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The impact of institutional volatility on financial volatility in transition economies: a GARCH family approach

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Abstract

The volatility of financial markets has been a relevant topic for transition economies, as the countries of Central and Eastern Europe and the former Soviet Union have seemingly endured high levels of volatility in their financial sectors during the transition process. But what have been the determinants of this financial volatility? This paper posits that institutional changes, and in particular the volatility of various crucial institutions, have been the major causes of financial volatility in transition. Examining 20 transition economies over various time-frames within the period 1993–2012, this paper applies the GARCH family of models to examine financial volatility as a function of institutional volatility. The results from the EGARCH and TGARCH modelling supports the thesis that more advanced and more stable institutions help to dampen financial sector volatility at their levels, while institutional volatility feeds through directly to financial sector volatility in transition.

Keywords: institutions, financial sector, volatility, transition, GARCH, EGARCH, TGARCH

JEL Codes: G20, O43, P30

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1 Introduction

Owing to the severity of the global financial crisis and the apparent increased incidence of financial crises over the past twenty years, the examination of financial volatility and its determinants has become a fruitful and important topic for economists in recent years. Part of this interest is the fact that financial assets and instruments apparently have a much higher level of volatility than ‘real’ output, such as consumption, growth, and savings; the more relevant fact, however, is that persistent financial volatility can feed through to and damage the real economy. As Daly (2011:46) noted, these effects, especially if they appear unrelated to economic fundamentals, “may lead to an erosion of confidence in capital markets and a reduced flow of capital into equity markets.” Thus, ascertaining the determinants of financial volatility would appear to be a first step towards reducing the possible effects of this volatility on the real economy.

The volatility of financial markets has similarly been a relevant topic for transition economies as well, as the countries of Central and Eastern Europe (CEE) and the former Soviet Union (FSU) have seemingly endured higher levels of volatility in their financial sectors during the transition process. With financial crises ranging from region-wide breakdowns, such as Russia in 1998−99 and the global financial and Eurozone crises from 2007 to the present, to country-specific crises such as Latvia in the mid−1990s and Slovakia in the late 1990s, the countries transitioning from communism to capitalism appear to have felt first-hand the damaging consequences of financial volatility.

However, while the determinants of financial sector volatility have been studied in a developing country context, there has been a notable lack of focus exclusively on transition economies. Indeed, much of the transition literature has treated the rise of financial volatility as part of the broader transition process, an inevitable by-product of the learning curve of financial sector institutions and the volatile macroeconomic environment that the financial sector faces in transition. But has this really been the case? What are the drivers of financial volatility that appear to plague even late-stage transition economies?

An obvious culprit for the source of this volatility would appear to be the financial liberalization that accompanied transition. Financial liberalization, including the freeing of interest rates, allowance of private banks (internal liberalization) and removal of capital controls (external liberalization) has been part and parcel of the transition to capitalism. An extensive literature links financial sector liberalization in transition with expansion of credit to the private sector (Cottarelli, Dell'Ariccia and Vladkova-Hollar (2005)), development of sound banks (Fries and Taci (2002)), growth in firm sales and use of debt for financing (Giannetti and Ongena (2009)) and, teamed with governmental fiscal and monetary responsibility (Berglof and Bolton (2002)), sustained economic growth (Akimov, Wijeweerab and Dollery (2009)). But while there may be some theoretical conjecture on the link between liberalization and extreme volatility (as in Stiglitz (2002), where he argues the premature exposure of immature financial institutions to world markets will bring more harm than good), there has been little formal work done linking financial liberalization with volatility in transition economies. This *does not* mean that the volatility does not exist: as Buiter (2003) and Egert and Koubaa (2004) point out, "in general, equity markets in Central and Eastern Europe are high yield, volatile markets" (Buiter (2003: 132)). It *does* mean that the modelling of volatility and financial liberalization in transition is at a very early stage.

Perhaps a deeper explanation, however, for the uptick in financial volatility in transition relates to the very reason for transition, and that is the change of institutions from communist-era to capitalist institutions. Given that changes in financial sector institutions in transition occur in tandem with broader institutional changes throughout an economy, it is not unreasonable to assume that the broader institutional environment will both influence financial sector development *and* influence the incidence of volatility. Here, too, there is a noticeable gap in the literature regarding the interactions of economic institutions and financial institutions; Coricelli and Maurel (2011) is one of the few papers to model the interplay of financial institutions and other market-supporting institutions, but they shy away from the concept of volatility. Other studies that do delve into volatility in transition likewise miss the institutional aspect, limited to an examination of macroeconomic variables and their effect on volatility (see, for example, Hsing and Hsieh (2012)).

The purpose of this paper is, thus, to examine several interrelated questions regarding the nature of institutions and financial volatility in transition:

- Did economic and political institutions, specifically property rights and democratic accountability, have a discernible effect on financial sector volatility during the transition period?
- Do other macroeconomic variables found to already have an impact in the literature on volatility (such as growth of M2/GDP, as in Hsing and Hsieh (2012)) have more or less of an effect in the presence of market-supporting institutions?

- Did the volatility of these institutions and their changes during the transition period affect financial markets? Put simply, did *institutional* volatility feed through to *financial* volatility?

This paper makes a novel contribution to the literature on financial sector institutions and transition economics in three ways. First, it examines the institutional influence on financial sector volatility exclusively for transition economies, an issue that has been little explored except in the context of the transition process itself. Secondly, this paper uses monthly institutional data from transition economies, a difficult but appropriate choice in an environment in flux and where institutional change is precisely the goal of transition. Thirdly, given this higher-frequency data, we explore the impact of institutional volatility on financial sector volatility through the use of the ARCH/GARCH family of models. This paper would be the first, to my knowledge, to explicitly model financial volatility in transition countries exclusively as a function of institutional volatility.

The rest of the paper proceeds as follows. Section II discusses the literature behind institutional volatility, while Section III describes the empirical model used in this paper to investigate these questions. Section IV discusses the data and diagnostics utilized, while Section V presents estimation results on the series of GARCH-family models utilized. Section VI concludes with implications and future avenues for research.

2 Literature review: institutions, volatility and the financial sector

A voluminous literature exists in finance and economics on the determinants of stock market volatility, with these determinants loosely grouped into three separate areas:

- The intrinsic or actualized attributes of stock markets that make them susceptible, such as systematic risk, size or capitalization (Bekaert and Harvey (1997)), turnover (Andersen (1996)), leverage (Christie (1982)) and other attributes of a particular stock exchange (Gabaix et al. (2006));
- Domestic and international macroeconomic factors and policies (Schwert (1989)), including growth (Beltratti and Morana (2006)), inflation (Flannery and Protopapadakis (2002)), credit (Gourinchas, Valdes and Landerretche (2001)), overall macroeconomic health (Errunza and Hogan (1998)) and other business cycle factors exogenous to the stock exchange but not necessarily to the specific country (Bollerslev and Zhou (2006)); and

- Behaviour and performance of other stock markets (King and Wadhwani (1990), Forbes and Rigobon (2002), Beirne et al. (2009) and literally hundreds of other papers), as a method of importing either stability or volatility exogenous to both specific stock exchanges and specific countries.

However, while the first area of research somewhat concerns the workings of a stock exchange as an institution in and of itself (see Demirgüç-Kunt and Levine (1996)), there has been little work done on the interplay between institutions *outside of* the stock market and performance within the exchange. This omission is somewhat puzzling, but can be explained by the fact that the impact of institutions on economic growth and other metrics of economic success is still a young (if growing) field, characterized by both high-level arguments about the relative impact of institutions (Sachs (2003), Rodrik, Subramanian and Trebb (2004), Acemoglu and Johnson (2005)) and, more recently, highly detailed research about the impact of specific institutions (Hartwell (2013)). By contrast, the relationship between institutions and the financial sector has been conducted mainly at the higher level, focusing on overviews that answer the question *if* institutions influence financial sector development and activity. The overwhelming consensus is "of course", with work such as Claessens and Laeven (2003) finding that property rights improve asset allocation in the financial sector, which then in turn leads to positive effects on growth in sectoral value. Andrianaivo and Yartey (2009) reinforce this result, finding that one important facet of property rights, creditor protection, is a strong and highly significant factor in financial sector development in Africa. Other work from Beck and Levine (2008) concludes that legal origins can account for differences in property rights regimes and thus the development of a country's financial sector, while Demirgüç-Kunt and Levine (1996) find that countries with well-developed institutional systems tend to have large and liquid stock markets and Durham (2002) notes that rule of law and institutions more broadly support financial development. Chinn and Ito (2006) also find that 'general' institutional quality indicators, such as rule of law and bureaucratic quality, support successful financial sector development more than financial sector-specific institutions (such as transparency of accounting procedures).

Given the large amount of evidence linking institutional quality to financial sector development and, in many cases, performance, it stands to reason that institutional changes would also translate through to financial sector outcomes. But as noted above, in regards to the financial sector, the issue of the effects of institutional volatility or instability has been relatively less explored in the literature. Part of this can be attributable to the reality that institutional volatility is rarely observed, given that institutional changes tend to take place over a long period of time (as opposed to financial sector movements, which are very high-frequency) and may be unrecognizable to outside observers; moreover, while theories regarding institutions are relatively well-developed in both economics (North (1971)) and political science literature (see especially Levitsky and Murillo (2009)), quantification of institutions is still an area that is in its infancy (see Moers (1999) and Voigt (2013) for a lively debate on how to even measure institutions). Given this basic fact of slow-paced institutional change (and the difficulty of quantifying it), researchers interested in volatility have gravitated more towards examining 'policy uncertainty' as a determinant of financial sector outcomes. A somewhat first-order solution to a second-order issue (after all, policies are the inputs that can shape institutions and their development, either explicitly or implicitly), the policy uncertainty literature has laid a theoretical groundwork for the effects of institutional volatility, with papers such as Rodrik (1991), Aizenman and Marion (1993) and Baker, Bloom, and Davis (2013) focusing on the feed-through of instability to the real economy via expectations and investment decisions.

This does not mean that explicit modelling of institutional volatility has been entirely neglected, as much of the work that has been done in this area has been focused on quantification of the impact of institutional instability on economic growth, rather than on financial sector outcomes. Brunetti and Weder (1998) focus on changes in national-level institutions, including constitutional changes and probability of institutional shifts (based on survey data), finding that constitutional changes (i.e. political volatility) are negatively correlated with growth. In a similar vein, Svensson (1998) examines political institutional volatility, modelling the effect of political institutions on economic ones (in this case, property rights). His results point to a negative effect on investment, with the probability of an imminent political change (derived from a probit model) harming property rights formation, which then in turn feeds through to investment decisions (Yang (2011) also finds that normal democratic processes tend to increase macroeconomic instability). Berggren, Bergh and Bjornskov (2011) take this examination even further to model the effects of institutional 'instability' on growth, using coefficients of variation from a set of institutional measures (constructed by principal components analysis) to proxy for instability over a five-year period. Using a GLS estimator with fixed effects and controlling for other macroeconomic influences, their results are 'context dependent': in particular, they find that instability in legal and policy institutions in rich countries actually contributes significantly to higher growth rates, while instability of social institutions is a drag on growth across all countries.

Beyond the linkages between growth and institutional volatility, the economics research tends to thin out, with other disciplines only taking up the slack marginally. For example, Chung and Beamish (2005) examine the dynamic nature of institutions in the context of multinational decisions in emerging economies, finding that firms that are either wholly-owned subsidiaries or majority-domestic joint ventures weather periods of institutional volatility better than mostly 'foreign' firms. Other researchers have come at the issue of institutional volatility from either a law or political science perspective; Gallo and Alston (2008), for example, place the difficulties in Argentina's banking system since 1949 as a function of the breakdown of judicial independence and purge of 80% of the Supreme Court justices in 1947. Similarly, Stern et al. (2002) come closer to the issue of financial sector performance and institutional volatility, but their focus is less on the impact of institutional volatility on the financial sector as on the second-order impact on governmental crisis management in the Baltic countries. More recent work from Bialkowski, Gottschalk and Wisniewski (2008) and Boutchkova et al. (2012) also touches on the financial sector in an examination of elections and their financial impact, concluding that the variance in a country's major index return doubles during an election week. However, the idea that sustained or unexpected institutional volatility (after all, elections are planned months, if not centuries, in advance) can have immediate effects on financial performance throughout the economy has remained unexplored.

