and ex post forecast errors. 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 proxies in the latter group are further decomposed into adverse and positive uncertainty measures, depending on the direction of the errors. The proxies are estimated using firm-level data from monthly business surveys conducted in Cyprus. Uncertainty shocks measured by either ex ante disagreement or 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. Adverse shocks to aggregate uncertainty proxies generate negative and significant effects on total employment, aggregate output and investment, which are rather protracted.

Keywords: Uncertainty; Business Surveys; Cyprus

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

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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 about 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 readily available time series of uncertainty proxies 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).

[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

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 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 index (VXO) 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. The sectoral dimension of business and consumer surveys is utilised by van Aarle and Moons (2017) 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 macroeconomic 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 resource 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 error 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 negative and positive ex post forecast errors, reflecting adverse 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. Adverse uncertainty shocks at the aggregate level trigger long-lasting negative effects on economic sentiment, employment, GDP and investment.

The paper contributes to the empirical literature on uncertainty by constructing uncertainty proxies from business survey data and assessing their dynamic relationships with business cycles. Although the analysis in the paper is focused on a single country, the methods for constructing uncertainty proxies can be applicable to other countries, particularly in Europe, and the findings can be relevant to other economies that are relatively small, open and service oriented, especially towards financial, professional or hospitality services. Moreover, the sectoral analysis points to the sectors that are resilient to an uncertainty shock and may serve as a buffer against uncertainty effects at the aggregate level. Finally, the comparison of output and employment responses to an uncertainty shock offers insights into the dynamic adjustment of each variable to its pre-shock path and the channels through which the shocks propagate in the economy.

Section 2 provides a preview of the constructed uncertainty proxies for Cyprus at the aggregate level. Section 3 describes the business survey data and discusses the construction of uncertainty proxies employed in the paper. Section 4 presents uncertainty proxies for sectors of economic activity and explores their relationships with confidence indicators, output and employment. Section 5 presents uncertainty proxies for the economy derived from the sectoral proxies given in section 4; section 5 also investigates the dynamic relationships between aggregate uncertainty proxies and macroeconomic variables. Section 6 concludes.

2. A preview of the constructed uncertainty proxies

This section gives an overview of the uncertainty proxies for Cyprus at the aggregate level and discusses their evolution over time in relation to major events. Figure 1 plots the time series of proxies in standardised form.[2] The upper graph shows the proxies

[2] The sample period in Figure 1 is extended beyond the default estimation period used in the paper (i.e. 2008q2 – 2019q4) to plot movements in the proxies during the outbreak of the COVID-19 pandemic.

based on ex ante disagreement and negative ex post forecast errors, as well as two additional measures derived from inter-question dispersion in business survey data, and historical stock market volatility; the lower graph depicts the proxy based on positive ex post forecast errors, reflecting upside uncertainty. The shaded regions represent periods of negative GDP growth in Cyprus.

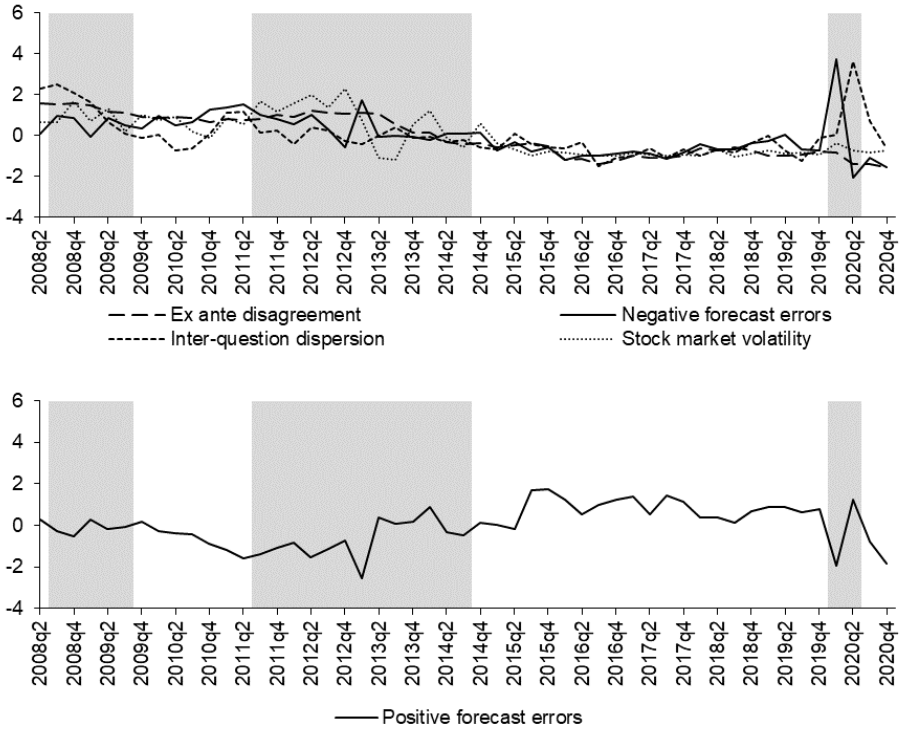
All proxies in the upper graph exhibit increases in uncertainty around dates of major economic and political developments. All proxies point to increased uncertainty during the period 2008 – 2013; this period was marked by the global financial crisis, the European debt crisis, particularly the Greek 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 international 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 because of 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 with international lenders on a bailout. 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 60% 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, because of state programmes to support jobs during the pandemic. Following the reopening of the economy in May – June 2020, uncertainty fell substantially, though the forecast error proxy showed an uptick towards the end of 2020 due to a resurgence in COVID-19 infections.

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 proxy based on negative errors, positive uncertainty declined at its lowest point in the first quarter of 2013 as a result of the domestic economic crisis. In 2020, upside uncertainty dipped twice, reflecting different COVID-19 infection waves and related containment measures.

FIGURE 1

Uncertainty proxies, economy of Cyprus



3. Uncertainty proxies from survey data

3.1 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.[3] 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.[4]

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 economic aspects of their firms, such as 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

[3] 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.

[4] For the period May 2008 – April 2015, the monthly samples for the surveys in industry, construction, retail trade and services consist of 100, 100, 200 and 200 firms, respectively.

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 presents the monthly survey questions on expectations and realisations utilised in constructing the uncertainty proxies discussed in the next section. One set of proxies considered exploits all available expectation questions in the monthly surveys; these questions are listed in the second column of Table 1. However, in deriving proxies from firm-specific forecast errors, only expectations paired with realisations can be utilised; hence, the third column of Table 1 shows the questions on recent trends (i.e. realisations) that correspond to questions on expected developments.

As seen from Table 1, not all expectation questions have a realisation counterpart. In the monthly surveys there are several questions on recent trends, but we only focus on those that can be matched to a forward-looking question about an identical or a closely related economic concept. For example, in the industry, retail trade and services surveys, the question on recent activity developments uses the same wording as the question on expected activity developments; thus, the firm-specific responses to these questions can be combined to form forecast errors. In the construction survey, there is a question on activity developments over the past three months, but no question on expected activity developments. In order to compute forecast errors for the construction sector, 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.[5]

[5] Other available survey questions on recent trends relate to current order books (industry, construction), current stocks of finished products (industry), stock volume (retail trade) and business situation (services); these questions do not closely match the available expectation questions on activity (industry, retail trade, services) and employment (construction, services) and are therefore not utilised for constructing proxies.

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?	_

3.2 Ex ante disagreement and ex post forecast errors

Following Bachmann et al. (2013), ex ante disagreement measured by the dispersion of firms' responses to forward-looking questions can be used as a proxy for uncertainty. The qualitative responses 'increase', 'no change' and 'decrease' to a survey question can be coded using the numerical values 1, 0 and -1, respectively. Then, 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. The proxy can be expressed as follows:

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

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.

The forecast error made by firm i, operating in sector s, is formed as:

$$e_{s,i(q)t+3} = realisation_{s,i(q)t+3} - expectation_{s,i(q)t} \quad (2)$$

where $expectation_{s,i(q)t}$ denotes the response of firm i to expectation question q, and $realisation_{s,i(q)t+3}$ represents the answer provided by the same firm to the corresponding realisation question three months later $(t+3)$. Both expectation and realisation questions have three response options 'increase', 'no change' and 'decrease' that are coded as 1, 0 and -1, respectively. Therefore, the forecast error in (2), takes numerical values ranging from -2 to 2. Table 2 shows all possible numerical values of the forecast error, depending on the responses to expectation and realisation questions.

