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Bruno Ćorić and Geoff Pugh

The Financial Accelerator, Globalization and Output Growth Volatility

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The Financial Accelerator, Globalization and Output Growth Volatility *

Bruno Ćorić* (University of Split Faculty of Economics)

Geoff Pugh (Staffordshire University Business School)

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Abstract

One explanation of waning output growth volatility in the decades before the current global downturn is that international diversification of net worth reduced the strength of the Financial Accelerator. We analyse data from 85 countries over the period 1970-2004 and, consistent with this theory, cannot reject the hypothesis that international net worth diversification reduced output growth volatility. We also find that increasing trade openness may have increased output growth volatility. In these respects at least, while globalization may make national economies more exposed to external economic shocks it may also have helped to make them more resistant to such shocks. Finally, we report some limited evidence that this source of stability was transient and that its attenuation may have contributed to the end of the "Great Moderation".

JEL Classification: E32, F41

Key words: GDP growth volatility; the "Great Moderation"; Financial Accelerator; globalization.

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*Address for correspondence: Bruno Ćorić, University of Split, Faculty of Economics, Matice Hrvatske 31, 21000 Split, Croatia. (e-mail: bcoric@efst.hr). This paper is based on the fifth chapter of Bruno Ćorić's PhD dissertation at Staffordshire University. We thank Philip Lane, Gian Maria Milesi-Ferretti and the World Bank's Development Data Group Client Services Team for help with the construction of our data set. We thank Bill Russell, Peter Reynolds and Ahmad Seyf for their many helpful suggestions. Remaining errors are the responsibility of the authors.

1 Introduction

The decades preceding the current downturn were a period of unprecedented stability for the US economy. Namely, there is considerable evidence that US GDP growth after 1984 became less volatile than in previous decades (Kim and Nelson, 1999; McConnell and Perez-Quiros, 2000); indeed, that the contrast was sufficiently marked to characterise these changes as “The Great Moderation”, an appellation that became current around the turn of the century. Moreover, such moderation has not been confined to the US; similar changes in output growth volatility have been detected for a number of other developed market economies (Dalsgaard, Elmeskov and Park, 2002; Mills and Wang, 2003; Stock and Watson, 2003), suggesting that declining output growth volatility may have been a more general development. Most recently, Ćorić (2007) analyses GDP growth volatility for 97 countries over the period 1961-2005, finding that: a considerable number of countries experienced change(s) in short-run growth volatility; in most cases, such change was towards less volatile output growth; this “moderation” took place in economies at all income levels; and that the year 1984 is not a global turning point in output growth volatility. These findings inform the question addressed by this paper; namely, why did so many countries across the world experience reduced output volatility in the decades preceding the current global downturn? Although we cannot dismiss the possibility that the explanation(s) is (are) unique for each country, consistency in findings for the US economy, a larger number of developed economies and, most recently, for economies accounting for most of the world’s output suggests the possibility of some common explanation(s).

New facts stimulated the search for theoretical explanation, which focussed primarily on changing volatility in the US economy (seminal contributions include: Stock and Watson, 2002;

Blanchard and Simon, 2001; Kahn et al., 2002; more recent ones include: Arias et al., 2007; Justiniano and Primiceri, 2008; Gali and Gambetti, 2009). In contrast, in this paper we focus on changing volatility across the world. In particular, we investigate from a global perspective the possibility that international diversification of economic agents' net worth influenced the strength of the Financial Accelerator which, in turn, contributed to changes in GDP growth volatility. The contribution of the present paper is to test this hypothesised explanation by econometric analysis of 85 countries over the period 1970 to 2004.

The paper is organised as follows. Section 2 explains the potential role of the Financial Accelerator in changing output growth volatility. Section 3 describes the model and data. Section 4 presents the results of empirical analysis. Section 5 concludes.

2 The Financial Accelerator effect and Globalization

The Financial Accelerator, a term introduced by Bernanke, Gertler and Girlchrist (1996), describes a process by which relatively small initial economic shocks can be amplified and propagated by financial market imperfections. Figure 1 outlines this Financial Accelerator mechanism. Arrow 1 depicts a positive relationship between changes in aggregate economic activity and agents' net worth. In turn, Arrow 2 depicts an inverse relationship between net worth and the size of the external finance premium. Finally, because the external financial premium is inversely related to investment, spending and production, the return arrow depicts pro-cyclical feedback into aggregate economic activity.

Figure 1. The Financial Accelerator in outline

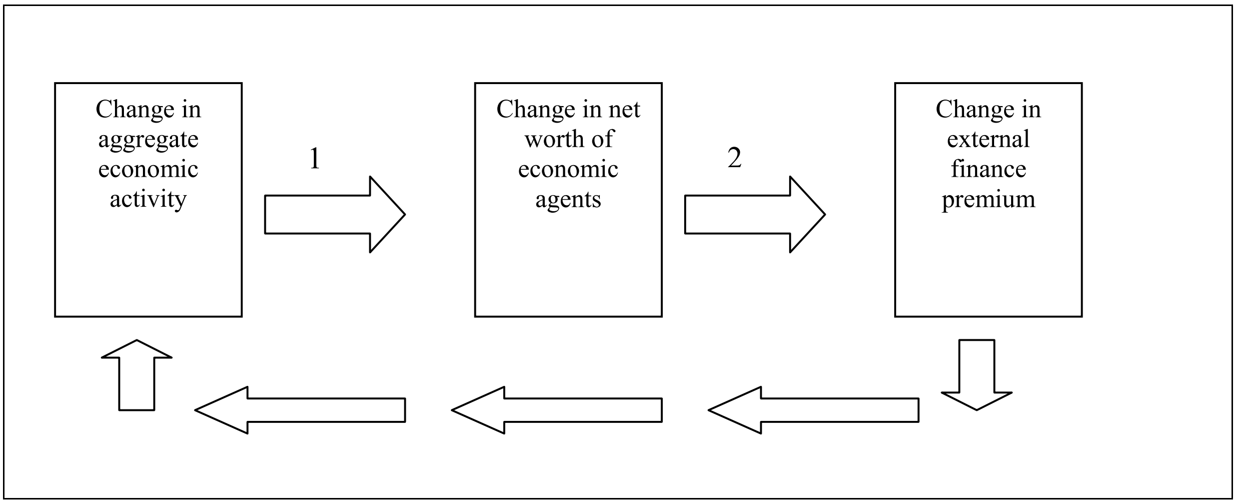

Figure 1 highlights that the Financial Accelerator could weaken in two ways, thereby reducing output growth volatility. First, the effect of changes in aggregate economic activity on net worth may have weakened over recent decades. Secondly, if financial market imperfections associated with asymmetric information have reduced, then the external financial premium would have correspondingly diminished and, consequently, the Financial Accelerator effect attenuated. In this paper, we consider the first possibility.

