Stock Market Volatility and Economic Activity

by

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Abstract

This paper examines the extent to which uncertainty impacts real economic activity. The short-term impact of uncertainty on labour market and industrial production variables in eight countries is analysed. Uncertainty is measured by the expected volatility implied by option prices on a country's stock market index. The implied volatility index on each respective stock market is decomposed to examine the asymmetric effects of big changes in implied volatility. A significant asymmetric effect of uncertainty is present in most countries. The negative effects of uncertainty are particularly strong in the period during and after the Global Financial Crisis. This suggests that the spikes in uncertainty in recent years may have contributed to the slow global economic recovery.

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1. Introduction

There has been increased interest in the effects of uncertainty on real economic activity in recent years following the Global Financial Crisis (GFC). The weak recovery and periodic spikes of uncertainty, as well as advancement in econometric techniques, have prompted economists to explore the effects of uncertainty on the real economy. These recent uncertainty spikes include the European sovereign debt crisis, the United States debt ceiling crisis, the taper tantrum[1] and recent global growth concerns.

Economic theory suggests that this uncertainty may lower economic activity as firms postpone investments and consumers postpone their purchases. There is a "wait and see" effect as market participants wait to determine whether economic prospects (such as product demand and job security) will improve before investing or consuming. This has implications for the real economy.

The concern over the weak global recovery and its link to uncertainty has been noted by many policymakers, economists and the financial press. The Chief Economist of the Bank of England, Andrew Haldane (2015), recently noted in a speech the damaging effects of uncertainty, citing it as a reason for interest rates being stuck on the zero lower bound in many economies:

"This cautious behaviour… can be seen in the weakness of global investment since the crisis, despite the cost of company borrowing being at its lowest-ever levels. Uncertainty-induced weakness in investment has provided a continuing drag on recovery, globally if not nationally."

The aim of this research is to test the implications of uncertainty shocks on economic activity growth. This project is specifically interested in the asymmetric effects of uncertainty: is there a temporary, symmetric response, where large decreases in uncertainty offset large increases in uncertainty? Or is there an asymmetric effect, where uncertainty shocks have a persistent, negative effect on economic activity?

The implied volatility index is used as a measure of macro-economic uncertainty and is decomposed in a statistical model to analyse the asymmetric effects of uncertainty on economic activity indicators. Labour market and industrial production data are used as indicators of economic activity. I construct impulse response functions to illustrate the effect

[1] The taper tantrum was a market reaction to the tapering off of U.S. Federal Reserve quantitative easing, as the market became uncertain about the strength of the economy without such supportive monetary policy.

of a spike in implied volatility and the subsequent decline in economic activity growth over the months that follow.

I extend the analysis to data from several economies that have implied volatility indices on their stock markets. The economies included are the United States, the euro area, Japan, Germany, the United Kingdom, Switzerland, France and Hong Kong. Results are consistent with the previous available empirical literature, which focuses on the United States and United Kingdom economies.

The empirical study breaks the whole sample into two sub-sample periods: the pre-GFC period (before 2007m08) and the GFC-onwards period (2007m08 onwards). The asymmetric effects of uncertainty tend to be more significant and persistent in the GFC-onwards sub-sample period. This result supports recent literature on the heightened negative impact of uncertainty when monetary policy is constrained at the zero lower bound, as is the case with many of the countries analysed.

The results suggest a strong role of uncertainty in the slow global economic recovery. Significant asymmetric effects of uncertainty are found across the economies analysed and are generally stronger during and after the Global Financial Crisis. This suggests that the large spikes in uncertainty that we have seen frequently in recent years have contributed to the weak economic recovery, as has been suggested by many market participants.

2. Literature Review

2.1 Theory

Economic theory (Bernanke (1983), Bloom (2009)) suggests that uncertainty may lower economic activity as firms postpone investments and consumers postpone their purchases.

Three main theories regarding the effect of uncertainty on economic activity are real options, risk premia and growth effects. The first two theories support the view that an increase in uncertainty has negative effects on the real economy while the growth effects theory highlights the positive impact that uncertainty may have on economic growth.

Real Options

Bernanke (1983) developed the theoretical work on investment in the face of uncertainty. Investment should only proceed when the costs of deferring a project exceed the expected value of information gained by waiting. By increasing the value of waiting for new information, uncertainty slows the current rate of investment. This real options effect from increased uncertainty over future business conditions causes an initial drop in activity as firms delay investment and hiring. This happens rapidly as expectations change upon impact of the uncertainty shock, so hiring and investment instantly freeze (Bloom, 2009).

The literature on irreversible investment and the option value of waiting therefore predicts a negative relationship between growth uncertainty and average growth. A similar channel exists for consumption, with uncertainty causing consumption to be postponed. The real options argument not only suggests that uncertainty reduces levels of investment, hiring, and consumption, but that it also makes economic actors less sensitive to changes in business conditions. This can make monetary policy less effective (Bloom, 2014).

There are also reasons that the usual real options effect may be weakened or not hold. If the decision can be easily reversed, the option no longer matters. For example, firms may be happy to hire part-time employees even when uncertainty is extremely high. These workers are flexible and can easily be laid off if conditions worsen. If the cost of delay is very high, then the option to wait and see is not valuable. Similarly, if a firm does not have the ability to wait, for example, if they are competing to patent a new idea, there is no value in waiting (Bloom, 2014). Boyle and Guthrie (2003) also note the conflicting effects of uncertainty on investment. While uncertainty surrounding project value increases the value of delay, the

presence of a financing constraint means that financing uncertainty can increase the value of investing today.

Bloom (2000) shows that real options play no role in determining the long-run rate of investment. However, they play an important role in shaping the short-run dynamics of investment and hiring.

Risk Premia

In the presence of financial constraints, uncertainty can raise borrowing costs which reduces economic growth (Arellano, Bai & Kehoe, 2010). As uncertainty increases, so do risk premia, as investors need to be compensated for the higher risk. Therefore the cost of finance should also increase. The default premium also increases because uncertainty raises the probability of default, by expanding the size of the left-tail default outcomes (Bloom, 2014). Uncertainty can therefore negatively impact economic activity by increasing the cost of borrowing for firms.

Growth Effects

Conversely, increased uncertainty may have a positive effect on long-run growth. Uncertainty can encourage investment if it increases the size of the potential prize. Firms may be able to benefit from growth options created through a wider range of potential outcomes. These growth options are particularly important for research and development-intensive firms. If the downside is limited, due to the ability to lose only sunk research and development costs, then a rise in mean-preserving risk means higher expected profit when the product goes to market (Bloom, 2014).

Another argument in favour of a positive relation between output volatility and growth comes from the theory of precautionary savings, where increased risk raises desired savings and therefore investment and growth may increase in the longer-term (Grier et al. 2004).

2.2 Empirics

The difficulty of distinguishing the effects of uncertainty from the effects of recession is often noted in the literature. Bloom (2014) notes three approaches in the empirical literature to identifying the causal impact of uncertainty on firms and consumers. The first focuses on timing; estimating the movements in output, hiring, and investment that follow jumps in uncertainty. This approach works well for unexpected shocks to uncertainty.

A second approach uses structural models calibrated from macro and micro moments to quantify the potential effect of uncertainty shocks. Like many structural models, it is sensitive to potentially debatable modelling assumptions. A third approach exploits natural experiments like disasters, political coups, trade changes, or movements in energy and exchange rates.

A vector autoregressive estimation for the United States by Bloom (2009) shows that following a large stock market volatility shock (at least 1.65 standard deviations above the mean), there is a sharp drop in industrial production in the first six months followed by a gradual rebound. Similar results are found for employment data. Foerster (2014) also analyses the United States economy, using a statistical model to relate employment and economic activity growth to changes in uncertainty. Foerster finds asymmetry in the response of both employment growth and economy activity growth to changes in the implied volatility index, a proxy for aggregate uncertainty. Large decreases in uncertainty and small changes in either direction seem to have little or no effect on employment. Large increases in uncertainty, however, produce statistically significant declines in both employment and economic activity growth in the months following.

Bloom (2009) uses a parameterised model to simulate a macro uncertainty shock, which produces a rapid drop and rebound in aggregate output and employment. Hiring and investment rates fall dramatically in the four months after the shock because higher uncertainty increases the real option value to waiting, so firms scale back their plans. The immediate short-term impact of these shocks is similar to the vector autoregressive model with the negative impact on economic activity being greatest two months after the uncertainty shock. Once uncertainty starts to drop, pent-up demand for hiring and investment leads to a rapid rebound. Hence, uncertainty shocks generate short, sharp drops and rebounds in output.

The literature tends to focus on data from the United States. Using data from the United Kingdom, Denis and Kannan (2013) find a significant impact of uncertainty shocks on industrial production and GDP, while unemployment is less affected. A vector autoregressive model is used with the implied volatility index of the stock market as the primary measure of uncertainty, as well as the dispersion of GDP forecasts. The peak impact of uncertainty shocks is felt fairly quickly at around six to twelve months after the shock, with the most substantial shifts occurring in the first few months. They conclude that uncertainty shocks have a relatively short, but sharp, impact on economic activity.

Bekaert, Hoerova and Lo Duca (2013) decompose the S&P500 implied volatility index, the VIX, into two components; a proxy for risk aversion and expected stock market volatility. The latter component can give a purer measure of 'physical' expected volatility, as the variance premium (risk aversion) is removed. This technique requires high frequency stock market data, in this case five minute returns, to compute the conditional variance. Similarly, Jones and Enders (2013) estimate the S&P500 index as a GARCH process for volatility clustering and use the estimated conditional variance as an uncertainty measure.

Bekaert and Hoerova (2014) note that using the implied volatility index to measure uncertainty, as Bloom (2009) does, may mean that results are driven by the variance premium rather than uncertainty per se. Using a similar decomposition, they find that while the variance risk premium predicts stock returns, it has no predictive power for future economic activity. Stock market volatility meanwhile does predict industrial production growth, again with data from the United States. The bivariate regressions with its two components show that whatever predictive power the implied volatility index has for future output, is coming from the uncertainty component. They find that the implied volatility index predicts economic activity with a negative sign at all horizons, with industrial production growth falling sharply over the next quarter.

Basu and Bundick (2011) calibrate the size of uncertainty shocks using fluctuations in the implied volatility index. Relevant to the current global economic environment, they show that if the central bank is constrained by the zero lower bound, then monetary policy can no longer perform its usual stabilising function and higher uncertainty has even more negative effects on the economy. Caggiano, Castelnuovo and Pellegrino (2015) also find the contractionary effects of uncertainty shocks are statistically larger when the zero lower bound is binding, using a vector autoregressive model. This is consistent with recent statements by policymakers, economists and the financial press regarding uncertainty.

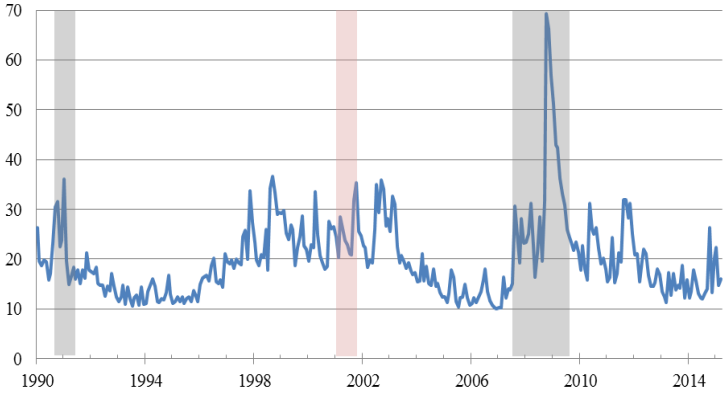
Together the empirical literature suggests that uncertainty is damaging to short-run economic activity. There has been advancement into the area of uncertainty in recent years, with a wealth of new research and the application of econometric techniques. The longer-run evidence of the effect of uncertainty on output is more limited and inconclusive. One reason is that while uncertainty appears to reduce short-run hiring and investment, it may also stimulate research and development – the growth effects argument.

3. Measuring Uncertainty

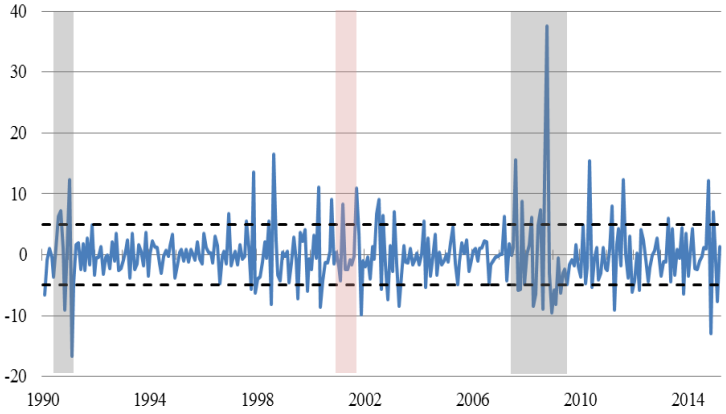
There are many uncertainty measures noted in the literature – economic surprise index, policy uncertainty index, forecasts, level of disagreement in forecasts, a measurement of how many times the words 'uncertain' and 'economy' appear in articles. What I will use in this paper to measure uncertainty is the change in the implied volatility index, commonly referred to as the VIX, on the respective stock market.

Implied volatility indices are intended to provide a benchmark of expected short-term (30-day) market volatility. The VIX is forward-looking and measures volatility that investors expect to see (Whaley, 2008). The most familiar implied volatility index is the United States VIX index on the S&P500 index which is traded on the Chicago Board Options Exchange. It is constructed from the values of a range of call and put options on the stock market index and essentially measures the 'risk-neutral' expected stock variance for the S&P500 index (Bekaert et al. 2013). More volatility is priced in by the market over the coming month when uncertainty is high. Implied volatility indices have the advantage of being market based, forward-looking, and based on expectations. Movements in the implied volatility index provide an almost instantaneous measure of the level of aggregate uncertainty in the economy.

Figure 1: United States S&P500 VIX Index



Change in the United States S&P500 VIX Index



Implied stock market volatility has been used as a proxy for uncertainty previously in the literature in recent years (Denis & Kannan (2013), Foerster (2014), Bloom (2009), Bekaert, Hoerova & Lo Duca (2013)). Bloom (2009) shows that stock market volatility shocks are highly correlated with other measures of uncertainty, like the cross-sectional spread of firm and industry level earnings and productivity growth.