3 Methodology and empirical model

The GARCH family and institutions

This paper attempts to rectify the above-mentioned omission through the application of some innovative econometric tools. While these prior papers may have looked at institutional volatility writ large, they have shied away from using one of the most powerful tools for exploring conditional variance: the autoregressive conditionally heteroskedastic (ARCH) family of models. A major contribution of this current paper is to apply the ARCH family to institutional volatility in specifically transition economies. While ARCH models have been utilized to investigate the effects of financial volatility in a large and well-established literature (Engle (1982), Hayo and Kutan (2005) and Wu and Shea (2011) are but a few examples), ARCH modelling in institutional economics is relatively unheard of.

Much of this omission of ARCH applications is due to the nature of the beast being examined. ARCH models are typically used with high-frequency data, and institutions are the complete antithesis of data such as daily stock market returns. Indeed, the persistent nature of institutions is one of the key things that defines them as 'institutions': their time-invariant nature, characterized by semi-permanence, is perhaps the most important distinguishing feature of institutions versus policies and other attributes of the economy. This problem has bedevilled quantitative institutional economics, as institutional changes can occur either over a long period of time through very gradual evolution (as in the case of religious dogma) or in a sudden structural break; in the first instance, quantification of institutions would show only the most minute changes (if any) over a long period, while in the second, large changes may be missed in highly aggregated data.

However, ARCH models also have positives that recommend them to the application of institutional changes, especially in the context of transition economies. In the first instance, they can deal with the specific attributes of institutions that may skew normal econometric estimation: institutional shocks can display a high degree of persistence (if not an outright structural break) due to their slow-moving and slow-changing nature, and the volatility of institutional change is not constant over time. More importantly, and addressing the issue of permanence, institutions in transition economies are fundamentally different to the semi-permanent institutions normally examined in the literature. Indeed, the transition from communism to capitalism is precisely about the accelerated evolution of institutions, the replacement of one set of institutions with another. These transition processes are almost entirely designed to follow in reality what an ARCH model is designed to capture econometrically: periods of large and volatile movements, followed by periods of 'normalcy', only to be followed again by high volatility, either endogenously or exogenously generated. Given this conditionally heteroskedastic nature of institutions and transition itself, ARCH models may help to capture this non-constant variance.

Thus, in regards to both financial volatility and institutional volatility, the ARCH family of models, as standard tools for modelling volatility, have value added that may not be present in other estimators. For example, while GMM estimators are equipped to handle conditional heteroskedasticity, as Fleming (1998) notes, time-series volatility data have a high degree of serial correlation that may generate spurious results in a GMM framework. In this data-set especially (and as noted below), there is high persistence of volatility, meaning longer lags of variables would be needed as valid instruments; as Tauchen (1986: 397) notes, however, the bias of GMM rises as more instruments based on deeper lags of variables are introduced, leading to estimates concentrating "around biased values [while] confidence intervals become misleading." Finally, diagnostic tests using a 'system-GMM' approach with this sizeable dataset inevitably resulted in an over-proliferation of instruments even after collapsing instruments and restricting lags, a problem that Roodman (2009) has noted can lead to imprecise estimates of the optimal weighting matrix.

Having settled on the relative merits of the ARCH family, for this examination, the next step is choosing the appropriate estimator from the alphabet soup of ARCH models, which is of course conditioned by the dataset. While Lunde and Hansen (2005) tout the predictive power of a simple GARCH (1,1) model versus other challengers, there are effects in this data and related to the idiosyncrasies of institutions in general that may need additional modelling power. Choosing an appropriate model becomes more difficult as, to date, only a few outstanding papers have been produced in the past decade attempting to apply ARCH models to institutional variables: these include Asteriou and Price (2001), Henisz (2004), Jayasuriya (2005), Klomp and De Haan (2009)[1] and the spiritual father of this current paper, Campos and Karanasos (2008). Asteriou and Price (2001) use both a GARCH and GARCH in means (GARCH-M) model to test the effects of political uncertainty on the conditional variance of GDP growth in the United Kingdom. Constructing a principal components measure of political instability from various indicators including strikes and terrorism, they find that political instability has a highly negative, significant and persistent effect on GDP growth. Similarly, in order to examine the effects of political instability on growth in Argentina, Campos and Karanasos (2008) apply a Power-ARCH (PARCH) model, as first introduced by Ding, Granger and Engle (1993); in their words, the PARCH model "increases the flexibility of the conditional variance specification by allowing the data to determine the power of growth for which the predictable structure in the volatility pattern is the strongest" (Campos and Karanasos (2008:136)). Their results

[1] Klomp and De Haan (2009) utilize GARCH (1,1) modelling in order to isolate their political uncertainty variables, but otherwise include these variables in a standard GMM and mean group series of panel data estimations.

also find that both formal (government changes) and informal (assassinations) political volatility affected growth in Argentina over 1896–2000, with informal volatility having a greater short-run and direct effect.

In regards to this panel dataset, theoretically, either the exponential generalized autoregressive conditional heteroskedasticity (EGARCH) model of Nelson (1991), the threshold GARCH (TGARCH) model of Zakoian (1994), or, as in Campos and Karanasos (2008), one of the power-ARCH (PARCH or APARCH) models should be the preferred estimator. This narrowing down of choices is due to the fact that institutional shocks in transition should exhibit highly asymmetric effects that would not be captured in a simple GARCH specification: negative institutional shocks in an environment in flux (and where the end goal is by no means assured) should impact financial volatility much more than a positive shock (which may be reversed in the next election). Indeed, it can be theorized that institutional volatility would have a similar effect to bad news, with 'bad' institutional changes having much 'worse' effects on volatility (Engle and Ng (1993)), but in a much more persistent and deeper manner than mere bad news. Given that the EGARCH model has been used precisely to model this asymmetric response (Braun, Nelson, and Sunier (1995); Koutmos and Booth (1995); Malik 2011; Andraz and Norte (2013)), it is the front-runner for inclusion here. Such an EGARCH model would follow the form:

(1) $$y_{it} = \mu_{it} + \epsilon_t$$

(2) $$\mu_{it} = \alpha + \beta_1 INST_{t-1} + \beta_2 MACRO_{t-1} + \sum_{j=i}^{n} \pi \varepsilon_{t-j}$$

(3) $$\varepsilon_t = \sqrt{h_t}\, v_t$$

(4) $$\log(h_t) = \omega + \sum_{i=1}^{p} \zeta_i \log\left(h_{t-i}\right) + \sum_{j=i}^{q} \left[n_j \left|v_{t-j}\right| + k_j \left(v_{t-j}\right)\right] + \lambda PropRights_{t-1} + \rho Democracyt{-}1$$

where Equation 1 is the whole panel EGARCH model, Equation 2 is the mean equation and Equations 3 and 4 model the conditional variance as a function of institutional volatility.[2]

[2] As noted throughout this paper, the approach taken is a panel-GARCH model, due mainly to the research question: did institutional volatility across transition economies affect financial volatility? As Cermeno and Grier (2006) note, "to study the determinants and real effects of uncertainty in the developing world, we need a panel GARCH model", based on the relative paucity of observations per country and the heightened effects

Moreover, the EGARCH κ measure captures the 'leverage effect' (Jayasuriya 2005) of institutional volatility, or the idea that negative institutional shocks have a greater (negative) effect on financial volatility than positive shocks of the same magnitude would. As Jayasuria (2005) correctly notes, we should thus see the leverage effect be negative in the conditional variance equation. In contrast to the EGARCH model, the TGARCH specification of Zakoian (1994) models the conditional variance as a function of the standard deviation, but it too allows for asymmetric effects of the institutional volatility indicators. Given the similarity in the treatment of volatility shocks, both EGARCH and TGARCH models will be attempted below, with post-estimation statistics such as the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) used to determine which approach models the conditional volatility more effectively.

4 Data and diagnostics

The Y variable in equation (1) above is financial volatility, which is proxied by two separate measures. The first (as is standard in the literature, starting with Merton (1980) and Perry(1982)), is *realized volatility*: that is, the volatility of the entire stock market index returns, as measured by the log sum of squared daily returns, aggregated monthly:

(5) $$\sigma^2 = \log\left(\sum_{t=1}^{Nt} r_{\_it}^2\right)$$

In equation 5, *r* is defined as the log difference of the returns in the stock market index of country *i* between day *t* and day *t-1*, a common formulation in the finance literature to measure volatility (see Brailsford and Faff (1996), for example, and especially Andersen and Bollerslev (1998) for a discussion of its suitability).[3] This indicator of volatility has the benefit of long histories in the transition economies (in some cases, such as the Czech Republic, 223 separate monthly observations are available) but is unfortunately not available for all of the countries of Central/Eastern Europe and the former Soviet Union (a complete

that are anticipated in an emerging or transition framework. And while country studies may be developed from this data (noting the relatively shorter data series), the purpose of this paper is to take a broader look at the influence of institutions, and thus the panel structure was retained. It is, of course, possible to examine each country separately (which indeed was done in post-estimation inspection), but that is beyond the scope of this paper.

[3] Taking the log of this series is crucial for smoothing the admittedly 'noisy' data in the GARCH specifications used later, and also follows a similar approach to Paye (2012), although Paye uses the log of excess returns rather than actual returns.

description of the data is shown in Table 1). Moreover, as noted above, there is also a chance that we are somewhat limiting ourselves in examining this metric of volatility, as a country must attain a certain level of financial sector development to even have an equity exchange. However, we believe that, given the wide dispersion of country development and transition levels (especially at the moment that the various stock exchanges were created), the inclusion of stock market volatility as a proxy for overall financial volatility will still yield fruitful results.

Additional measures of financial volatility will also be utilized for robustness tests, including the log of absolute returns (as suggested by Ding, Granger, and Engle (1993)), the log of squared percentage changes (Rogers and Siklos (2003)), and, finally, the interest rate spread, defined as the difference between the (average) lending rate and deposit rate in a country for that month. This last measure, unlike stock market returns, is more of an indirect proxy for volatility, in that it captures *ex post facto volatility* rather than direct volatility; as has been empirically noted (see Agenor, Aizenman, and Hoffmaister (1998)), financial volatility can drive interest rate spreads higher, providing an after-the-fact picture of a market in turmoil. As noted by Kliesen, Owyang, and Vermann (2012), high interest rate spreads can also indicate financial sector risk perceptions, which would also be an important component of financial sector volatility.[4]

The most important part of this examination, where this paper breaks new ground, concerns the INST variable shown in Equation 4. At this point, we run into the familiar debate in institutional economics of subjective versus objective indicators (see Moers (1999) and Voigt (2013) for a good explanation of both sides' arguments): succinctly put, subjective indicators may indicate bias (as they are based on subjective ratings), while objective indicators may capture much more than the effect under examination, due to their broad nature. To satisfy both camps, and present a full series of sensitivity and robustness checks, we approach the quantification of institutional change through utilization of both subjective and, as a robustness test, objective indicators.

In the aggregate, the institutional variable will be a vector of institutions, both *economic* and *political*, found to be correlated with economic outcomes in transition economies (see Hartwell (2013) for an extensive treatment of institutional influence in transition). In terms of economic institutions, property rights, in particular, have been

[4] Additionally, other indicators for financial volatility are utilized for sensitivity analyses below.

found to have a great impact on financial sector development in transition economies, as well as being associated strongly with broader successful transition dynamics (Hartwell 2013) and economic growth (Torstensson (1994), Acemoglu and Johnson (2005), Asoni (2008) and many others). The reason for this association between property rights and financial sector development is clear: more secure property rights, in addition to providing the basis for greater savings (and thus lending), also allow for the use of collateral in financing (as well as increasing the value of that collateral (see Claessens and Laeven (2003)). Additionally, property rights create incentives for investment (Besley (1995)) that would contribute to financial sector development, as firms seek out better financing vehicles to allow them to take advantage of market opportunities.

In regards to the theoretical link between property rights and financial volatility, we would anticipate a similar effect to hold as to the link between property rights and financial depth. In particular, stronger property rights exert their hold throughout the economy in many different ways, including stronger enforcement of contracts, stronger judicial independence, and an overall higher level of trust throughout society. In such an atmosphere, every bit of bad news or financial shock need not necessarily lead to panic, and the spillover effects of some financial failures should be contained by the deeper financial structure that property rights engender (similar to Baumol's (1990) assertion that property rights enable entrepreneurs to survive technology shocks). Similarly, if we define property rights as a hedge against government expropriation, an environment of stronger rights means less chance of a catastrophic financial outcome in the economy caused by government (e.g. nationalization) that would induce high levels of volatility. As Angelopoulos, Economides and Vassilatos (2011) also note, property rights have a direct influence on the evolution of macroeconomics in a country, which would in turn influence financial volatility. This indirect effect may also work to dampen volatility.