In a closed economy, agents' net worth has a completely domestic origin. In this case, and taking the level of capital market imperfections as given, the strength of the Financial Accelerator depends directly on the correlation between GDP changes and agents' net worth. In contrast, in an integrated open economy agents' net worth may consist of both domestic and foreign assets, in which case only part of net worth is directly influenced by domestic GDP changes, while the remaining foreign component is directly influenced by foreign GDP changes. Building on Bernanke, Gertler and Girlchrist's (1999) Financial Accelerator framework, Portes (2007) develops a general equilibrium model according to which international diversification, advanced by economic globalization, provides economic agents with a smoother time path of net worth, which results in a less volatile external finance premium and, hence, less volatile aggregate output. Portes' (2007) simulations suggest that international net worth diversification can account for almost 20 percent of the observed decline in US output growth volatility. Since the internationalization of economic activity is a global phenomenon rather than affecting the US specifically, we investigate this hypothesised globalisation effect on GDP growth volatility for a large number of countries. Accordingly, we first test the hypothesis that, in the decades preceding the current downturn, *international net worth diversification reduced output growth volatility.*

The hypothesized mechanism depends on the assumption of asymmetric economic shocks across national economies; that is, of incomplete GDP growth synchronization. This assumption is consistent with considerable empirical evidence (see, for example: Kose Prasad and Terrones, 2003b; Stock and Watson, 2003). Yet the current generalized downturn suggests considerable synchronization of national business cycles. This possibility is consistent with the most recent empirical evidence, which detects considerable time-variation in business cycle synchronization. In particular, Kose, Otrok and Prasad (2008) and Yoon (2005) suggest that there has been recent increase in business cycle synchronization. Moreover, many researchers argue that synchronization of national business cycles is positively related to trade and financial integration (see, for example: Imbs, 2006; Baxter and Kouparitsas, 2005; Calderon, Chong and Stein, 2007), although this view is still contested (see Kose, Otrok and Prasad 2008). From this perspective, it is possible that globalization has given rise to offsetting processes: on the one hand the hypothesized moderating effects of international net worth diversification on GDP growth volatility; and, on the other, a tendency towards synchronization of national economic cycles that eventually may have attenuated these effects. This suggests a further hypothesis; namely, that *the* *moderating or stabilizing influence of net worth diversification may have been merely transient*, as its capacity to stabilize the global economy was eventually undermined by the synchronizing effects of globalization. Accordingly, we also investigate whether the effect of international net worth diversification on output growth volatility weakens towards the end of our sample period.

3 Empirical Model and Data Description

The hypothesised negative relationship between international diversification of economic agents' net worth and GDP growth volatility is tested by a panel linear regression model:

$$GDPvolatility_{i,t} = \alpha_i + \beta NWD_{i,t} + Q_{i,t}\gamma + \varepsilon_{i,t} \qquad (1)$$

where *GDPvolatility* represents the standard deviation of GDP growth; α_i stands for the country-specific fixed effects; *NWD* is a measure of agents' net worth diversification and β is the corresponding parameter to be estimated; Q is a $1\times k$ vector of k control variables and γ is the corresponding $k\times 1$ vector of parameters to be estimated; ε is the error term; and i and t index country and time periods, respectively. All continuous variables are in natural logarithms. The fixed-effects help to address endogeneity caused by omitted country-specific variables, which may be important in this study since the number of control variables is limited by data availability.

We use this model to analyse a panel of non-overlapping averages of annual data. To avoid arbitrary selection of the time span, which is characteristic of previous studies, the analysis draws on findings from Ćorić (2007) about structural changes in the GDP growth volatility of 97 countries over the period 1961-2005. Following these results the countries are selected into three groups. The first group includes countries for which change(s) in GDP growth volatility are detected as break change(s) by the Bai and Perron (1998) test for multiple structural breaks. Countries for which change in GDP growth volatility is detected as a trend comprise the second group. Finally, the third group includes countries for which no change in GDP growth volatility is detected. The observations for each country included in the first group are divided into periods according to the detected break points in GDP growth volatility: in cases when one break in GDP growth volatility is detected, observations are divided into two periods and standard deviations are calculated for each of them; analogously, in the cases when two breaks are detected, data are divided into three time periods respectively. Overall, for this first group, the time span differs across countries. The length as well as the initial and the end year of time periods are unique for each country and depend on the position of the detected break point(s). Since the maximum number of detected break points in GDP growth volatility for each country is two, this method provides a maximum of three time-series observations per country.[1] To preserve consistency with the maximum possible number of time-series observations in the first group, the observations for each country included in the second group of countries are divided into three time periods (1970-1981, 1982-1993, 1994-2004).[2] The situation is a bit more complex with the third group of

[1] The maximum number of detected break points in GDP growth volatility of the 97 economies analyzed in Ćorić (2008) over the period 1961-2005 is three. However, due to data limitations (explained below) our present analysis is limited to the period 1970-2004. So, considering the results of the Bai and Perron test only for that period, the maximum number of detected break points for each country is two.

[2] Data limitations, mentioned in the previous footnote, limited our analysis to the period 1970-2004. Consequently, our data sample contains 35 time series observations. This precludes creation of three equal-length time periods and

countries. Here two approaches are adopted. First, division of observations into periods is avoided, since the standard deviation of GDP growth seems to be constant in these countries over the entire sample period. However, the employment of this method limits the size of the data sample, since it results in just one time-series observation for each country in this group. Hence, secondly, we apply the same procedure to this third group of countries as we do to the second group.