The level of the VIX tends to increase during recessions, as well as the change in the VIX. This is consistent across the countries analysed. Figure 1A in the appendix shows the volatility indices for each country. The shaded areas are periods of recession, defined as two consecutive periods of negative real GDP growth.

The correlations presented in Table 1 show the strong co-movement in the implied volatility indices across the various countries. The United States has an implied volatility index that is highly correlated with the other countries' implied volatility indices. This is a sign of the increasingly globalised and interconnected financial markets and an indication of the prominent status of the United States as a key player in the global financial market. Also of note is the very high correlation between the European indices, while the volatility indices for Hong Kong and Japan show slightly weaker correlation.

Table 1: Implied Volatility Correlations

	US VIX	*Swiss VIX*	*UK VIX*	*Euro VIX*	*German VIX*	*French VIX*	*HK VIX*	*Japan VIX*
US VIX	1.000							
Swiss VIX	0.866	1.000						
UK VIX	0.952	0.924	1.000					
EURO VIX	0.882	0.869	0.917	1.000				
DAX VIX	0.809	0.946	0.876	0.854	1.000			
French VIX	0.817	0.943	0.880	0.847	0.974	1.000		
HK VIX	0.833	0.756	0.791	0.693	0.648	0.658	1.000	
Japan VIX	0.824	0.705	0.805	0.743	0.612	0.608	0.705	1.000

All volatility indices are also plotted together on Figure 2A in the appendix. This again illustrates the strong co-movement between the different implied volatility indices.

4. Methodology

The implied volatility index on each respective stock market is used as a proxy for market uncertainty. Using monthly data, I regress the change in economic activity variables on a number of lagged variables. These lagged variables include stock market growth and change in the implied volatility index. This is to examine the effect that changes in uncertainty have on economic activity indicators in the next period, while controlling for other factors such as the change in the exchange rate or stock market movements. This regression therefore looks at the impact of uncertainty shocks on the subsequent month.

This project adds to the existing literature in two ways. Firstly, it expands the analysis to a number of economies that have not been analysed by the growing empirical literature. The literature focuses almost exclusively on data from the United States, perhaps because it has the original and longest implied volatility series. However, these implied volatility indices are also available on the stock markets of other economies, albeit with a shorter data horizon. I extend the analysis to data from the United States, the euro area, Japan, Germany, the United Kingdom, Switzerland, France and Hong Kong. Data availability on an implied volatility index limits the analysis to these economies, although it is still a far broader analysis than that available in the current literature.

Secondly, I break down the samples into sub-sample periods 'pre-GFC' (before 2007m08) and 'GFC-onwards' (2007m08 onwards). This is to see if the effect of uncertainty on economic activity in recent years is different from that before the GFC.

The recent literature on uncertainty, mentioned previously, has emphasised the negative impact of uncertainty shocks on economic activity in the months following the shock. Uncertainty shocks are shown to have a short, sharp effect on economic activity. Economic activity gradually returns to previous levels following the shock and may overshoot in the medium term. Therefore it is appropriate to look at monthly data and the direct, immediate effects of uncertainty.

Jones and Enders (2013) note that small changes in the level of uncertainty may not matter due to adjustment costs. However, in the face of large uncertainty shocks, the costs of inaction are likely to outweigh these adjustment costs. It is therefore important to distinguish between the relative impacts that big uncertainty shocks may have. They also note that uncertainty increases are likely to be transmitted to the economy faster than uncertainty decreases, as it takes longer to expand capacity and hire labour than it does to shut down

capacity or lay off workers. The asymmetric effect of uncertainty is therefore an important factor which the model will explore.

This paper will follow the procedure of Foerster (2014) in analysing the asymmetric effects of implied volatility shocks in the months following. The regressions only consider the direct effects of uncertainty. Longer lags and feedback are ignored in this model; however, the empirical evidence discussed previously supports the short, sharp nature of uncertainty shocks.

The Model

Three regressions are analysed to test the symmetric and asymmetric effects of uncertainty on economic activity. The three regressions are symmetric, symmetric with big changes, and asymmetric.

The model is at a monthly frequency from the first availability of the implied volatility index through to March 2015:

$$\Delta y_t = c + a\Delta y_{t-1} + b\Delta SMI_{t-1} + dr_{t-1} + e\Delta q_{t-1} + \gamma\Delta VIX_{t-1} + \gamma_+\Delta VIX_{t-1}^{big+} + \gamma_-\Delta VIX_{t-1}^{big-} + e_t$$

For each country;

$\Delta y_t = 100 * \ln\left(\frac{y_t}{y_{t-1}}\right)$, monthly percentage change in economic activity.

$\Delta SMI_{t-1} = 100 * \ln\left(\frac{SMI_{t-1}}{SMI_{t-2}}\right)$, lagged monthly percentage change in stock market index.

r_{t-1} = lagged inflation adjusted short-term interest rate. The real short-term interest rate is defined as the 90-day Libor less CPI inflation. The annual rate of CPI inflation is calculated as $lnCPI_t - lnCPI_{t-12}$.

$\Delta q_{t-1} = 100 * \ln\left(\frac{q_t}{q_{t-1}}\right)$, lagged monthly percentage change in the real trade weighted exchange rate.

$\Delta VIX_{t-1} = VIX_{t-1} - VIX_{t-2}$, lagged monthly change in the implied volatility index.

The coefficient a captures persistence in economic activity. The coefficient b captures the effect of stock market prices on economic activity. We might expect this to be positively related to economic activity. This is because news that boosts the stock market index is likely to be beneficial to economic activity in the next period.

Labour market variables, such as employment growth or unemployment rate growth, are used as dependent variables in the regressions. This is to explore the effect that an uncertainty

shock has on employment decisions, as employment is a form of investment in human capital. Industrial production growth is also used as a dependent variable in a second set of regressions. Industrial production is a good measure of economic activity and both these indicators are widely available as monthly data across the countries analysed.

The real interest rate and the change in the exchange rate are also included in the regression as control variables, although their results are not reported as they are generally not significant and do not affect the results of the regressions materially.

Following the procedure of Foerster (2014) on the United States economy, additional variables are constructed by decomposing the change in the VIX into big changes (greater than one standard deviation from the mean) and distinguishing between positive and negative big changes;

$$\Delta VIX_{t-1}^{big+} = \begin{cases} \Delta VIX_{t-1}, & if\ \Delta VIX_{t-1} > 1\ standard\ deviation\ from\ the\ mean \\ 0, & otherwise \end{cases}$$

$$\Delta VIX_{t-1}^{big-} = \begin{cases} \Delta VIX_{t-1}, & if\ \Delta VIX_{t-1} < -1\ standard\ deviation\ from\ the\ mean \\ 0, & otherwise \end{cases}$$

The symmetric regression only includes the change in the volatility variable (γ_+=γ_-=0).

The symmetric with big changes regression sets the coefficients on the two 'big changes' variables equal to each other (γ_+=γ_-). It takes a value of zero if the observation is less than one standard deviation from the mean, and it retains its value otherwise. This regression therefore looks at the additional effect that big uncertainty shocks have.

The asymmetric regression is of the form of the equation above, where the two additional variables capture possible asymmetry in VIX changes. The equation allows changes in the VIX to have different effects on the change in activity depending on their size and direction. For example, the effect of a small change in the VIX is γ·ΔVIX, the effect of increases in the VIX by more than one standard deviation is $(\gamma + \gamma_+)$·ΔVIX, and the effect of decreases in the VIX by more than one standard deviation is $(\gamma + \gamma_-)$·ΔVIX.

To test the hypothesis of an asymmetric response of uncertainty, I use a Wald test to see if the difference of the coefficients on ΔVIX_{t-1}^{big+} and ΔVIX_{t-1}^{big-} is statistically significant from zero; $\gamma_+ - \gamma_- = 0$. The resulting F-statistic tests whether large positive and large negative changes have equal influence. A statistically significant F-statistic means that the coefficients are significantly different from each other. In the case of a spike in implied volatility, as shown

later in the impulse response function charts (Figure 3A), a statistically significant F-statistic means that a big decrease in implied volatility does not offset the effect on economic activity that the big increase in implied volatility had.

The impulse response functions show the economic effects of a two standard deviation increase, and subsequent decrease, in the implied volatility index. Ninety percent confidence intervals for the asymmetric regression are also shown. The results are reported as monthly figures, not annualised, for easier interpretation when the results are displayed on the impulse response functions.

Table 2: Summary Statistics of Change in the Implied Volatility Index

	United States	Japan	Euro area	Germany	United Kingdom	Switzerland	France	Hong Kong
Stock market index	S&P500	Nikkei 225	STOXX 600	DAX30	FSTE100	SMI20	CAC40	Hang Seng
Average change	-0.04	-0.10	-0.20	0.01	-0.05	-0.02	-0.04	-0.08
Standard deviation	4.94	5.47	11.38	4.44	5.67	4.96	5.44	4.47
Largest increase	37.55	36.95	58.47	30.67	32.31	29.59	32.59	26.95
Largest decrease	-16.59	14.16	-39.07	-10.57	-14.85	-11.86	-12.87	-13.23
Number of big increases	32	20	21	30	21	23	22	19
Number of big decreases	30	19	19	32	17	24	21	20
Observations	301	209	195	267	185	188	183	171
Series start	01/1990	11/1997	01/1999	01/1993	11/1999	07/1999	01/2000	01/2001

The reported standard errors are Newey-West standard errors, robust to autocorrelation. All series run from the earliest available implied volatility index data, reported above, through to 03/2015. The dramatic March 2011 spike in implied volatility for Japan is reduced to one standard deviation from the mean, as the shock was about a ten standard deviation move. This outlier was due to the natural disaster that struck Japan.

Summary statistics for the raw implied volatility indices are also reported in Table 1A of the appendix.

5. Results

5.1 United States

EFFECT OF UNCERTAINTY ON EMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent employment growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.7605***	.7562***	.7150***
	(.0663)	(.0658)	(.0580)
S&P500 growth	.0043*	.0045*	.0048**
	(.0023)	(.0023)	(.0023)
VIX changes	.0019	.0067**	.0076***
	(.0023)	(.0027)	(.0029)
VIX big changes	--	-.0057*	--
		(.0030)	
VIX big increases	--	--	-.0107***
			(.0035)
VIX big decreases	--	--	.0023
			(.0038)
Constant	.0179*	.0197*	.0340***
	(.0101)	(.0101)	(.0090)
F-statistic for asymmetry	--	--	10.43***
Adjusted R-squared	.6232	.6271	.6368
Dependent variable: percent industrial production growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.1840*	.1865*	.1425*
	(.0951)	(.0951)	(.0796)
S&P500 growth	.0377**	.0380**	.0375**
	(.0158)	(.0159)	(.0152)
VIX changes	.0238*	.0456**	.0486**
	(.0137)	(.0206)	(.0207)
VIX big changes	--	-.0263	--
		(.0187)	
VIX big increases	--	--	-.0544***
			(.0169)
VIX big decreases	--	--	.0232
			(.0295)
Constant	.1233*	.0130**	.2035***
	(.0647)	(.0650)	(.0481)
F-statistic for asymmetry	--	--	8.401***
Adjusted R-squared	.0644	.0669	.1116

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.
Sample period: 01/1990-03/2015

The table for the United States shows two sets of regressions against two different economic activity dependent variables; a labour market growth variable and industrial production growth.

The first set of regression results for the United States uses the percentage growth in employment as the dependent variable. The data comes from non-farm private payrolls, with a mean monthly change of 0.09 percent and a standard deviation of 0.17. The second set of regression results considers the effects of changes in uncertainty on industrial production growth. The mean monthly change in industrial production is 0.18 percent, with a standard deviation of 0.65.

The symmetric regression results from the employment growth set show the importance of considering an asymmetric effect of uncertainty; the change in VIX alone suggests an insignificant effect on employment growth. For industrial production, the symmetric regression shows a small positive effect of change in uncertainty on industrial production growth. Both sets of regression results show a significant, positive effect of SMI growth on economic activity. The coefficients on the real interest rate and change in exchange rate were statistically insignificant.

The coefficient on the ΔVIX_{t-1}^{big} is negative in both regressions and statistically significant in the employment regression, suggesting that big increases in uncertainty have a more negative effect than small increases. Importantly, for the asymmetric regression, the coefficients on the ΔVIX_{t-1}^{big+} and ΔVIX_{t-1}^{big-} variables are statistically significantly different from each other (statistically significant F-statistic), implying an asymmetric effect of uncertainty on both economic activity indicators i.e. lag increases in uncertainty are detrimental to economic growth.

The implications of these results are shown in the impulse response functions in Figure 3A of the appendix. The effect of a two standard deviation increase, and subsequent decrease, in the implied volatility index is shown. As a result, employment growth is reduced 0.1 percentage points at its lowest point before slowly returning to its original growth level. Similarly, industrial production growth falls 0.7 percentage points following the uncertainty shock before recovering over time. These results are economically significant, given the fall in employment growth is greater than the average monthly employment growth, and industrial production growth falls more than one standard deviation.

5.2 Euro area

EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent change in unemployment rate	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.4077***	.4095***	.3686***
	(.1289)	(.1301)	(.1175)
Stoxx600 growth	-.0591***	-.0631***	-.0404**
	(.0177)	(.0182)	(.0157)
VIX changes	-.0183***	-.0466***	-.0412***
	(.0066)	(.0163)	(.0155)
VIX big changes	--	.0319**	--
		(.0158)	
VIX big increases	--	--	.0522***
			(.0168)
VIX big decreases	--	--	.0044
			(.0177)
Constant	.1080*	.0961	-.0005
	(.0598)	(.0613)	(.0624)
F-statistic for asymmetry	--	--	7.569***
Adjusted R-squared	.2653	.2767	.3106
Dependent variable: percent industrial production growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.0054	.0055	-.0056
	(.1995)	(.0745)	(.1791)
Stoxx600 growth	.0711***	.0725***	.0495**
	(.0207)	(.0201)	(.0197)
VIX changes	.0053	.0157	.0099
	(.0078)	(.0190)	(.0159)
VIX big changes	--	-.0117	--
		(.0190)	
VIX big increases	--	--	-.0341*
			(.0196)
VIX big decreases	--	--	.0019
			(.0194)
Constant	.0332	.0371	.0433**
	(.0847)	(.0785)	(.0077)
F-statistic for asymmetry	--	--	6.386**
Adjusted R-squared	.0740	.0708	.1102

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.
Sample period: 01/1999-03/2015

The results from the euro area are consistent with the idea of an asymmetric effect of uncertainty on both percentage change in the unemployment rate and industrial production growth.