On the other hand, there is also a theoretically plausible scenario where property rights can correlate with high volatility. A key tenet of ownership is the right to dispose of assets as one sees fit. Given that property rights make ownership easier, in an atmosphere of financial uncertainty or exogenous financial shocks, it stands to reason that property rights may actually act as a lubricant for volatility: firms or investors would be able to unload their assets more quickly than in an environment where exchange is more difficult. Thus, security of property rights may actually contribute to an increase in turnover, which may magnify rather than dampen volatility.

For the purposes of this paper, we utilize two separate indicators to test the effects of the level of property rights on volatility: the first, objective indicator is 'contract intensive money' (CIM), a measure used by *inter alia* Clague et al. (1996, 1999), Dollar and Kraay (2003), Knack, Kugler and Manning (2003), Fortin (2010), Compton and Giedeman (2011) and Hartwell (2013), and which measures the proportion of money held outside the formal banking sector:

$$(6) \qquad \frac{(M_2 - C)}{M_2}$$

where M2 is a measure of broad money and C is the amount of money held outside formal deposit institutions. Under the concept of contract-intensive money, greater property rights would manifest as larger amounts of money held inside the formal banking sector for, as Clague et al. (1999:200) note, "each firm and individual can decide, after taking account of the type of governance in that society, in what form it wants to holds its assets. Where citizens believe that there is sufficient third-party enforcement, they are more likely to allow other parties to hold their money in exchange for some compensation." While this objective indicator may capture more than pure property rights protection,[5] the use of contract-intensive money not only avoids some of the critiques of a subjective measure such as that levelled by Voigt (2013); as Clague et al. *(*1996) demonstrate, variation in the CIM indicator across countries mirrors actual changes in institutions and policies, and thus is empirically more reliable than subjectively derived data on property rights enforcement. Finally, and perhaps most relevant from an econometric standpoint, as Fortin (2010:664) correctly notes, "using CIM as an indicator of the reliability of contract enforcement and the security of property rights also has the advantage of offering much improved data availability over ICRG or Heritage Foundation indicators", which is certainly the case in regards to transition economies. Thus, contract-intensive money offers an expansive, high-frequency, reliable and extensively available proxy for property rights and is suitable for inclusion here.

[5] It has been suggested (see Brown, Carmignani and Fayad (2013)) that contract-intensive money may be a better indicator for financial depth than property rights. However, I disagree with this assertion due to the frequency of the data – in a transition economy, property rights may be in a state of flux, with various initiatives changing the overall perception of rights protection in a short period of time. In contrast, financial depth is a slower-moving creature that may change radically as new legislation or instruments are introduced, but in general doesn't exhibit the same volatile shifts that basic institutions in flux would. Thus, saying that financial depth changes from month to month and can be captured by this indicator is a much bigger reach than noticing the reaction of the populace to changes that can directly affect their property.

Given that property rights are a measure of a key *economic* institution, inclusion of a measure of *political* institutions will also shed light on the institutional determinants of volatility and how political institutions interact with economic ones. For this, we use the International Country Risk Guide (ICRG) indicators for 'democratic accountability' as a proxy for political institutions and how they may influence financial volatility (following Campos and Karanasos (2008)). The inclusion of democracy is of course an imperfect catch-all for political institutions, especially given that it is theoretically unclear why democracy would lead to better (worse) outcomes with financial volatility; moreover, previous work in growth economics has shown a negative effect of democracy (Hartwell 2013).[6] However, given the paucity of monthly political institutional data, this remains one of the best proxies available for ascertaining the state of a country's political institutions and their effect on financial markets (Akitoby and Stratmann (2010)).

These measures of both economic and political institutions will enter the mean equation at their levels (or, more accurately, at their lag, in order to avoid simultaneity issues). However, the real purpose of this current examination is to understand institutional volatility and how it feeds through to the financial sector. Unlike the theoretical ambiguity surrounding the level of property rights and democracy, there should be no such illusions here: institutional volatility should correlate strongly with financial volatility, as changes in property rights or the political system inject large measures of uncertainty into decision-making at the firm and investor level. As noted above, this idea of 'institutional uncertainty', mirroring the 'policy uncertainty' debate, should be felt first and foremost on financial markets, which have been shown to be very sensitive even to news (Engle and Ng (1993)). Such a large change as in institutions should thus have a correspondingly larger effect.

The variables constructed to test institutional volatility are also based on the ICRG and objective indicators noted above, but are intended to capture their movement over time. In particular, we have constructed 3-month and 6-month rolling standard deviation variables that capture institutional changes over these varying time frames. As a check on these core volatility measures (and given the radically different scaling of the objective versus subjective measures), we also include for sensitivity purposes the coefficient of

[6] This also enters under the heading of 'agenda for future research', as there may be better monthly metrics to measure political institutions. Other metrics that have been utilized in other papers, however, such as the ICRG's measure of the military in politics (used by Miletkov and Wintoki (2012)) are unsuitable for the set of transition economies examined in this paper. The search continues.

variation (as similarly used by Berggren, Bergh and Bjornskov (2011)) of the variables over the same rolling 3-month and 6-month time frames.[7] Defined as the standard deviation divided by the mean, this measure should give additional and comparable data on the dispersion of democracy and property rights, as well as providing further insight into the effects of institutional volatility.

As a control, and as explanators for other variables that may be influencing financial volatility, the MACRO vector shown in Equation 2 above includes a set of macroeconomic variables that may influence financial volatility. Due to the difficulties of finding monthly macroeconomic data, the set of controls for the ARCH family models are necessarily somewhat parsimonious, but follow on from the variables established in prior literature (see especially the comprehensive examination of Garcia and Liu (1999) and Panetta (2002)) that affect financial volatility:[8]

- *Money growth*, a proxy for monetary policy in the target country, will undoubtedly feed through rather rapidly to stock markets and thence to volatility. For this examination, we include several measures of money growth, including the period change of M2 (in per cent), the acceleration of the change in M2 (to capture rapid policy shifts) and lagged acceleration of M2 changes (to capture adjustments in expectations). Given the issues that may occur with convergence in GARCH specifications, this buffet of indicators may also help to mitigate convergence difficulties in specific models (more on this below).
- In tandem with money growth, *volatility of inflation* is also included, as periods of hyperinflation or even sustained bouts of inflation signal government mismanagement and are a good proxy for general macroeconomic policy instability. Inflation has also been shown to negatively impact financial sector performance (Boyd, Levine and Smith (2001)), as well as being correlated (weakly in Schwert (1989) and strongly in Chen, Roll and Ross (1986), Engle and Rangel (2008) and Corradi, Distaso and Mele (2013)) with greater financial volatility. Given the persistence of inflation and the relationship between variability of inflation and its levels (Friedman (1977)), we use as a control either the standard deviation or the rolling coefficient of variation of inflation over a 6-month window.
- *Acceleration of credit growth to GDP:* Growth of credit to GDP is a common precursor to both volatility and systemic crashes (Demirgüç-Kunt and Detragiache (1998); Gourinchas, Valdes and Landerretche (2001)), but while credit data is available on a monthly basis from the IMF, GDP data is (at best)

[7] The coefficient of variation is also useful in this context, as the institutional factors are all positive in their means.
[8] A measure of openness was also contemplated (and constructed) as a control for this examination, but the incredible paucity of monthly export and import data made a rather significant loss of observations. Given that diagnostics even on the reduced set of observations showed little significance, it was decided not to include it in the analysis.

only available quarterly. To somewhat circumvent this problem, we use the Chow-Lin (1971) method of linear interpolation via a modified 'interpolate' code in Stata,[9] as done in previous work on financial movements (Dunis and Shannon (2005)), to fill in the missing GDP series and provide a monthly ratio of credit to GDP. In the GARCH family regressions shown below, we experiment with various measures of credit growth and change, as done with money growth, including acceleration of credit growth and lagged acceleration of credit growth.

- Finally, *economic growth*, measured here by the monthly change in interpolated monthly GDP (subject to the caveat noted above), is a proxy for the overall macroeconomic health of an economy. While most of the literature has focused on the relationship of financial development to growth volatility (Beck, Lundberg and Majnoni (2006)) or financial volatility to economic growth (Loayza and Ranciere (2006)), there is little guidance on the theoretical link between prior period growth and current period volatility (Engle and Rangel (2008) is a notable exception). We believe, as in Engle and Rangel (2008: 1209), the effect should be that "countries experiencing low or negative economic growth observe larger expected volatilities than countries with superior economic growth." Indeed, we should see a pronounced dampening effect on volatility in the presence of robust economic growth, as the presence of 'good times' mitigates both the need for asset prices to swing wildly and the need for traders to move in herds in response to news. Growth in both the present period and the prior period are utilized in various combinations as proxies for macroeconomic health.

The last term in Equation 2, FINLIB, is included as a final control for the importation of volatility from abroad; we include an indicator to proxy for the financial liberalization of a country. The lack of monthly data for most commonly used subjective liberalization indicators, such as the EBRD's 'financial reform' index or the Chinn-Ito (2008) index of financial openness, means we need to explore other, objective high-frequency indicators to proxy for financial liberalization. For the purposes of this examination, we include the growth of bank deposits as a percentage of GDP as a proxy for internal liberalization, based on the assumption that more liberalized countries will draw more formal bank accounts and encourage savings in the formal financial sector. A country with a more liberalized (and deeper) financial sector should also be expected to dampen volatility, although, as Dabla-Norris and Srivisal (2013) note, the relationship may be quadratic, in that the highest levels of financial depth could correlate with more rather than less volatility. Given the development stages of the transition countries, however, we would expect this relationship to remain as greater depth leading to less volatility. As a test for robustness, we also

[9] Thanks to Nick Cox of Durham University for providing this code to Statalist members, available at: http://www.stata.com/statalist/archive/2005-09/msg00129.html.

include the share of foreign bank claims in the economy as a proxy for external liberalization; as Naaborg et al. (2003) noted, the presence of foreign banks in transition economies has been a prime determinant of their financial sector development, while the proportion of foreign bank involvement has correlated strongly with less crises (Yilmaz, Yabasakal and Koyuncu (2009)). We anticipate this relationship to hold here, with the presence of foreign banks acting as a means to smooth out volatility rather than contribute to it.

The data for this exercise came from a large variety of sources, including Bloomberg and CEIC for stock market returns; M2, currency outside depository corporations, and other macroeconomic variables from either the IMF's International Financial Statistics (IFS) or from the central banks of each transition economy (often obtained via arduous excel manipulation); and investor protection and democracy data from ICRG, as noted above. Given the smaller sub-set of transition countries that have functioning stock exchanges, this restricts the data somewhat to 20 countries, over various time periods starting from 1989 and ending in 2010.[10]

High-frequency data: diagnostics

The first step in proceeding with a multi-faceted ARCH analysis like this is, of course, to conduct the appropriate data diagnostics to a) test for bias and stationarity in the underlying data (Egert and Koubaa (2004)) and b) ascertain the existence of ARCH errors. In regards to the first point, the results of the Augmented Dickey-Fuller test for stationarity on the dependent volatility metrics reject the presence of a unit root (as shown in Table 2, we have ADF statistics of −16.46 for the 'headline' square of stock market returns and −24.38 for the interest rate spread, well above the 1% critical level of −3.961 to reject the null of a unit root). While ADF and PP are normally used in a panel context, their power is low, especially in relation to processes that are 'near' I(1) (Granger and Swanson (1997)). To deal with these issues in common unit root tests, Clemente, Montañés and Reyes (1998) proposed a series of tests that allow for two structural breaks, examining both additive outliers (known as the AO model, which captures a sudden change in a series) or innovational outliers (the IO model, which allows for a gradual shift in the mean of the series).

[10] The countries included in the dataset are Belarus, Bosnia, Bulgaria, Czech Republic, Croatia, Estonia, Hungary, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Macedonia, Mongolia, Poland, Romania, Russia, Serbia, Slovakia, Slovenia and Ukraine.

In order to better test for the presence of a unit root, we show in Table 3 the results of a CMR unit-root test with double structural breaks, Innovation Outlier and Additive Outlier Models. The results of the CMR test for each country show stationarity for contract-intensive money across all countries in the AO test, and only four exceptions in the IO test (with Croatia at the threshold for significance). On the other hand, the ICRG democratic accountability indicator shows incredibly strong evidence of a unit root in the IO model (and to some extent in the AO model). In order to deal with these issues, a transformation must be applied to the data in order to make it stationary. While simple differencing would be effective for this purpose, it is not relevant to the research question we are exploring regarding the levels of institutions and financial volatility. Thus, rather than differencing, we apply a Hodrick-Prescott filter to de-trend the monthly data for countries that showed evidence of a unit root during the original tests (for example, Belarus, Latvia and Russia had their original data retained for the democratic accountability indicator).[11] Further CMR tests on the de-trended data (not reported) showed stationarity for democratic accountability indicators for all countries.