TABLE 2

Qualitative forecast error

Expectations stated in month t ($expectation_{s,i(q)t}$)	Realisations stated in month t+3 ($realisation_{s,i(q)t+3}$)		
	Increase: 1	No change: 0	Decrease: -1
Increase: 1	0	-1	-2
No change: 0	1	0	-1
Decrease: -1	2	1	0

The forecast errors defined above can be used to construct uncertainty proxies. Following Bachmann et al. (2013), we can compute two different proxies using either the standard deviation of forecast errors, or the mean of absolute errors across firms:

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

$$U^c_{s(q)t} = \frac{1}{N}\sum_{i=1}^{N}\left|e_{s,i(q)t+3}\right|. \quad (4)$$

In (3) and (4), N is the number of firms that stated both their expectations in month t and the corresponding realisations three months later, and $\bar{e}_{s(q)t+3}$ in (3) denotes the

average error across firms.[6] The proxy in (4), $U^{c}_{s(q)t}$, can be decomposed into two components, $U^{c,n}_{s(q)t}$ and $U^{c,p}_{s(q)t}$, associated with negative and positive forecast errors, respectively. Therefore, $U^{c}_{s(q)t}$ can be expressed as the sum of negative and positive surprises faced by firms,

$$U^{c}_{s(q)t} = U^{c,n}_{s(q)t} + U^{c,p}_{s(q)t}, \tag{5}$$

where

$$U^{c,n}_{s(q)t} = \frac{1}{N}\sum_{i=1}^{N_n}\left|e_{s,i(q)t+3}\right|, \tag{6}$$

$$U^{c,p}_{s(q)t} = \frac{1}{N}\sum_{i=1}^{N_p}\left|e_{s,i(q)t+3}\right|; \tag{7}$$

N_n and N_p denote the number of firms that made negative and positive errors, respectively. The two components, $U^{c,n}_{s(q)t}$ and $U^{c,p}_{s(q)t}$, can form proxies of 'negative' or 'downside', and 'positive' or 'upside' uncertainty. When more firms experience a worse-than-anticipated outcome, 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 $U^{a}_{s(q)t}$ and $U^{b}_{s(q)t}$, point to low uncertainty when the dispersion among firms' expectations or among forecast errors is low. This may occur if, for example, many firms are simultaneously pessimistic or make negative errors at the same time as a result of a negative shock; nevertheless, a negative shock is expected to lead to a rise in uncertainty. The proxy given in equation (4), $U^{c}_{s(q)t}$, and its components, $U^{c,n}_{s(q)t}$ and $U^{c,p}_{s(q)t}$, do not suffer from this shortcoming.

4. 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 shown in equations (1), (3) and (4). The proxies computed using the mean absolute forecast error are further decomposed into negative and positive uncertainty components as shown in equations (5) – (7). 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.[7] The sample covers the period from 2008q2 to 2019q4. Next, we present summary

[6] 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.

[7] 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.

statistics for the constructed uncertainty proxies and explore their interrelationships with employment and output in each sector.

4.1 Summary statistics of sectoral proxies

We construct two sets of sectoral proxies: the first set is based on ex ante disagreement using the dispersion in firms' expectations (equation (1)), and the second set is derived from ex post forecast errors made by firms in business surveys (equations (3), (4), (6), (7)). Some unconditional descriptive statistics for the constructed proxies are given in the Appendix (Table A1). 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 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.

Inspecting the evolution of proxies over time, we see that ex ante disagreement measures move closely together with ex post forecast error proxies, in all of the four sectors (see Figure A1 in the Appendix). Both types of proxies signalled increased uncertainty during periods of economic distress (e.g. the global financial crisis, the 2012 – 2013 crisis in Cyprus) marked by a collapse in sectoral confidence. Proxies point to lower levels of uncertainty in recent years (2016 – 2019) characterised by robust growth and an upswing in confidence.

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 Roehe 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 3 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, suggesting that fluctuations in proxies based on ex ante disagreement reflect changes in uncertainty rather than effects caused by firm heterogeneity.

TABLE 3

Correlations between sectoral uncertainty proxies

	Proxies based on ex ante disagreement	
	Activity (production/sales/turnover)	Employment
Proxies based on ex post forecast errors		
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**

Notes: Proxies based on ex ante disagreement are computed using equation (1); proxies based on ex post forecast errors are derived using equations (3), (4), (6) and (7). The economic variables referred to in the relevant survey questions (e.g. production, employment, etc.) are shown after the sector names in the first column. The correlation coefficients in bold indicate statistical significance at the 5% level.

4.2 Uncertainty, employment and output in sectors of economic activity

The dynamic relationships between uncertainty and the real economy are explored using separate VARs for each sector. Each VAR includes the following sectoral variables: an uncertainty proxy (one at a time), employment and real gross value added expressed in quarterly growth rates, as well as the sector's confidence indicator. The inclusion of the confidence indicator in the VAR is warranted to address possible endogeneity between uncertainty and confidence. First, the sectoral proxies and confidence indicators are derived from very similar business survey data, and as indicated by the descriptive analysis, most of the constructed proxies are negatively correlated with confidence indicators; periods of strong increases in uncertainty proxies correspond to times of tumbling business confidence (see Table A1 and Figure A1 in the Appendix). By including the confidence indicator in the VAR, we can uncover whether the constructed uncertainty proxies contain information over and above that found in confidence indicators, or they simply mirror the signals of confidence indicators. Second, uncertainty and confidence may be jointly determined, and uncertainty shocks may feed back to employment and output, both directly and through their impact on confidence; similarly, negative confidence shocks that affect economic activity may trigger high uncertainty. Claeys and Vasicek (2019) argue for the inclusion of a confidence measure in the model to separate the impact of uncertainty shocks on activity from the effects of other similar shocks (e.g. confidence, financial) that may hit the

economy.[8] Using a six-variable panel Bayesian VAR for EU countries and employing an uncertainty proxy and a confidence indicator derived from the European Commission's Business and Consumer Surveys, Claeys and Vasicek (2019) find a two-way relation between uncertainty and confidence.[9] Bachmann et al. (2013) discuss the 'by product' hypothesis where high uncertainty is driven by a confidence shock with prolonged adverse effects on production. Bachmann et al. (2013) include a confidence measure in the VAR in addition to an uncertainty proxy and industrial production, to investigate the 'by product' hypothesis in the case of the United States, and thus to disentangle uncertainty effects from confidence effects on production.

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.[10] 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 and Reuter 2017). However, Granger causality tests reveal that causality tends to run from uncertainty to confidence but not vice versa (Appendix, Table A2).[11]

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 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 2; panels (a) and (b) plot the responses to uncertainty shocks using proxies based on disagreement about 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

[8] The interrelationship between confidence and uncertainty can be viewed in the context of a probability density function that describes how probabilities are distributed over different economic outcomes. The first moment of the distribution (central tendency) is associated with confidence, which reflects expectations about economic outcomes. The second moment, which indicates the spread of probabilities over different outcomes, is connected with uncertainty. In this context, shocks to the second moment may be linked to shifts in the first moment. For example, the onset of a crisis may lead economic agents to revise their expectations downwards and, at the same time, perceive a larger range of possible economic outcomes, affecting both first and second moments of the distribution (see e.g. Claeys and Vasicek 2019).
[9] Other studies that use the European Commission's Business and Consumer Surveys as this paper, employ specifications that control for possible confidence effects in examining the impact of uncertainty on economic activity, by including a confidence indicator in the VAR (see e.g. Girardi and Reuter 2017, and van Aarle and Moons 2017).
[10] The lag lengths in the VARs are 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 is applied.
[11] 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.

equation. The shaded region around the estimated response gives the 95% bootstrap confidence interval.[12]

The impulse responses estimated using 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 from 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 reduction in employment growth varies between 0.2 percentage points (pp) in retail trade and 0.8 pp in construction. The maximum decrease in output growth ranges between 0.3 pp in retail trade and 1.5 pp in construction, occurring within less than a year of the shock.

Similar responses to those described above are found when negative and positive forecast errors are used separately as proxies for uncertainty. The impulse responses are shown in the Appendix (Figure A2). In the sector of construction, an uncertainty innovation has more persistent and larger effects on employment and output vis-à-vis other sectors. An adverse uncertainty shock leads to a maximum reduction in confidence that ranges between 3 (industry) and 6 (services) balance points. The largest negative effects of an adverse uncertainty shock on employment and output are found at most three quarters after the shock; the estimated declines in employment vary from 0.3 pp (retail trade and industry) to 0.8 pp (construction), while the losses in output are estimated between 0.3 pp (retail trade and services) and 2.0 pp (construction). Conversely, a positive uncertainty surprise can lead to a boost in confidence, as well as in employment and output growth. The positive effects on confidence, employment and output at their peak, occurring at most four quarters after the shock, reach 7 balance points (services), 0.8 pp (construction) and 2.4 pp (construction), respectively.