By compiling country-period observations for all three groups of countries, we create two panel data samples. The only difference between these samples is in the approach to the third group of countries: in Sample 1 the observations for each country included in the third group of countries are divided into three periods, yielding a maximum of 232 observations; in Sample 2, observations for countries in the third group are not divided into periods, yielding a maximum of 152 observations. (All data samples together with a more detailed and necessarily lengthy description of sample construction are available on request.)

The stock values of foreign direct investment (FDI) are used to construct a proxy for international diversification of economic agents' net worth (*NWD*). FDI reflects a "lasting interest" of an entity resident in one economy in an enterprise located in another economy (IMF, 1993). Accordingly, we consider that annual stocks of FDI assets (liabilities) should proxy relatively well the overall value of domestic (foreign) economic agents' net worth in other

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forces us to divide the data into two time periods of 12 and one of 11 time-series observations. The decision that the first two time periods are to include 12 (1970-1981, 1982-1993) and the last time period 11 (1994-2004) observations is based on the intention to minimize the possible influence of data gaps on the analysis (see pp. 9 and 10), since the problem of missing observations is more pronounced in the earlier than in the later years.

economies (the domestic economy). The *NWD* variable is constructed as the ratio of the sum of a country's stocks of FDI assets and liabilities to its GDP. Agents doing businesses in a particular country comprise both domestic and foreign economic agents. Hence, the net worth of all economic agents in that country would be more internationally diversified if domestic economic agents have more net worth outside of the country (measured by the country's stock of FDI assets), and if foreign economic agents have more net worth in the country (measured by the country's stock of FDI liabilities). The annual FDI (stocks) data were obtained from Lane and Milesi-Ferretti (2006). Unfortunately, the Lane and Milesi-Ferretti (2006) data does not match completely the data on changes in GDP growth volatility provided by Ćorić (2007). Hence, some countries and years are lost. Overall, the empirical analysis is based on annual data for 85 countries - accounting in 2004 for 82.13 percent of the world's population and 92.09 percent of the world's GDP (current US dollars) - for the years 1970-2004. The observations on *NWD* for each country are divided into the same periods as GDP growth volatility and the average value calculated for each time period. Taken together, a larger mean value of the sum of a country's stocks of FDI assets and liabilities in its GDP over some period should indicate a larger net worth diversification of economic agents in that country-period and vice versa.

To account for possible alternative determinants of output growth volatility, a number of control variables are included in the analysis. The control variables are suggested by previous studies that explore various aspects of output growth volatility (Beck, et al., 2006; Bekaert et al., 2006; Buch et al., 2005; Kose et al., 2003a; Levy-Yeyati and Sturzenegger, 2003; Denizer, et al., 2002; Easterly et al., 2000), although their number is limited by data availability for the countries and years in our sample. The set of control variables includes proxies for the effects of monetary, fiscal and real (supply side) volatility on GDP growth volatility. The proxy variables for the exposure of the economy to monetary shocks are *the standard deviation of money growth* and *the standard deviation of the inflation rate*. The proxy variable for the exposure of the economy to fiscal shocks is *the standard deviation of the share of government consumption in GDP*. The *standard deviation of terms of trade changes* is used to proxy supply-side shocks. The set of control variables also includes variables for international trade openness and financial system development. The measure of trade openness is the ratio of the *sum of imports and exports to GDP*. Two measures proposed by King and Levine (1993), the *ratio of M2 to GDP* and the *ratio of credits to the private sector to GDP*, are used to proxy financial development. Due to the empirically observed regularity between countries' GDP growth volatility and economic development (see, for example, Kose, Prasad and Terrones, 2005) the set of control variables includes countries' *GDP per capita*. According to Rodrik (1998), larger government purchases may better smooth economic shocks and cause lower GDP growth volatility. The *share of government consumption in GDP* controls for this possibility. Finally, we control for the possible effect of political instability on GDP growth volatility by including the *Civil Liberties Index*. Unfortunately, observations for the control variables are not available for all country-periods in the sample. Hence, two general principles are adopted in the construction of the data set. In the country-periods where one or maximally two observations for a certain variable are missing, the standard deviation or average values of that variable are still calculated. In the cases when more than two observations are missing, the country-periods are excluded from the analysis. Consequently, the inclusion of these variables shrinks the sample available for estimation. Complete lists of countries and data sources together with variable definitions are given in the Data Appendix.

In addition, to test the hypothesis that the effect of international net worth diversification on output growth volatility attenuated towards the end of our sample period, the model is estimated in cross-section form using the final seven years of the sample.

4 Results

Table 1 reports the results of estimating our panel regression model for four samples: Samples 1 and 2 have been discussed above; Samples 3 and 4 arise from a different definition of the dependent variable, which is an aspect of the robustness checking reported below. For each of these four samples, two regressions are reported: a bivariate regression of GDP growth volatility (*GDPvolatility*) on net worth diversification (*NWD*); and our fully specified model. For each sample, comparison between these two regressions provides two internal robustness checks. First, comparison reveals that the results on our variable of interest are not substantially influenced by the specification of our model: the reported signs are uniformly negative; levels of statistical significance vary little; and the size of the estimated coefficients does not greatly vary. Secondly, since missing data dictates that the number of countries in the sample varies with the number of included control variables, comparison confirms the robustness of our estimated effects of *NWD* with respect to the reported changes in sample size.

In the remainder of this Section, we report and discuss the estimates from Samples 1 and 2. Standard diagnostic tests establish that the fixed-effects models are well specified as statistical models with respect to autocorrelation and normality. Potential heteroskedasticity is addressed by White's heteroskedasticity-corrected standard errors, which are consistent if the residuals are correlated within but uncorrelated between groups. The construction of our samples should minimise the potential problem of cross-sectional correlation. Because the number and duration of periods are unique for each country in the first group, depending on the break point(s), not only are time dummies precluded in our specification but also the problem that they are typically intended to address is less likely to occur; namely, unobserved common shocks that can cause cross-sectional dependence. To address remaining concerns about cross-sectional dependence, we use Driscoll and Kraay's standard errors, which are robust to both within- and between-group dependence (although these are based on asymptotic theory, their value has been demonstrated in panels down to T=5; Hoechle, 2007). Driscoll and Kraay's robust standard errors outperform White's robust standard errors in the presence of between-group dependence while underperforming in its absence (Hoechle, 2007). Unfortunately, because our samples are unbalanced and short, we are unable to implement any of the available tests for cross-sectional dependence in panel data (Hoyos and Sarafides, 2006). Accordingly, both White's and Driscoll and Kraay's covariance matrix estimators were estimated, although the more conservative White's standard errors are reported.