The second step, as noted above, is to ascertain the structure of the data regarding possible ARCH effects. Table 2 also shows the descriptive statistics for our data, including the skewness, kurtosis, Ljung-Box Q and Q^2 white noise tests and, finally, the Lagrange Multiplier (LM) test of Engle (1982) for ARCH effects. The Q and Q^2 statistics confirm that there is serial correlation in the conditional variance for all data, while the LM test wholeheartedly confirms the presence of ARCH effects; thus, some form of GARCH modelling will be required to model the 'true' relationships between financial volatility and institutional volatility from our data. Moreover, the high levels of leptokurtosis in the institutional data points strongly towards use of a GARCH-family model incorporating either the Student *t* or generalized error distribution (GED), as opposed to a Gaussian (normal) one, in order to capture the 'fat tails' of the institutional variables (Bollerslev (1987), Nelson (1991) and Bollerslev, Engle and Nelson (1994)). The precise 'correct' distribution will be determined by the data and post-estimation testing.

Finally, examination of the autocorrelation and partial autocorrelation functions of the volatility variables (Figures 1–4) shows the persistence of the dependence over time. Given this state of affairs, it is prudent to extend the GARCH models utilized below with

[11] The lambda utilized for the HP smoothing was 129,600, as suggested by Ravn and Uhlig (2002) for monthly data and used by Bloom (2009) in a similar examination of uncertainty.

an AR(*p*) model, depending upon the precise structure of the data. For this dataset, it would appear that the square of returns data shows extensive persistence through the 8th lag, meaning an AR(8) model is most appropriate (diagnostics regarding model using at various AR(p) lags also showed that the Akaike (AIC) and Schwarz Bayesian (SBIC) information criteria were minimized with an AR(8) model – see Table 4). Given the similarities in the underlying data, the log of absolute returns and squared percentage changes are also modelled as AR(8) processes (see Figures 2 and 3 for ACF and PACF correlograms and Tables 5 and 6 for the AIC and SBIC criteria), while the 6-month interest rate spread volatility (Table 7 and Figure 4) shows a conflict between the AIC and SBIC values: given the tendency for the AIC to overestimate the optimal lag length in large samples (Shibata 1976), we choose the SBIC optimal length of 6 for this indicator.

5 Results

The results of the effect of both institutional levels and institutional volatility on financial volatility are shown in Tables 7–9. The first series of regressions (Table 8) utilize contract-intensive money as a proxy for property rights, with volatility measured at both the 3-month and 6-month rolling standard deviations. In Columns 1 and 2, the simplest model, testing for the relationship between institutional volatility at the 6-month standard deviation and financial volatility without the presence of any controls, are shown as both a Threshold-GARCH (AR(8)-TGARCH(2,2), Column 1) process and an Exponential GARCH (AR(8)-EGARCH(3,2), Column 2) specification. There is a significant dampening effect of better property rights at their level in the EGARCH specification (but not in the TGARCH one), while democracy at its level is significant in dampening financial volatility across both specifications. In regards to institutional volatility, however, the effect shifts, where we can see property rights volatility having a much more exacerbating effect on financial volatility (while democratic volatility shows a negative yet almost wholly insignificant effect). Based on the AIC, the Kolmogorov-Smirnov test of the normality of the residuals, the Jarque-Bera statistics (and QQ-plot, see Figure 5) and the Q-test, it appears that the EGARCH specification here has a slight edge as being the ‘correct’ specification.[12]

[12] While it may appear that there is some slight residual kurtosis in the student-t distribution, the Jarque-Bera test statistic reported of 4.404 is against a critical value of 6.136, meaning that the kurtosis displayed is well

This basic model is expanded across Columns 3–7 for various combinations of macroeconomic controls as both a sensitivity and robustness check; in general, the inclusion of the macroeconomic controls made the estimation more difficult, with several failures to reach convergence. The most egregious offenders were the monetary policy indicators, which also suffered from having little effect on the model (in most permutations). However, the same picture emerges from the EGARCH specifications across the columns, in line with the simple model of Column 2: property rights, at their levels, are significantly correlated with lower stock market volatility, while volatility in property rights over a 6-month period leads to significantly higher levels of financial volatility.[13] This effect holds, albeit at a lower level of significance and scale, for the coefficient of variation of property rights (Column 8). Democracy, and its effect in the mean equation, is much more sensitive to the choice of model and the included controls, but in no specification is democratic volatility significant in the conditional variance. As regards controls, as noted, money growth has little effect on financial volatility, while the variability of inflation contributes positively and significantly to volatility, albeit on a much smaller scale. Finally, growth seems to work in two separate channels, with current period growth changes (that is, the growth from t-1 to t) showing a dampening effect on volatility, but prior period growth (t-2 to t-1) encouraging volatility.[14]

Unlike our prediction above, there seems to be little leverage effect due to institutional volatility, at least at the first EGARCH term, with symmetrical effects (the EGARCH-theta terms in Table 8) outweighing any leverage. The only exception to this result is in model 6, incorporating credit changes, where the more distance leverage effect (encapsulated in the second-order EGARCH term) shows negative and significant leverage effects. On the whole, however, there appears to be relative symmetry of the effect of institutional shocks for the 6-month standard deviations of institutions.

Shifting our time-frame, Columns 1–8 of Table 9 include the 3-month rolling standard deviation of institutional changes, with an eye on seeing if short-term institutional volatility has a larger effect on financial volatility than relatively longer shocks (which

within ‘normal’ bounds. As can be seen from the QQ plot, however (Figure 5), there is one outlier, meaning that there may be an even better fit if the outlier can be isolated.

[13] Unlike the diagnostic model of Column 2, which utilized a student’s t distribution, the better fit in terms of post-estimation testing was provided by a generalized error distribution (GED).

[14] Across all the GARCH specifications in Table 7, post-estimation tests carried out confirm the appropriate choice of the specific GARCH modelling. Using a Portmanteau test (Q) on the residuals of each country’s estimation, as shown in the Table, the problem of serial correlation has been eliminated across the data (using wntestq in Stata as an average across panels).

could be, to some extent, priced in). As above, Columns 1 and 2 are diagnostic models of just the institutional variables versus financial volatility for both a TGARCH and an EGARCH specification. Unlike the 6-month volatility metrics, the data for 3-month metrics are best suited to a TGARCH (3,3) and an EGARCH (3,2) specification; additionally, for both the TGARCH model shown in Column 1 and the EGARCH model shown in Column 2, the student's t distribution resulted in a better fit than the GED distribution.[15] Finally regarding this diagnostic model, the EGARCH specification once again provides a better fit, and thus will be utilized going forward.

In terms of the results, both the TGARCH and the EGARCH models note the importance of democracy in the mean equation in dampening volatility (while property rights are significant only in the TGARCH model), and both democratic and property rights volatility enter the EGARCH conditional variance equation as significant, albeit in different directions. To check whether this is a statistical artifact or a true representation of the model, Columns 3–8 of Table 9 thus present the varying combinations of macroeconomic controls as conditioning factors. Problems on convergence upon the inclusion of the monetary policy indicators were even more severe utilizing the 3-month institutional volatility indicators, with only the lagged growth of M2 and, in one model (Column 5), the 3-month coefficient of variation of M2 allowing for convergence. However, despite these macro issues, the results shown above still hold: apart from the diagnostic equation (Column 2) and the equation including the coefficient of variation of M2 (Column 6), property rights have a significant dampening effect on financial volatility at their levels, while volatility of property rights feeds through to financial volatility in nearly every model, albeit on a scale that is smaller than anticipated. Democracy for the most part also has a significant negative effect on volatility at its levels, while, as in the earlier models, democratic volatility also feeds through to less volatility, not more (although, as before, this is conditional on the model specified). This political volatility is seen most strongly in the last column, where the coefficient of variation of democratic accountability is included and has the largest effect across all democratic accountability variables. Thus, it appears that democratic volatility in the short run has very strong dampening effects on financial volatility; this may be

[15] It should be noted, however, that the Jarque-Bera result for both models showed excessive kurtosis, with the TGARCH model having a statistic of 5.393 against a critical value of 4.547 and the EGARCH model having a statistic of 5.867 versus a critical value of 4.401. This statistic will be monitored in the later regressions, in order to ensure that the GARCH errors are indeed providing a better goodness-of-fit.

due to financial markets adopting a 'wait and see' attitude in the short run (i.e. not moving money out of the market too quickly) as democratic changes play out.

Robustness and sensitivity tests

As noted above, many papers have shown that contagion or spillovers from larger (and possibly more developed) markets may explain domestic volatility (with Beirne et al. (2009) noting that nearly half of all domestic stock market volatility in emerging markets can be explained by spillovers). In order to account for this possibility within the transition space (and to avoid a possibly enormous omitted variable), we include as a robustness test two variables to proxy for global volatility: firstly, monthly volatility of the US S&P 500 index (as a check for US market volatility, calculated as above as the sum of log-squared monthly returns), and secondly, the 6-month standard deviation of the change in the price of gold (as a metric of world financial instability more generally). The results of this inclusion are shown in Columns 1 and 2 of Table 10, and the use of either proxy confirms earlier research about the effect of global volatility on financial movements in the transition economies. However, while global volatility is an important determinant of stock market volatility in these economies at its level, volatility of property rights still remains a significant exacerbating mechanism for financial volatility (while the level of property rights remains significant as a dampener, albeit at lower levels of significance than previously). This result holds for both S&P 500 volatility and the price of gold, suggesting that property rights do indeed matter, even when (or perhaps especially when) the rest of the world has gone off the rails.

While all of these results are consistent for the chosen measure of financial volatility (squared returns), as a robustness check we substitute the other measures of volatility noted above. Regardless of the indicator utilized, however, the picture remains the same: institutional volatility feeds through directly to financial volatility. Using the log of absolute returns as a volatility metric (Columns 3 and 4 of Table 10), a simple AR(8)-TARCH(1) model shows even more impressive results for property rights volatility, which is more significant at the 6-month and 3-month intervals than in the EGARCH/squared returns regressions (interestingly, neither property rights nor democracy are important at their levels in the 3-month volatility regressions). Similarly, for the log of squared percentage changes (Columns 5 and 6), a TGARCH(2,1) model is most appropriate based on AIC statistics, also showing a highly significant impact of institutional volatility. Indeed, in these regressions, democracy shows as significant, but in the opposite (yet consistent) direction, where higher volatility of democratic accountability leads to less financial volatility. Finally, Columns 7 and 8 show the interest rate spread variability, modelled as an AR(6)-EGARCH(2,2) for the 6-month and 3-month institutional volatility; while the modelling was problematic due to the exigencies of the interest rate variable (there was lack of convergence for many models and even the 'best-fitting' EGARCH model shown here still exhibited excess kurtosis after the model fit), the theme of institutional volatility feeding into financial volatility continues to hold.

As a final check, perhaps it is not the measurement of financial volatility that is driving the results, but the chosen measure of property rights (contract-intensive money). As a further robustness check, or, perhaps more accurately, to utilize a different measurement of property rights, we include a 'subjective measure' for property rights protection: the ICRG 'political risk' indicator. With good coverage back to pre-transition for many countries, the political risk indicator has been used in other studies as a broad proxy for institutional quality more generally (see, for example Busse and Hefeker (2007) or Catrinescu et al. (2009)). Indeed, the sub-component of 'investor protection' is more commonly utilized as an indicator of property rights, used originally in (amongst others) Knack and Keefer (1995), Knack (1996) and Svensson (1998), and more recently in a financial sector context by Durnev, Errunza and Molchanov (2009), Ali, Fiess and MacDonald (2010), Dutta and Roy (2011) and Lin, Lin and Zhou (2012).

However, the full political risk index has many features that we believe encompass a clearer picture of property rights protection and attitudes in a country: in the first instance, the index covers not only investor protection, but corruption, conflict (internal and external), the extent of the military in government, law and order and bureaucratic quality. All of these components, if negligent in some manner, have a direct impact on property rights protection. For example, while investor protection may measure the extent of the legal definition of property rights, measures of corruption or bureaucratic quality can help to measure the actual application of those rights (also highlighting the disjoint between legislation and administration inherent in developing economies). Additionally, the presence of conflict has rarely been associated with strong property rights protection, nor has ongoing religious tension. Coded from 0 to 100, with higher numbers denoting less political risk, this measure makes a further check on the previous results.[16]

Columns 9 and 10 of Table 10 show the inclusion of the ICRG indicator instead of contract-intensive money versus the square of returns. This measure is somewhat more problematic in the GARCH styling, as it shows much less variability than contract-intensive money on a month-to-month basis; this reality also led to a lack of convergence in several models, meaning we are somewhat constrained in terms of the model selection. The models that were able to converge, however, tell the same tale as the use of contract-intensive money: at their level, property rights as measured by the ICRG indicator have a dampening effect on volatility, as does level of democracy. Similarly to the previous models, the volatility of the political risk measure increases financial volatility over a 6-month period (albeit at a marginal level of significance and with the model being more problematic in terms of its residual normality – moreover, a TGARCH model, not reported, showed no significance of the institutional volatility), while at the 3-month timeframe volatility also begets volatility, more significantly (Column 8).