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 macroeconomic variables are smaller compared to the case when its components based on negative and positive forecast errors are used as separate uncertainty proxies.[13]

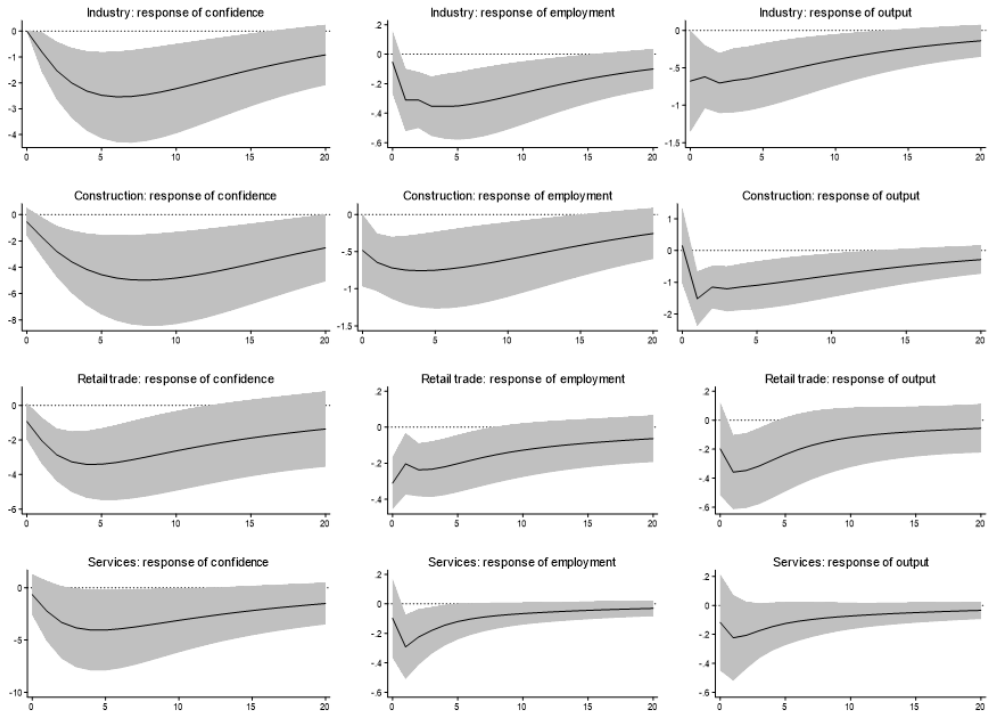
[12] The standard errors used in the construction of the bootstrap confidence intervals were obtained by drawing random samples with replacement from the residual vectors of the VAR model, using 250 replications. The estimated standard error of an impulse response function was computed as the standard deviation across the 250 bootstrapped impulse response function estimates.

[13] 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.

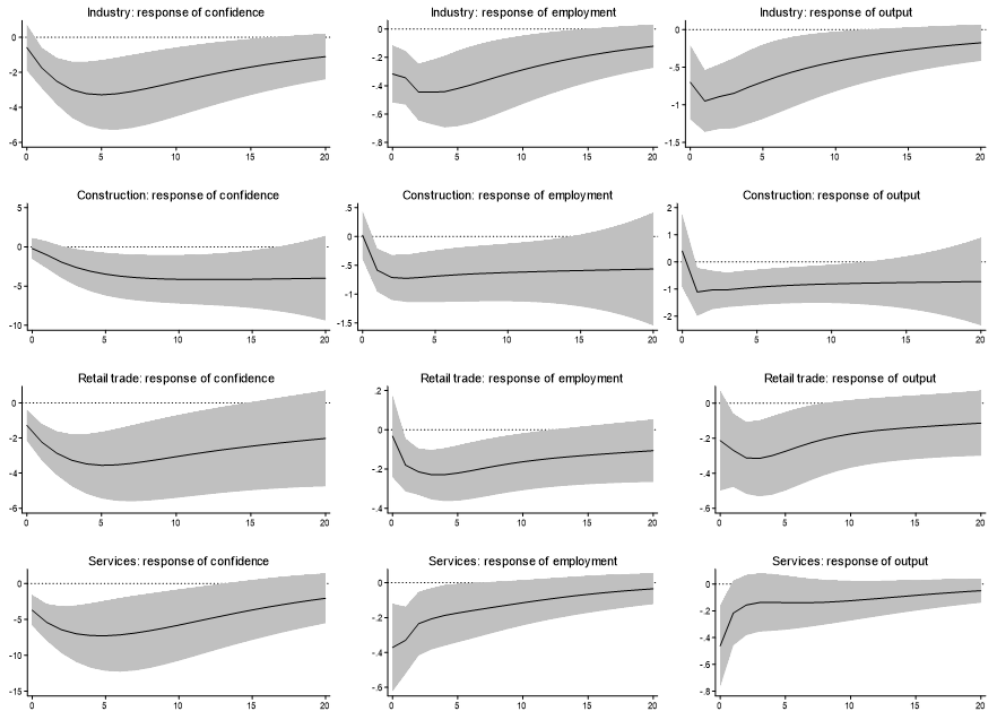
FIGURE 2

Responses of sectoral variables to a sectoral uncertainty shock, using uncertainty proxies based on ex ante disagreement

(a) Sectoral variable shocked: uncertainty proxy based on disagreement about employment expectations



(b) Sectoral variable shocked: uncertainty proxy based on disagreement about price expectations



Notes: 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 standard errors used in the bootstrap confidence intervals are obtained by bootstrapping the VAR residuals with 250 replications. The results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion.

The contribution of a sectoral uncertainty shock to the forecast error variance of employment and output in VARs for industry, construction, retail trade and services is presented in the Appendix (Table A3). Uncertainty is measured via the different sectoral proxies discussed above. The contribution of uncertainty shocks tends to be higher in the case of employment variance. 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 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 disagreement proxies at the 20-quarter horizon exceeds 40% for employment and 30% for output. Within the ex post forecast error group, uncertainty proxies based on negative and positive errors regarding activity (industry, retail trade, services) and employment (construction) fare better in terms of variance contribution than proxies calculated using the mean of the absolute errors or the standard deviation of firms' errors. The contribution of adverse and positive uncertainty surprises, measured through activity forecast errors, ranges between 20% and 40% at the end of the horizon.

5. 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 or 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 confidence, employment and output at the sectoral level. Moreover, the coefficients of the VARs underlying the estimated effects of uncertainty shocks, measured through the above-mentioned sectoral proxies, are found to remain stable over the estimation period (see Table A4 in the Appendix). Thus, these proxies can be viewed as containing valid signals about uncertainty levels in industry, construction, retail trade and services, and can therefore be used to compute uncertainty proxies for the economy as a whole. The effects of uncertainty shocks on aggregate employment and output are investigated.

5.1 Aggregate uncertainty proxies

An aggregate uncertainty proxy is constructed by computing the simple average across all sectoral proxies based on ex ante disagreement about employment and prices. Another proxy for uncertainty in the economy as a whole is constructed as the simple average across sectoral proxies based on ex post negative forecast errors; similarly, sectoral proxies derived from positive forecast errors are used to compute an aggregate proxy for upside uncertainty.[14, 15]

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

[14] Other aggregate uncertainty proxies constructed using the weighted instead of the simple average, or common factors of all sectoral proxies yield significant but less pronounced effects on employment and output, and their information content is inferior to those of the proxies discussed in this section.
[15] The proxies based on ex post negative and positive errors relating to employment in the services sector are not included in the construction of the aggregate proxies due to weak information content.

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.[16] 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 from the dispersion of firms' expectations about a single business aspect (i.e. proxies based on ex ante 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 because of the shock. Finally, a proxy based on historical stock market volatility is derived from the daily returns of the Cyprus Stock Exchange Index.[17]

As shown in Table 4, all of the economy-wide proxies constructed are highly correlated, suggesting that the different measures convey similar signals about uncertainty. Moreover, the aggregate proxies and the economic sentiment indicator, which is an aggregate measure of economic confidence, move closely together but in opposite directions, and periods of weakening confidence tend to coincide with rising uncertainty (see Figure A3 in the Appendix).[18] The opposite holds for the upside uncertainty proxy (based on positive forecast errors) that falls and recovers with confidence. All proxies exhibit significant correlation with the sentiment indicator, ranging from 0.5 to 0.7 in absolute value. The only exception is the proxy based on inter-question dispersion, which failed to increase strongly when confidence plummeted during the 2012 – 2013 crisis in Cyprus, possibly owing to a prolonged period of low business expectations in the run-up to the crisis.

[16] 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 is associated with a higher information content.
[17] The stock market volatility measure is computed using the standard deviation of the historical daily returns of the Cyprus Stock Exchange General Index; the measure refers to realised, historical volatility, as opposed to forward-looking volatility implied by option prices as in the Cboe Volatility Index (VIX). To the best of our knowledge, there is no implied volatility index for the Cyprus stock market and no readily available aggregate or sectoral uncertainty measures for the economy of Cyprus with sufficiently long time series. The sectoral and aggregate data on uncertainty for Cyprus that have been published by the European Commission since October 2021 only cover the period from March 2019 to August 2019 and from May 2020 onwards (European Commission 2021).
[18] The economic sentiment indicator for Cyprus is constructed in the same way as the indicator published by the European Commission (see European Commission 2020); however, the sectoral weights used in the computation of the sentiment indicator employed in this paper reflect the contribution of each sector to the GDP of Cyprus.

TABLE 4

Correlations between aggregate uncertainty proxies

	Proxy based on ex ante disagreement	Proxy based on inter-question dispersion	Proxy based on non-survey data
	Simple average of sectoral proxies: employment and 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 and 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.