Table 1 reports a uniformly negative and statistically significant relation between *NWD* and GDP growth volatility (except in column 4, where the estimated effect is borderline at the 10 percent level), with the size of the coefficients on *NWD* in the fully-specified models for Sample 1 and Sample 2 being, respectively -0.15 (Column 2) and -0.19 (Column 4), suggesting that a one percent increase in *NWD* on average decreases GDP growth volatility by, respectively, between 0.15 and 0.19 percent. For a rough illustration, the percentage increase of *NWD* from its median (13.26 percent) to the 75th percentile value (30.43 percent) results in a reduction of GDP growth volatility of between 19 to 25 percent (say, from the median volatility of 3.01 percent to, respectively, 2.42 and 2.27 percent). Hence, the effect of *NWD* on output growth volatility is economically relevant. However, the regression R^2 measures suggest that, although relatively large, the effect of *NWD* on GDP growth volatility is able to explain only a small part of the observed changes in GDP growth volatility.

Table 1. Fixed-effects estimates

Dependent variable	**GDP growth volatility**				**GDP growth volatility around HP trend**			
	Sample 1		Sample 2		Sample 3		Sample 4	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net worth diversification (*NWD*)	−0.199***	−0.152**	−0.347***	−0.192*	−0.217***	−0.269***	−0.452***	−0.377***
	(0.050)	(0.073)	(0.086)	(0.116)	(0.055)	(0.083)	(0.082)	(0.124)
GDP per capita		0.207		−0.193		-0.003		−0.510
		(0.261)		(0.434)		(0.224)		(0.359)
Government to GDP ratio		−0.312		−0.154		−0.472		−0.573
		(0.339)		(0.775)		(0.320)		(0.602)
Inflation rate volatility		0.257***		0.176		0.111		0.086
		(0.100)		(0.164)		(0.085)		(0.139)
Money growth volatility		-0.002		−0.059		0.040		0.042
		(0.111)		(0.195)		(0.092)		(0.149)
Government to GDP volatility		0.044		0.185		0.045		0.119
		(0.089)		(0.169)		(0.068)		(0.137)
Trade openness		0.338		0.257		0.659***		0.332
		(0.228)		(0.459)		(0.245)		(0.376)
Private credits to GDP		0.014		0.028		−0.099		−0.310
		(0.167)		(0.283)		(0.169)		(0.234)
M2 to GDP		0.071		0.131		0.106		0.540
		(0.076)		(0.465)		(0.282)		(0.442)
Civil Liberties		0.247		0.337		0.302		0.324
		(0.176)		(0.395)		(0.201)		(0.313)
Terms of trade volatility		0.161		0.317		0.092		0.061
		(0.108)		(0.193)		(0.075)		(0.092)
Constant	1.588***	−1.940	2.005***	0.651	1.594***	−0.374	2.200***	4.571
	(0.133)	(2.183)	(0.230)	(3.883)	(0.146)	(1.943)	(0.228)	(3.041)
Test for Normality H_0:normally distributed res.	0.46	0.65	0.06	0.36	0.54	0.89	0.18	0.40
Wooldridge test for Autocorrelation H_0: no first order correlation	0.83	0.99	0.86	0.93	0.01	0.03	0.10	0.17
Within R^2	0.09	0.32	0.20	0.42	0.12	0.29	0.32	0.49
No. of countries	85	76	85	73	85	74	85	73
No. of observations	232	197	152	132	223	185	153	132

Notes: *,**,*** indicate the 10%, 5% and 1% levels of significance. White's heteroskedasticity-robust standard errors are reported in parentheses for Samples 1, 2 and 4. For Sample 3, the reported standard errors are Rogers' heteroskedasticity and autocorrelation robust standard errors. Reported values for diagnostic tests represent their p -values. The reported test for normality is the D'Agostino, Balanger and D'Agostino test for normality as adjusted by Royston.

One more variable appears to have a statistically significant effect on GDP growth volatility in Sample 1 (Column 2). To the extent that inflation volatility is a good approximation for monetary policy shocks, the significantly positive coefficient on inflation rate volatility indicates that a higher monetary disturbance on average leads to higher GDP growth volatility. This finding is in line with Beck, Lundberg and Majoni (2006) and Denizer, Iyigun and Owen (2002). The loss of significance generally observed in the Sample 2 estimates (Column 4) is consistent with the smaller number of observations (132 for the fully-specified model compared to 197 in Sample 1).

Volatility measured around the Hodrick-Prescott trend

Output growth volatility defined as the standard deviation of GDP growth implicitly assumes constant mean GDP growth over the sample period. Yet this assumption may not be fulfilled for many countries in the sample (Ćorić, 2008). To account for the possibility that mean GDP growth rates may change over time, GDP growth volatility is redefined as the standard deviation of GDP growth around the Hodrick-Prescott (HP) trend. This resulted in Samples 3 and 4, as noted above. The only difference between them is that observations for countries with constant GDP growth volatility are divided into three periods in Sample 3, but are not divided into time periods in Sample 4. The estimates from Samples 3 and 4 are reported in Table 1, Columns 5-8. The diagnostic tests establish that the fixed-effects models are well specified as statistical models with respect to normality. However, the diagnostic procedure revealed possible autocorrelation in the residuals of the estimates from Sample 3. The problem of autocorrelation in the residuals is addressed by Rogers' heteroskedasticity- and autocorrelation-corrected (robust) standard errors. The potential problem of cross-sectional dependence is addressed in the same way as in Samples 1 and 2 by Driscoll and Kraay's standard errors. As in the previous cases, we report estimates with the more conservative standard errors.

