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150 years of financial market volatility[1]

This paper investigates the behaviour of the volatility of returns in bond and stock markets for a sample of eight countries using very long samples of data. Volatility has been high during episodes of economic and political turbulence, in particular during the interwar period. Moreover, volatility has generally been high since the early 1970s.

JEL classification: G1, G2.

Despite a rise in financial market volatility in the second quarter of 2006, volatility in most markets remains below where it was at the turn of the millennium.[2] Shifts in volatility affect investors' willingness to hold risky assets and their prices. The level of volatility in financial markets can also influence corporations' investment decisions and banks' willingness and ability to extend credit. Sharp changes in the level of financial market volatility can also be of concern to policymakers. For instance, a sudden increase in volatility might discourage major market participants from providing two-way price quotations, which in turn can reduce liquidity and trigger adverse price reactions, with potential consequences for the real economy.

The importance of financial volatility is demonstrated by the large literature it has given rise to. Since volatility – the second moment of the distribution of returns – is unobserved, much work has been devoted to measuring, modelling and understanding its evolution.[3] For natural reasons, much of that literature is methodological and has focused on data for the recent past. To understand the importance of factors that may only gradually affect financial markets (such as changes in the probability distribution of macroeconomic outcomes, the effectiveness of risk management systems and

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2 See BIS (2006) for a discussion on the recent decline in financial market volatility.

3 Bollerslev et al (1992) and Poon and Granger (2003) survey the literature on modelling and forecasting volatility in financial markets. Ex ante measures of uncertainty derived from market prices on derivative instruments – ie "implied volatility" – are also frequently used in volatility analysis. However, such measures incorporate risk premia and, furthermore, data generally do not go back more than a few decades.

developments in market liquidity), it is of interest to investigate the behaviour of volatility over very long time spans and across a wide range of financial markets. While some such studies exist, these tend to focus on individual countries and markets or on specific episodes.[4] To our knowledge, there is no cross-country study of the evolution of volatility for a range of financial markets and instruments over an extended period of time.

This article uses extremely long time series of monthly bond and stock returns to document the evolution of the volatility of returns in Australia, Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. Depending on the country, the data start as early as 1850; all data end in 2005. We also discuss how the volatilities are linked to macroeconomic conditions. While it would have been interesting to also investigate the volatility of short-term interest rates and exchange rates, the data in many cases display little, if any, variation. Thus, short-term interest rates are typically closely tied to interest rates set by central banks, which in many historical episodes were fixed for long periods of time. Similarly, many bilateral exchange rates were fixed during extended time spans as a consequence of the operation of the gold standard or the Bretton Woods system. For this reason, we focus here on the volatility of stock and bond returns.

Volatility varies over time ...

While the purpose of the study is merely to describe the evolution of volatility, several interesting conclusions are readily apparent. First, volatility varies considerably over time and is typically dominated, not unexpectedly, by occasional episodes of economic and political turbulence.[5] Second, volatility has risen across the world since about 1970. Third, while the econometric analysis provides some evidence that weaker economic conditions or higher inflation are associated with higher volatility in financial markets, these correlations are unstable over time. Furthermore, there appears to be no robust relationship between macroeconomic volatility and volatility in financial markets. One possible explanation for these findings is that some relevant factors, for instance the occurrence of financial crises and episodes of political instability, have been omitted from the analysis.

... but displays no robust link to macroeconomic conditions

Methodology and data

The volatilities of returns have been computed using exponentially weighted moving averages (EWMA) of squared returns, which follows closely the RiskMetrics methodology, as discussed in the box.

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[4] The Kearns and Pagan (1993) study on stock market volatility in Australia between 1857 and 1987 and the Mitchell et al (2002) study on the volatility of returns on consols in the United Kingdom in 1821–60 are examples of the first type of study. The studies by Choudhry (1997) on stock return volatility in 1926–44 and by Voth (2002) on stock market volatility during the Great Depression are examples of the second type.

[5] Such episodes often involve financial crises, which Kearns and Pagan (1993) note play a major role in triggering financial volatility.

Estimating the volatility of returns

To compute the volatilities, let r_t^2 denote the squared returns in period t. The return volatilities are updated using the following recursive equation for the variance of returns:

$$\sigma^2_{t+1|t} = \lambda\sigma^2_{t|t-1} + (1-\lambda)r_t^2$$

where λ, the decay factor, is set at 0.95 for monthly data. This choice of λ ensures that, while computing volatilities, a less than 10% weighting is given to data older than 45 months. Further, the forecast errors (predicted variance minus the average squared monthly returns over the following three months) are lower on average for this choice of λ compared to others. The annualised volatility estimates using monthly returns (computed by multiplying monthly volatility by the square root of 12) are somewhat lower than those based on daily returns (computed by multiplying daily volatility by the square root of 256, which is the number of trading days in a year), perhaps because monthly returns have less measurement errors, but the choice of data frequency does not alter the inferences drawn on the changing pattern of volatility over time.