5.2 Uncertainty, employment and output

The empirical analysis at the aggregate level is carried out in four-variable VARs, similarly to the sectoral analysis in section 4.2. The endogenous variables consist of an aggregate uncertainty proxy (one at a time), the economic sentiment indicator, and total employment and real GDP expressed as quarter-on-quarter growth rates.[19] We include the economic sentiment indicator in the aggregate VARs to deal with possible endogeneity between uncertainty and economic confidence, as discussed in section 4.2. Four of the aggregate proxies considered above are derived from survey data similar to those used in the economic sentiment indicator; also, most proxies, including that based on stock market volatility, strongly correlate with the sentiment indicator, and uncertainty surprises appear to coincide with large movements in sentiment. By including the sentiment indicator in the VARs, we can determine whether the constructed proxies contain signals in addition to those in the sentiment indicator and separate the uncertainty from confidence effects on employment and output (see also section 4.2).

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 (see Table A5 in the Appendix).[20, 21]. This recursive identification results in orthogonal innovations via the Cholesky decomposition of the variance-covariance matrix, and hence is used to

[19] For the economic sentiment indicator, see footnote 18. Data on total employment (total number of persons employed) and GDP (chain-linked volume measures) were obtained from the Statistical Service of Cyprus. The data used are seasonally adjusted.

[20] The lag length in the VARs is 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 is applied.

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

estimate the causal effects of an uncertainty shock on economic sentiment, employment and output. All uncertainty proxies are standardised. The VARs are estimated over the period 2008q2 – 2019q4. Cumulative sum tests reveal that the coefficients of the VARs do not exhibit any signs of instability over the estimation period (see Table A4 in the Appendix).

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 adverse 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.[22]

In panel (a), an uncertainty shock triggers negative and significant effects on the overall confidence, total employment and aggregate output. The estimated responses are similar in shape and magnitude across the proxies considered. 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 negative effects of the shock on economic sentiment, employment and GDP are found to remain statistically significant for up to 18, 14 and 11 quarters after the shock, respectively. The ex post forecast error and stock market volatility proxies generate somewhat more persistent effects on macroeconomic variables. The economic sentiment indicator loses 1 to 2 points within the first quarter and continues to decline for 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 pp and 0.3 pp across proxies and occurs on impact or up to four quarters after the shock, depending on the proxy. The negative effect of an uncertainty shock on GDP growth varies across proxies between 0.2 pp and 0.4 pp; the maximum effect is observed one or two quarters following the shock.

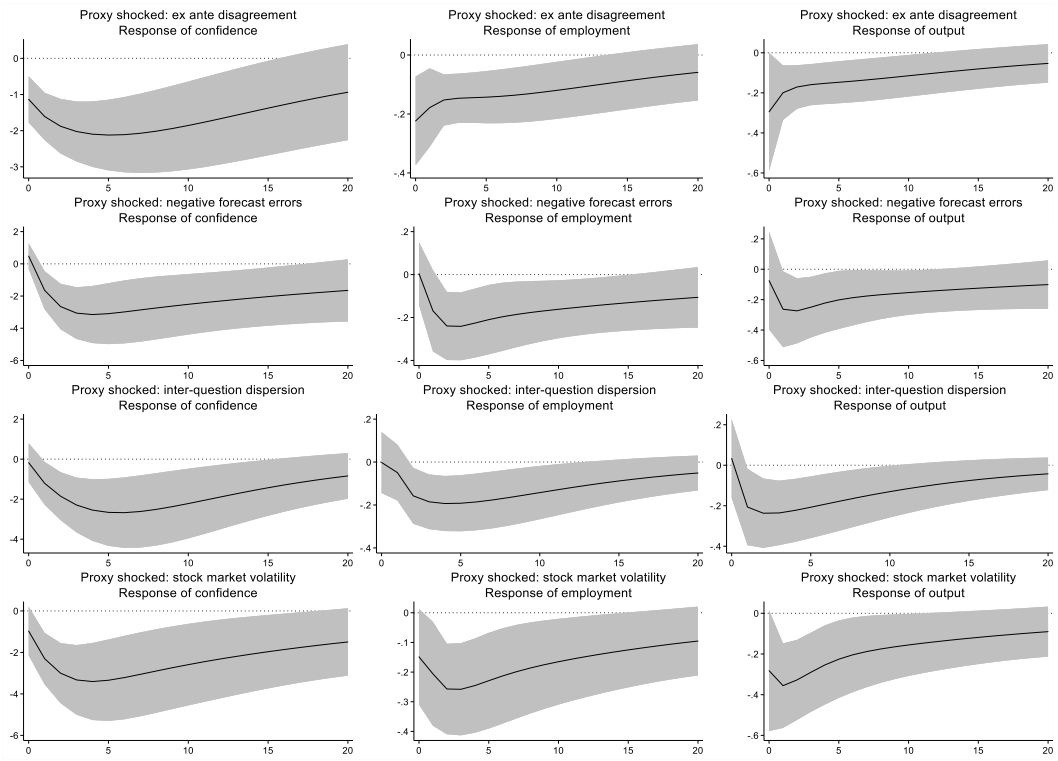
A positive uncertainty surprise in panel (b) generates positive and significant effects on confidence, employment and output. The responses to the positive innovation are more persistent than those estimated for an adverse shock. The effects of an upside uncertainty surprise on sentiment are of similar magnitude as those of an adverse shock, but of the opposite sign. The positive effects on employment and output growth peak early on, reaching 0.4 pp and 0.5 pp respectively, and subsequently taper off.

[22] The standard errors used in the construction of the bootstrap confidence intervals were obtained by drawing random samples with replacement from the residual vectors of the VAR model, using 250 replications. The estimated standard error of an impulse response function was computed as the standard deviation across the 250 bootstrapped impulse response function estimates.

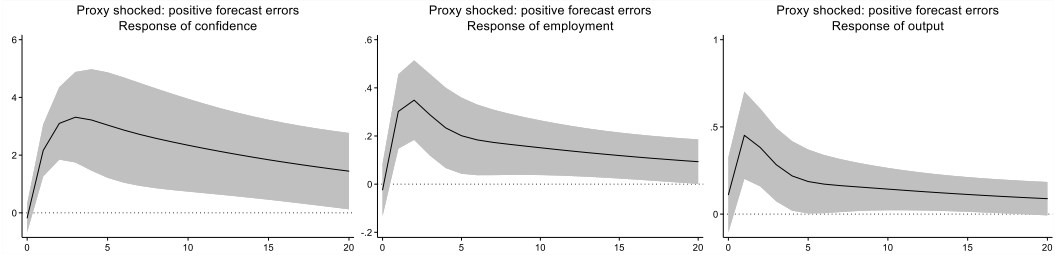
FIGURE 3

Responses of aggregate variables to an aggregate uncertainty shock, using different uncertainty proxies

(a) Proxies representing an adverse shock



(b) Proxy representing a positive shock



Notes: 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 standard errors used in the bootstrap confidence intervals are obtained by bootstrapping the VAR residuals with 250 replications. The results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion. The ex-ante disagreement proxy is constructed as the simple average across all sectoral proxies based on ex ante disagreement about employment and price expectations. The ex post forecast error proxy is given by the simple average of sectoral proxies based on ex post forecast errors. The inter-question dispersion proxy is computed as the standard deviation of 3-month balance changes across forward-looking questions. The stock market proxy refers to historical volatility.

The forecast error variance decomposition for employment and output computed from VARs for the total economy is presented in the Appendix (Table A6). The table entries show the proportion of the forecast error variance of employment and GDP that arises from an uncertainty shock; the shock is measured using the different aggregate uncertainty proxies, over a forecast horizon of 20 quarters. The contribution of an uncertainty surprise to the VAR forecast error variance of both employment and

output rises as the horizon increases. 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 in the case of the positive forecast error and stock market volatility proxies. At the end of the horizon, the contribution associated with most proxies rises to over 40% for employment and above 30% for GDP.

The fraction of error variance accounted for by uncertainty shocks is larger for employment than for GDP, especially for longer horizons, a result also found at the sectoral level (section 4.2). An explanation for this result is that output growth exhibits larger fluctuations than employment growth, both at the aggregate level and in the sectors examined, as institutional factors (e.g. hiring and firing procedures and legislation) limit extreme fluctuations in employment. As output is more volatile than employment, the residual variance is higher for the output equation in the VAR than for the employment equation. Hence, in the case of output the overall mean squared error is higher for all horizons (and therefore the denominator in the variance decomposition is larger), even if the variation attributed to uncertainty shocks (in absolute terms) is larger for output than for employment. This suggests that output is more susceptible than employment to shocks beyond those represented by the uncertainty proxies included in the VARs, particularly shocks that directly hit output. Nevertheless, the bulk of output forecast error variance is attributed to output innovations and uncertainty shocks, with the former dominating in short horizons and the latter gaining importance as the horizon increases. Furthermore, institutional factors relating to the labour market can explain why employment reacts somewhat less strongly than output to uncertainty shocks in the very short run, but exhibits rather more protracted uncertainty effects than output.