The estimates from Samples 3 and 4 indicate that the results discussed for Samples 1 and 2 above are robust to our alternative definition of the dependent variable. *NWD* is again a uniformly negative and statistically significant influence on growth volatility. The estimates from Sample 3, as from Sample 1, also indicate a statistically significant effect of one more variable on GDP growth volatility. However, this time that variable is trade openness. The significantly positive coefficient on trade openness suggests that increased international trade is associated with larger swings in output, which is consistent with the findings of Beck, Lundberg and Majoni (2006), Kose, Prasad and Terrones (2003) and Easterly, Islam and Stiglitz (2000). The estimated coefficients on inflation rate volatility remain positive, but lose statistical significance.

In addition to different definitions of GDP volatility, we also check our results with respect to different estimation techniques. For reasons of space, we do report results from either pooled ordinary least squares (OLS) or random effects (RE) estimation, although both are available upon request.[3] In both, RE and pooled OLS, estimates of the coefficients on *NWD* from our fully-specified models are similar with respect to sign and level of significance to those reported in Table 1, although smaller (in absolute terms). Such differences as do appear between the pooled OLS and the results reported in Table 1 are likely to reflect the advantage of our fixed effects model in controlling for unobserved country-specific (but time-invariant) effects.

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[3] In addition, outlier-robust estimation demonstrates that our results are not influenced by undue "leverage" on the regressions exerted by observations with extreme values. (These results are available upon request.)

Finally, since we deal with unbalanced panels with only three time-series observations, in which the number of countries with a lower number of time-series observations is substantial, the introduction of a lagged dependent variable into the model led to a large reduction in the size of our samples. However, we did experiment with dynamic model specifications. (The results are available upon request.) Overall, the coefficients on *NWD* remain negative in the dynamic model specification as well. The size of the coefficients, estimated by the Arellano and Bover (1995) system GMM estimator, are very similar to their sizes in random-effect and OLS estimations; however, they lose statistical significance. As far as the lagged dependent variable is concerned, the results are mixed. Namely, a statistically significant coefficient on the lagged dependent variable is revealed in the estimates on Samples 3 and 4, but not in the estimates on Samples 1 and 2. Moreover, the coefficient on the lagged dependent variable changes its sign from negative in the estimates on Samples 1 and 2 to positive in the estimates on Samples 3 and 4.

Endogeneity

It is possible that more stable economic conditions attract more FDI and vice versa. Accordingly, instrumental variables (IV) estimation of the fixed-effects model is implemented to account for the possible endogeneity of *NWD*. The Wu-Hausman test for endogeneity (Table 2) establishes that the assumption of *NWD's* exogeneity cannot be rejected at conventional levels of significance. However, to address remaining concerns on theoretical grounds that *NWD* may be endogenous, we define three sets of instruments to estimate the effect of *NWD* on output growth volatility.

The first instrument set comprises: the average share of urban population; the average life expectancy; and the beginning of country-period values of GDP per-capita, trade openness and *NWD*. The orthogonality of the instruments is tested by Hansen's (1982) *J* statistic:[4] the results do not suggest correlation between instruments and residuals. Even so, in case the beginning of country-period instruments may, by themselves, influence GDP growth volatility, we define a second set of instruments comprising only the lagged share of urban population and the lagged average life expectancy. Finally, in the third set, the lagged levels of *NWD* are used as instruments.

Table 2 reports the results for our fully-specified model from IV estimation using Sample 1, with *NWD* instrumented by the first set of instruments. If instruments are uncorrelated, or weakly correlated, with endogenous variable(s) then IV estimators can perform poorly (Baum, Schaffer and Stillman, 2007). Hence, tests for underidentification and weak identification of instruments are reported. The Kleibergen and Paap (2006) test statistics suggest that underidentification is not a problem at conventional levels of significance,[5] while the value of the Kleibergen-Paap *rk Wald F* statistic (12.32) suggests that the null of weak correlation of instruments and *NWD* should be rejected as well.[6]

As well as conventional 2SLS estimation, we report results from three alternative approaches to IV estimation. In the presence of heteroskedasticity, the GMM

[4] In the presence of heteroskedasticity, Sargan's statistic is not valid. However, the heteroskedasticity-robust overidentification statistic is identical to Hansen's *J* statistic (Baum, Schaffer and Stillman, 2003).

[5] The Kleibergen-Paap rk LM statistic is robust to heteroskedasticity and autocorrelation (Baum, Schaffer & Stillman, 2007).

[6] Baum, Schaffer and Stillman (2007) suggest reporting the *Wald F* statistic based on the Kleibergen and Paap (2006) *rk* statistic to test for weak identification in the cases when *i.i.d.* residuals are not assumed. Furthermore, since Stock and Yogo's (2005) tabulated critical values for the weak identification test are compiled for the case of *i.i.d.* residuals, they suggest application of the older "rule of thumb" that the *F* statistic should be at least 10 for weak identification not to be considered as a problem.

estimator is more efficient than the 2SLS estimator, whereas if heteroskedasticity is not present, GMM is no worse asymptotically than 2SLS (Baum, Schaffer and Stillman, 2003). However, the efficient GMM estimator often has poor small sample properties (Baum, Schaffer and Stillman, 2003). GMM continuously updated estimation (CUE) (Hansen, Heaton and Yaron, 1996) and limited information maximum likelihood (LIML) estimation may perform better than 2SLS or GMM when instruments are weak (Hahn, Hausman and Kuersteiner, 2004) and, although not more efficient asymptotically, may have better small sample properties (Baum, Schaffer and Stillman, 2007). In all cases, potential problems of heteroskedasticity and serial correlation are addressed by estimation of the Newey-West covariance matrix.

In comparison to the fixed-effects models, the IV estimates in which *NWD* is instrumented by the first set of instruments are very similar. The coefficients on *NWD* are all negative and statistically significant at five percent or better, while the absolute size of the coefficients remains similar.[7] Compared to the IV estimates reported in Table 2, the IV estimations on Sample 1 from the second set of instruments are similar. The coefficients on *NWD* are generally less significant but are uniformly negative and of similar size.[8] Finally, system GMM estimation, in which *NWD* was instrumented with its own lagged levels, was undertaken. The estimated coefficients on *NWD* remain uniformly negative, except for Sample 3. However, the coefficients on *NWD* are not estimated with acceptable levels of statistical significance. (The results from IV

[7] The IV estimates using Samples 2, 3 and 4 do not differ substantially (these are available on request).