6 Conclusions

This paper has explored several related questions regarding financial liberalization, institutional change and financial volatility, using novel methods and indicators, as well as high-frequency data. The results have mirrored earlier research, which found that better institutions in transition economies supplemented financial sector development. Going further than these earlier works, this study broke new ground in examining the effects of institutional volatility on financial volatility using GARCH modelling. The application of this modelling to institutional change showed that institutional effects manifest themselves on financial markets both in the conditional mean and the conditional variance. In particular, it was shown that property rights volatility led to much higher levels of financial volatility, while in some sense democratic accountability changes generally had a dampening effect on financial volatility. In short, better *and* more stable institutions such as property rights

[16] As democratic accountability is one of the constituent measures of the political risk indicator, I have removed its score from the composite political risk indicator in order to keep democratic volatility as its own separate measure of political volatility.

also made financial stability more likely. These results held across various specifications and were robust to various macroeconomic and institutional controls.

The policy ramifications of this research are apparent, especially for the transition economies which are still being tossed about due to the lingering effects of the global financial crisis and the ongoing Eurozone crisis. Given these results, an emphasis should be made (as noted elsewhere, such as Hartwell (2013)) on 'getting the basics right' and protecting the most fundamental institutions of a market economy. Protection of private property will help to quell financial volatility, thus protecting the real economy from wide and damaging swings. This would mean that countries in transition such as Hungary and Slovenia, which have seen degradation of property rights during the past 5 years in tandem with financial volatility, would be better served in focusing their energy towards property rights protection than financial sector taxation.

The research presented here is of course in a preliminary phase, as it is only beginning to explore areas in quantitative institutional economics that have been thus far untouched. The extensions to this work are legion, including the testing of various types of models from the ARCH/GARCH family (in addition to the EGARCH and TGARCH models shown here) for their suitability in institutional analysis; a promising avenue, given the differential frequency of data and also of speed of movement of indicators, is the application of GARCH-MIDAS modelling to account for mixed frequencies. Also, as noted earlier, a logical extension to this work is expanding the set of controls for the models contained in this paper, with the first step exploring better and higher-frequency indicators to proxy for financial liberalization as a control for institutional and policy effects. Continued research into the quantification of institutions, especially objective indicators for both economic and political institutions at a high frequency, will also contribute to our knowledge of the effects of institutional volatility on financial markets; perhaps an approach similar to the pioneering work done by Hayo and Kutan (2005) is called for, proxying political volatility by its appearance in the media rather than as a direct measurement. And last but not least, of course, this paper has only focused on transition economies, due to the idiosyncratic nature of institutional change in these countries: a welcome addition to the literature would be an expansion of this analysis to other (including developed) countries undergoing institutional changes, to assess the impact of institutional volatility on these economies. In one sense, all economies are 'transition' economies, as their institutions and policies are changing, and expansion of this current work to OECD and emerging market economies would take this reality into account

Tables and figures

Table 1 Underlying data description and sources

Data	Description	Source
Volatility variables		
Stock market data		
Belarus	Belarus Stock Exchange Index, 2005–2012	CEIC database and personal correspondence
Bosnia	Sarajevo Stock Exchange BIFX Index, 2006–2012	Sarajevo Stock Exchange Website, http://195.222.43.81/sase-final/
Bulgaria	SOFIX Index, 2000–2012	Bulgarian Stock Exchange website, http://www.bse-sofia.bg/
Croatia	CROBEX Stock Market Index, 1997–2012	Datastream
Czech Republic	Prague Stock Exchange PX Index, 1994–2012	Bloomberg
Estonia	Tallinn Stock Market Index; TALSE 1996−2004, OMX 2004–2012	Datastream
Hungary	Budapest Stock Exchange BUX Index, 1991–2012	Bloomberg
Kazakhstan	MSCI Kazakhstan Total Market Index, 2000–2012	Datastream
Kyrgyz Republic	Kyrgyz Stock Exchange Share Price Index, 2009–2012	Kyrgyz Stock Exchange website, www.kse.kg
Latvia	Riga Stock Exchange OMX Index, 2000–2012	NASDAQ OMX website, http://www.nasdaqomxbaltic.com/
Lithuania	Vilnius Stock Exchange OMX Index, 2000–2012	NASDAQ OMX website, http://www.nasdaqomxbaltic.com/
Macedonia	Macedonian Stock Exchange MBI Index, 2005–2012	Datastream
Mongolia	Mongolian Stock Exchange MSE Top-20 Index, 1995–2012	CEIC database
Poland	Warsaw Stock Exchange WIG Total Stock Index, 1991–2012	Bloomberg
Romania	Bucharest Stock Exchange Trading Index (BET), 1997–2012	Datastream
Russia	Moscow Exchange RTS Index, 1995–2012	Datastream
Serbia	MSCI Serbia Stock Market Index, 2008–2012	Datastream
Slovakia	Bratislava Stock Exchange SAX Index, 1993–2012	Datastream
Slovenia	Ljubljana Stock Exchange SBI TOP Blue Chip Index, 2003–2012	Bloomberg
Ukraine	Ukraine Stock Exchange PFTS Index, 1997–2012	CEIC Database
Institutional variables		
Contract-intensive money	Calculated as in the text as M2 less the money held outside formal financial institutions as a percentage of M2	IMF International Financial Statistics; Bank of Mongolia website
Political risk	Original ICRG political risk index, coded 0 to 100 with higher numbers indicating lower risk – the indicator computed here has democratic accountability removed, meaning in practice an index of 0−94.	International Country Risk Guide (ICRG)
Democratic accountability	A measure of how responsive government is to its people, coded from 0 to 6 with 6 representing full democracy and 0 autarky.	ICRG

Data	Description	Source
Macroeconomic variables		
GDP growth	Monthly change in interpolated monthly GDP, derived from quarterly GDP statistics	IMF IFS; Eurostat
Money growth	Change in M2 month on month	IMF IFS
Volatility of inflation	3- or 6-month rolling standard deviation of monthly CPI changes	IMF IFS; Economist Intelligence Unit; Various national banks
Credit to GDP	Nominal credit to interpolated monthly GDP	Bank for International Settlements
Price of gold	Spot price of gold as of last day of the month, US$	World Gold Council website, http://www.gold.org/download/value/stats/statistics/xls/gold_prices.xls
S&P 500 Index	Difference between close of day price and previous day's closing price. Volatility as calculated in the text.	Yahoo! Finance, http://finance.yahoo.com/q/hp?s=%5EGSPC+Historical+Prices

Table 2 Descriptive statistics

	n	Mean	Std deviation	Skewness	Kurtosis	LM-statistic	Box-Ljung Q statistic	Q-squared	ADF test
Volatility (dependent) variables									
Log of squared returns	2715	−7.34	1.173	0.607***	1.392***	194.11***	5682.37***	5851.63***	−16.459***
Log of absolute returns	2743	−1.072	0.267	0.09***	1.05***	187.53***	5977.63***	5619.37***	−21.089***
Log of return percentage changes	2787	3.286	1.3516	−0.49***	1.96***	230.46***	13422.00***	8086.46***	−13.51***
6-month interest rate volatility	3561	3.53	55.67	37.78***	1517.3***	303.43***	1298.68***	916.874***	−24.376***
Institutional variables									
Property rights (CIM)	3180	0.79	0.10	−1.12***	1.32***	11102.0***	79471.5***	83507.6***	−4.712***
Property rights volatility (CIntenM 3 months)	3130	0.005	0.005	3.62***	291.66***	177.84***	13205.9***	2307.34***	−17.798***
Property rights volatility (CIntenM 6 months)	3070	0.006	0.006	2.81***	12.68***	1262.4***	24375.3***	10068.6***	−14.865**
Democratic accountability	3545	4.52	1.47	−0.99***	−0.21***	13835.0***	96146.7***	93461.9***	−4.892***
Democratic volatility (3 months)	3511	0.03	0.14	6.79***	57.19***	223.20***	1094.63***	957.21***	−25.345***
Democratic volatility (6 months)	3460	0.05	0.18	4.33***	23.04***	2054.6***	5641.35***	4824.33***	−23.158***

Note: *** denotes significance at the 1% level. ADF test performed with both a trend and intercept

Table 3 CMR unit-root test results

	Contract-intensive money							
	Additive outlier				Innovation outlier			
Country	Break point 1	Break point 2	t statistic	Decision	Break point 1	Break point 2	t statistic	Decision
Belarus	2002m11	2007m7	−2.434	I(0)	2002m12	2007m8	−4.331	I(0)
Bosnia	2007m10	2009m7	−4.044	I(0)	2006m11	2008m11	−3.656	I(0)
Bulgaria	1997m4	2006m10	−1.857	I(0)	1997m1	2006m8	−8.493*	I(1)
Croatia	2000m2	2002m5	−3.006	I(0)	2000m3	2002m2	−5.606*	I(1)
Czech Republic	1999m6	2002m11	−3.240	I(0)	1999m3	2002m12	−4.732	I(0)
Estonia	2006m2	2009m4	−2.337	I(0)	2004m10	2008m10	−0.993	I(0)
Hungary	2003m9	2011m9	−2.896	I(0)	2003m10	2011m6	−5.276	I(0)
Kazakhstan	2005m6	2008m8	−3.911	I(0)	2002m2	2005m9	−3.501	I(0)
Kyrgyz Republic	2009m12	2011m11	−2.651	I(0)	2010m12	2012m1	0.545	I(0)
Latvia	2003m10	2006m10	−2.841	I(0)	1999m11	2003m11	−4.604	I(0)
Lithuania	2005m4	2008m8	−3.432	I(0)	2004m10	2008m10	−4.910	I(0)
Macedonia	2005m11	2007m3	−2.349	I(0)	2005m12	2006m12	−4.833	I(0)
Poland	1998m2	2002m10	−2.804	I(0)	1994m11	1996m10	−4.002	I(0)
Romania	2006m1	2008m9	−1.494	I(0)	2004m9	2005m2	−2.964	I(0)
Russia	2005m10	2009m10	−3.581	I(0)	2005m6	2009m3	−2.976	I(0)
Serbia	2006m11	2011m9	−4.703	I(0)	2006m12	2011m11	−3.359	I(0)
Slovakia	2001m10	2008m10	−1.159	I(0)	2001m8	2008m11	−15.043*	I(1)
Slovenia	2006m10	2009m1	−0.865	I(0)	2001m11	2006m11	−17.497*	I(1)
Ukraine	2005m5	2008m7	−2.401	I(0)	2002m11	2010m7	−3.241	I(0)

* denotes significance at the 5% level

Table 3 (continued) CMR unit-root test results

	Democratic accountability							
	Additive outlier				Innovation outlier			
Country	**Break point 1**	**Break point 2**	**t statistic**	**Decision**	**Break point 1**	**Break point 2**	**t statistic**	**Decision**
Belarus	2000m6	2002m12	−2.924	I(0)	1999m6	2008m7	−4.583	I(0)
Bosnia		n/a				n/a		
Bulgaria	1991m9	1995m12	−4.146	I(0)	1991m10	1995m9	−6.872*	I(1)
Croatia	2000m2	2004m11	−21.270*	I(1)	1999m11	2004m7	−51.603*	I(1)
Czech Republic	1996m7	1997m10	−0.950	I(0)	1996m4	1997m11	−5.612*	I(1)
Estonia	2007m1	2007m4	0.000	I(0)	2007m1	2011m12	−12.390*	I(1)
Hungary	1993m4	1997m5	−1.859	I(0)	1993m5	1997m6	−10.981*	I(1)
Kazakhstan	2000m8	2005m11	−9.594*	I(1)	2005m5	2005m7	−14.682*	I(1)
Kyrgyz Republic		n/a				n/a		
Latvia	2002m10	2003m1	0.000	I(0)	2002m10	2011m12	0.000	I(0)
Lithuania	2002m10	2003m1	0.000	I(0)	2002m10	2011m12	−12.454*	I(1)
Macedonia		n/a				n/a		
Mongolia	1996m9	2000m3	−2.628	I(0)	1996m6	1999m12	−35.194*	I(1)
Poland	1994m1	1997m5	−5.733*	I(1)	1993m5	1997m6	−12.650*	I(1)
Romania	1993m3	1997m5	−4.156	I(0)	1993m2	1997m3	−11.731*	I(1)
Russia	1996m7	1997m9	−1.952	I(0)	1996m3	1997m6	−4.755	I(0)
Serbia	2006m11	2012m4	−0.032	I(0)	2006m11	2007m2	−8.122*	I(1)
Slovakia	1998m3	1998m7	−5.990*	I(1)	1998m1	1998m8	−12.465*	I(1)
Slovenia	2006m6	2007m6	−12.356*	I(1)	2006m2	2007m5	−17.390*	I(1)
Ukraine	2000m11	2004m11	−2.762	I(0)	2000m3	2004m12	−9.161*	I(1)