5.3 Robustness: results from panel VARs

The aggregate proxies based on ex ante disagreement and ex post forecast errors are computed from sectoral proxies. Thus, the robustness of the estimated responses of confidence, employment and output to uncertainty shocks measured through these two aggregate proxies is investigated further by estimating panel VARs using sectoral data. More specifically, the sectoral proxies derived from expectation disagreement about employment and prices, as well as the sectoral proxies based on negative and positive forecast errors analysed in section 4 are used in panel VARs (one proxy at a time), together with data on confidence indicators, employment and value added for the sectors of industry, construction, retail trade and services. These four sectors cover about 65% of GDP and 70% of aggregate employment in Cyprus and therefore the responses estimated from panel VARs, without interdependencies across sectors, can be viewed as comparable to those from VARs with aggregate variables discussed in section 5.2.[23, 24]

[23] Homogeneous panel VARs are deemed appropriate as the focus here is on the average effects of an uncertainty shock across sectors, and as the number of available observations is not very large. The panel VARs are estimated over the period 2008q2 – 2019q4 using the Generalised Method of Moments. Employment and gross value added are expressed in quarter-on-quarter percentage changes.

[24] As an additional robustness check, the responses of aggregate employment and GDP to uncertainty shocks measured through the aggregate proxies discussed in sections 5.1 and 5.2 are estimated from VARs that exclude the economic sentiment indicator, following the baseline specifications in some studies (e.g. Bachmann et al. 2013, Girardi and Reuter 2017). Employment and GDP react negatively to an adverse uncertainty shock, exhibiting declines in their growth rates that bottom out within at most four quarters

Figure 4 plots the responses of confidence, employment and output to an uncertainty shock of one standard deviation obtained from the panel VARs. The responses to adverse uncertainty shocks in the case of proxies derived from ex ante disagreement and negative ex post forecast errors are shown in panel (a).

Confidence, employment and output react negatively to an uncertainty shock, with the duration of statistically significant reductions being similar to those estimated from the VARs with aggregate variables shown in Figure 3 (panel (a)). However, compared to the responses from the aggregate VARs, the negative effects from the panel VARs build up more gradually, diminish more slowly and are generally larger; this result is driven by pronounced effects in construction and industry, as suggested by the sectoral analysis in section 4.2.

Positive uncertainty surprises measured by positive ex post forecast errors induce increases in confidence, employment and output as shown in panel (b); compared to the effects obtained from the VAR with aggregate variables, the estimated increases from the panel VAR are larger but turn insignificant more quickly.

The responses of confidence, employment and output estimated from the panel VARs are consistent with those obtained from sectoral VARs and appear to form lower (upper) bounds for responses to adverse (upside) uncertainty shocks at the economy level. The impact of uncertainty on aggregate employment and GDP is somewhat diluted when uncertainty is approximated by expectation disagreement or forecast errors in industry, construction, retail trade and services, despite the fact that the four sectors adequately represent the economy as a whole. This is because in addition to the four sectors above, the sector of public administration, defence, education and health is a significant contributor to aggregate employment and GDP (about 20%). Employment and output in the sector of public administration, defence, education and health, are less sensitive to the particular uncertainty shocks described above, as the production of public services constitutes the largest component of this sector's activities.[25]

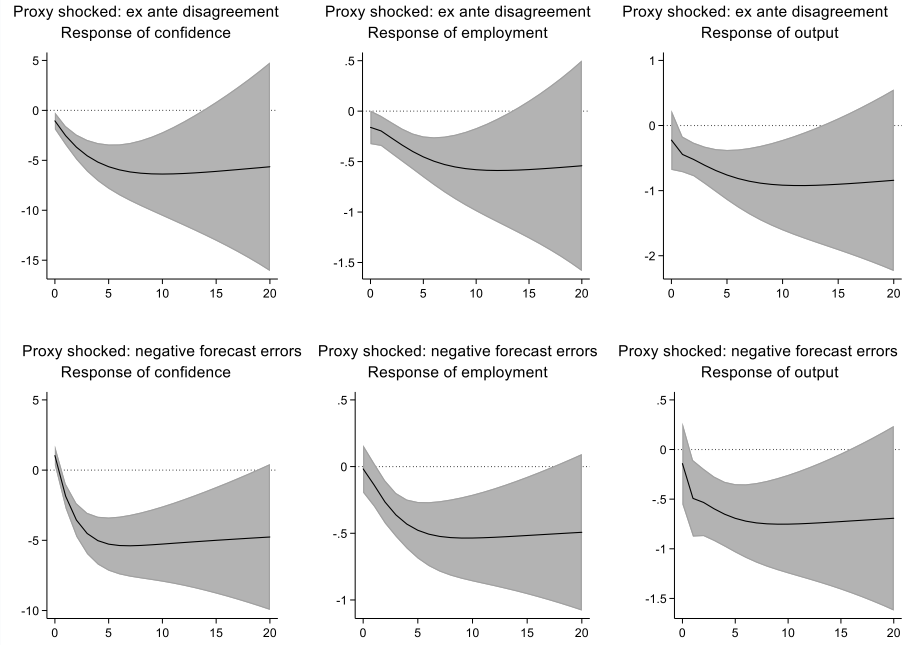
of the shock; subsequently the declines fade away. Conversely, a positive uncertainty surprise generates significant increases in GDP growth and employment growth that peak one and two quarters after the shock, respectively, and diminish afterwards. The magnitude of the statistically significant effects (as well as the proportions of forecast error variance attributed to the shock) is very close to that obtained from VARs that include the economic sentiment indicator, although in some instances the effects tend to remain statistically significant for a shorter period when the sentiment indicator is excluded from the VARs. Employment and output responses at the sectoral level estimated from sectoral VARs without a confidence indicator closely resemble those obtained from sectoral VARs that include a confidence indicator.

[25] Another important aspect of the economy of Cyprus is tourism; the accommodation and food service activities that are closely linked to tourism contribute about 13% and 30% to the value added and employment of the services sector examined in this paper, respectively. Adverse uncertainty shocks are found to trigger significant declines in employment and output in the sector of accommodation and food service activities, as well as in tourist arrivals, while the opposite is found for upside uncertainty surprises. The significant effects are rather short-lived, lasting one to two quarters in the case of output and tourist arrivals, and somewhat longer in the case of employment.

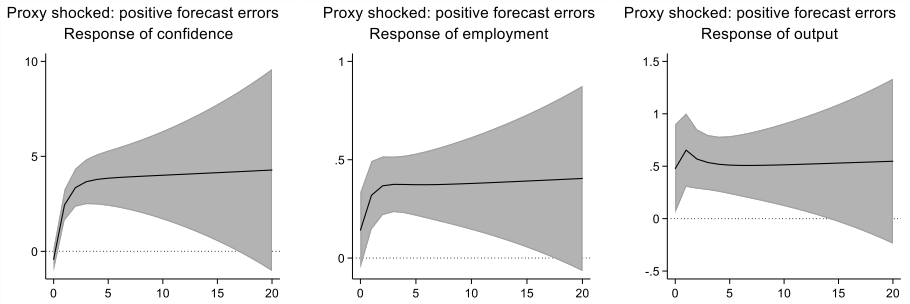
FIGURE 4

Responses of confidence, employment and output to uncertainty shocks, panel VARs

(a) Proxies representing an adverse shock



(b) Proxy representing a positive shock



Notes: 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% confidence interval estimated using Monte Carlo draws from the fitted models and Gaussian approximation. The results shown are obtained from panel VARs of order one, as determined by the Bayesian Information Criterion. The ex-ante disagreement proxy in the panel VAR is given by the average of the two proxies based on employment and price expectations.

5.4 Uncertainty, consumption and investment

The results of the previous sections show that uncertainty shocks have a significant effect on employment and output at sectoral and economy-wide levels. Next, we explore how two key components of GDP, namely private consumption and investment, react to uncertainty shocks. This allows us to examine possible channels via which uncertainty affects economic activity, such as the 'precautionary saving motive' of households and the 'wait and see' approach of firms, discussed in the literature (e.g. Basu and Bundick 2017; Bloom 2009).

To this end, the aggregate VARs described in section 5.2 are estimated by replacing GDP with one of the following GDP components at a time: private consumption and

investment.[26] Figure 5 plots the estimated responses of consumption and investment (solid lines) to one standard deviation surprise in each one of the five aggregate uncertainty proxies discussed in sections 5.1 and 5.2.[27] Panel (a) shows the responses to an adverse uncertainty shock measured through proxies derived from ex ante disagreement, negative ex post forecast errors, inter-question dispersion, and stock market volatility. Panel (b) plots the responses to a positive uncertainty surprise measured by positive ex post forecast errors.

As seen in panel (a), a sudden increase in uncertainty induces negative effects on consumption that are of similar magnitude to but less persistent than the adverse effects on GDP. The significant effects on consumption kick in one to two quarters after the shock when consumption growth loses between 0.3 pp and 0.5 pp across all proxies, except for the stock market volatility proxy which generates negative but insignificant effects. Subsequently, the declines weaken, but remain significant for up to five quarters after the shock in the case of the ex-ante disagreement and inter-question dispersion proxies.

Turning to investment, irrespective of the proxy used, an uncertainty shock results in more pronounced and more protracted effects compared to those found for consumption. The stock market volatility proxy generates the strongest effects, as investment growth registers a drop of 2.6 pp on impact, followed by diminishing effects, which, nevertheless, remain statistically significant for up to 13 quarters after the shock. The remaining proxies trigger significant declines in investment growth ranging from 0.6 pp to 1 pp two quarters following the shock; the duration of significant negative effects on investment varies between nine (inter-question dispersion proxy) and 18 (negative forecast error proxy) quarters after the shock.