[8] The IV estimations on Samples 2, 3 and 4 are also negative and statistically significant. However, the Kleibergen and Paap (2006) test statistics suggest that the instruments are uncorrelated with the potentially endogenous variable.

estimation in which *NWD* is instrumented by the second and third sets of instruments respectively are available on request.)

Table 2. Instrumental Variables estimates (Sample 1)

Dependent variable: GDP growth volatility	2SLS	GMM	LIML	CUE
Net worth internationalization (*NWD*)	-0.337**	-0.336**	-0.408**	-0.360***
	(0.147)	(0.141)	(0.184)	(0.141)
GDP per capita	0.381	0.385	0.444	0.459*
	(0.266)	(0.259)	(0.283)	(0.256)
Government to GDP ratio	-0.449	-0.402	-0.500	-0.345
	(0.352)	(0.342)	(0.363)	(0.343)
Inflation rate volatility	0.237**	0.205*	0.228**	0.161
	(0.113)	(0.109)	(0.116)	(0.109)
Money growth volatility	0.000	-0.002	0.002	0.028
	(0.112)	(0.108)	(0.114)	(0.110)
Government to GDP volatility	0.019	0.011	0.010	0.005
	(0.097)	(0.096)	(0.101)	(0.100)
Trade openness	0.480*	0.493**	0.529*	0.388
	(0.260)	(0.257)	(0.278)	(0.243)
Private credits to GDP	-0.042	-0.082	-0.066	-0.175
	(0.201)	(0.192)	(0.209)	(0.211)
M2 to GDP	0.071	0.058	0.070	0.026
	(0.090)	(0.087)	(0.096)	(0.090)
Civil Liberties	0.189	0.211	0.161	0.183
	(0.193)	(0.191)	(0.200)	(0.189)
Terms of trade volatility	0.097	0.069	0.071	0.007
	(0.127)	(0.123)	(0.134)	(0.128)
Endogeneity test H_0: OLS estimator is consistent with IV estimator	0.12	0.12	0.12	0.12
Overidentification test H_0: Instruments are orthogonal to the errors	0.19	0.19	0.20	0.20
Underidentification test H_0: Instruments are uncorrelated with endogenous variable	0.00	0.00	0.00	0.00
Weak identification test H_0: Instruments are weak	12.32	12.32	12.32	12.32
No. of countries	72	72	72	72
No. of observations	191	191	191	191

Notes: *,**,*** indicate the 10%, 5% and 1% levels of significance. Heteroskedasticity and autocorrelation robust standard errors are reported in parentheses. The net worth diversification (*NWD*) variable is instrumented by: average share of urban population; average life expectancy; and by the beginning of country-period values of GDP per-capita, trade openness, Civil Liberties and *NWD*. The reported diagnostic tests are as follows: for endogenous regressors, the Wu-Housman F-test version of the endogeneity test, which is robust to various violations of conditional homoscedasticity; for overidentification, the Hansen *J* statistic; for underidentification, Kleibergen and Paap's (2006) test; for weak identification, the Kleibergen-Paap rk Wald F statistic. The reported values for the diagnostic tests, except for the weak identification test, are their respective p -values.

Overall, both the Wu-Hausman test statistics and different approaches to IV estimation suggest that the effect of *NWD* on output growth volatility is unlikely to be driven by endogeneity.

Model in changes

Because our theory suggests a relationship between the level of globalisation and output growth volatility, we have focussed on this relationship in our empirical work. However, our proxy for globalisation, *NWD*, is a cumulative measure, which over the period considered is generally trending upwards.[9] Accordingly, we investigate the possibility that our results are "spurious", merely reflecting common underlying statistical generating mechanisms rather than economically interesting relationships. In the remainder of this section, we report the results from estimating the first difference of our model, hence with all variables transformed into (approximate) percentage rates of change. This is a much more demanding test of our hypothesis, in that we now investigate whether or not the changes in the growth rate of net worth diversification are systematically linked with changes in output growth volatility.[10] Country-specific fixed effects are differenced out of the growth model (their joint lack of significance was confirmed by a standard likelihood ratio test). The results of ordinary least squares estimation without the fixed-effects are reported in Table 3.

[9] Of the 147 observations on the percentage change in net worth diversification, 21 (14 percent) are negative, with a mean value of -34%. The remaining 126 have a mean value of 89%.

[10] Of 147observations on the percentage change in output growth volatility, 64 are from countries with two observations.

Table 3. Ordinary least squares estimates of the model in rates of change (%Δ)

Dependent variable	%Δ GDP growth volatility				%Δ GDP growth volatility around HP trend			
	Sample 1		Sample 2		Sample 3		Sample 4	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
%Δ Net Worth Diversification	-0.141 * (0.083)	-0.139 (0.097)	-0.145 (0.117)	-0.123 (0.134)	-0.150 * (0.080)	-0.246 ** (0.105)	-0.289 *** (0.111)	-0.285 ** (0.142)
%Δ GDP per capita		0.394 (0.294)		0.125 (0.440)		0.102 (0.286)		-0.274 (0.419)
%Δ Government to GDP ratio		-0.181 (0.337)		0.060 (0.589)		-0.419 (0.309)		-0.299 (0.497)
%Δ Inflation rate volatility		0.281 *** (0.076)		0.171 (0.120)		0.119 (0.077)		0.087 (0.111)
%Δ Money growth volatility		-0.018 (0.091)		0.053 (0.165)		0.027 (0.084)		0.053 (0.124)
%Δ Government to GDP volatility		0.046 (0.094)		0.167 (0.152)		0.014 (0.075)		0.080 (0.126)
%Δ Trade openness		0.341 * (0.209) [a]		0.205 (0.368)		0.584 ** (0.238)		0.344 (0.313)
%Δ Private credits to GDP		0.013 (0.155)		-0.106 (0.258)		-0.260 (0.176)		-0.405 * (0.232)
%Δ M2 to GDP		0.110 (0.127)		0.599 (0.480)		0.318 (0.280)		0.690 (0.426)
%Δ Civil Liberties		0.246 (0.204)		0.331 (0.340)		0.173 (0.210)		0.212 (0.301)
%Δ Terms of trade volatility		0.095 (0.112)		0.172 (0.176)		0.008 (0.094)		0.022 (0.120)
Constant	-0.139 * (0.085)	-0.133 (0.112)	-0.355 *** (0.134)	-0.320 * (0.192)	-0.174 ** (0.082)	-0.198 * (0.118)	-0.283 ** (0.122)	-0.280 (0.184)
Cameron & Trivedi's test for:								
Heteroskedasticity	0.500	0.086	0.392	0.439	0.403	0.668	0.059	0.439
Skewness	0.507	0.226	0.155	0.643	0.203	0.617	0.250	0.342
Kurtosis	0.187	0.914	0.205	0.381	0.900	0.783	0.402	0.629
Breusch-Pagan test for heteroskedasticity	0.265	0.133	0.134	0.720	0.584	0.144	0.050	0.296
Ramsey RESET test using powers of the fitted values	0.842	0.000	0.771	0.062	0.985	0.301	0.216	0.032
Variance Inflation Factor:								
Maximum		2.94		2.88		4.46		4.36
Mean		1.54		1.75		1.92		2.00
Adjusted R^2	0.013	0.188	0.008	0.052	0.018	0.069	0.079	0.047
No. of countries	85	73	45	41	85	70	50	44
No. of observations	147	121	67	59	138	111	68	59