Stock returns are computed as the logarithm of the ratio of stock index levels:

$$r_t = \ln\left(P_t / P_{t-1}\right)$$

where P_t is the stock index level at time *t*. Bond returns are computed using the following approximation (the available time series is bond yields):

$$r_t = -D_{t-1} \times (y_t - y_{t-1})$$

The return in time period *t* is thus approximated by duration, *D*, multiplied by the change in yield, *y*. The duration for the bond has been estimated on the basis of the underlying maturity of the bond yield time series. Specifically, let the yield data for different bonds correspond to a fixed maturity bond, say *N* years. Assuming that the bond is priced at par and is issued today, the duration of the bond can be determined using the following equation:

$$D = \frac{1}{(1+y)}\left[\sum_{i=1}^{N} \frac{i \times y}{(1+y)^i} + \frac{N}{(1+y)^N}\right]$$

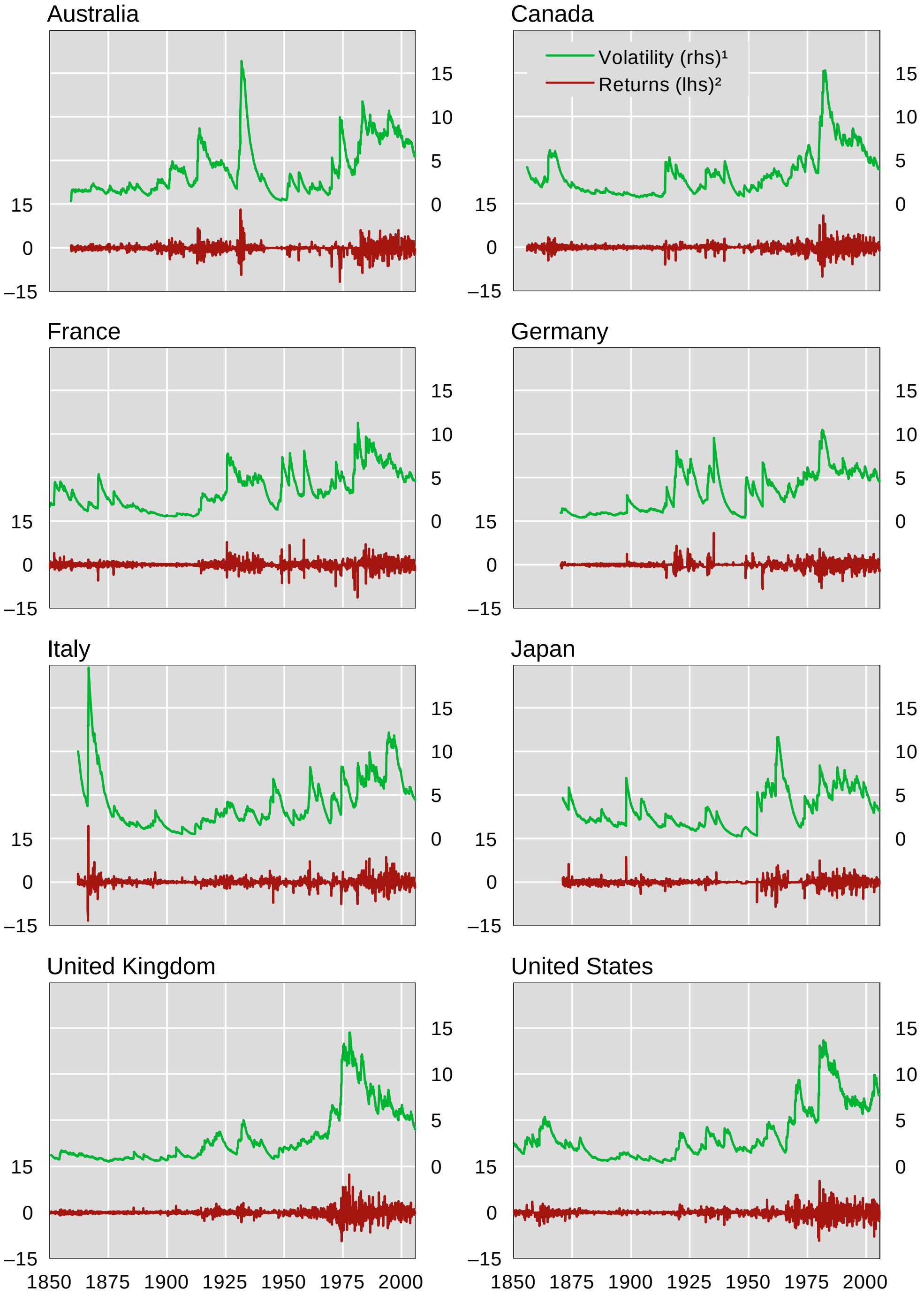
We used a similar procedure to compare the volatility of GDP growth and inflation, but set the decay factor to 0.6 since that yielded a rate of decay similar to that of the monthly data when the latter were transformed into annual data.