Consumption and investment react positively to an upside surprise, with the effects on consumption being smaller and shorter-lived than the effects on investment, as shown in panel (b). The positive effects on consumption peak at 0.4 pp two quarters after the shock, but significant increases last for two quarters only. On impact, the positive and significant response of investment is estimated at 1.8 pp; subsequently the positive effects diminish, although they are found to remain statistically significant for up to 15 quarters following the positive surprise.

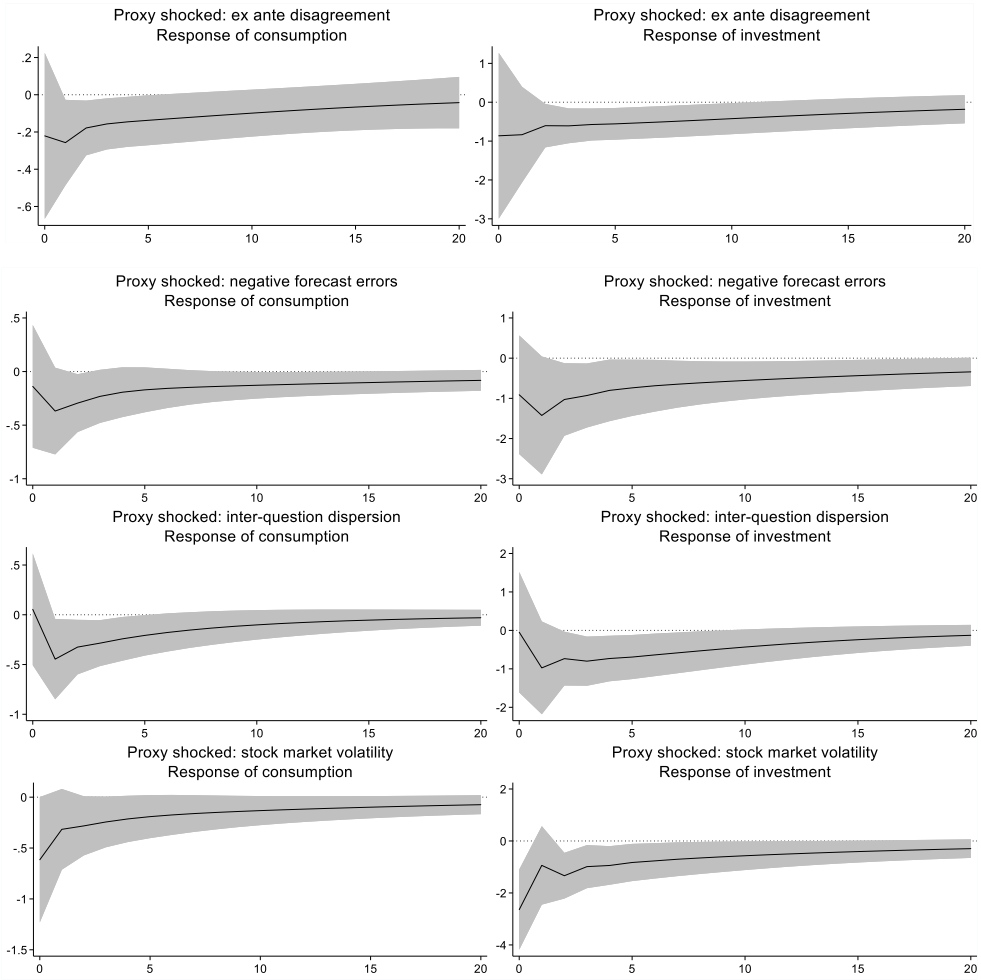
[26] Data on private consumption expenditure and gross fixed capital formation (chain-linked volume measures) were obtained from the Statistical Service of Cyprus. Gross fixed capital formation relating to transport equipment is excluded because of extreme fluctuations in the series. The data used are seasonally adjusted and expressed in quarter-on-quarter percentage changes.

[27] The responses of confidence and employment to uncertainty shocks obtained from VARs with either consumption or investment are very similar (in terms of magnitude and duration of significant effects) to the responses in Figure 3 and are therefore omitted for brevity.

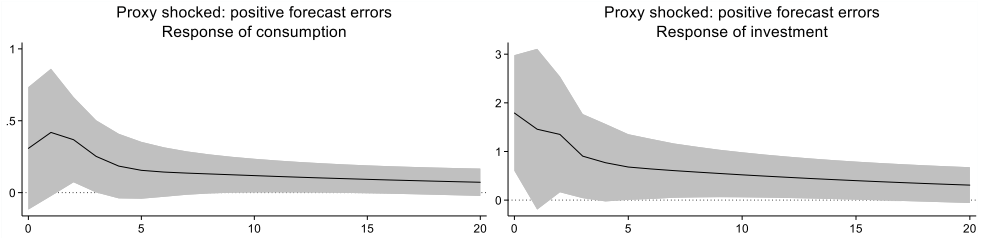
FIGURE 5

Responses of consumption and investment to an aggregate uncertainty shock, using different uncertainty proxies

(a) Proxies representing an adverse shock



(b) Proxy representing a positive shock



Notes: 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 standard errors used in the bootstrap confidence intervals are obtained by bootstrapping the VAR residuals with 250 replications. The VARs are estimated over the period 2008q2–2019q4.The results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion. See notes to Figure 3.

Our results show that adverse uncertainty shocks negatively affect the macroeconomic variables considered; the effects on employment, investment and GDP tend to be long-lived, while the impact on private consumption is rather temporary. As discussed in the literature, firms may adopt a 'wait and see' approach in conditions of elevated uncertainty (see e.g. Bloom 2009). Under this approach, higher uncertainty raises the real-option value to waiting when firms face labour and capital adjustment costs; hence, firms temporarily scale down investment and hiring. Furthermore, under the 'wait and see' approach uncertainty shocks result in a quick drop and rebound in output and employment, followed by an overshoot in the two aggregates, driven by pent-up demand for labour and capital (Bloom 2009). In our results, the estimated responses of investment, employment and output are only partly consistent with the 'wait and see' approach, as the negative effects found are rather protracted instead of short-lived, the rebound is gradual and no evidence of overshooting is found.

In our results, the observed drop in consumption growth may be driven by the precautionary saving motive, i.e. when consumers face increased income uncertainty they may consume less than what they would in the absence of uncertainty, and choose to save to create a buffer stock. Our results seem to fit with the setting proposed by Basu and Bundick (2017) in which an adverse uncertainty shock triggers significant declines in output, consumption, investment and hours worked that fade away gradually. Basu and Bundick (2017) show that these negative responses of output, consumption, investment and hours worked to an uncertainty shock can arise in a model where output is demand-determined in the short run, prices are sticky and firm markups change endogenously.[28] In this setting, higher uncertainty increases desired saving and lowers consumption demand, which in turn reduces output; lower output reduces the desired capital stock, leading to lower investment. Moreover, increased desired labour supply as a result of higher uncertainty, pushes the marginal cost for firms down and in the presence of price rigidity, increases firm markups, reducing labour demand. Thus, in the setting proposed by Basu and Bundick (2017), uncertainty may result in lower equilibrium employment, if the shift in labour demand resulting from higher markups dominates the increase in labour supply due to the precautionary saving motive.

Finally, Bachmann et al. (2013) refer to the 'by product' hypothesis where high uncertainty is driven by a confidence shock with prolonged adverse effects on production. Our results do not seem to lend credence to this hypothesis, as there is no evidence that movements in the uncertainty proxies considered are driven by changes in confidence indicators. Our results show that causality runs from uncertainty to confidence and not vice versa. Moreover, shocks to confidence do not trigger any significant effects on uncertainty.[29]

[28] Basu and Bundick (2017) argue that the negative and significant responses of output, consumption, investment and employment to uncertainty shocks found in empirical studies cannot be explained in the context of standard general equilibrium models with flexible prices. In models with flexible prices, higher uncertainty lowers consumption by inducing precautionary saving, but increases output, investment and hours worked. Under flexible prices, higher uncertainty increases the marginal utility of wealth so that individuals desire to supply more labour for given real wages and thus, with unchanged capital and technology, output rises; with higher output and lower consumption, investment must increase.

[29] The estimated response of uncertainty to a confidence shock is not statistically significant in VARs in which confidence is ordered first and uncertainty second, followed by employment growth and output growth. Also, the effects of a confidence shock on uncertainty are insignificant in the VARs discussed in section 5.2 where uncertainty is ordered first.

6. 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.

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 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 by negative ex post forecast errors, reflecting negative surprises, while effects of the opposite sign, but of similar magnitude and duration, are estimated when positive ex post forecast 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, adverse uncertainty shocks result in significant and rather persistent negative effects on economic sentiment, aggregate employment, GDP and investment, while the negative response of consumption to uncertainty shocks is short-lived. A positive uncertainty surprise generates significant increases in economic sentiment, total employment, GDP and investment.