Notes: *,**,*** indicate the 10, 5 and 1% levels of significance. [a] – borderline at 10% (p=0.106). Standard errors are reported in parentheses. p -values are reported for the diagnostic tests.

In each regression (Columns 1-8), the estimates are supported by generally satisfactory diagnostic results (the corresponding assumptions of linear regression are not rejected at conventional significance levels); the failure of linearity reported in Column 2 (p=0.000) and the borderline result in Column 8 (p=0.032) are the exceptions. The pattern of the estimates is very similar to that reported in Table 1. Qualitatively, the results for our variable of interests are identical; in each case, positive change in *NWD* is associated with negative change in GDP growth volatility. Quantitatively, the estimated (constant) elasticities are similar, ranging from -0.123 to -0.289 in Table 3 and from −0.152 to −0.452 in Table 1. Moreover, the percentage change in net worth diversification is the only variable to display a statistically significant effect in the majority of regressions (two at the 10% level, two at 5% and one at 1%). If we disregard the Column 2 regression, noting the clear rejection of linearity from the Ramsey test of functional form, then five from seven estimates of the effects of *NWD* are as hypothesised. Overall, both the general pattern of results and the particular results for our variable of interest are consistent across Tables 1 and 3. Hence, it is reasonable to conclude that our findings are not driven by spurious regression.

Results of Cross-section Regression

Finally, we test the hypothesis that the moderating effects of international net worth diversification on GDP growth volatility have been attenuated in recent years. Unfortunately the options to test this hypothesis using our data are very limited. First, because the number and duration of periods are unique for each country, depending on the break point(s) in GDP growth volatility, the estimation of either period dummies or a time trend is precluded. Second, due to limited availability of data on *NWD*, our analysis cannot extend beyond 2004. Consequently, we estimate a cross-section regression on the final one fifth of our sample – the seven years 1998-2004 – with the variables appearing, as appropriate, either as averages or as standard deviations over the period.

The estimated coefficients on *NWD* reported in Table 4 are different from those reported in Tables 1, 2 and 3. First, they are smaller (-0.049 and -0.062 respectively, in the fully-specified models, compared to those in Table 1 which range from -0.152 to -0.377). And, secondly, in no case are the coefficients on *NWD* reported in Table 4 estimated as significantly different from zero (in each case, the standard errors are much larger than the corresponding coefficients). Moreover, statistically significant effects of inflation volatility and trade openness on GDP volatility similar to those noted in Tables 1, 2 and 3 suggest that lack of any significant effects from *NWD* is unlikely to reflect merely the lower number of observations available for the cross-section regressions.

This evidence should not be over-interpreted. First, cross-section regression offers no possibility to control for unobserved country-specific effects. Secondly, the distribution of the detected break periods in GDP growth volatility across the countries in the sample, as well as lack of data for the early years for some countries, precludes construction of a consistent data sample for either the first or subsequent seven year periods (or, indeed, for earlier periods of any other duration). Hence, we are unable to compare the estimates in Table 4 with estimates from earlier periods.

The evidence presented in this section does suggest that the effects of international net worth diversification on GDP growth volatility have attenuated in more recent years compared to the entire 1970-2004 period and is thus consistent with the hypothesis that *the moderating or stabilizing influence of net worth diversification may have been merely transient*. However, this evidence is too limited to be more than suggestive.

Table 4. Cross-section regression estimated by ordinary least squares

Dependent variable	**GDP growth volatility:**		**GDP growth volatility around HP trend:**	
	(1)	(2)	(3)	(4)
Net Worth Diversification	0.035	-0.049	0.018	-0.062
	(0.082)	(0.111)	(0.082)	(0.112)
GDP per capita		0.127		0.180 **
		(0.087)		(0.087)
Government to GDP ratio		(-0.115)		-.097
		(0.212)		(0.213)
Inflation rate volatility		0.366 ***		0.360 ***
		(0.095)		(0.096)
Money growth volatility		0.120		0.082
		(0.132)		(0.133)
Government to GDP volatility		0.164		0.186 *
		(0.104)		(0.104)
Trade openness		0.333 *		0.360 **
		(0.172)		(0.173)
Private credits to GDP		0.140		0.123
		(0.155)		(0.156)
M2 to GDP		0.178		0.127
		(0.176)		(0.176)
Civil Liberties		0.057		0.180
		(0.210)		(0.212)
Terms of trade volatility		0.233 **		0.229 **
		(0.114)		(0.115)
Constant	0.615 **	-3.313 **	0.607 **	-3.673 **
	(0.297)	(1.412)	(0.298)	(1.417)
Cameron & Trivedi's test for:				
Heteroskedasticity	0.635	0.446	0.627	0.446
Skewness	0.310	0.107	0.389	0.367
Kurtosis	0.165	0.078	0.117	0.114
Breusch-Pagan test for heteroskedasticity	0.543	0.050	0.535	0.022
Ramsey RESET test using powers of the fitted values	0.569	0.063	0.518	0.068
Variance Inflation Factor:				
Maximum		5.14		5.14
Mean		2.76		2.76
Adjusted R^2	-0.001	0.314	-0.012	0.316
No. of countries	85	75	85	75
No. of observations	85	75	85	75

Notes: *,**,*** indicate the 10, 5 and 1% levels of significance. Standard errors are reported in parentheses. p -values are reported for the diagnostic tests.