While financial volatility is normally estimated using daily returns, we use monthly returns for data availability reasons. The volatilities of inflation and GDP have also been calculated using EWMA but applied to annual changes in the variables of interest.

The main source of data is the Global Financial Data database. The period under consideration covers the years between 1850 and 2005; depending on availability, the data start between January 1850 (French, German and US bond yields and US equity prices) and January 1919 (Canadian equity prices) and end in all cases in November 2005. A few data points were missing and had to be interpolated.

The data on long-term yields refer to government bonds with a maturity of 10 years for all countries except Japan, for which the maturity is seven years. Until the 1970s, the series is based on individual bonds. Stock price indices are constructed by taking the weighted average market capitalisation of each stock

Volatility and returns of bonds



[1] Annualised, in per cent. [2] Change in yields, in per cent, times negative modified duration.

Source: Global Financial Data. Graph 1

excluding dividends.[6] Although the composition of the stock price indices has changed over time, it is unlikely that such changes would substantially alter the

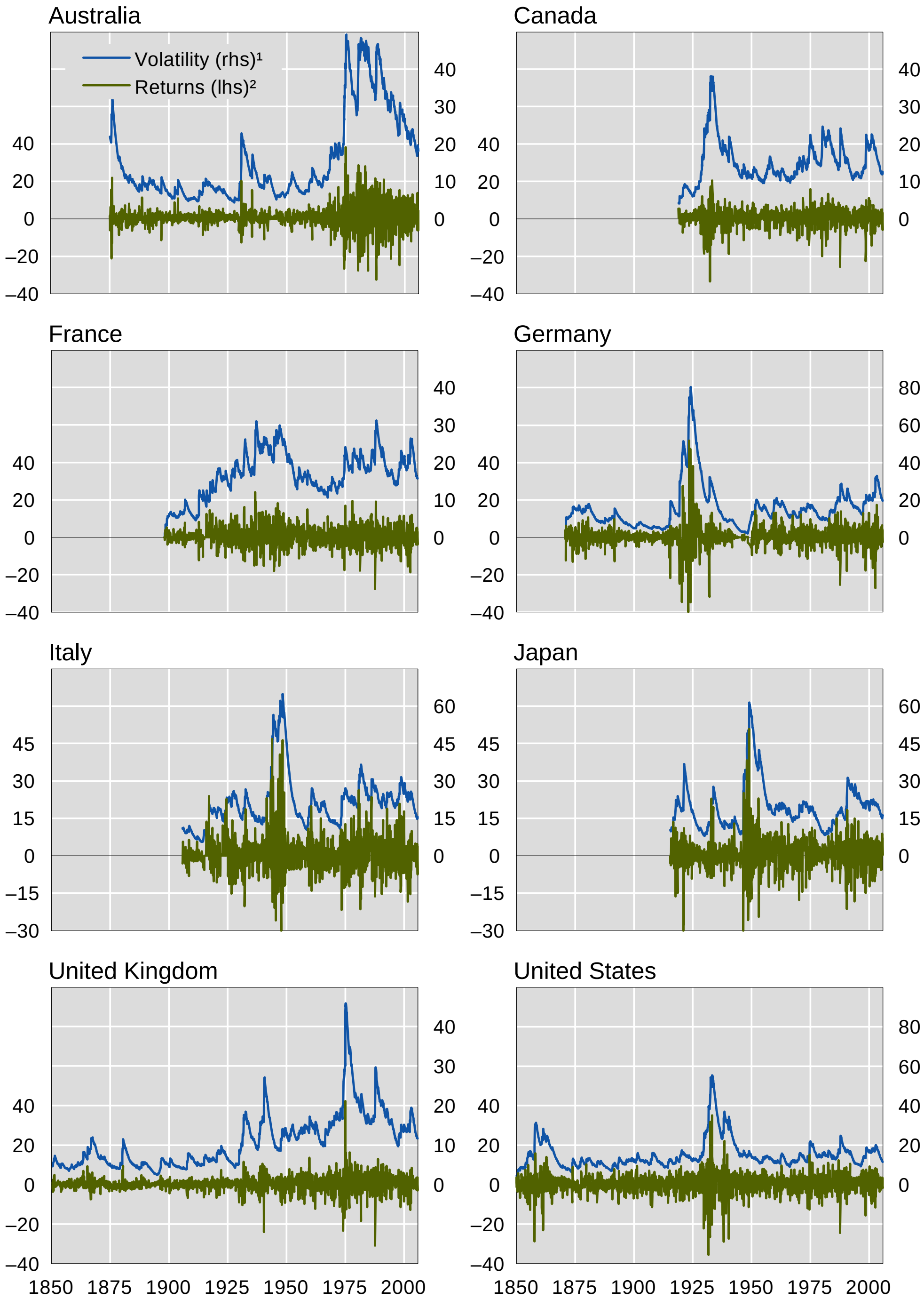
[6] The indices used are: S&P 500 for the United States, CDAX for Germany, SBF-250 for France, ASX-all ordinaries for Australia, TOPIX for Japan, FT-Actuaries all-shares for the United Kingdom, S&P/TSX 300 for Canada and Banca Commerciale Italiana index for Italy.