The first set of regression results for the euro area uses the percentage change in the unemployment rate as the dependent variable. Therefore a positive coefficient indicates an increase in the unemployment rate – an indicator of decreased economic activity. It is important to distinguish between the unemployment rate and the percentage change in the unemployment rate when interpreting the results. The mean monthly percentage change in the unemployment rate is 0.06 percent, with a standard deviation of 1.05. This means that if the unemployment rate was at 10.00% for example, then a one standard deviation increase in the percentage change of the unemployment rate would raise the unemployment rate to 10.11% (10*1.0105) in a given month, i.e. a 0.11 percentage point increase in the unemployment rate. The second set of regression results considers the effects of changes in uncertainty on industrial production growth. The mean monthly change in industrial production is 0.05 percent, with a standard deviation of 1.05.

The symmetric regression shows no significant effect of change in uncertainty on industrial production growth, but the positive effect of stock market index growth on economic activity is significant throughout the regressions.

The F-statistic of 7.57 for percentage change in the unemployment rate and 6.39 for industrial production growth shows a statistically significant difference between the ΔVIX_{t-1}^{big+} and ΔVIX_{t-1}^{big-} coefficients, indicating an asymmetric effect of big changes in uncertainty.

The impulse response function chart in Figure 3A in the appendix illustrates the implications of these results. The effect of a two standard deviation increase, and subsequent decrease, in the implied volatility index on the Stoxx600 is shown. Note that the axis for unemployment growth has been inverted to show consistently that a downward movement in the chart is associated with a decrease in economic activity. As a result of the shock, the percentage change in the unemployment rate increases a maximum of 0.9 percentage points above the norm before slowly returning to its original growth level. Similarly, industrial production growth falls 0.65 percentage points following the uncertainty shock, before recovering. These results are economically significant, given that the percentage change in the unemployment rate increases almost one standard deviation following the shock, and industrial production falls two thirds of a standard deviation.

5.3 Japan

EFFECT OF UNCERTAINTY ON ECONOMIC ACTIVITY AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent coincident index growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.3515**	.3514**	.3094**
	(.1509)	(.1511)	(.1432)
Nikkei growth	.0144	.0152	.0187
	(.0164)	(.0164)	(.0168)
VIX changes	-.0292*	-.0554	-.0483
	(.0175)	(.0468)	(.0458)
VIX big changes	--	.0327	--
		(.0481)	
VIX big increases	--	--	-.0166
			(.0501)
VIX big decreases	--	--	.0949
			(.0617)
Constant	-.0486	-.0592	.0551
	(.1272)	(.1331)	(.1225)
F-statistic for asymmetry	--	--	4.434**
Adjusted R-squared	.2384	.2363	.2541
Dependent variable: percent industrial production growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.0726	.0729	.0519
	(.1384)	(.1391)	(.1259)
Nikkei growth	.0187	.0207	.0236
	(.0252)	(.0249)	(.0251)
VIX changes	-.0496	-.1114	-.1002
	(.0304)	(.0715)	(.0699)
VIX big changes	--	.0771	--
		(.0759)	
VIX big increases	--	--	.0038
			(.0812)
VIX big decreases	--	--	.1691*
			(.0957)
Constant	-.1218	-.1468	.0219
	(.1952)	(.2035)	(.1672)
F-statistic for asymmetry	--	--	3.404*
Adjusted R-squared	.0554	.0549	.1049

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.
Sample period: 11/1997-03/2015

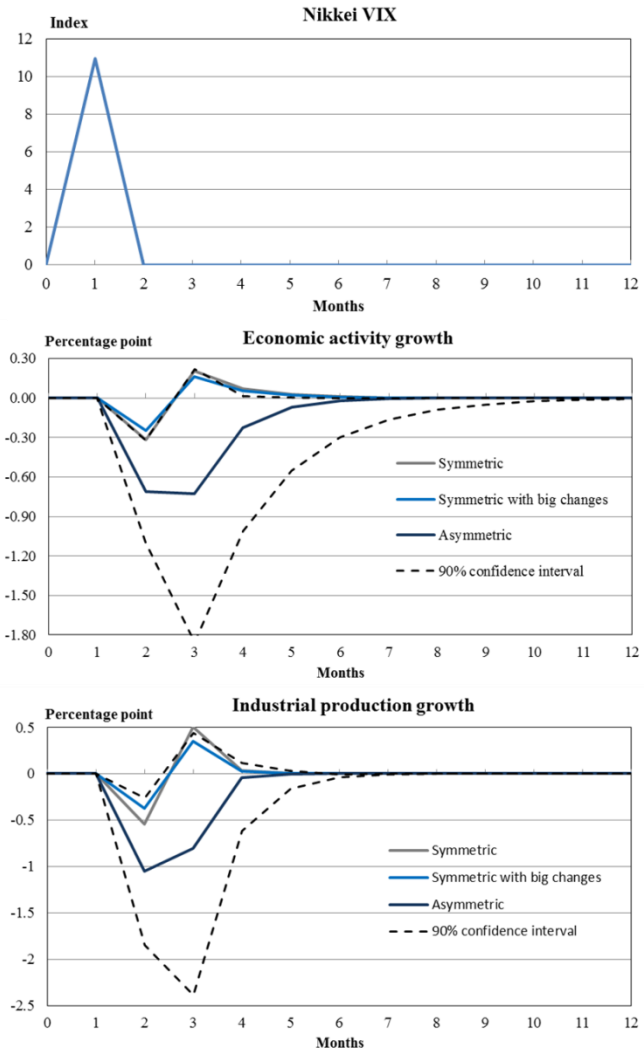
The results for Japan show a statistically significant asymmetric response to big changes in uncertainty for both economic activity indicators.

A coincident index is used as an indicator of economic activity, similar to Foerster's (2014) use of an aggregate economic activity index on the United States economy. The coincident index is a single summary statistic that tracks the current state of the Japanese economy. The index is calculated using month-over-month percentage changes in 11 leading indicators, 11 coincident indicators, and 6 lagging indicators. The mean monthly change in the coincident index is 0.04 percent, with a standard deviation of 1.54.

The second set of regression results considers the effects of changes in uncertainty on industrial production growth. The mean monthly change in industrial production is -0.03 percent, with a standard deviation of 2.34.

The impulse response function (Figure 2) shows the effect of a two standard deviation shock to uncertainty, in this case a 10.94 increase in the VIX on the Nikkei stock market. While the coefficients on the implied volatility index changes are all statistically insignificant in the coincident index regression results, the combined overall effects ($\gamma + \gamma_+$ and $\gamma + \gamma_-$) produce a statistically significant result. As a result of the shock, economic activity growth falls 0.75 percentage points before slowly returning to its original growth level. Similarly, industrial production growth falls 1.00 percentage points following the uncertainty shock, before recovering. The persistence in activity is only 0.05 in this case, so activity recovers fairly quickly. These results are economically significant, given the shock produces falls of around half a standard deviation in economic activity.

Figure 2: Japan Impulse Response Function



5.4 Germany

EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent change in unemployment rate	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.3717***	.3907***	.3903***
	(.0626)	(.0633)	(.0636)
DAX growth	-.0361**	-.0303**	-.0298**
	(.0160)	(.0143)	(.0139)
VIX changes	-.0256	.0943**	.0941**
	(.0245)	(.0388)	(.0388)
VIX big changes	--	-.1350***	--
		(.0346)	
VIX big increases	--	--	-.1302***
			(.0331)
VIX big decreases	--	--	-.1432***
			(.0454)
Constant	-.0816	-.0676	-.0778
	(.0849)	(.0845)	(.0894)
F-statistic for asymmetry	--	--	.1498
Adjusted R-squared	.1433	.1758	.1728
Dependent variable: percent industrial production growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	-.1870	-.1823	-.2135*
	(.1322)	(.1325)	(.1252)
DAX growth	.0560**	.0532**	.0486**
	(.0256)	(.0251)	(.0245)
VIX changes	.0093	-.0503	-.0459
	(.0348)	(.0557)	(.0584)
VIX big changes	--	.0675	--
		(.0561)	
VIX big increases	--	--	.0113
			(.0619)
VIX big decreases	--	--	.1592**
			(.0641)
Constant	.2024	.1969	.3160***
	(.1251)	(.1244)	(.1209)
F-statistic for asymmetry	--	--	5.684**
Adjusted R-squared	.0542	.0560	.0817

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.
Sample period: 01/1993-03/2015

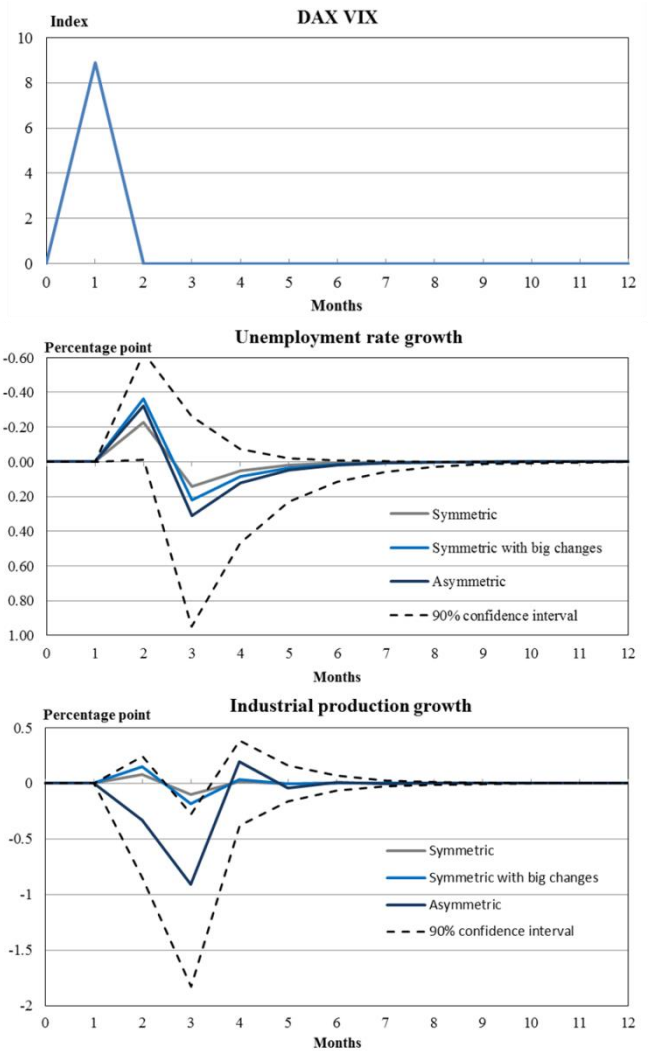
The first set of regression results for Germany uses the percentage change in the unemployment rate as the dependent variable. The mean monthly percentage change in the unemployment rate is -0.09 percent, with a standard deviation of 1.19. For example an unemployment rate of 8.00% would move one standard deviation up to 8.10 % or down to 7.90% in a given month. The second set of regression results considers the effects of changes in uncertainty on industrial production growth. The mean monthly change in industrial production is 0.11 percent, with a standard deviation of 1.46.

Germany shows no significant asymmetric response in uncertainty for the labour market variables, but a strong symmetric effect. This result may be due to the more rigid labour market conditions in Germany in comparison to other countries such as the United States. When industrial production growth is considered, a statistically significant asymmetric response to big changes in uncertainty does appear.

In the impulse response function shown, note again that the y-axis values have been inverted in the unemployment rate growth to illustrate consistently across the charts that a movement downwards reflects a decrease in economic activity.

As a result of the shock, unemployment rate growth falls about 0.30 percentage points then increases 0.30 percentage points before returning to its original growth level – a symmetric response. In contrast, industrial production growth falls 0.90 percentage points following the uncertainty shock, before recovering. The results show that the uncertainty shock has an economically significant effect on industrial production growth, given the shock produces a fall of around two thirds of a standard deviation. The symmetric response of the percent change in the unemployment rate to the shock demonstrates how in this case the effects on economic activity are offset by the subsequent decrease in uncertainty.

Figure 3: Germany Impulse Response Function



5.5 Switzerland

EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent change in unemployment rate	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.8320***	.8331***	.8189***
	(.0992)	(.1003)	(.1003)
SMI20 growth	-.0195	-.0168	-.0077
	(.0164)	(.0164)	(.0162)
VIX changes	-.0196	.0186	.0178
	(.0225)	(.0325)	(.0316)
VIX big changes	--	-.0419	--
		(.0312)	
VIX big increases	--	--	.0016
			(.0281)
VIX big decreases	--	--	-.1153**
			(.0462)
Constant	.0482	.0568	-.0499
	(.0863)	(.0835)	(.0832)
F-statistic for asymmetry	--	--	7.477***
Adjusted R-squared	.7008	.7001	.7093
Dependent variable: percent industrial production growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.8942***	.8947***	.8920***
	(.0363)	(.0379)	(.0375)
SMI20 growth	.1301***	.1290***	.1197***
	(.0427)	(.0455)	(.0439)
VIX changes	.1316***	.1162	.1164
	(.0441)	(.1459)	(.1457)
VIX big changes	--	.0169	--
		(.1277)	
VIX big increases	--	--	-.0225
			(.1193)
VIX big decreases	--	--	.0817
			(.1480)
Constant	.2723	.2676	.3717*
	(.1898)	(.1819)	(.1887)
F-statistic for asymmetry	--	--	2.89*
Adjusted R-squared	.8347	.8347	.8290

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.
Sample period: 07/1999-03/2015

The first set of regression results for Switzerland uses the percentage growth in the unemployment rate as the dependent variable. The mean monthly change in the unemployment rate is 0.09 percent, with a standard deviation of 2.32. The second set of regression results considers the effects of changes in uncertainty on industrial production growth. The mean monthly change in industrial production is 2.83 percent, with a standard deviation of 5.59.

The percentage change in Switzerland's unemployment rate displays an asymmetric response to big changes in uncertainty. The persistence of both variables is high, as shown by the large coefficients (around 0.8) on the lagged economic activity variables. The percentage change in the industrial production variable shows less significant results, yet still has asymmetric properties in the big implied volatility changes variable. This weaker regression result for industrial production growth may be due to the small contribution of industrial production to the Swiss economy.