5 Conclusion

This paper contributes to understanding the waning of GDP growth volatility that characterised the "Great Moderation" in the decades before the current downturn. In addition, it presents some evidence suggesting why this moderation may have been inherently transient.

Previous research into the effects of the Financial Accelerator in the US suggest that international diversification smoothes the time path of net worth, resulting in a less volatile external finance premium and, hence, less volatile aggregate output. The contribution of this paper is to draw upon recent analysis, by one of the authors, of structural breaks in growth volatility in order to construct an almost global database - 85 countries for the years 1970-2004, accounting for more than 90 percent of world GDP in 2004 – and then to test the hypothesis that, in recent decades, and across the world, international net worth diversification has reduced output growth volatility. The results from panel regression analysis do not reject this hypothesis. The consistently negative and statistically significant coefficients on net worth diversification (*NWD*) suggest that increased international diversification of agents' net worth is associated with lower GDP growth volatility. The results are robust with respect to a different definition of output growth volatility as well as to different estimation techniques. The robustness checks also suggest that the effect of *NWD* on output growth volatility is unlikely to be driven by endogeneity or spurious regression.

The results reported in this paper also suggest significant effects on GDP growth volatility from two more variables. The significantly positive coefficients on inflation volatility suggest that higher (lower) monetary disturbance on average leads to higher (lower) GDP growth volatility. The positive coefficients on trade openness suggest that an increase in international trade intensity is associated with higher growth volatility.

This analysis provides new evidence on the causes of changes in GDP growth volatility across the world in the period preceding the current global downturn. Yet the estimated models reported in this paper account for only a small part of the changes in growth volatility over our sample period. Hence, a more complete explanation of changes in the GDP growth volatility of many of the world's economies requires further investigation. Nonetheless, this analysis does have three implications for the possible direction of future research.

The first implication is the role of financial acceleration in output growth volatility. The evidence reported in this paper is consistent with the possibility that economic globalization, by promoting the international diversification of agents' net worth, may have caused reduction in GDP growth volatility by reducing the strength of the Financial Accelerator. The second concerns the impact of globalisation more generally. If we consider only the suggested effect of economic globalization on the strength of the Financial Accelerator, the findings suggest that globalization may have reduced GDP growth volatility during the sample period. Yet our findings also include some significantly positive coefficients on trade openness, suggesting that this aspect at least of economic globalization may have increased GDP growth volatility. This evidence is consistent with previous studies that have found more open economies to be more exposed to foreign economic shocks and, hence, to have more volatile output growth. Taken together, the results reported in this paper suggest that while globalization may have made national economies more exposed to external economic shocks it may, during the sample period, have helped to make them more resistant to such shocks.

The third implication of our analysis is tentative, because the evidence is more limited. Subject to this caveat, we report some evidence that the moderating effect of net worth diversification did not operate during the final years of our sample period. Accordingly, in the absence of consensus on other causes of the Great Moderation, if net worth diversification was a transient cause of the Great Moderation, then to this extent the Great Moderation itself is shown to be inherently transient. Even though the supporting evidence is tentative, this speculation does suggest a new line of enquiry. It is possible that globalization not only enabled greater international net worth diversification but also, by increasing business cycle synchronization, gradually reduced the stabilising effect of this diversification. If so, then reduction in the strength of financial acceleration as a cause of diminished output growth volatility, which is consistent with the main evidence reported in this paper, may have been a transient process whose attenuation contributed to the end of the Great Moderation.

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Data Appendix

Variable	Definition	Sources
GDP volatility	Standard deviation of the real GDP growth rates	World Bank, World Development Indicators online data base (2007)
Net worth internationalization	Ratio of the average value of the sum of Foreign Direct Investment assets and liabilities (stocks) to GDP	Lane and Milesi-Ferretti (2006)
Money growth volatility	Standard deviation of the M1 growth rates	International Monetary Fund, International Financial Statistics, CD-Rom (2006), Yearbook (2000, 2002, 2007)
Inflation rate volatility	Standard deviation of inflation rates	World Bank, World Development Indicators online data base (2007)
Government to GDP volatility	Standard deviation of the real government consumption to GDP ratio	Penn World Tables version 6.2.
Terms of trade volatility	Standard deviation of terms of trade (2000=100) change	World Bank, National Account data, kindly provided by the Development Data Group's Client Services Team
Trade openness	Ratio of the average value of the sum of imports and exports to GDP	Penn World Tables 6.2. World Bank, World Development Indicators online data base (2007)
M2 to GDP ratio	Ratio of the average value of M2 to GDP	World Bank, World Development Indicators online data base (2007) International Monetary Fund, International Financial Statistics Yearbook (2000, 2007)
Private credits to GDP ratio	Ratio of the average value of the credits provided to the private sector to GDP	World Bank, World Development Indicators online data base (2007)
GDP per capita	Average value of GDP per capita (in 2000 US$)	World Bank, World Development Indicators online data base (2007)
Government to GDP ratio	Ratio of the average value of real government consumption to GDP	Penn World Tables version 6.2.
Civil Liberties	Average value of the sum of the political rights and civil liberties ratings (measured on the 1 to 7 scale, with 1 corresponding to the highest degree of freedom)	Freedom House, Freedom in the World Country Ratings (2007)
Countries	Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Cameroon, Canada, Chad, Chile, China, Colombia, Congo Republic, Costa Rica, Côte d'Ivoire, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Finland, France, Gabon, Germany, Ghana, Greece, Guatemala, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Japan, Kenya, Korea, Madagascar, Malawi, Malaysia, Malta, Mexico, Morocco, Myanmar, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Rwanda, Senegal, Singapore, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Thailand, Togo, Trinidad and Tobago, United Kingdom, United States, Uruguay, Venezuela, Zambia, Zimbabwe	

Note: All data are annual.