volatility of these indices, so that the conclusions of this study are likely to hold despite compositional changes in stock indices (Officer (1973)).

Equity and bond return volatilities

Graphs 1 and 2 show our estimates of volatility for bonds and stocks, respectively. Since these depend on the exact way in which we model volatility,

Volatility and returns of stocks



[1] Annualised, in per cent. [2] Differenced logs, in per cent.

Source: Global Financial Data. Graph 2

we also plot the bond returns and stock returns used to construct them. One empirical regularity is that the data are dominated by one or a few episodes of sharp increases in volatility. In most cases, these occur between the start of World War I (WWI) in 1914 and the end of World War II (WWII) in 1945. In Australia there is a spike at the beginning of the sample period and again during the 1930s, and in the United Kingdom a very sharp increase in 1975 and again in 1987. In the United States volatility rose to a high level in 1858 and remained high during the Civil War period in the 1860s, before peaking during the Great Depression in the 1930s.

Occasional episodes of high volatility

Several studies have investigated why volatility rose so dramatically in the interwar period. As is discussed below, volatility tends to rise in recessions. Given extremely weak economic conditions, and episodes of very high inflation in some countries, during much of the interwar period, it is not surprising that volatility rose sharply. However, as noted by Schwert (1989), the rise in volatility was so extreme that it seems likely that other factors played a role. Voth (2002) studied equity price volatility in 10 countries in 1919–39 and argued that political factors, in particular the fear of revolution, explain a substantial part of stock market volatility in this period. Bittlingmayer (1998) analyses the German experience in the interwar period and also concludes that political factors played a critical role in explaining both economic conditions and movements in stock price volatility. That political stability more generally reduces volatility in financial markets is emphasised by Brown et al (2006), who study the volatility of consol prices in the United Kingdom between 1729 and 1959. Jorion and Goetzmann (1999) identify wars and adverse political developments as the main factors causing major stock market declines, which tend to raise volatility sharply, in 39 countries between the 1920s and the 1990s.

Dramatic increase in interwar period

A further finding is that stock and bond return volatilities have been high since 1970 relative to their long-term averages.[7] While the volatilities have

Volatility high since 1970

Median level of volatility for stock returns

Annualised, in per cent

	1850–2005	1850–1914	1914–45	1945–2005	1850–1969	1970–2005	2004–05
Australia	10.2	8.5	8.8	20.4	8.8	31.9	18.7
Canada	13.9	…	15.3	13.6	12.2	15.6	12.8
France	17.0	6.1	17.7	18.1	15.5	18.9	17.7
Germany	13.4	8.6	19.2	15.3	11.5	16.4	23.2
Italy	20.4	8.7	18.0	22.5	17.6	23.3	16.9
Japan	18.3	…	13.5	19.4	17.9	18.7	16.7
United Kingdom	9.1	5.1	8.8	15.1	6.6	17.2	13.2
United States	13.2	11.3	16.5	14.1	12.6	15.1	13.7

Sources: Global Financial Data; BIS calculations. Table 1

[7] An exception is stock market volatility in the United States. See Schwert (1989), Kearns and Pagan (1993) and Ineichen (2000) for a discussion of how volatility has risen. Campbell et al (2001) emphasise that while the volatility of US stock market averages has not increased over time, that of individual stock prices has. For a theoretical discussion of why volatility may vary over time, see Campbell and Cochrane (1999).

Median level of volatility for bond returns Annualised, in per cent							
	1850–2005	1850–1914	1914–45	1945–2005	1850–1969	1970–2005	2004–05
Australia	2.8	1.8	4.5	4.4	2.0	7.6	6.3
Canada	2.8	1.4	3.0	4.5	2.0	6.7	4.2
France	3.2	1.6	4.1	5.2	2.6	6.0	4.8
Germany	3.1	0.9	3.8	5.0	1.7	5.5	5.0
Italy	3.1	1.7	2.6	5.3	2.5	6.6	4.9
Japan	2.7	2.3	1.5	4.9	2.2	5.1	3.5
United Kingdom	1.9	1.0	2.5	5.5	1.3	6.9	4.9
United States	2.4	1.4	2.2	6.1	2.0	7.3	8.6

Sources: Global Financial Data; BIS calculations. Table 2

generally declined somewhat in recent years, they remain above their long-run averages. More importantly, they are below their peak levels, suggesting that sharp increases would not be unusual given their past behaviour.