Interestingly, the change in the real trade-weighted exchange rate is significantly negatively correlated with industrial production growth at a 5 percent level of confidence. The strength in the Swiss franc has been noted as one of the key issues faced by Swiss manufacturing companies, forcing them to make operational adjustments while cutting into margins. In a recent industry survey 48% of respondents assessed the effects of the strong Swiss franc on their profitability as "very negative", while an additional 43% assessed it as "rather negative" (Deloitte, 2014).

The impulse response function in Figure 3A of the appendix shows the effect of a two standard deviation shock to uncertainty. As a result of the shock, the percentage change in the unemployment rate falls 1.15 percentage points before slowly returning to its original growth level. Industrial production growth increases initially, before falling and recovering slowly over time. The persistence mentioned previously means that the economic activity indicators take a long time to return to their original growth levels. The shock produces a persistent increase of around one half of a standard deviation in unemployment rate growth.

5.6 United Kingdom

EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

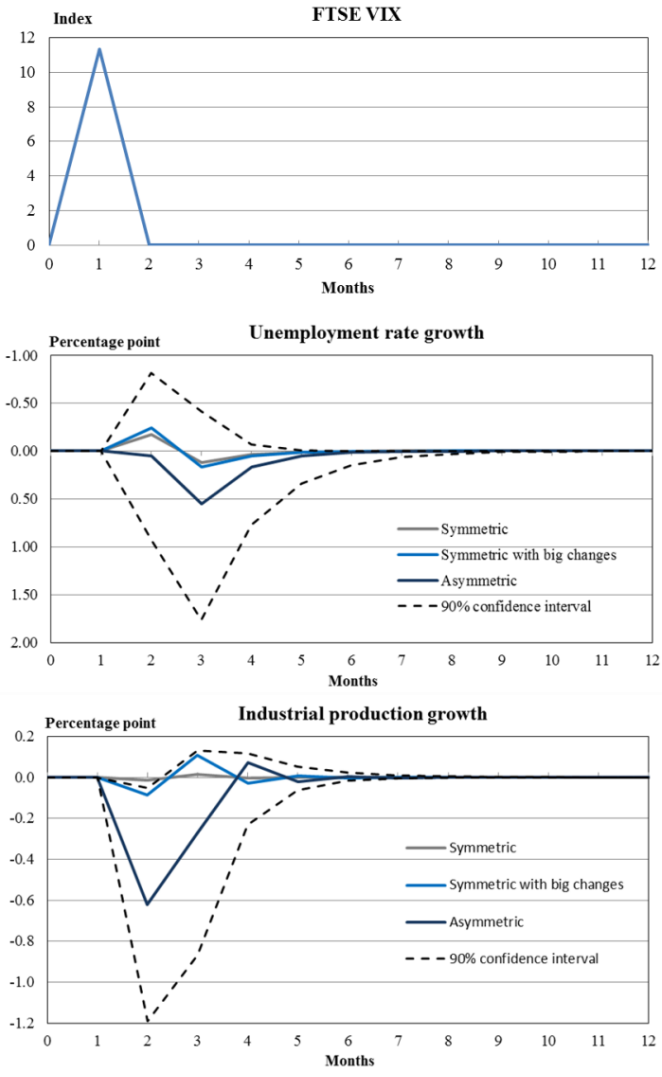
Dependent variable: percent change in unemployment rate	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.3065***	.3037***	.2963***
	(.0932)	(.0911)	(.0863)
FTSE growth	-.0384	-.0348	-.0219
	(.0478)	(.0462)	(.0472)
VIX changes	-.0149	.0313	.0376
	(.0355)	(.0480)	(.0495)
VIX big changes	--	-.0527	--
		(.0534)	
VIX big increases	--	--	-.0329
			(.0551)
VIX big decreases	--	--	-.0847
			(.0667)
Constant	.0059	.0256	-.0262
	(.1518)	(.1592)	(.1643)
F-statistic for asymmetry	--	--	.8370
Adjusted R-squared	.0866	.0853	.0840
Dependent variable: percent industrial production growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	-.2596**	-.2708***	-.2675**
	(.1020)	(.1011)	(.1034)
FTSE growth	.0184	.0222	-.0024
	(.0286)	(.0292)	(.0271)
VIX changes	-.0011	.0441	.0321
	(.0213)	(.0316)	(.0314)
VIX big changes	--	-.0515	--
		(.0312)	
VIX big increases	--	--	-.0868**
			(.0355)
VIX big decreases	--	--	.0065
			(.0385)
Constant	-.0980	-.0802	.0114
	(.0751)	(.0758)	(.0731)
F-statistic for asymmetry	--	--	4.009**
Adjusted R-squared	.0470	.0537	.0904

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.
Sample period: 11/1999-03/2015

The effect on the labour market is not significant in the first set of regressions for the United Kingdom. In fact, the marginal predictive power of the model is negative as the asymmetric variables are included. There is, however, a statistically significant asymmetric effect of uncertainty on industrial production growth in the United Kingdom. The predictive power of the model is still low, at 9.04%, but the asymmetric variables do add predictive power when compared to the adjusted r-squared of the symmetric regression.

The first set of regression results for the United Kingdom uses the percentage growth in the unemployment rate as the dependent variable. The mean monthly change in the unemployment rate is -0.03 percent, with a standard deviation of 1.71. The second set of regression results considers the effects of changes in uncertainty on industrial production growth. The mean monthly change in industrial production is -0.07 percent, with a standard deviation of 0.96.

Figure 4: United Kingdom Impulse Response Function



The impulse response function shows the effect of a two standard deviation uncertainty shock on both labour market and industrial production variables. There is no statistically significant effect of the uncertainty shock on unemployment rate growth, as shown by the 90% confidence interval for the asymmetric regression being indistinguishable from zero. Industrial production growth falls 0.6 percentage points as a result of the shock. This is economically significant given the mean monthly industrial production growth is -0.07 percent, with a standard deviation of 0.96 for the United Kingdom.

These results are consistent with the work from Denis and Kannan (2013), who use a vector autoregressive model and find a significant impact of uncertainty shocks on industrial production and GDP, while unemployment is less affected.

5.7 France

EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent change in unemployment	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.6714***	.6731***	.6614***
	(.0964)	(.0942)	(.0863)
CAC40 growth	-.0239*	-.0278**	-.0242*
	(.0140)	(.0131)	(.0140)
VIX changes	-.0175	-.0612***	-.0603***
	(.0170)	(.0224)	(.0224)
VIX big changes	--	.0492*	--
		(.0250)	
VIX big increases	--	--	.0599*
			(.0315)
VIX big decreases	--	--	.0300
			(.0228)
Constant	.0892	.0762	.0482
	(.0431)	(.0428)	(.0540)
F-statistic for asymmetry	--	--	1.025
Adjusted R-squared	.4918	.5010	.5023
Dependent variable: percent industrial production growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	-.2601***	-.2623**	-.2771***
	(.0749)	(.1190)	(.1012)
CAC40 growth	.0569**	.0639**	.0493*
	(.0268)	(.0306)	(.0288)
VIX changes	-.0047	.0704	.0661
	(.0270)	(.0529)	(.0509)
VIX big changes	--	-.0841*	--
		(.0463)	
VIX big increases	--	--	-.1245**
			(.0555)
VIX big decreases	--	--	-.0130
			(.0644)
Constant	-.0159	.0051	.1230
	(.1062)	(.0801)	(.1102)
F-statistic for asymmetry	--	--	1.950
Adjusted R-squared	.1093	.1197	.1426

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.
Sample period: 01/2000-03/2015

5.8 Hong Kong

EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent change in unemployment rate	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.3851***	.3871***	.3316***
	(.1195)	(.1202)	(.0996)
Hang Seng growth	-.0894**	-.0903**	-.0698
	(.0370)	(.0375)	(.0440)
VIX changes	-.0363	-.1110	-.1146
	(.0627)	(.1175)	(.1180)
VIX big changes	--	.0892	--
		(.1399)	
VIX big increases	--	--	.2382
			(.1598)
VIX big decreases	--	--	-.1311
			(.1604)
Constant	-.2767	-.2862	-.6096
	(.2484)	(.2425)	(.2095)
F-statistic for asymmetry	--	--	4.441**
Adjusted R-squared	.1514	.1482	.1874
Dependent variable: percent industrial production growth	Symmetric ($\gamma_+=\gamma_-=0$)	Symmetric with big changes ($\gamma_+=\gamma_-$)	Asymmetric
Lagged activity	.6904***	.6913***	.6879***
	(.0602)	(.0603)	(.0600)
Hang Seng growth	.0099**	.0098**	.0096**
	(.0047)	(.0047)	(.0048)
VIX changes	.0013	-.0072	-.0073
	(.0060)	(.0184)	(.0184)
VIX big changes	--	.0100	--
		(.0202)	
VIX big increases	--	--	.0071
			(.0198)
VIX big decreases	--	--	.0142
			(.0245)
Constant	-.0469	-.0474	-.0418
	(.0373)	(.0373)	(.0411)
F-statistic for asymmetry	--	--	.1662
Adjusted R-squared	.5194	.5167	.5138

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.
Sample period: 01/2001-03/2015

The results from the French economy show no statistically significant asymmetric response to either economic activity indicator. The first set of regression results for France uses the percentage growth in unemployment as the dependent variable. The second set of regression results considers the effects of changes in uncertainty on industrial production growth.

The unemployment growth asymmetric regression shows that a big uncertainty increase has a statistically significant effect, increasing unemployment. However, overall the impulse response functions in the appendix show a statistically insignificant effect of the two standard deviation uncertainty shock on both labour market and industrial production variables, with the 90 percent confidence interval bands indistinguishable from zero.

The first set of regression results for Hong Kong uses the percentage growth in the unemployment rate as the dependent variable. The mean monthly change in unemployment rate growth is -0.17 percent, with a standard deviation of 3.20. The second set of regression results considers the effects of changes in uncertainty on industrial production growth. The mean monthly change in industrial production growth is -0.21 percent, with a standard deviation of 0.67.

The significant coefficients on stock market growth for both the CAC and Hang Seng in each set of regressions are consistent with lagged stock market growth being positively correlated with economic activity, as was the case with the United States, the euro area, and Germany.

For the Hong Kong economy, the implied volatility coefficients are not statistically significant in either regression set. Regardless of this, the ΔVIX_{t-1}^{big+} and ΔVIX_{t-1}^{big-} coefficients are statistically different from each other in the unemployment rate growth asymmetric regression.

The second set of regression results show no significant effect of the change in the implied volatility index on industrial output growth. An explanation for this weak industrial production regression result may be that industrial production does not contribute much to the Hong Kong economy. Hong Kong is one of the most service-oriented economies in the world, with 88.5% of total employment in 2014 coming from the services sector. In contrast, the manufacturing sector only accounted for 2.8% of total employment (Hong Kong Government (2015)).

Although the results for the Hong Kong unemployment rate growth coefficients are insignificant, the overall combined effect from the increase ($\gamma + \gamma_+$), and subsequent decrease ($\gamma + \gamma_-$), in uncertainty produce statistically significant results in the impulse response function (Figure 3A). The unemployment rate growth increases a maximum of 2.50 percentage points before returning back to the previous growth level. This is economically significant as the shock causes the percentage change in the unemployment rate to increase the equivalent of three quarters of a standard deviation.

The effect of the uncertainty shock on industrial production growth is minimal, and the 90 percent confidence interval indicates the decline in industrial production growth is not statistically distinguishable from zero.

6. Sub-Sample Analysis

The previous results showed strikingly consistent effects of uncertainty across the range of developed countries. While some results are not statistically significant, the results generally suggest a common asymmetric response to uncertainty shocks.

For the statistically significant impulse response functions, the negative impact on economic activity tends to fall between one half and one standard deviations before slowly recovering. The reactions of the impulse response functions to a large uncertainty shock illustrates statistically significant negative employment effects for the United States, euro area, Switzerland, the United Kingdom and Hong Kong. The shock causes a reduction in economic activity in Japan which is not offset.

The reactions of the impulse response functions to a large uncertainty shock also illustrates statistically significant negative industrial production growth effects for the United States, euro area, Japan, Germany and the United Kingdom.

Table 4: F-statistic for Asymmetry

Unemployment rate	Pre-GFC	GFC-onwards	Whole period
United States^	6.356**	7.563***	10.43***
Euro area	1.193	9.957***	7.569***
Japan^	4.157**	.9331	4.434**
Germany	.1875	.3610	.1498
Switzerland	.1552	7.333***	7.477***
United Kingdom	3.713*	2.888*	.8370
France^	1.237	2.787*	1.025
Hong Kong	3.936*	5.810**	4.441**
Industrial production	Pre-GFC	GFC-onwards	Whole period
United States	2.187	4.605**	8.401***
Euro area	1.365	6.062**	6.386**
Japan	2.655	.5635	3.404*
Germany	2.358	6.270**	5.684**
Switzerland	.5789	2.474	2.89*
United Kingdom	.6076	6.290**	4.009**
France	.0730	3.825*	1.950
Hong Kong	.9031	.0002	.1662

Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively
^United States: employment, Japan: coincident index, France: unemployment

A strand in the recent literature has emphasised the greater impact of uncertainty when central banks are constrained by the zero lower bound (Basu & Bundick (2011), Caggiano et al. (2015)). Along with recent emphasis on uncertainty effects in the current global economic environment by policymakers, economists, and the financial press, it is of interest to split the data into two sub-sample periods: pre-GFC (before 2007m07) and GFC-onwards (2007m08 onwards), to assess if the effect of uncertainty on economic activity has been stronger in recent years.

Summary statistics for the two sub-sample periods are presented in Table 2A of the appendix. The results of the asymmetric regressions are reported in Table 3A of the appendix and the F-statistic results, which test for asymmetry in the big negative and big positive changes in uncertainty, are summarised in Table 4. The table shows clearly a much stronger asymmetry over the GFC-onwards subsample period.