* denotes significance at the 5% level

Figure 1 Autocorrelation and partial autocorrelations of log of squared returns

Autocorrelation	Partial correlation		AC	PAC	Q-stat	Prob
|**** |	|**** |	1	0.621	0.621	778.62	0.000
|**** |	|* |	2	0.506	0.195	1294.6	0.000
|*** |	|* |	3	0.432	0.097	1670.6	0.000
|*** |	|* |	4	0.399	0.097	1992.4	0.000
|*** |	| |	5	0.364	0.056	2259.9	0.000
|*** |	|* |	6	0.358	0.083	2519.4	0.000
|*** |	|* |	7	0.358	0.079	2778.3	0.000
|*** |	|* |	8	0.369	0.090	3054.1	0.000
|** |	| |	9	0.343	0.022	3292.5	0.000
|** |	| |	10	0.315	0.007	3493.5	0.000
|** |	| |	11	0.274	−0.022	3646.1	0.000
|** |	| |	12	0.266	0.022	3789.7	0.000
|** |	| |	13	0.235	−0.020	3901.5	0.000
|** |	| |	14	0.229	0.012	4007.6	0.000
|** |	| |	15	0.227	0.020	4112.3	0.000
|* |	| |	16	0.192	−0.045	4187.1	0.000
|* |	| |	17	0.178	−0.006	4251.6	0.000
|* |	| |	18	0.191	0.043	4326.2	0.000
|* |	| |	19	0.191	0.025	4400.7	0.000
|* |	| |	20	0.172	−0.010	4461.3	0.000
|* |	| |	21	0.132	−0.050	4496.9	0.000
|* |	| |	22	0.120	−0.010	4526.4	0.000
|* |	| |	23	0.106	−0.013	4549.2	0.000
|* |	| |	24	0.113	0.026	4575.5	0.000
|* |	| |	25	0.102	−0.004	4596.9	0.000
|* |	| |	26	0.118	0.032	4625.1	0.000
|* |	| |	27	0.134	0.036	4661.6	0.000
|* |	| |	28	0.135	0.021	4699.1	0.000
|* |	| |	29	0.121	0.001	4729.1	0.000
|* |	| |	30	0.125	0.027	4761.2	0.000
|* |	| |	31	0.118	0.011	4789.6	0.000
|* |	| |	32	0.121	0.016	4819.5	0.000
|* |	| |	33	0.127	0.023	4852.8	0.000
|* |	| |	34	0.135	0.018	4890.1	0.000
|* |	| |	35	0.137	0.016	4928.8	0.000
|* |	| |	36	0.130	−0.005	4963.2	0.000

Table 4 AR(*p*) lag length selection for log of squared returns

Lag	AIC	SBIC
0	2.950451	2.953684
1	2.490233	2.496699
2	2.456237	2.465937
3	2.442615	2.455548
4	2.429295	2.445461
5	2.427457	2.446857
6	2.416917	2.43955
7	2.413635	2.439501
8	2.405633*	2.434732*
9	2.406406	2.438738
10	2.407544	2.443109
11	2.408637	2.447436
12	2.409725	2.451757
13	2.409984	2.455249
14	2.410426	2.458924
15	2.411364	2.463096
16	2.410028	2.464993
17	2.411218	2.469416
18	2.410361	2.471792
19	2.409579	2.474244
20	2.410754	2.478652
21	2.408286	2.479417
22	2.409393	2.483758
23	2.410513	2.48811
24	2.410347	2.491178

AIC = Akaike information criterion, SBIC = Schwarz Bayesian information criterion
* signifies minimum value

Figure 2 Autocorrelation and partial autocorrelations of log of absolute returns

Autocorrelation	Partial correlation		AC	PAC	Q-stat	Prob
|***** |	|***** |	1	0.628	0.628	796.57	0.000
|**** |	|* |	2	0.510	0.191	1322.3	0.000
|*** |	|* |	3	0.452	0.124	1734.8	0.000
|*** |	|* |	4	0.407	0.077	2069.2	0.000
|*** |	| |	5	0.381	0.073	2363.1	0.000
|*** |	| |	6	0.369	0.073	2637.8	0.000
|*** |	|* |	7	0.367	0.078	2910.3	0.000
|*** |	|* |	8	0.385	0.104	3210.7	0.000
|*** |	| |	9	0.365	0.033	3480.6	0.000
|** |	| |	10	0.331	−0.001	3702.6	0.000
|** |	| |	11	0.297	−0.013	3881.0	0.000
|** |	| |	12	0.298	0.042	4060.9	0.000
|** |	| |	13	0.257	−0.035	4195.0	0.000
|** |	| |	14	0.244	0.005	4316.2	0.000
|** |	| |	15	0.247	0.025	4440.1	0.000
|** |	| |	16	0.215	−0.038	4533.7	0.000
|* |	| |	17	0.203	−0.005	4617.2	0.000
|* |	| |	18	0.212	0.036	4708.5	0.000
|* |	| |	19	0.210	0.024	4798.6	0.000
|* |	| |	20	0.190	−0.017	4872.1	0.000
|* |	| |	21	0.150	−0.050	4918.0	0.000
|* |	| |	22	0.144	0.005	4960.4	0.000
|* |	| |	23	0.133	−0.008	4996.5	0.000
|* |	| |	24	0.143	0.032	5038.3	0.000
|* |	| |	25	0.127	−0.010	5071.0	0.000
|* |	| |	26	0.143	0.039	5112.8	0.000
|* |	| |	27	0.151	0.020	5159.6	0.000
|* |	| |	28	0.149	0.018	5204.8	0.000
|* |	| |	29	0.136	0.003	5242.5	0.000
|* |	| |	30	0.140	0.024	5282.4	0.000
|* |	| |	31	0.145	0.029	5325.3	0.000
|* |	| |	32	0.141	0.006	5365.8	0.000
|* |	| |	33	0.138	0.011	5404.8	0.000
|* |	| |	34	0.151	0.028	5451.3	0.000
|* |	| |	35	0.146	0.005	5494.9	0.000
|* |	| |	36	0.148	0.012	5540.0	0.000

Table 5 AR(*p*) lag length selection for log of absolute returns

Lag	AIC	SBIC
0	1.612528	1.615761
1	1.113801	1.120268
2	1.077006	1.086705
3	1.056196	1.069129
4	1.047865	1.064031
5	1.044554	1.063953
6	1.035228	1.057861
7	1.033854	1.05972
8	1.021603*	1.050702*
9	1.021898	1.05423
10	1.022997	1.058562
11	1.024186	1.062984
12	1.024098	1.06613
13	1.023026	1.068291
14	1.023735	1.072233
15	1.024471	1.076202
16	1.023903	1.078868
17	1.025093	1.083291
18	1.025114	1.086545
19	1.02391	1.088575
20	1.024804	1.092702
21	1.022774	1.093905
22	1.023941	1.098305
23	1.024995	1.102592
24	1.024186	1.105017

AIC = Akaike information criterion, SBIC = Schwarz Bayesian information criterion
* signifies minimum value

Figure 3 Autocorrelation and partial autocorrelations of log of percentage changes squared

Autocorrelation	Partial correlation		AC	PAC	Q-stat	Prob
|***** |	|***** |	1	0.635	0.635	800.91	0.000
|**** |	|* |	2	0.523	0.201	1345.0	0.000
|*** |	|* |	3	0.461	0.119	1768.0	0.000
|*** |	| |	4	0.411	0.068	2103.6	0.000
|*** |	|* |	5	0.387	0.076	2401.0	0.000
|*** |	| |	6	0.370	0.066	2672.9	0.000
|*** |	|* |	7	0.369	0.079	2943.9	0.000
|*** |	|* |	8	0.373	0.079	3221.7	0.000
|*** |	| |	9	0.354	0.030	3471.1	0.000
|** |	| |	10	0.323	0.001	3679.9	0.000
|** |	| |	11	0.290	−0.013	3848.0	0.000
|** |	| |	12	0.290	0.040	4015.4	0.000
|** |	| |	13	0.247	−0.040	4136.9	0.000
|** |	| |	14	0.243	0.022	4255.3	0.000
|** |	| |	15	0.234	0.007	4365.0	0.000
|* |	| |	16	0.209	−0.023	4452.2	0.000
|* |	| |	17	0.190	−0.016	4524.8	0.000
|* |	| |	18	0.200	0.039	4604.9	0.000
|* |	| |	19	0.194	0.013	4680.1	0.000
|* |	| |	20	0.176	−0.012	4742.1	0.000
|* |	| |	21	0.135	−0.055	4778.5	0.000
|* |	| |	22	0.121	−0.012	4807.8	0.000
|* |	| |	23	0.114	0.001	4833.8	0.000
|* |	| |	24	0.123	0.029	4864.0	0.000
|* |	| |	25	0.111	−0.002	4888.9	0.000
|* |	| |	26	0.134	0.048	4924.9	0.000
|* |	| |	27	0.131	0.007	4959.6	0.000
|* |	| |	28	0.130	0.017	4993.7	0.000
|* |	| |	29	0.123	0.010	5023.9	0.000
|* |	| |	30	0.115	0.005	5050.4	0.000
|* |	| |	31	0.118	0.024	5078.6	0.000
|* |	| |	32	0.118	0.011	5106.8	0.000
|* |	| |	33	0.126	0.026	5138.9	0.000
|* |	| |	34	0.140	0.031	5178.6	0.000
|* |	| |	35	0.133	0.000	5214.3	0.000
|* |	| |	36	0.129	0.001	5248.1	0.000

Table 6 AR(*p*) lag length selection for log of percentage changes squared

Lag	AIC	SBIC
0	2.968222	2.971505
1	2.481068	2.487633
2	2.443272	2.453121
3	2.423723	2.436854
4	2.418141	2.434555
5	2.413625	2.433322
6	2.40564	2.428619
7	2.402539	2.428801
8	2.395294*	2.424839*
9	2.395919	2.428747
10	2.396959	2.433069
11	2.398171	2.437564
12	2.398677	2.441352
13	2.397854	2.443813
14	2.398288	2.44753
15	2.399475	2.451999
16	2.399818	2.455625
17	2.400846	2.459935
18	2.400126	2.462499
19	2.400494	2.46615
20	2.401655	2.470593
21	2.398681	2.470901
22	2.399714	2.475217
23	2.40083	2.479616
24	2.400498	2.482567

AIC = Akaike information criterion, SBIC = Schwarz Bayesian information criterion
* signifies minimum value

Figure 4 Autocorrelation and partial autocorrelations of log of interest rate spreads

Autocorrelation	Partial correlation		AC	PAC	Q-stat	Prob
|*******	|*******	1	0.947	0.947	3184.9	0.000
|******|	*| |	2	0.885	−0.115	5968.4	0.000
|******|	| |	3	0.832	0.060	8428.6	0.000
|******|	| |	4	0.789	0.049	10638.	0.000
|***** |	| |	5	0.755	0.071	12666.	0.000
|***** |	|* |	6	0.736	0.109	14589.	0.000
|***** |	| |	7	0.720	0.034	16433.	0.000
|***** |	| |	8	0.706	0.033	18208.	0.000
|***** |	| |	9	0.692	0.025	19913.	0.000
|***** |	| |	10	0.681	0.046	21562.	0.000
|***** |	| |	11	0.667	0.006	23148.	0.000
|***** |	| |	12	0.655	0.026	24676.	0.000
|***** |	| |	13	0.642	0.010	26145.	0.000
|***** |	| |	14	0.627	−0.014	27547.	0.000
|**** |	| |	15	0.612	0.008	28881.	0.000
|**** |	| |	16	0.600	0.029	30163.	0.000
|**** |	| |	17	0.587	−0.012	31390.	0.000
|**** |	| |	18	0.571	−0.020	32554.	0.000
|**** |	| |	19	0.558	0.018	33666.	0.000
|**** |	| |	20	0.546	0.005	34731.	0.000
|**** |	| |	21	0.535	0.008	35754.	0.000
|**** |	| |	22	0.529	0.040	36752.	0.000
|**** |	| |	23	0.523	0.006	37729.	0.000
|**** |	| |	24	0.516	−0.003	38681.	0.000
|**** |	| |	25	0.506	−0.012	39598.	0.000
|**** |	| |	26	0.495	−0.005	40475.	0.000
|**** |	| |	27	0.486	0.024	41319.	0.000
|*** |	| |	28	0.478	0.010	42136.	0.000
|*** |	| |	29	0.471	0.010	42931.	0.000
|*** |	| |	30	0.464	−0.006	43703.	0.000
|*** |	| |	31	0.457	0.007	44451.	0.000
|*** |	| |	32	0.451	0.016	45181.	0.000
|*** |	| |	33	0.446	0.006	45894.	0.000
|*** |	| |	34	0.440	−0.003	46586.	0.000
|*** |	| |	35	0.434	0.008	47261.	0.000
|*** |	| |	36	0.428	0.001	47917.	0.000