Tables 1 and 2 show the median level of volatility for stock and bond returns, respectively, for the full sample and several subsamples. We first divide the sample into the period before the start of WWI in 1914, the period between 1914 and 1945, and the period from the end of WWII in 1945 onwards. The reason for choosing these subperiods is that volatility was very high in most countries during the tumultuous 1914–45 period, which involved two world wars, episodes of both rapid deflation and high inflation in the early 1920s and the Great Depression in the 1930s. It is therefore of interest to explore whether volatility differed before 1914 and after 1945. We also compute volatility for the period before and after 1970, since Graphs 1 and 2 suggest that it has risen in recent decades. For comparison purposes, we also tabulate results for the 2004–05 period.

Increased trading volume ...

The finding that volatility has been high since the 1970s is surprising, given that the increased completeness, integration and liquidity of financial markets should allow market participants to spread risks more effectively. One hypothesis is that the increased trading volume accompanying far-reaching deregulation and sharp reductions in transactions costs over the last 30 years has increased volatility. However, empirical evidence from stock markets suggests that although declines in transactions costs raise trading volumes, they reduce volatility.[8] If so, this mechanism would not be operational.

... tends to reduce volatility

Faster dissemination of news ...

Another possible explanation is that more rapid dissemination of news across the world could have increased the speed by which financial prices respond to economic and other events. However, the historical evidence suggests that capital markets have in this sense in fact been integrated for quite some time. For instance, Sylla et al (2004) compare the prices in New York and London on securities issued in the United States and argue that

[8] See, for instance, Jones and Seguin (1997), who show that volatility on the NYSE fell after the reduction of fixed trading commissions in 1975, and the references cited therein. However, Summers and Summers (1989) hypothesise that declines in trading costs may raise the relative importance of “noise traders” in markets and thereby raise volatility.

the speed and regularity of information flowing between the New York and London capital markets rose sharply already in the early 1800s as a result of innovation in the shipping industry. They conclude that the markets were well integrated even before the opening of the transatlantic cable in the 1860s. The hypothesis that increased information flow since the 1970s can explain the observed rise in volatility may therefore be implausible.

... not likely to explain increased volatility

It may also be that for some reason the shocks impacting on the global economy have been more severe since the 1970s. For example, the two oil shocks, perhaps coupled with poor monetary and fiscal policy responses that led to sharp increases in inflation, might have played a role. Another potential explanation for the rise in volatility is that leverage, which is positively correlated with stock market volatility, has risen. However, Campbell et al (2001) argue that this hypothesis is not supported by the US evidence since leverage declined during the 1990s when stock prices rose rapidly. They hypothesise instead that increased volatility at the firm level may be due to changes in corporate governance and to the growing role of institutional investors.

Overall, it remains important to conduct further research to understand better the sources of the observed increase in volatility in recent decades.

Volatility and the sign of returns

It is commonly observed that volatility tends to rise during periods of negative returns. For stocks, this could reflect the increase in (marked to market) debt/equity ratios when stocks decline, the so-called leverage effect proposed by Black (1976). For financial assets more generally, it could also reflect the limited tolerance for losses on the part of structurally long, leveraged investors, which was noted in government bond markets in the mid-1990s by Borio and McCauley (1996). But is the asymmetry of volatility movements in response to positive and negative returns a phenomenon that holds over the long time periods of our sample?

Does volatility respond asymmetrically?

Table 3 presents the results from regressions of bond market volatility on the lagged level of interest rates (since the level and volatility of interest rates are correlated), on the holding period return and on the absolute value of the holding period return. If volatility responds symmetrically to positive and negative returns, the parameter on returns should be insignificant and the parameter on absolute returns should be positive and significant. If volatility rises more in response to negative than to positive returns, we expect the parameter on returns to be negative and significant.

Since we are principally interested in exploring how bond return volatilities have changed over time (rather than how they differ between countries), we estimate panel regressions.[9] Table 3 shows that the parameter on the lagged interest rate is always highly significant, as is the parameter on the absolute

[9] These allow for fixed effects and incorporate seasonal dummies and 12 lags of the dependent variable to ensure that the errors are serially uncorrelated. The standard errors reported are robust to time-varying heteroscedasticity.