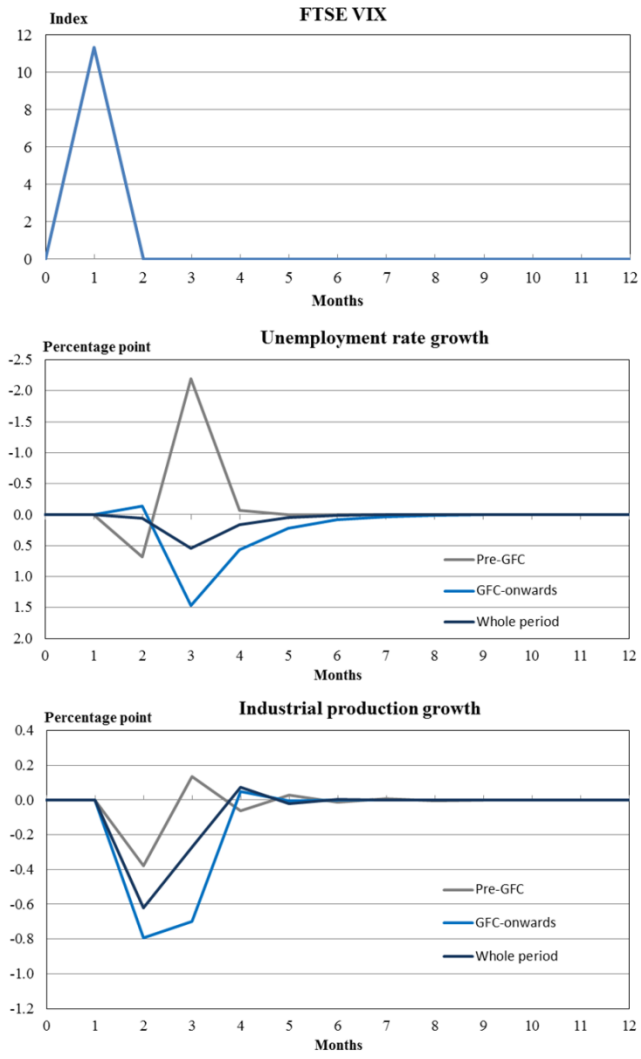
The reported impulse response functions (Figure 4A) also show a greater negative effect of uncertainty for the United States, the euro area, Switzerland, the United Kingdom, France and Hong Kong on labour market growth and industrial production growth.

Germany shows a more volatile symmetric response GFC-onwards and a greater negative impact of uncertainty on industrial production growth. The results for Japan are more inconclusive. The smaller sample sizes make it difficult to prove statistically significant differences in the effects between the two sub-sample periods, although the impulse response functions and regressions give an indication of the direction and significance.

The most dramatic change between the two periods is for the United Kingdom. The impulse response function on this page shows the asymmetric responses to a two standard deviation shock for each United Kingdom sub-sample and the whole period.

The regression results support the conclusion that the GFC-onwards period has greater negative uncertainty effects on economic activity. Unlike for the whole period, the effect of uncertainty on unemployment rate growth in the GFC-onwards period has a statistically significant asymmetric effect (F-statistic of 2.888), and the big decreases coefficient is statistically significant. The adjusted r-squared also increases greatly.

Figure 5: United Kingdom Sub-Sample Impulse Response Function



Similarly for industrial production growth, the asymmetric effect is more statistically significant in the GFC-onwards period. This sharper negative effect can be seen in the impulse response function.

Further regression tables and impulse response functions for each economy are reported in Figure 4A of the appendix.

7. Conclusion

This paper has investigated the short-term effects of uncertainty on economic activity, as measured by the implied volatility index. This measure of aggregate uncertainty is market-based, highly correlated with other measures of uncertainty, and is available on a range of developed stock market indices.

There is evidence of asymmetric effects of uncertainty on economic activity. A Wald test was used to analyse the difference between the effects of a large increase and a large decrease in uncertainty. Asymmetric effects can be seen in the significance of the F-statistics reported in each regression.

The impulse response functions provide a useful illustration of the impact of an uncertainty shock. Evidence is presented of statistically significant negative employment effects for the United States, euro area, Switzerland, the United Kingdom and Hong Kong. The shock causes a reduction in economic activity in Japan which is not offset. Similarly, the uncertainty shock has negative effects on industrial production growth for the United States, euro area, Japan, Germany and the United Kingdom.

The results are consistent with findings on the United States (Bloom (2009), Foerster (2014)) and United Kingdom economies (Denis & Kannan (2013)). The short, sharp impact of uncertainty shocks on economic activity is noted in the recent literature, which is consistent with the results presented in this paper.

The sub-sample analysis also shows the increased impact of uncertainty shocks on the economic activity indicators in a number of economies following the outbreak of the Global Financial Crisis.

The evidence that large increases in uncertainty – as we have seen frequently in recent years – are not offset by subsequent decreases in many economies, suggests that uncertainty has played an important role in hindering the global economic recovery.

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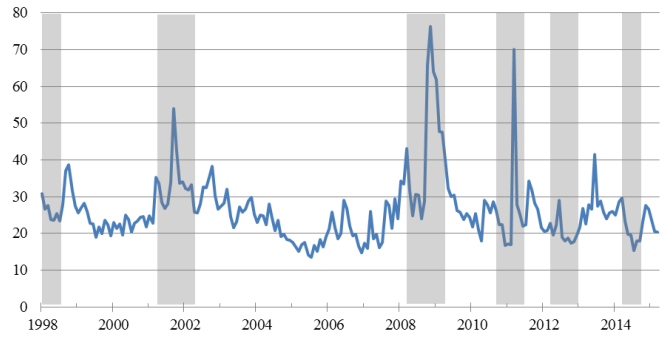
9. Appendices

Table 1A: Summary Statistics of Implied Volatility Data

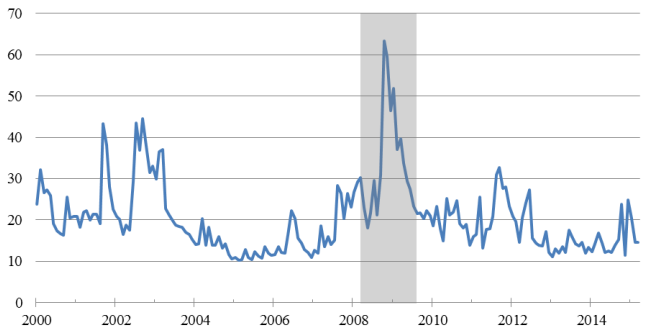
	United States	Japan	Euro area	Germany	United Kingdom	Switzerland	France	Hong Kong
Stock index	S&P500	Nikkei 225	STOXX 600	DAX30	FSTE 100	SMI20	CAC40	Hang Seng
Average value	19.95	26.15	29.90	21.93	20.61	19.49	23.54	23.40
Standard deviation	8.17	9.14	14.05	8.68	9.07	8.39	9.02	9.84
Maximum value	69.25	76.35	106.48	57.06	63.26	59.45	64.33	69.56
Minimum value	10.05	13.58	13.06	10.44	10.29	9.63	11.48	11.60
Series start	01/1990	11/1997	01/1999	01/1993	11/1999	07/1999	01/2000	01/2001

Figure 1A: VIX and change in VIX country data

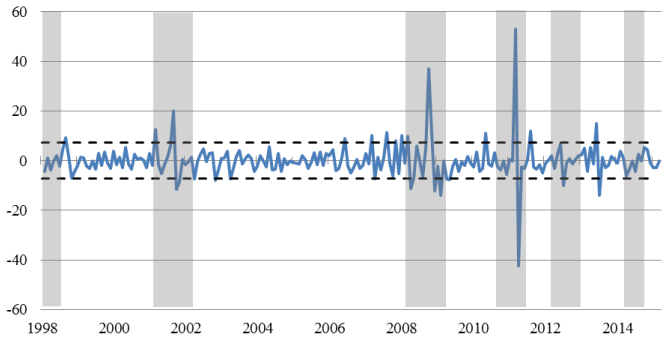
Japan Nikkei VIX Index



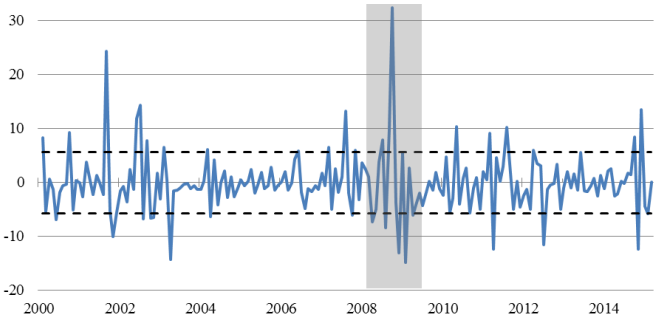
United Kingdom FTSE VIX Index



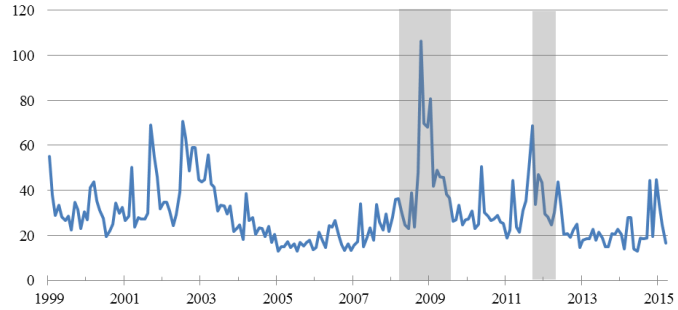
Change in Japan Nikkei VIX Index



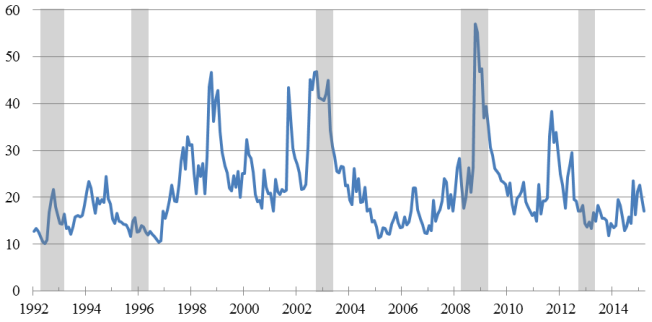
Change in United Kingdom FTSE VIX Index



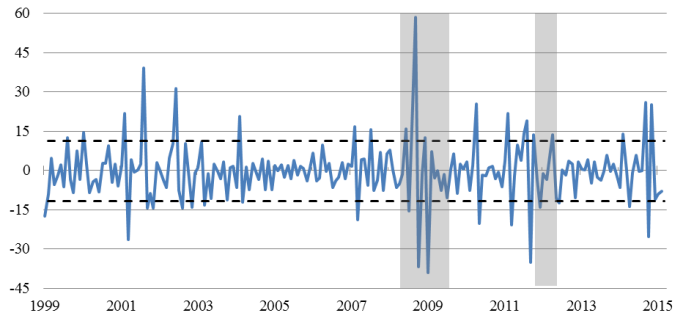
Euro area Stoxx VIX Index



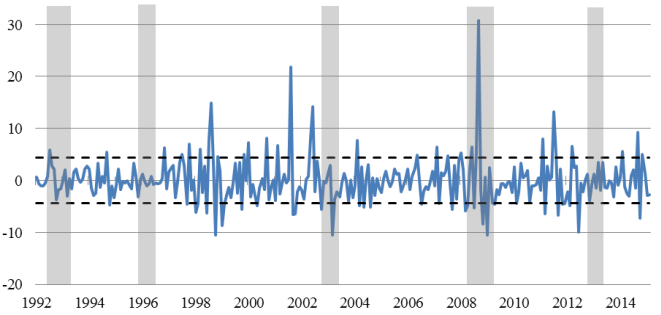
Germany DAX VIX Index



Change in Euro area Stoxx VIX Index

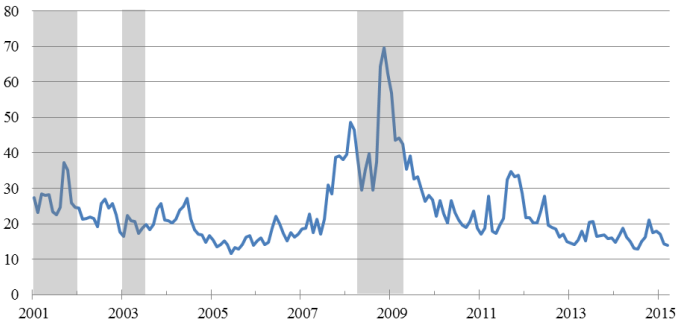


Change in Germany DAX VIX Index

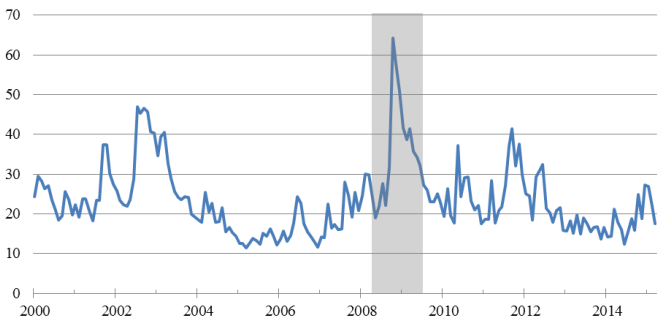


Financial market events:
1990-1991 Gulf War, 1997 Asian Financial Crisis, 1998 Russian and LTCM hedge fund default, 2001 9/11, 2002 WorldCom and Enron accounting scandals, 2007-2008 Global Financial Crisis, 2010-2011 Euro Debt Crisis, March 2011 Japanese Tsunami, 2011 US debt ceiling, 2013 taper tantrum, October 2014 flash crash (Bloom 2009, 2014).