The results of the analysis are along the lines of those in other studies, namely that adverse 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 paths; similar findings are reported in 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), a result possibly driven by institutional factors relating to the labour market. 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 employment and output 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. The negative response of investment to an adverse uncertainty shock is more pronounced than the reaction of consumption, a result also found in Claeys and Vasicek (2019) and Ghirelli et al. (2019); moreover, the negative

effects of uncertainty on investment are longer-lived than the effects on consumption as in Claeys and Vasicek (2019).

The paper contributes to the empirical literature on uncertainty by constructing sectoral and aggregate uncertainty proxies from business survey data and assessing their dynamic relationships with economic activity. Business survey data similar to the data employed in this paper are available for many countries and therefore the proxies discussed can be easily extended to other economies. Uncertainty proxies based on business survey data can offer timely signals about the direction and magnitude of fluctuations in macroeconomic variables, inform decision-making and lead to comparable uncertainty measures across countries that carry out similar surveys.

The findings of the paper can be relevant to economies that are relatively small, open and oriented towards services, especially business or hospitality services. An economy with a relatively large financial sector that is not sufficiently diversified across markets is rendered vulnerable to financial crises, and therefore susceptible to episodes of high and prolonged uncertainty, resulting in output and employment losses. A considerable exposure of the banking system to the construction sector reinforces uncertainty during a crisis, as employment and output losses generated by uncertainty shocks tend to be larger in construction than in other sectors. Also, a heavy concentration of investment in the construction sector could exacerbate the negative effects of uncertainty shocks on activity through lower investment, as well as through employment and output losses in the construction sector. On the other hand, large and diversified services and retail trade sectors may buffer the effects of uncertainty shocks in the economy as a whole.

The comparison of employment and output responses to an uncertainty shock reveals that both variables exhibit protracted effects, but employment is slower to return to its pre-shock path. This result is probably driven by market rigidities, most notably institutional factors connected with the labour market, resembling those in other advanced countries, particularly in Europe.

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Appendix

TABLE A1

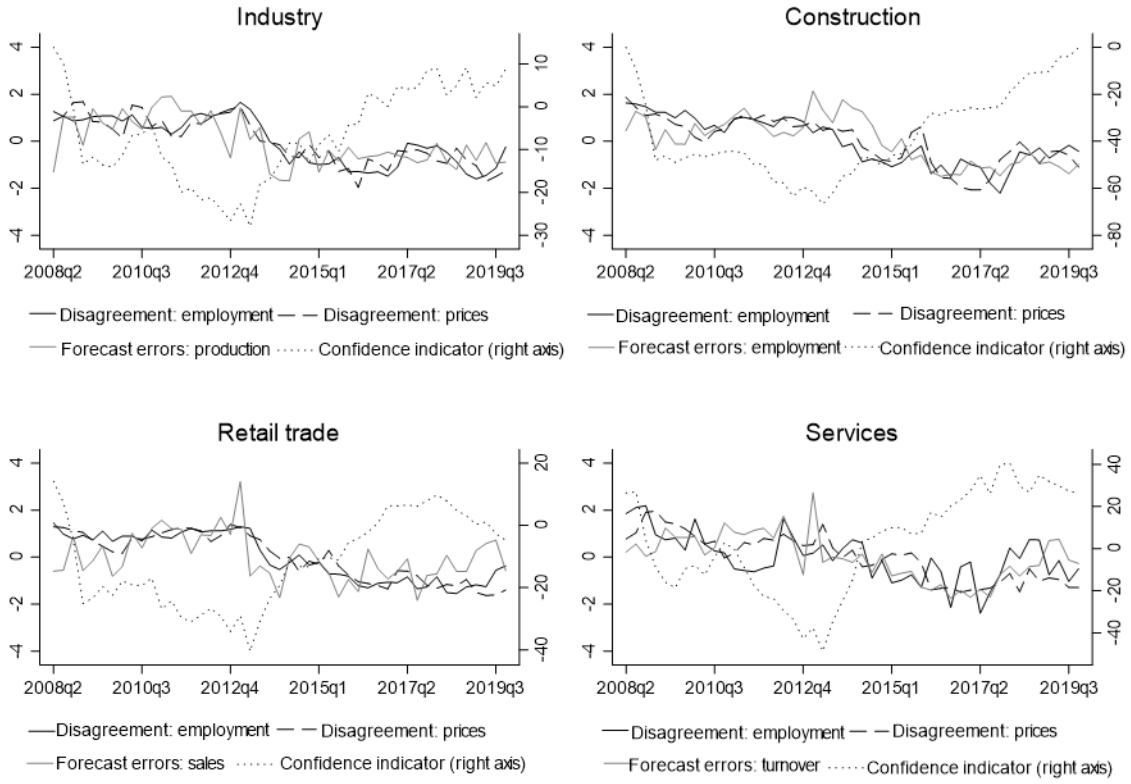
Summary statistics for sectoral uncertainty proxies

	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: Proxies based on ex ante disagreement are computed using equation (1); proxies based on ex post forecast errors are derived using equations (3), (4), (6) and (7). The economic variables (e.g. production, prices, employment, etc.) referred to in the relevant survey questions are shown after the sector names in the first column. 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). 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.

FIGURE A1

Sectoral uncertainty proxies and sectoral confidence indicators



Notes: The figure shows sectoral proxies based on ex ante disagreement and ex post forecast errors that exhibit strong correlation with output and employment in each sector (see Table A1). The ex ante disagreement proxies are derived from employment and price expectations in the four sectors. In industry, construction and services, the ex post forecast error proxies refer to negative errors made by firms in forming expectations about production, employment and turnover, respectively. In retail trade, the ex post forecast error proxy refers to positive errors made by firms in forming expectations about their sales; the sign of the proxy graphed is inverted to convey downside uncertainty, similarly to the rest of the proxies shown in the figure. For the sectoral confidence indicators, see footnote 7. All series plotted were converted from monthly into quarterly frequency.

TABLE A2

Granger causality tests in sectoral VARs, p-values

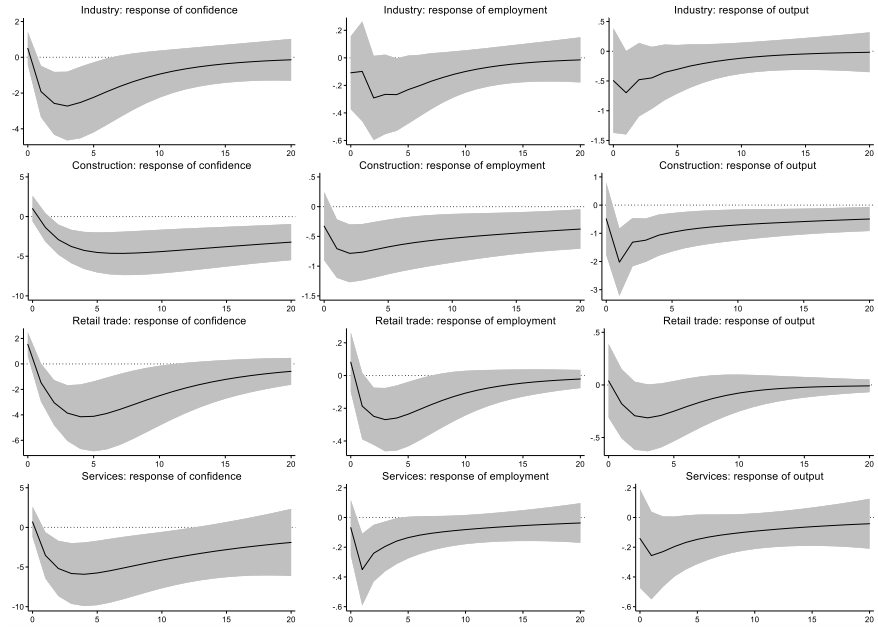
	Null hypotheses	
	Confidence indicator does not Granger cause uncertainty proxy	Uncertainty proxy does not Granger cause confidence indicator
Proxies based on ex ante disagreement		
Industry: production	0.37	0.04
Industry: prices	0.15	0.03
Industry: employment	0.87	0.13
Construction: employment	0.92	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: Proxies based on ex ante disagreement are computed using equation (1); proxies based on ex post forecast errors are derived using equations (3), (4), (6) and (7). The economic variables (e.g. production, prices, employment, etc.) referred to in the relevant survey questions are shown after the sector names in the first column. The VARs also include employment growth and output growth as endogenous variables. The results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion. The variance - covariance matrix of the VAR residuals and the test statistics are adjusted for small samples by using a degrees-of-freedom correction and the F distribution for hypothesis tests.