Volatility and the sign of returns Dependent variables: bond and stock market volatility					
Sample	1851:1–2005:11	1851:2–1914:6; 1945:9–2005:11	1914:7–1945:8	1851:2–1914:6	1945:9–2005:11
Bond market volatility					
Long rate, lagged	1.168	1.246	1.215	2.598	1.268
	(10.282)	(9.862)	(2.431)	(6.831)	(7.663)
Return	–0.796	–0.712	–1.661	–4.033	–0.229
	(–4.743)	(–3.848)	(–3.953)	(–11.288)	(–0.959)
│Return│	3.455	3.051	5.511	4.880	2.584
	(14.637)	(11.615)	(9.756)	(10.587)	(7.457)
R-squared	0.991	0.992	0.985	0.988	0.987
Durbin-Watson	2.206	2.187	2.299	2.230	2.176
Stock market volatility					
Return	–0.451	–0.219	–0.764	–0.038	–0.190
	(–2.929)	(–1.308)	(–2.209)	(–0.119)	(–0.941)
│Return│	3.010	2.579	3.620	3.831	2.306
	(13.125)	(10.087)	(7.402)	(8.308)	(7.404)
R-squared	0.991	0.992	0.990	0.989	0.990
Durbin-Watson	2.191	2.165	2.262	2.271	2.174

Note: t-statistics in parenthesis. Panel regression allowing for fixed effects, seasonal dummies and 12 lags of the dependent variable. White period standard errors. Table 3

value of bond returns. The parameter on returns is also typically significant and is always negative, consistent with volatility responding more to negative than to positive returns. Interestingly, the parameter on returns is much smaller and statistically insignificant in the 1945–2005 period, suggesting that the tendency for bond market volatility to be high in declining markets was not pronounced over the last 60 years, at least not at the monthly frequency.

Table 3 provides the analogue results for the volatility of stock returns (in which case, of course, we do not include the lagged level of the interest rate). While the parameter on returns is significant for the full sample, the subsample analysis indicates that it is only significant in the interwar period. Leverage thus appears to have played a role in raising volatility during the interwar period but not necessarily afterwards, as argued by Campbell et al (2001).

Macroeconomic conditions and volatility

In this section, we focus on the relationship between macroeconomic conditions and the volatility of bond and equity returns. Our main question concerns how output gaps and inflation impact on the volatility of asset returns. A number of papers have noted that volatility tends to be higher in recessions (see, for example, Officer (1973) or Schwert (1989)).

To address this question, we regress the level of volatility on its two lagged values, the current and lagged change in the output gap (which we compute using the Hodrick-Prescott filter), the lagged level of the output gap, the current and lagged change in CPI inflation, and the lagged level of CPI inflation. The signs on the parameters on the lagged output gap and inflation indicate the impact of a permanent increase in these variables on volatility and are therefore of particular interest. Since the macroeconomic data are annual, we converted the monthly data on the financial volatilities into yearly averages. Panel regression results, which allow for fixed effects and time-varying heteroscedasticity, are shown in Table 3. Since the data in many cases are missing during WWI and WWII (and to allow for lags), we drop the observations for 1914–20 and 1940–47.

Volatility and macroeconomic conditions

Dependent variables: bond and stock market volatility

Sample	1853–1913 1921–1939 1948–2005	1853–1913 1948–2005	1921–1939	1853–1913	1948–2005
Bond market volatility					
Δ GAP	–0.009	0.022	0.043	0.014	–0.115
	(–4.267)	(13.123)	(4.940)	(7.207)	(–15.050)
Δ GAP, lagged	0.002	0.036	–0.050	0.004	0.185
	(0.692)	(20.395)	(–3.464)	(1.071)	(25.992)
GAP, lagged	–0.029	0.010	–0.021	0.002	–0.047
	(–6.965)	(4.237)	(–1.153)	(0.588)	(–7.586)
Δ Inflation	–0.000	2.161	0.000	0.741	1.722
	(–5.274)	(2.793)	(0.357)	(1.084)	(0.989)
Δ Inflation, lagged	–0.000	2.376	–0.000	1.249	4.422
	(–24.764)	(6.470)	(–12.662)	(3.410)	(6.630)
Inflation, lagged	0.000	3.687	0.000	0.740	4.031
	(10.480)	(4.566)	(9.090)	(0.820)	(3.351)
R-squared	0.897	0.912	0.873	0.777	0.868
Durbin-Watson	1.839	2.067	1.951	1.766	1.985
Stock market volatility					
Δ GAP	–0.124	–0.032	–0.089	0.019	0.025
	(–5.224)	(–2.612)	(–2.416)	(2.109)	(1.168)
Δ GAP, lagged	–0.127	–0.074	–0.173	-0.140	–0.069
	(–12.866)	(–4.635)	(–10.580)	(–12.273)	(–2.665)
GAP, lagged	–0.051	0.017	–0.021	0.216	–0.154
	(–1.837)	(1.133)	(–0.392)	(10.829)	(–3.340)
Δ Inflation	0.000	4.396	0.000	–0.298	2.757
	(40.285)	(1.269)	(41.636)	(–0.150)	(0.579)
Δ Inflation, lagged	0.000	1.592	0.000	3.150	2.670
	(7.978)	(0.606)	(2.328)	(0.911)	(0.735)
Inflation, lagged	0.000	14.141	0.000	–0.470	13.792
	(14.575)	(5.318)	(10.834)	(–0.342)	(3.948)
R-squared	0.911	0.914	0.926	0.858	0.894
Durbin-Watson	2.012	1.981	1.826	2.162	1.946