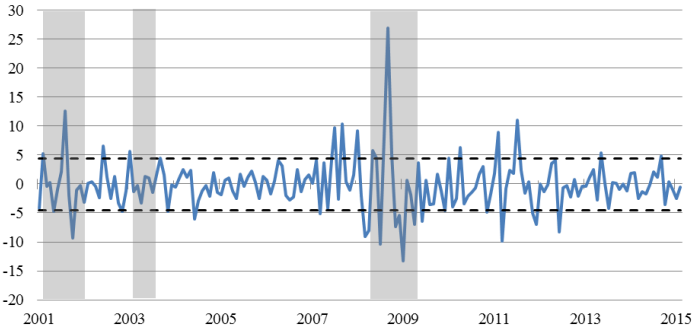
Hong Kong Hang Seng VIX Index



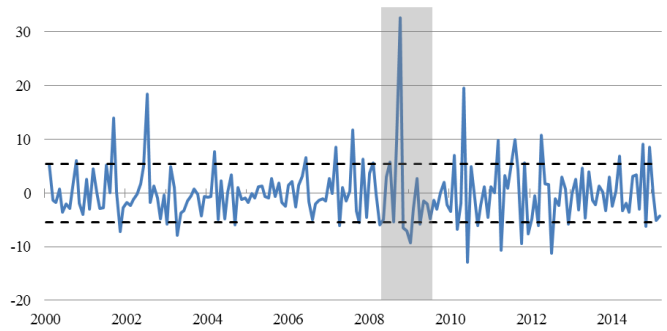
France CAC VIX Index



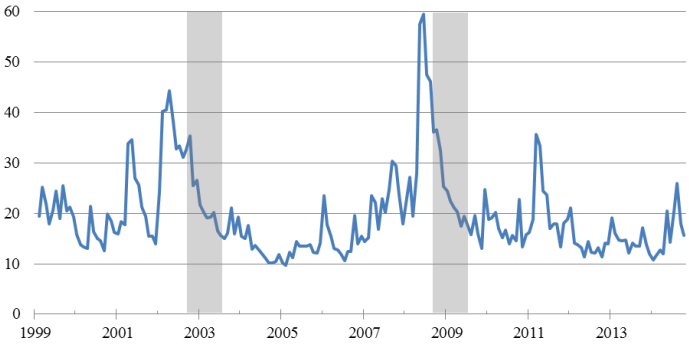
Change in Hong Kong Hang Seng Index



Change in France CAC VIX Index



Switzerland SMI VIX Index



Change in Switzerland SMI VIX Index

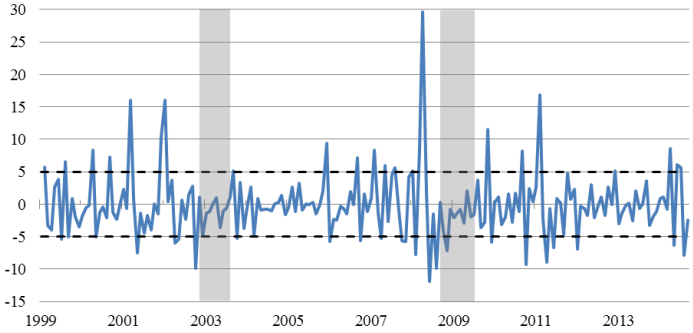


Figure 2A: All Volatility Indices

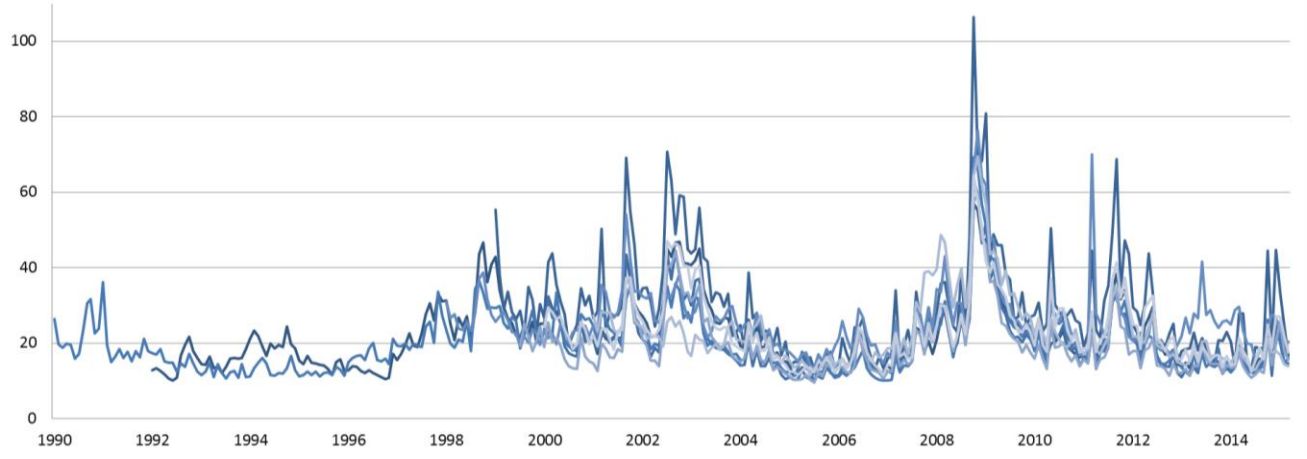
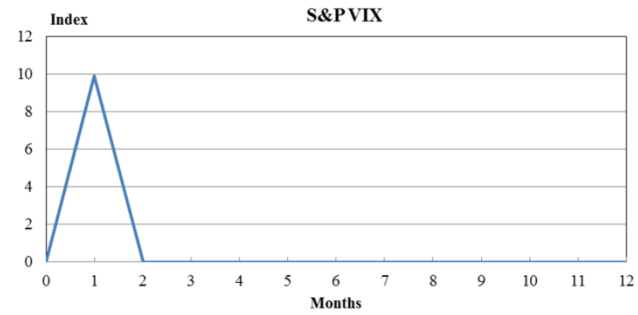
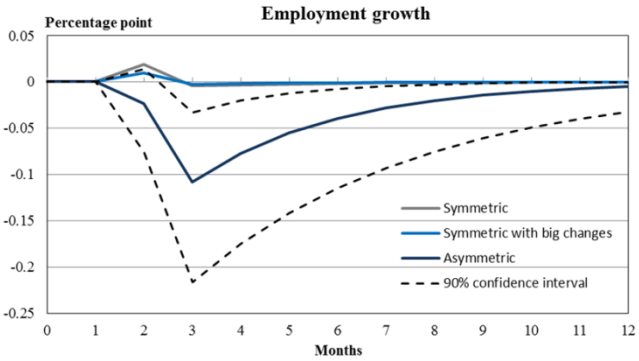
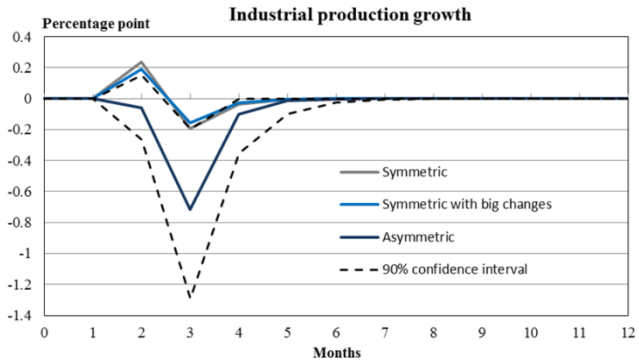


Figure 3A: Impulse Response Functions

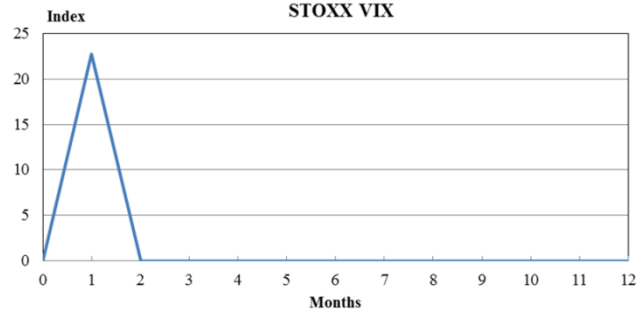
United States

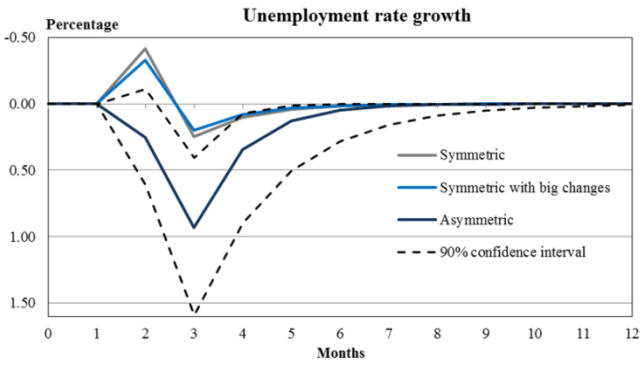


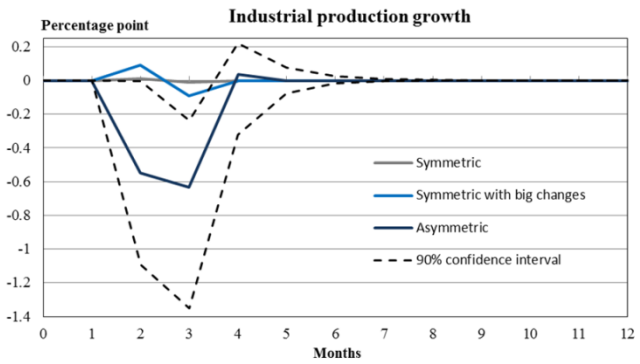




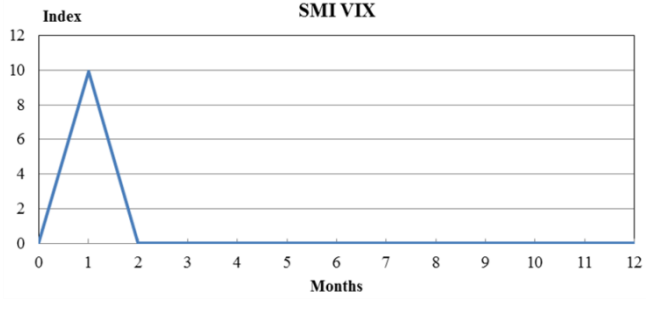
Euro area

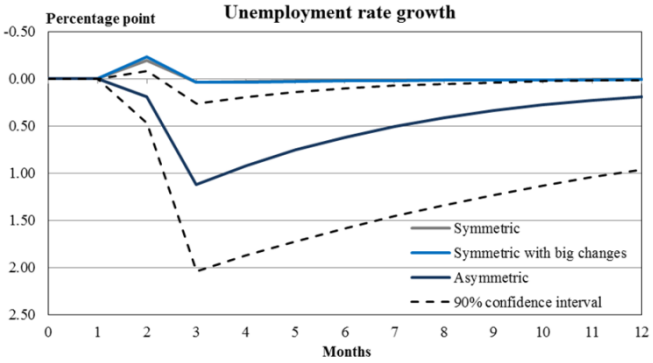


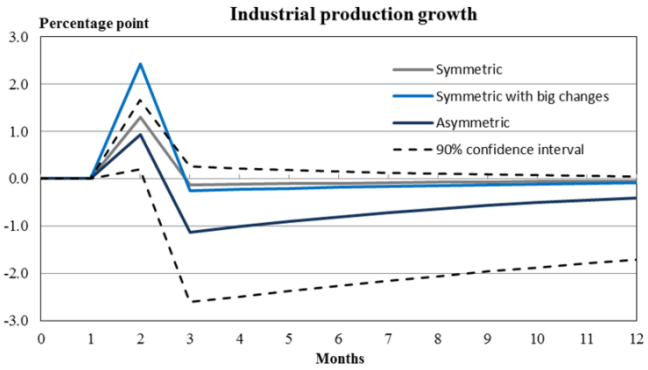




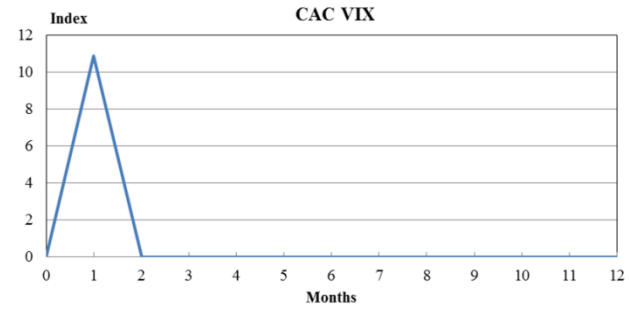
Switzerland

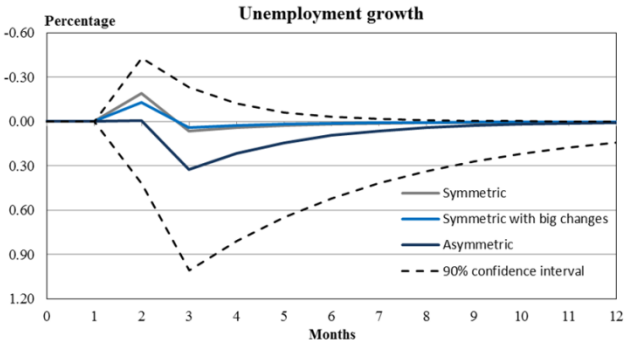


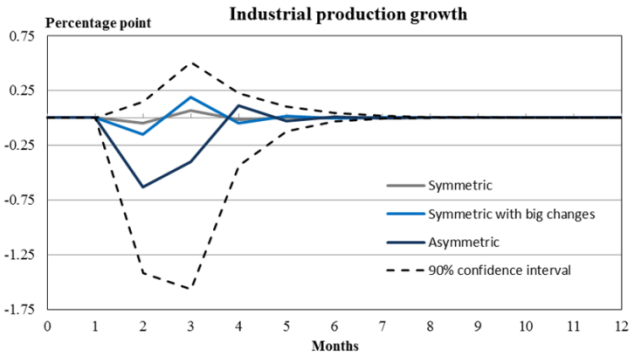




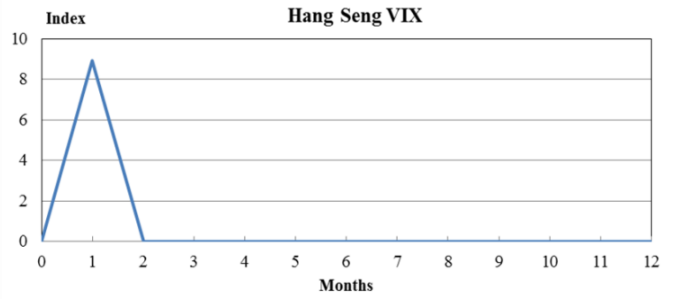
France

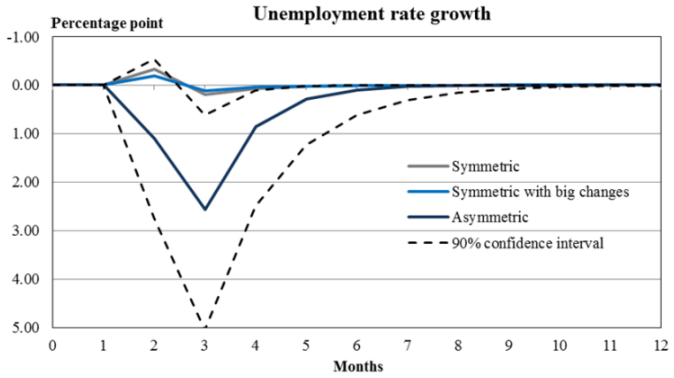






Hong Kong





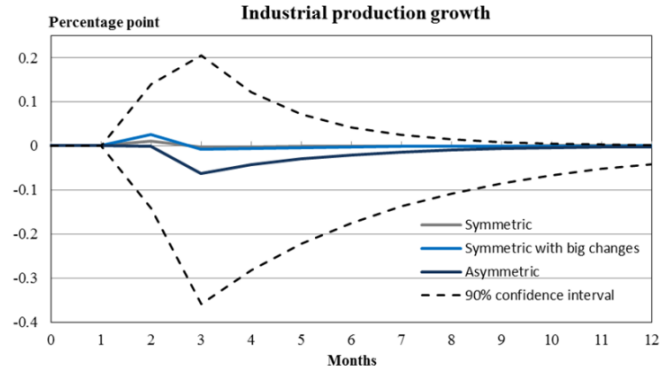


Table 2A: Summary Statistics of Sub-Sample Change in the Implied Volatility Index