Table 7 AR(*p*) lag length selection for log of interest rate spread volatility (6 months)

Lag	AIC	SBIC
0	3.255616	3.257594
1	0.784783	0.78874
2	0.770315	0.77625
3	0.770345	0.778259
4	0.766739	0.776632
5	0.755364	0.767235
6	0.738895	0.752745*
7	0.73704	0.752868
8	0.736927	0.754733
9	0.735654	0.755439
10	0.733501	0.755264
11	0.733479	0.757221
12	0.731876	0.757597
13	0.731978	0.759677
14	0.732632	0.76231
15	0.731316	0.762972
16	0.730896	0.764531
17	0.731551	0.767164
18	0.732208	0.7698
19	0.732039	0.771609
20	0.730752	0.772301
21	0.730813	0.77434
22	0.728418*	0.773923
23	0.729059	0.776543
24	0.729699	0.779161

AIC = Akaike information criterion, SBIC = Schwarz Bayesian information criterion
* signifies minimum value

Table 8 TGARCH/EGARCH regressions of financial volatility (squared returns) v. 6-month institutional volatility (contract-intensive money)

	Dependent variable: squared returns							
	6 month institutional volatility							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	AR(8)-TGARCH (2,2)	**AR(8)-EGARCH (3,2)**	**AR(8)-EGARCH (3,2)**	**AR(8)-EGARCH (2,1)**	**AR(8)-EGARCH (2,1)**	**AR(8)-EGARCH (2,2)**	**AR(8)-EGARCH (3,2)**	**AR(8)-EGARCH (3,3)**
Conditional mean equation								
INSTITUTIONAL VARIABLES								
Lag of property rights (contract-intensive money)	−0.92	−1.35	−2.54	−2.18	−2.43	−2.22	−2.49	−2.25
	0.82	*18.76***	*2.04**	*5.48***	*2.14**	*20.19***	*2.07**	*12.59***
Lag of democracy	−0.25	−0.22	−0.13	−0.13	−0.13	−0.12	−0.13	−0.06
	*3.10***	*13.81***	*1.32*	*0.92*	*1.51*	*5.65***	*1.33*	*2.12**
MACROECONOMIC VARIABLES								
Inflation, 6-month coefficient of variation			0.001	0.001	0.001	0.001		
			*2.89***	*2.59***	*2.86***	*2.11**		
Inflation, 6-month standard deviation							0.002	0.010
							0.15	*0.50*
GDP growth rate			−1.68		−1.36	−1.58	−1.80	
			*2.30**		*1.91**	*2.01**	*2.45**	
GDP growth rate, lagged				1.38				1.32
				*2.35**				*2.49**
Change in credit to GDP, lagged						−0.001		
						0.93		
Lagged growth of money (M2)							0.0001	0.0001
							1.13	*1.57*
Lagged acceleration of money growth			0.0001					

			1.34					
Money growth, 6-month coefficient of variation				−0.09	−0.14			
				0.82	*1.13*			
C	−5.57	−5.37	−4.87	−5.21	−4.88	−5.12	−4.95	−5.55
	*6.67***	*70.25***	*4.70***	*15.96***	*5.42***	*76.04***	*5.07***	*68.24***
Conditional variance equation								
SD of property rights (contract-intensive money), 6 months	28.37	12.77	7.81	42.33	39.68	18.59	9.02	
	*3.93***	*2.55***	*1.80**	*2.05**	*2.11**	*3.32***	*1.98**	
SD of property rights (contract-intensive money), 3 months								
Coefficient of variance, contract-intensive money, 6 months								4.07
								*1.71**
SD of democracy, 6 months	0.26	−0.32	−0.20	0.08	0.12	−0.34	0.26	
	0.50	*1.42*	*0.68*	*0.08*	*0.17*	*1.18*	*0.07*	
Coefficient of variance, democracy, 6 months								0.17
								0.82
(E/T)ARCH term 1	−0.07	−0.03	−0.04	−0.04	−0.04	0.05	−0.04	0.005
	*3.23***	*1.24*	*1.05*	*0.98*	*1.17*	*1.79**	*1.29*	*0.24*
(E/T)ARCH term 2	−0.14	−0.06	−0.08	−0.08	−0.07	−0.06	−0.07	−0.08
	*5.14***	*2.09**	*0.98*	*2.13**	*2.26**	*2.51***	*1.25*	*2.79***
(E/T)ARCH term 3								−0.07
								*2.74***
ABARCH term 1	0.49							
	*9.58***							
ABARCH term 2	0.48							
	*11.08***							
ABARCH term 3								

EGARCH (Theta) 1		0.21	0.18	0.33	0.34	0.05	0.18	0.20
		*3.58***	*3.58***	*5.69***	*5.71***	*0.45*	*3.48***	*4.24***
EGARCH(Theta) 2		0.17	0.13	0.28	0.29	0.02	0.13	0.14
		*2.57***	*1.71**	*4.67***	*4.68***	*0.22*	*1.27*	*2.84***
EGARCH(Theta) 3								*−0.05*
								0.99
EGARCH term 1		−0.57	−0.67	−0.88	−0.89	1.26	−0.57	−0.81
		*3.50***	*1.58*	*11.88***	*13.83***	*21.95***	*1.48*	*7.44***
EGARCH term 2		0.87	0.91			−0.81	0.89	0.93
		*16.38***	*15.78***			*4.92***	*13.07***	*24.05***
EGARCH term 3		0.52	0.64				0.55	0.76
		*3.79***	*1.65**				*1.61**	*6.30***
TGARCH term 1	−1.28							
	*32.46***							
TGARCH term 2	0.99							
	*15.83***							
TGARCH term 3								
AR terms								
AR(1)	0.44	0.45	0.49	0.45	0.46	0.45	0.45	0.46
	*19.84***	*18.07***	*18.29***	*20.75***	*18.20***	*15.42***	*17.41***	*28.29***
AR(2)	0.15	0.15	0.12	0.13	0.13	0.14	0.13	0.12
	*7.98***	*6.87***	*5.23***	*3.41***	*5.66***	*11.92***	*4.20***	*6.61***
AR(3)	0.01	0.01	0.01	0.01	0.01	−0.001	0.02	0.02
	0.33	*0.79*	*0.80*	*0.28*	*0.57*	*0.03*	*0.77*	*0.36*
AR(4)	0.04	0.05	0.05	0.07	0.07	0.08	0.05	0.05

	*1.75**	*2.24**	*1.90**	*1.78**	*2.37**	*1.67**	*1.79**	*2.82***
AR(5)	0.04	0.03	0.01	0.02	0.02	−0.01	0.01	0.02
	*1.90**	*2.46***	*0.35*	*0.48*	*0.60*	*1.13*	*0.40*	*1.19*
AR(6)	0.02	0.03	0.05	0.05	0.05	0.04	0.05	0.05
	0.69	*1.39*	*2.00**	*2.98***	*2.02**	*1.43*	*1.88**	*5.64***
AR(7)	0.09	0.04	0.03	0.02	0.02	0.07	0.03	0.03
	*3.00***	*2.19**	*1.21*	*0.77*	*0.91*	*2.31**	*1.17*	*2.54***
AR(8)	0.06	0.06	0.08	0.07	0.66	7.00	0.07	0.07
	*4.05***	*2.75***	*3.30***	*3.43***	*3.04***	*2.80***	*2.57***	*3.64***
n	2235	2235	2015	2002	2005	1694	2017	2011
Log likelihood	−2759.26	−2757.13	−2410.30	−2400.51	−2404.70	−2036.98	−2418.52	−2406.27
AIC (Stata)	5560.532	5558.25	4870.6	4847.01	4855.404	4119.957	4883.03	4866.535
AIC (normalized)	2.4879	2.4869	2.4172	2.4211	2.4216	2.4321	2.4209	2.4200
Jarque-Bera Kurtosis statistic	3.804	4.404	3.673	3.779	3.819	3.90	3.664	3.711
Kolmogorov-Smirnov test *p*-statistic	0.126	0.28	0.096	0.433	0.374	0.338	0.094	0.235
Q test *p*-statistic	0.41	0.41	0.50	0.49	0.51	0.60	0.49	0.47
Distribution	GED	Student's T	GED	GED	GED	GED	GED	GED

Note: absolute values of t-stats are under the coefficients, with * signifying significance at the 10% level and ** at the 1% level.

Figure 5 QQ plot of residuals from Model 2, EGARCH simple model of institutional volatility versus financial volatility

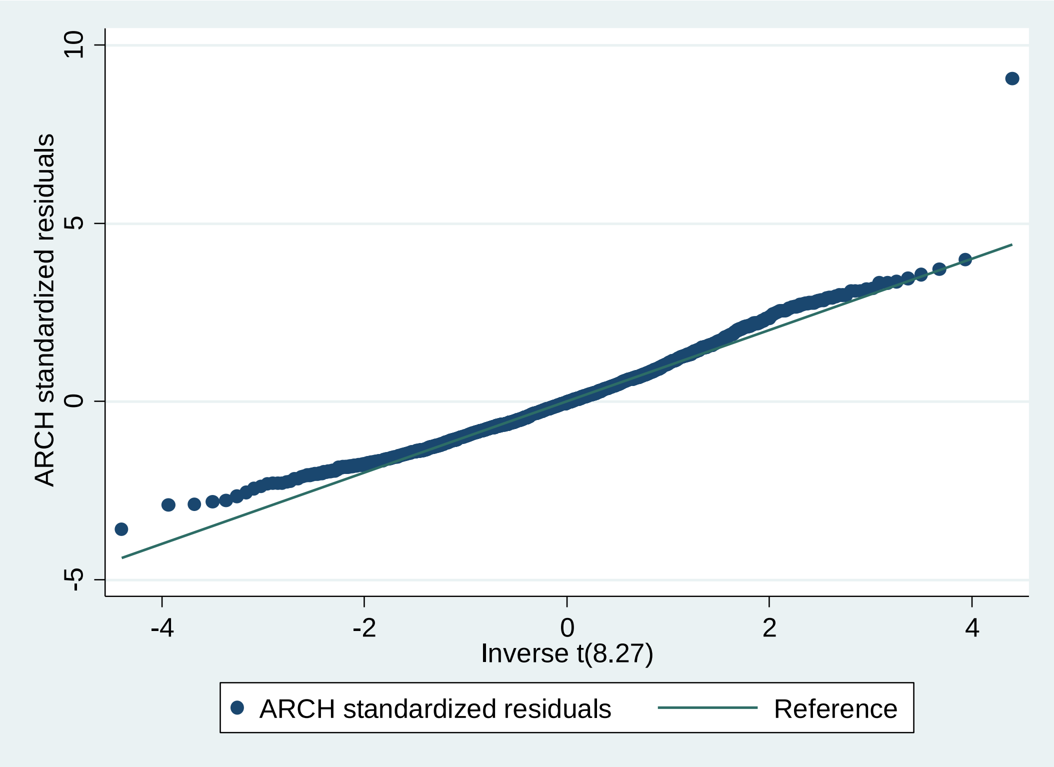

Table 9 TGARCH/EGARCH regressions of financial volatility (squared returns) v. 3-month institutional volatility (contract-intensive money)