Note: t-statistics in parenthesis. Panel regression allowing for fixed effects. White period standard errors. Table 4

We consider first the results for bond volatility in Table 4. For the full sample, we find that an increase in the output gap (a rise in real GDP relative to trend) is typically negatively correlated with bond market volatility. Moreover, a higher lagged level of the output gap is correlated with lower current volatility. Looking at the subsamples, however, we see that the parameters on the change in the output gap frequently change signs and are significantly different from unity. Given the observed time variation of the parameters, we focus on the results for the three subperiods identified above.

The results show that the contemporaneous change in the output gap is negatively correlated with the volatility of bond returns in the interwar period and the post-WWII period, but not in the pre-WWI period. The parameter for the lagged change in the output gap is insignificant before WWI, significantly negative in the interwar period and significantly positive in the post-WWII period. The lagged level of the output gap parameter is negative and significant only in the last subsample. Moreover, the parameters on the current and lagged change in inflation are generally positive, as is the parameter on the lagged level of inflation.

Next, we consider the results for stock return volatility. In this case, too, a strong time variation of the parameters is readily apparent, but there is some evidence that changes in the output gap have reduced volatility and that higher inflation tends to raise stock return volatility.

Volatility, output gaps and inflation

Overall, these results are compatible with the view that weaker business conditions and higher inflation have tended to raise volatility in financial markets but that this relationship is unstable over time. One potential reason for the lack of robustness is that some relevant factors, in particular financial crises and episodes of political instability, are not incorporated in the econometric analysis.[10]

Macroeconomic and financial market volatility

Macroeconomic volatility has declined ...

... but financial market volatility has risen

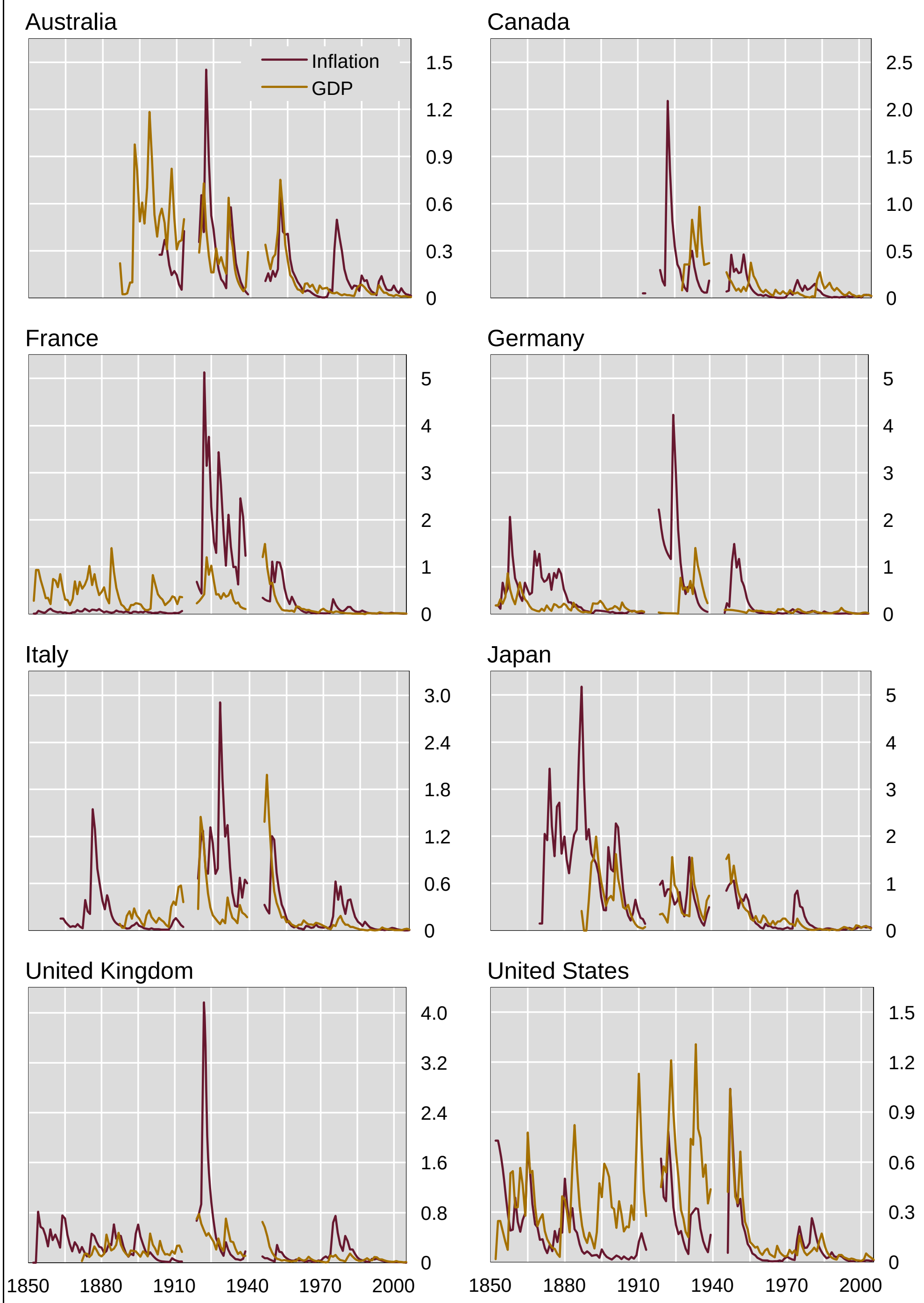
An alternative hypothesis for why financial volatility evolves over time is that the macroeconomy itself is subject to time-varying volatility. Several studies have shown that a number of economic aggregates have become more stable in the G7 countries since the 1980s.[11] If so, one would expect estimates of the volatility of output growth and inflation to be positively correlated with the volatility of bond and stock returns. From a longer-term perspective, however, the time series of financial market volatility are dominated by the *increase* in volatility from the 1970s onwards. For there to be a positive relationship between the two sets of variables in the full sample, macroeconomic volatility must also have increased in the last decades of the 20th century.