	United States		Euro area		United Kingdom		Japan	
	Pre-GFC	GFC-onwards	Pre-GFC	GFC-onwards	Pre-GFC	GFC-onwards	Pre-GFC	GFC-onwards
Stock exchange	S&P500		Stoxx600		FSTE100		Nikkei	
Average change	-0.052	-0.005	-0.367	-0.0133	-.0957	-0.0055	-0.1167	-0.0845
Standard deviation	3.957	6.687	9.261	13.33	4.952	6.306	4.250	6.693
Largest increase	16.45	37.55	39.24	58.47	24.28	32.31	20.15	36.95
Largest decrease	-16.59	-12.94	-26.53	-39.07	-14.28	-14.85	-11.75	-14.16
Number of big increases	19	12	7	14	10	11	8	12
Number of big decreases	14	16	9	10	7	10	7	12
Observations	209	92	101	92	93	92	117	92
Series	01/1990 07/2007	08/2007 03/2015	01/1999 07/2007	08/2007 03/2015	11/1999 07/2007	08/2007 03/2015	11/1997 07/2007	08/2007 03/2015

	Germany		Switzerland		France		Hong Kong	
	Pre-GFC	GFC-onwards	Pre-GFC	GFC-onwards	Pre-GFC	GFC-onwards	Pre-GFC	GFC-onwards
Stock exchange	DAX30		SMI20		CAC40		Hang Seng	
Average change	.0272	-.0235	-.0434	.0037	-.0888	0.0135	-.0780	-0.079
Standard deviation	4.016	5.159	4.204	5.637	3.996	6.550	3.154	5.338
Largest increase	21.87	30.67	16.06	29.59	18.34	32.59	12.63	26.95
Largest decrease	-10.57	-10.55	-9.96	-11.86	-7.845	-12.87	-9.35	-13.23
Number of big increases	18	12	10	13	6	16	5	14
Number of big decreases	18	14	10	14	5	16	6	14
Observations	172	92	96	92	93	92	79	92
Series	01/1993 07/2007	08/2007 03/2015	07/1999 07/2007	08/2007 03/2015	11/1999 07/2007	08/2007 03/2015	01/2000 07/2007	08/2007 03/2015

Table 3A: Asymmetric Sub-Sample Regression Tables

United States

ASYMMETRIC EFFECT OF UNCERTAINTY ON EMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent employment growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.5475***	.8010***	.7150***
	(.0828)	(.0735)	(.0580)
S&P500 growth	.0032	.0041	.0048**
	(.0028)	(.0039)	(.0023)
VIX changes	.0085**	.0051	.0076***
	(.0040)	(.0040)	(.0029)
VIX big increases	-.0125**	-.0078**	-.0107***
	(.0053)	(.0039)	(.0035)
VIX big decreases	-.0012	.0055	.0023
	(.0050)	(.0045)	(.0038)
Constant	.0452***	.0198**	.0340***
	(.0137)	(.0097)	(.0090)
F-statistic for asymmetry	6.356**	7.563***	10.43***
Adjusted R-squared	.4435	.8166	.6368
Dependent variable: percent industrial production growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	-.0106	.2223*	.1425*
	(.0993)	(.1146)	(.0796)
S&P500 growth	.0223*	.0374	.0375**
	(.0132)	(.0288)	(.0152)
VIX changes	.0481**	.0347	.0486**
	(.0205)	(.0386)	(.0207)
VIX big increases	-.0729***	-.0285	-.0544***
	(.0217)	(.0253)	(.0169)
VIX big decreases	-.0276	.0678	.0232
	(.0313)	(.0503)	(.0295)
Constant	.2270***	.1169	.2035***
	(.0597)	(.1028)	(.0481)
F-statistic for asymmetry	2.187	4.605**	8.401***
Adjusted R-squared	.0763	.1936	.1116

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.

Euro area

ASYMMETRIC EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent unemployment growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.1294	.4399***	.3686***
	(.1044)	(.1253)	(.1175)
Stoxx600 growth	-.0558**	-.0220	-.0404**
	(.0257)	(.0209)	(.0157)
VIX changes	-.0410**	-.0309	-.0412***
	(.0182)	(.0271)	(.0155)
VIX big increases	.0422**	.0525**	.0522***
	(.0211)	(.0258)	(.0168)
VIX big decreases	.0120	-.0100	.0044
	(.0259)	(.0288)	(.0177)
Constant	.0205	.0730	-.0005
	(.1229)	(.1134)	(.0624)
F-statistic for asymmetry	1.193	9.957***	7.569***
Adjusted R-squared	.1389	.3621	.3106
Dependent variable: percent industrial production growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	-.4485***	.1288	-.0056
	(.0733)	(.1707)	(.1791)
Stoxx600 growth	.0308	.0561*	.0495**
	(.0266)	(.0310)	(.0197)
VIX changes	-.0069	.0311	.0099
	(.0164)	(.0310)	(.0159)
VIX big increases	-.0124	-.0594*	-.0341*
	(.0209)	(.0303)	(.0196)
VIX big decreases	.0228	.0016	.0019
	(.0275)	(.0323)	(.0194)
Constant	.2695***	.0768	.0433**
	(.0977)	(.1210)	(.0077)
F-statistic for asymmetry	1.365	6.062**	6.386**
Adjusted R-squared	.1626	.2243	.1102

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.

Japan

ASYMMETRIC EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent coincident index growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.0075	.3043*	.3094**
	(.1565)	(.1577)	(.1432)
Nikkei growth	.0155	.0313	.0187
	(.0131)	(.0237)	(.0168)
VIX changes	.0344	-.1395*	-.0483
	(.0350)	(.0791)	(.0458)
VIX big increases	-.0909**	.1080	-.0166
	(.0405)	(.0866)	(.0501)
VIX big decreases	-.0046	.1831*	.0949
	(.0415)	(.0955)	(.0617)
Constant	.2860***	-.0509	.0551
	(.0916)	(.1979)	(.1225)
F-statistic for asymmetry	4.157**	.9331	4.434**
Adjusted R-squared	-.0087	.3327	.2541
Dependent variable: percent industrial production growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	-.3570***	.0629	.0519
	(.1119)	(.1379)	(.1259)
Nikkei growth	.0117	.0471	.0236
	(.0206)	(.0328)	(.0251)
VIX changes	.0566	-.2774**	-.1002
	(.0442)	(.1221)	(.0699)
VIX big increases	-.1373**	.2455*	.0038
	(.0573)	(.1436)	(.0812)
VIX big decreases	-.0651	.3448**	.1691*
	(.0512)	(.1436)	(.0957)
Constant	.4174***	-.2186	.0219
	(.1300)	(.3298)	(.1672)
F-statistic for asymmetry	2.655	.5635	3.404*
Adjusted R-squared	.0935	.1143	.1049

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.

Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.

Germany

ASYMMETRIC EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent unemployment rate growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.3967***	.2769**	.3903***
	(.0712)	(.1285)	(.0636)
DAX growth	-.0246*	-.0667**	-.0298**
	(.0141)	(.0300)	(.0139)
VIX changes	.0922*	.0301	.0941**
	(.0490)	(.0531)	(.0388)
VIX big increases	-.1118***	-.0989*	-.1302***
	(.0421)	(.0531)	(.0331)
VIX big decreases	-.1278**	-.1313**	-.1432***
	(.0535)	(.0635)	(.0454)
Constant	.2057	-.2589**	-.0778
	(.9063)	(.1231)	(.0894)
F-statistic for asymmetry	.1875	.3610	.1498
Adjusted R-squared	.1684	.1476	.1728
Dependent variable: percent industrial production growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	-.4042***	-.0146	-.2135*
	(.0560)	(.1586)	(.1252)
DAX growth	.0315	.0368	.0486**
	(.0212)	(.0465)	(.0245)
VIX changes	-.0151	-.1489	-.0459
	(.0662)	(.0967)	(.0584)
VIX big increases	-.0168	.0812	.0113
	(.0689)	(.0951)	(.0619)
VIX big decreases	.0723	.2839***	.1592**
	(.0648)	(.0876)	(.0641)
Constant	.5315***	.1486	.3160***
	(.1834)	(.2064)	(.1209)
F-statistic for asymmetry	2.358	6.270**	5.684**
Adjusted R-squared	.1607	.1488	.0817

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.

Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.

Switzerland

ASYMMETRIC EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent unemployment rate growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.9790***	.6890***	.8189***
	(.0304)	(.1705)	(.1003)
SMI20 growth	.0031	.0214	-.0077
	(.0198)	(.0294)	(.0162)
VIX changes	.0241	.0547	.0178
	(.0374)	(.0531)	(.0316)
VIX big increases	-.0092	-.0126	.0016
	(.0328)	(.0426)	(.0281)
VIX big decreases	-.0200	-.1858**	-.1153**
	(.0361)	(.0767)	(.0462)
Constant	-.0463	-.1330	-.0499
	(.0542)	(.1657)	(.0832)
F-statistic for asymmetry	.1552	7.333***	7.477***
Adjusted R-squared	.9583	.5018	.7093
Dependent variable: percent industrial production growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.9104***	.8372***	.8920***
	(.0597)	(.0543)	(.0375)
SMI20 growth	.1616**	.0578	.1197***
	(.0790)	(.0523)	(.0439)
VIX changes	.1654	.0671	.1164
	(.3051)	(.1309)	(.1457)
VIX big increases	-.0591	-.0051	-.0225
	(.2642)	(.1071)	(.1193)
VIX big decreases	.0209	.1366	.0817
	(.2883)	(.1531)	(.1480)
Constant	.3613	.4315	.3717*
	(.2883)	(.2846)	(.1887)
F-statistic for asymmetry	.5789	2.474	2.89*
Adjusted R-squared	.8454	.7854	.8290

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.

Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.

United Kingdom

ASYMMETRIC EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent unemployment rate growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.0317	.3813***	.2963***
	(.1133)	(.0977)	(.0863)
FTSE growth	.0921	-.0532	-.0219
	(.0665)	(.0547)	(.0472)
VIX changes	.0391	.0690	.0376
	(.0759)	(.0758)	(.0495)
VIX big increases	.0201	-.0808	-.0329
	(.0614)	(.0797)	(.0551)
VIX big decreases	.1560*	-.2026***	-.0847
	(.0876)	(.0636)	(.0667)
Constant	.7463	-.0750	-.0262
	(.7524)	(.2317)	(.1643)
F-statistic for asymmetry	3.713*	2.888*	.8370
Adjusted R-squared	.0458	.2465	.0840
Dependent variable: percent industrial production growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	-.4557***	-.0704	-.2675**
	(.1085)	(.1135)	(.1034)
FTSE growth	-.0242	.0023	-.0024
	(.0433)	(.0426)	(.0271)
VIX changes	-.0042	.0407	.0321
	(.0488)	(.0459)	(.0314)
VIX big increases	-.0292	-.1106***	-.0868**
	(.0638)	(.0385)	(.0355)
VIX big decreases	.0075	.0259	.0065
	(.0521)	(.0518)	(.0385)
Constant	.5840	.0498	.0114
	(.3603)	(.1103)	(.0731)
F-statistic for asymmetry	.6076	6.290**	4.009**
Adjusted R-squared	.1575	.0892	.0904

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.

Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.

France

ASYMMETRIC EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

Dependent variable: percent unemployment growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.5808***	.6557***	.6614***
	(.1047)	(.1302)	(.0863)
CAC40 growth	-.0633***	.0010	-.0242*
	(.0216)	(.0193)	(.0140)
VIX changes	-.0696**	-.0505	-.0603***
	(.0285)	(.0368)	(.0224)
VIX big increases	-.0001	.0787**	.0599*
	(.0326)	(.0377)	(.0315)
VIX big decreases	.0278	.0280	.0300
	(.0286)	(.0321)	(.0228)
Constant	-.0431	.1043	.0482
	(.0722)	(.0997)	(.0540)
F-statistic for asymmetry	1.237	2.787*	1.025
Adjusted R-squared	.4484	.4201	.5023
Dependent variable: percent industrial production growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	-.4720***	-.1132	-.2771***
	(.0926)	(.1005)	(.1012)
CAC40 growth	.0830**	-.0035	.0493*
	(.0319)	(.0375)	(.0288)
VIX changes	.1025**	-.0390	.0661
	(.0513)	(.0689)	(.0509)
VIX big increases	-.0684	-.0759	-.1245**
	(.0706)	(.0540)	(.0555)
VIX big decreases	-.1030	.0688	-.0130
	(.1261)	(.0833)	(.0644)
Constant	.0452	.0688	.1230
	(.1337)	(.1498)	(.1102)
F-statistic for asymmetry	.0730	3.825*	1.950
Adjusted R-squared	.2372	.1526	.1426

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.

Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.