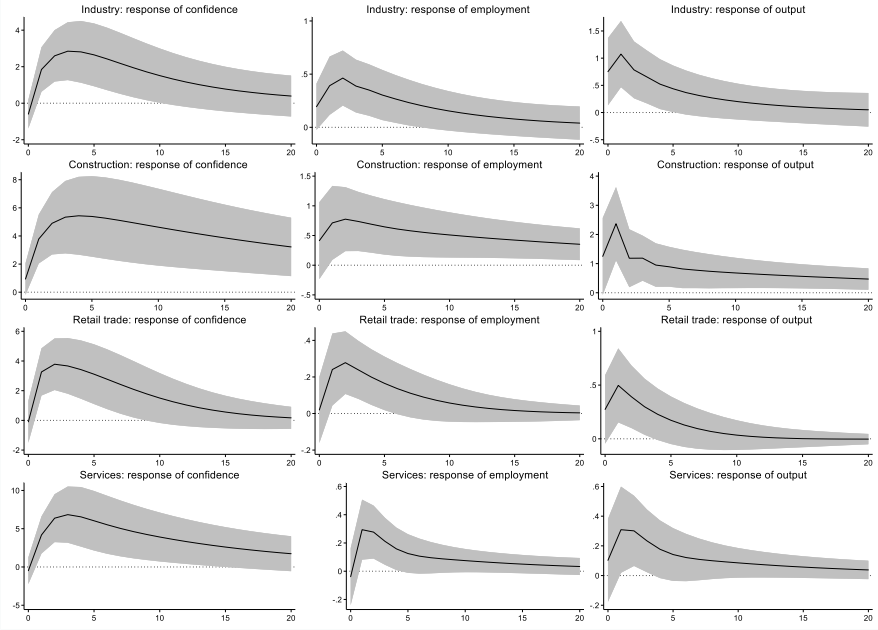
FIGURE A2

Responses of sectoral variables to a sectoral uncertainty shock, using uncertainty proxies based on ex post forecast errors

(a) Sectoral variable shocked: uncertainty proxy based on negative forecast errors



(b) Sectoral variable shocked: uncertainty proxy based on positive forecast errors



Notes: 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 standard errors used in the bootstrap confidence intervals are obtained by bootstrapping the VAR residuals with 250 replications. The results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion. The forecast errors for industry, construction, retail trade and services are derived from expectations about production, employment, sales and turnover, respectively.

TABLE A3

Forecast error variance decomposition, sectoral VARs

	Employment				Output			
Horizon (quarters)	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

Notes: Proxies based on ex ante disagreement are computed using equation (1); proxies based on ex post forecast errors are derived using equations (3), (4), (6) and (7). The economic variables (e.g. production, prices, employment, etc.) referred to in the relevant survey questions are shown after the sector names in the first column. The results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion. The values show the contribution of an uncertainty shock (measured via different sectoral proxies) to the forecast error variance of employment and output in industry, construction, retail trade and services.

TABLE A4

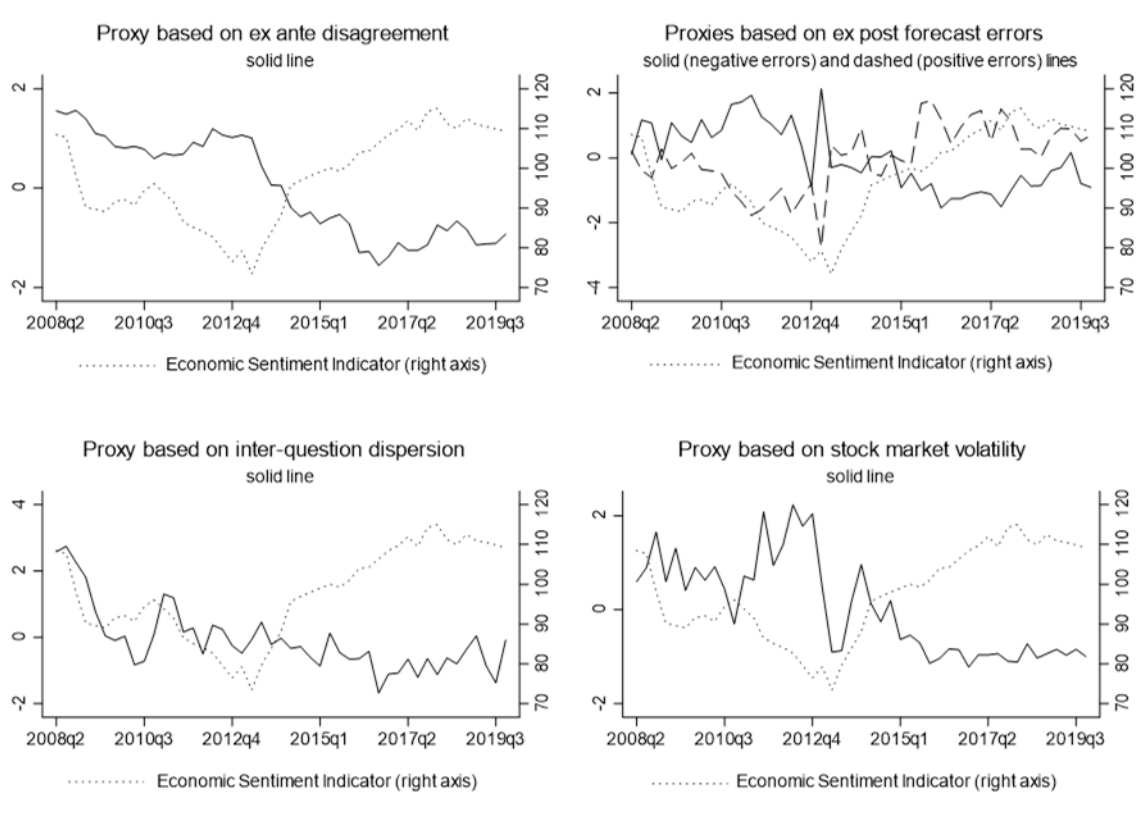
Cumulative sum test for the stability of the coefficients in the VARs, test statistics

	VAR equation			
	Uncertainty	Confidence	Employment	Output
Proxies based on ex ante disagreement				
Sectoral proxies				
Industry: prices				
Industry: employment				
Construction: employment	0.75	0.75	0.63	0.66
Construction: prices	0.64	0.95	0.70	0.77
Retail trade: employment	0.96	0.40	0.65	0.82
Retail trade: prices	0.78	0.67	0.73	0.91
Services: employment	0.68	1.39*	0.65	0.66
Services: prices	0.94	1.04	0.52	0.70
Aggregate proxy				
Simple average of sectoral proxies: employment & prices	0.79	0.65	0.62	0.72
Proxies based on ex post forecast errors				
Sectoral proxies				
Industry: production, negative errors	1.52*	0.75	0.98	1.12
Industry: production, positive errors	1.34	0.97	0.82	1.11
Construction: employment, negative errors	0.98	1.26	1.05	0.92
Construction: employment, positive errors	0.89	1.34	1.11	0.97
Retail trade: sales, negative errors	1.03	0.58	0.53	0.56
Retail trade: sales, positive errors	1.07	1.44	1.22	0.70
Services: turnover, negative errors	1.30	0.84	0.61	0.60
Services: turnover, positive errors	0.97	1.01	0.79	0.50
Aggregate proxies				
Simple average of sectoral proxies: negative errors	1.28	0.55	0.88	0.48
Simple average of sectoral proxies: positive errors	1.29	1.11	0.83	0.51
Other aggregate proxies				
Standard deviation of 3-month changes: forward-looking questions	0.71	1.18	0.61	0.63
Stock market volatility	1.12	0.84	0.56	0.49

Notes: The table shows the test statistics based on the cumulative sum of OLS residuals (Ploberger and Kramer 1992). The null hypothesis is that all coefficients in each VAR equation are stable over time. The null hypothesis is rejected if the value of the test statistic exceeds a critical value, with the 5% and 1% critical values being equal to 1.3581 and 1.6276, respectively. The symbol '*' denotes rejection of the null hypothesis at the 5% level but not at 1% level. The coefficient stability tests are carried out in the equations of VARs for sectors and for the economy as a whole, using the uncertainty proxies (one at a time) shown in the first column. Each VAR includes an uncertainty proxy, a confidence indicator, employment growth and output growth. The results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion.

FIGURE A3

Aggregate uncertaitny proxies and the Economic Sentiment Indicator



Notes: The top row shows the aggregate proxies computed as the average of sectoral proxies based on (i) ex ante disagreement about employment and prices, and (ii) negative (or positive) forecast errors made by firms in forming expectations about production (industry), employment (construction), sales (retail trade) and turnover (services). The bottom row shows (i) the proxy based on inter-question dispersion computed as the standard deviation of 3-month changes in the balance of forward-looking survey questions (see Girardi and Reuter 2017), and (ii) the proxy based on the historical volatility of the Cyprus Stock Exchange Index. All uncertainty proxies are standardised. For the economic sentiment indicator, see footnote 18. All series plotted were converted from monthly into quarterly frequency.

TABLE A5

Granger causality tests in VARs for the total economy, p-values

	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 results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion. The variance - covariance matrix of the VAR residuals and the test statistics are adjusted for small samples by using a degrees-of-freedom correction and the F distribution for hypothesis tests.

TABLE A6

Forecast error variance decomposition, VARs for the total economy

	Employment				Output			
Horizon (quarters)	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	0.00	0.12	0.27	0.37	0.00	0.15	0.24	0.30
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

Notes: The results shown are obtained from VARs of order one, as determined by the Bayesian Information Criterion. The values show the contribution of an uncertainty shock (measured via different aggregate proxies) to the forecast error variance of total employment and GDP.