[10] Using the dummy variables for banking and currency crises provided by Bordo et al (2001), we find that bond return volatility is correlated with the currency crisis dummy. Unfortunately, these dummy variables are available only for the 1883–1998 period and for a subset of countries.

[11] See, for instance, Sheffrin (1988), Romer (1999) or McConnell and Perez-Quiros (2000).

Inflation and GDP volatility

Annualised, in per cent



Source: Global Financial Data. Graph 3

Graph 3 shows the long-run behaviour of the volatility of GDP growth and inflation.[12] Both time series are subject to sharp spikes, and these are larger and more frequent in the interwar period. However, the volatilities of inflation

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12 Since estimates of macroeconomic volatility are completely dominated by occasional spikes in inflation (such as the German hyperinflation) and growth, we assume that the rate of change of prices is at most ±20%, and that the rate of change of GDP is at most ±15%, in computing volatility.

and, in particular, output growth are generally low in the post-WWII period. Since bond and equity return volatilities have been high in recent decades while estimates of macroeconomic volatility have been subdued, there appears to be an *inverse* relationship between the two sets of variables.[13] This suggests that there is no simple relationship between financial and macroeconomic volatility.

Estimating panel regressions analogue to those discussed above, but using the volatility of output growth and inflation as regressions, we find little evidence of a tight and stable relationship between macroeconomic and financial market volatility and we therefore do not report the results.[14] Again, the omission of relevant factors in the regression analysis may play a role.

Conclusions

This article has used very long time series of data for eight countries to investigate the evolution of the volatility of stock and bond returns, the extent to which volatility responds asymmetrically to returns, and the relationship between broad macroeconomic conditions and financial market volatility.

The three main conclusions we draw are readily apparent. First, volatility is dominated by large, temporary increases that appear correlated with episodes of economic weakness, political instability and financial turmoil. Second, volatility has been much higher from the 1970s onwards than it was previously. This finding appears surprisingly robust across countries and financial instruments. Seeking to explain it would be an important topic for future research. Third, the movements in volatility that have been observed in recent years are small from a historical perspective. These findings suggest that financial institutions and policymakers alike would be well advised to note that a sharp increase in volatility from the level observed in the last few years would not be unprecedented.

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[13] However, in a series of articles, Christina Romer has demonstrated that data on real economic activity in the United States were more volatile before than after WWII, but that the decline is spurious and due to changes in the way the data were constructed (for a summary, see Romer (1999)). This suggests that great care should be taken in interpreting the long-run behaviour of macroeconomic volatility. Sheffrin (1988) studies the behaviour of real economic activity in six European countries and argues that in five of these the volatility has not changed over time.

[14] We also included the volatility variables in the panel regressions with the output gap and inflation. This did not change the results very much, and in the interest of brevity we do not tabulate them.

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