Hong Kong

ASYMMETRIC EFFECT OF UNCERTAINTY ON UNEMPLOYMENT GROWTH AND INDUSTRIAL PRODUCTION GROWTH

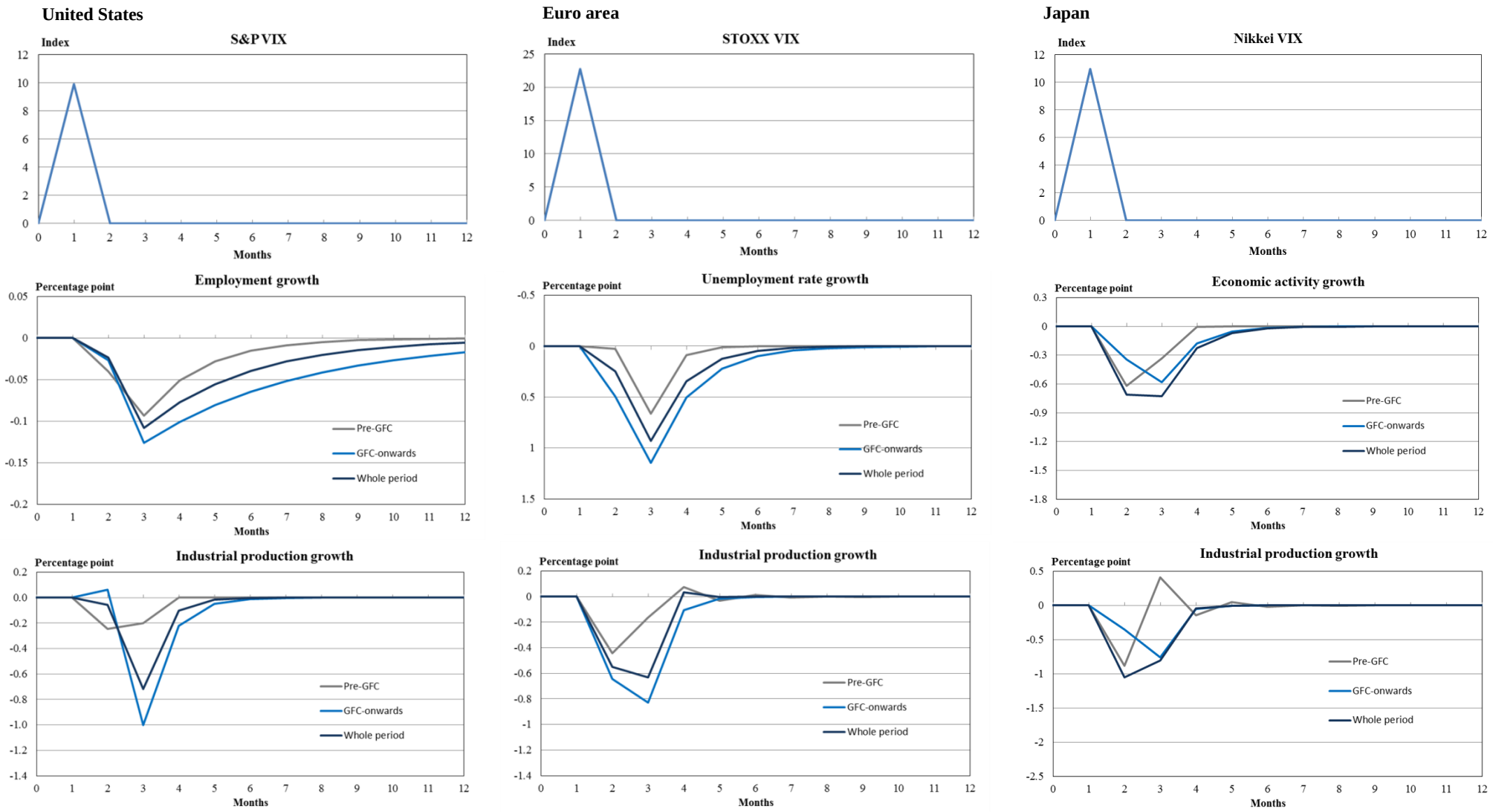
Dependent variable: percent unemployment growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.3229***	.3149**	.3316***
	(.1016)	(.1364)	(.0996)
Hang Seng growth	-.1326	-.0412	-.0698
	(.0826)	(.0603)	(.0440)
VIX changes	-.2313*	.0091	-.1146
	(.1259)	(.1830)	(.1180)
VIX big increases	-.2658*	.1702	.2382
	(.1358)	(.2031)	(.1598)
VIX big decreases	.0990	-.2729	-.1311
	(.1860)	(.2234)	(.1604)
Constant	-1.205	-.7422	-.6096
	(.6032)	(.5681)	(.2095)
F-statistic for asymmetry	3.936*	5.810**	4.441**
Adjusted R-squared	.2824	.1628	.1874
Dependent variable: percent industrial production growth	Pre-GFC	GFC-onwards	Whole period
Lagged activity	.5981***	.7378***	.6879***
	(.0906)	(.0562)	(.0600)
Hang Seng growth	.0152	.0100	.0096**
	(.0139)	(.0063)	(.0048)
VIX changes	-.0221	.0042	-.0073
	(.0281)	(.0249)	(.0184)
VIX big increases	.0494	.0013	.0071
	(.0428)	(.0285)	(.0198)
VIX big decreases	.0108	.0015	.0142
	(.0580)	(.0295)	(.0245)
Constant	.2192	-.0749	-.0418
	(.1651)	(.0903)	(.0411)
F-statistic for asymmetry	.9031	.0002	.1662
Adjusted R-squared	.4766	.5870	.5138

Note: Real interest rate and change in real exchange rate also included as explanatory variables in each regression.

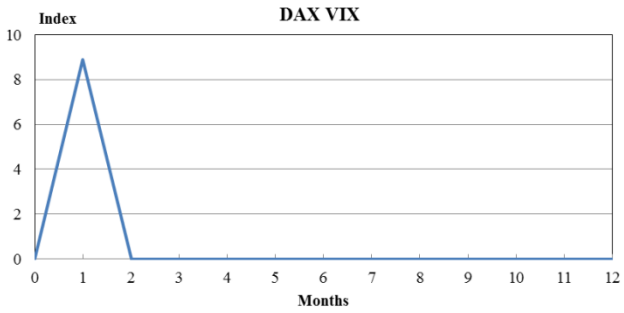
Results significant at 1%, 5%, and 10% levels are indicated by ***, **, and *, respectively.

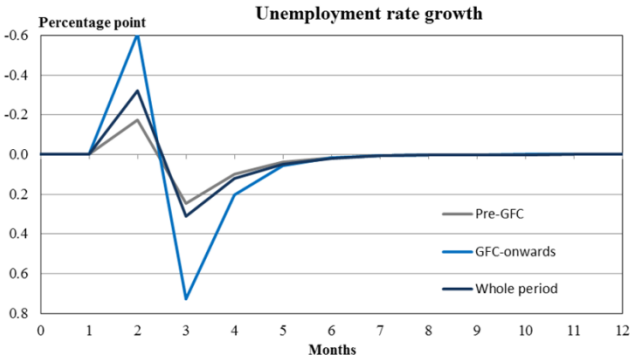
Newey West standard errors are in parentheses. Sources: DataStream, Bloomberg, and author's calculations.

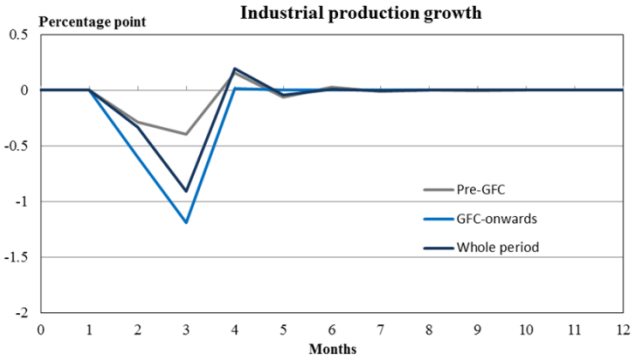
Figure 4A: Impulse Response Functions – Asymmetric Sub-Samples



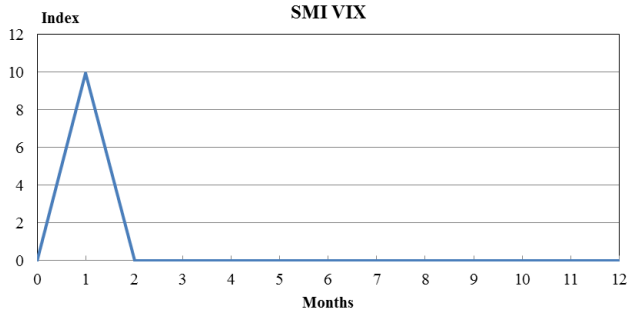
Germany

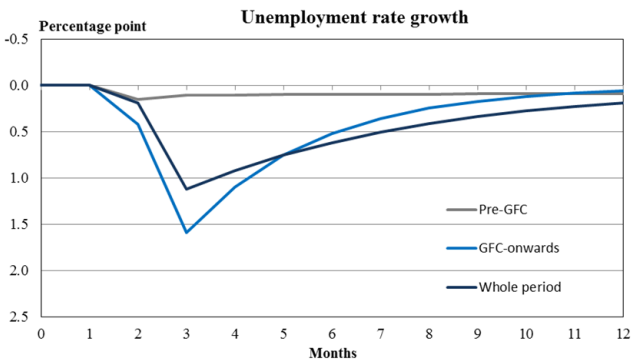


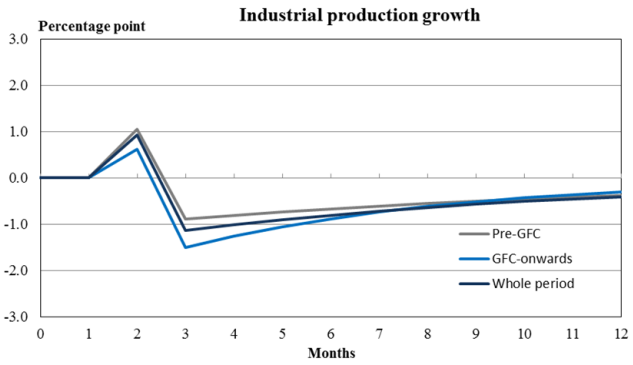




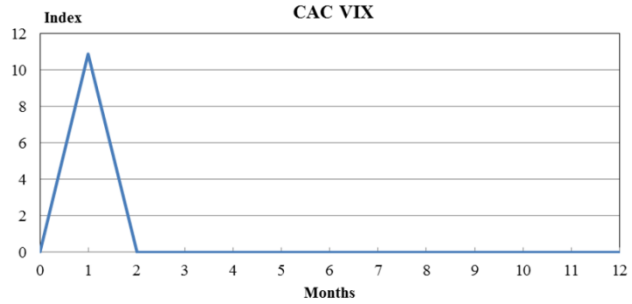
Switzerland

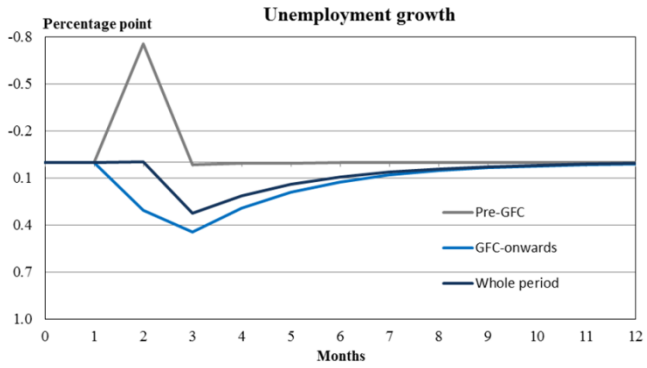


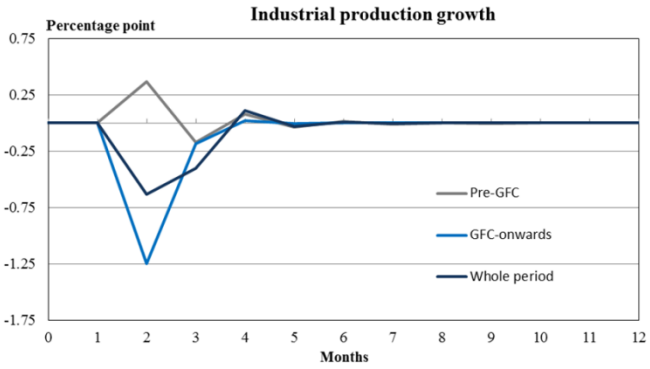




France

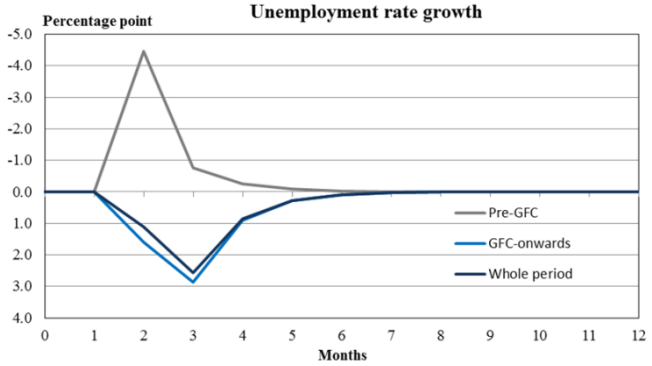


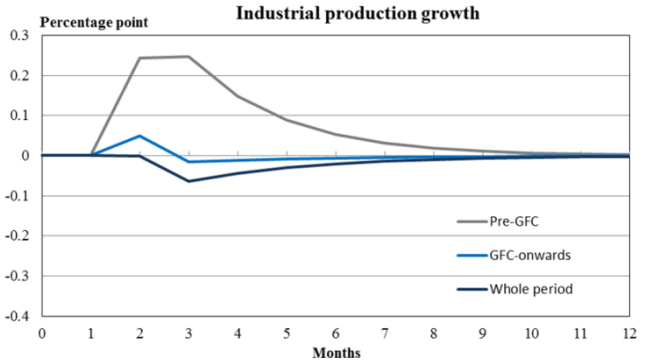




Hong Kong


Hang Seng VIX
Index
10
8
6
4
2
0
0 1 2 3 4 5 6 7 8 9 10 11 12
Months


Unemployment rate growth
Percentage point
-5.0
-4.0
-3.0
-2.0
-1.0
0.0
1.0
2.0
3.0
4.0
0 1 2 3 4 5 6 7 8 9 10 11 12
Months
Pre-GFC
GFC-onwards
Whole period


Industrial production growth
Percentage point
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
0 1 2 3 4 5 6 7 8 9 10 11 12
Months
Pre-GFC
GFC-onwards
Whole period