	Dependent variable: squared returns							
	3 month institutional volatility							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
	AR(8)-TGARCH (3,3)	**AR(8)-EGARCH (3,2)**	**AR(8)-EGARCH (2,2)**	**AR(8)-EGARCH (3,2)**	**AR(8)-EGARCH (3,2)**	**AR(8)-EGARCH (3,2)**	**AR(8)-EGARCH (3,3)**	**AR(8)-EGARCH (3,2)**
Conditional mean equation								
INSTITUTIONAL VARIABLES								
Lag of property rights (contract-intensive money)	−1.48	−1.45	−2.34	−2.82	−2.44	−2.88	−2.43	−2.43
	*13.91***	*1.47*	*14.69***	*60.54***	*40.33***	*1.41*	*56.84***	*48.64***
Lag of democracy	−0.21	−0.23	−0.13	−0.16	−0.09	−0.13	−0.10	−0.13
	*9.68***	*2.81***	*2.56***	*12.34***	*4.89***	*0.85*	*12.81***	*13.68***
MACROECONOMIC VARIABLES								
Inflation, 6-month coefficient of variation			0.001					
			*3.43***					
Inflation, 6-month standard deviation				0.002				
				0.17				
Inflation, 3-month standard deviation					0.01	0.001	0.001	0.001
					0.47	*0.17*	*0.11*	*0.14*
GDP growth rate				−1.60	−2.25	−1.64		
				*2.33**	*3.60***	*1.69**		
GDP growth rate, lagged			1.28				1.16	0.90
			*2.45**				*2.02**	*1.58*
Change in credit to GDP, lagged					0.0001			
					0.03			

Lagged growth of money (M2)						0.0001	0.0001	0.0001
						1.16	*2.26**	*0.88*
Lagged acceleration of money growth								
Money growth, 3-month coefficient of variation					−0.11			
					*1.84**			
C			−5.09	−4.68	−5.01	−4.82	−5.21	−5.04
			*35.86***	*140.48***	*64.07***	*4.39***	*130.94***	*122.55***
Conditional variance equation								
SD of property rights (contract-intensive money), 3 months	33.92	15.87	10.24	14.33	14.41	14.83	10.38	
	*1.99**	*2.59***	*2.17**	*2.23**	*1.28*	*1.74**	*1.83**	
Coefficient of variance, contract-intensive money, 3 months								10.58
								*1.74**
SD of democracy, 3 months	−1.38	−1.09	−0.81	−1.03	−0.89	−1.03	−0.58	
	1.57	*2.30**	*1.91**	*2.20**	*1.23*	*1.75**	*1.56*	
Coefficient of variance, democracy, 3 months								−3.82
								*2.07**
(E/T)ARCH term 1	−0.03	−0.03	0.002	−0.04	−0.10	−0.04	−0.01	−0.04
	0.28	*1.18*	*0.07*	*1.29*	*2.71***	*1.24*	*0.15*	*1.21*
(E/T)ARCH term 2	−0.16	−0.08	−0.08	−0.09	0.001	−0.09	−0.07	−0.09
	1.25	*2.48**	*3.27***	*2.93***	*0.02*	*2.69***	*2.90***	*2.66***
(E/T)ARCH term 3							−0.02	
							0.57	
ABARCH term 1	0.44							
	*5.74***							
ABARCH term 2	0.36							
	*4.12***							

ABARCH term 3	−0.14							
	1.22							
EGARCH (Theta) 1		0.24	0.17	0.20	0.28	0.22	0.28	0.21
		*4.79***	*4.09***	*4.39***	*3.30***	*4.16***	*4.57***	*3.82***
EGARCH(Theta) 2		0.09	−0.03	0.06	−0.07	0.04	0.06	0.04
		1.02	*0.63*	*0.82*	*0.57*	*0.61*	*1.49*	*0.57*
EGARCH(Theta) 3							*−0.18*	
							*2.77***	
EGARCH term 1		−0.24	0.10	−0.23	0.38	−0.20	−0.33	−0.19
		*2.51***	*1.48*	*2.34***	*1.32*	*2.62***	*2.12**	*1.82**
EGARCH term 2		0.33	0.82	0.34	−0.14	0.30	0.92	0.32
		*5.33***	*13.74***	*5.49***	*0.66*	*3.82***	*28.89***	*3.45***
EGARCH term 3		0.75		0.74	0.62	0.75	0.33	0.73
		*8.51***		*6.79***	*3.95***	*6.33***	*2.30**	*3.89***
TGARCH term 1	−1.33							
	*3.68***							
TGARCH term 2	0.35							
	*2.50**							
TGARCH term 3	0.83							
	*2.64***							
AR terms								
AR(1)	0.44	0.45	0.45	0.46	0.47	0.46	0.46	0.46
	*28.22***	*19.10***	*29.89***	*28.90***	*21.00***	*11.93***	*11.83***	*40.28***
AR(2)	0.14	0.13	0.13	0.12	0.11	0.11	0.12	0.11
	*9.18***	*5.92***	*4.22***	*10.92***	*4.75***	*4.10***	*3.88***	*12.04***
AR(3)	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.02
	0.39	*0.64*	*0.26*	*1.49*	*0.73*	*0.28*	*3.19***	*0.71*

AR(4)	0.08	0.06	0.06	0.06	0.07	0.06	0.06	0.06
	*2.52**	*2.56***	*2.70***	*5.94***	*2.16**	*0.67*	*4.38***	*4.86***
AR(5)	0.04	0.04	0.01	0.02	−0.01	0.02	0.02	0.02
	*1.87**	*1.73**	*0.66*	*1.38*	*0.11*	*0.20*	*0.92*	*1.31*
AR(6)	0.03	0.33	0.05	0.05	0.06	0.05	0.05	0.05
	1.23	*1.85**	*3.54***	*2.96*	*2.49**	*0.93*	*6.56***	*6.71***
AR(7)	0.04	0.04	0.03	0.03	0.05	0.03	0.03	0.03
	1.36	*1.70**	*1.33*	*0.70*	*0.38*	*0.83*	*2.61***	*1.55*
AR(8)	0.05	0.05	0.08	0.07	0.06	0.07	0.07	0.06
	*3.04***	*2.65***	*5.48***	*1.98**	*0.79*	*2.87***	*7.78***	*1.10*
n	2256	2256	2049	2052	1688	2029	2026	2026
Log likelihood	−2774.82	−2774.79	−2454.13	−2457.38	−2025.17	−2430.25	−2423.82	−2428.73
AIC (Stata)	5597.635	5593.58	4954.284	4962.762	4102.345	4910.496	4901.639	4907.462
AIC (normalized)	2.4812	2.4794	2.4179	2.4185	2.4303	2.4202	2.4194	2.4222
Jarque-Bera Kurtosis statistic	5.393	5.866	3.708	3.764	3.955	3.798	3.718	3.757
Kolmogorov-Smirnov test *p*-statistic	0.23	0.183	0.429	0.139	0.335	0.286	0.323	0.349
Q test *p*-statistic	0.41	0.40	0.47	0.47	0.63	0.47	0.47	0.47
Distribution	Student's T	Student's T	GED	GED	Student's T	Student's T	Student's T	Student's T

Note: absolute values of t-stats are under the coefficients, with * signifying significance at the 10% level and ** at the 1% level.

Table 10 Robustness tests

	Dependent variable: squared returns		Dependent variable: absolute returns		Dependent variable: squared percentage changes		Dependent variable: interest rate spread volatility		Dependent variable: squared returns	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
	AR(8)-EGARCH (4,2)	**AR(8)-EGARCH (4,2)**	**AR(8)-TARCH (1)**	**AR(8)-TARCH (1)**	**AR(8)-TGARCH (2,1)**	**AR(8)-TGARCH (2,1)**	**AR(6)-EGARCH (2,2)**	**AR(6)-EGARCH (2,2)**	**AR(8)-EGARCH (2,2)**	**AR(8)-EGARCH (2,2)**
Conditional mean equation										
INSTITUTIONAL VARIABLES										
Lag of property rights (contract-intensive	−2.27	−2.60	−0.78	−0.80	−3.57	−3.87	−1.88	−1.13		
	*2.07**	*2.30**	*15.40***	*1.08*	*2.87***	*15.14***	*2.19**	*1.25*		
Lag of property rights (political risk rating)									−0.02	−0.02
									*14.56***	*35.39***
Lag of democracy	−0.11	−0.09	−0.05	−0.06	0.04	0.04	−0.29	−0.35	−0.15	−0.17
	1.25	*1.20*	*3.99***	*1.01*	*0.33*	*0.60*	*4.50***	*5.97***	*5.14***	*11.02***
MACROECONOMIC VARIABLES										
Inflation, 6-month coefficient of variation	0.0003	0.0001	0.0004	0.0004	0.001		0.0002		0.00	
	0.28	*0.21*	*2.77***	*2.37**	*1.87**		*0.93*		*3.34***	
Inflation, 6-month standard deviation										
Inflation, 3-month standard deviation						0.003		0.001		0.003
						0.12		*0.99*		*10.28***
GDP growth rate						−1.98				
						*2.04**				
GDP growth rate, lagged	1.06	1.01	0.62	0.64	1.07		−0.08	−0.23	1.21	1.20
	1.55	*1.50*	*2.26**	*1.97**	*1.76**		*0.17*	*1.09*	*1.88**	*2.00**

Lagged growth of money (M2)			0.0001	0.0001	0.0001	0.0002	0.0001	0.0001	0.0001	0.0001
			*1.69**	*1.57*	*1.95**	*2.15**	*0.72*	*1.01*	*1.48*	*1.63*
S&P 500 volatility	66.29									
	*3.08***									
Price of gold, 6-month standard deviation		0.002								
		*1.78**								
C	−5.29	−5.11	−1.75	−1.68	5.74	5.99	2.40	2.15	−5.26	−5.22
	*6.68***	*6.00***	*41.88***	*2.40**	*5.54***	*33.66***	*4.61***	*3.90***	*40.72***	*102.65***
Conditional variance equation										
SD of property rights (contract-intensive	14.08	13.74	50.24		56.73		11.41			
	*2.12**	*2.07**	*5.02***		*3.60***		*2.00**			
SD of property rights (contract-intensive				59.35		65.42		10.82		
				*4.29***		*3.75***		*1.11*		
SD of property rights (political risk rating), 6									−0.02	
									*1.67**	
SD of property rights (political risk rating), 3										−0.03
										*1.82**
SD of democracy, 6 months	−0.39	−0.32	−0.70		−2.73		0.36		0.09	
	1.58	*1.30*	*1.34*		*2.47**		*1.11*		*0.71*	
SD of democracy, 3 months				−2.05		−3.44		1.48		0.12
				*2.48***		*2.50**		*2.25**		*0.91*
S&P volatility	−20.60									
	0.82									
Price of gold, 6-month standard deviation		0.0004								
		0.84								
(E/T)ARCH term 1	−0.04	−0.05	−0.14	−0.14	−0.08	−0.07	−0.39	−0.36	0.02	0.02
	1.03	*1.45*	*1.95**	*1.82**	*3.68***	*3.44***	*5.64***	*3.18***	*0.71*	*0.80*

(E/T)ARCH term 2	−0.11	−0.11					−0.18	0.20	−0.06	−0.09
	3.34**	3.60**					2.84**	1.79*	2.98**	3.05**
EGARCH (Theta) 1	0.28	0.27					0.09	0.35	0.13	0.13
	5.85**	5.93**					0.91	2.53*	3.03**	3.04**
EGARCH(Theta) 2	0.20	0.19					−0.28	−0.34	−0.04	−0.040
	4.67**	4.54**					3.28**	2.22*	0.73	0.84
ABARCH term 1			0.54	0.54	0.11	0.12				
			9.64**	9.43**	3.16**	3.57**				
EGARCH term 1	−0.67	−0.70					0.76	0.66	0.12	0.12
	2.31*	2.68**					11.48**	7.18**	1.54	1.71*
EGARCH term 2	0.42	0.40					−0.47	−0.53	0.86	0.86
	4.08**	4.19**					3.90**	4.98**	11.89**	12.48**
EGARCH term 3	0.69	0.72								
	2.55**	2.90**								
EGARCH term 4	0.45	0.47								
	4.04**	4.60**								
TGARCH term 1					0.53	0.49				
					3.40**	3.99**				
TGARCH term 2					0.38	0.43				
					2.92**	4.15**				
AR terms										
AR(1)	0.43	0.45	0.45	0.44	0.46	0.47	1.10	1.13	0.45	0.45
	17.54**	19.05**	25.46**	15.67**	19.46**	18.99**	80.81**	81.12**	20.82**	99.73**
AR(2)	0.12	0.13	0.10	0.10	0.12	0.12	−0.09	−0.14	0.12	0.12
	4.94**	5.18**	4.44**	3.58**	4.94**	3.37**	6.70**	6.58**	5.33**	24.69**
AR(3)	0.04	2	0.04	0.04	0.07	0.08	−0.05	−0.03	0.01	0.01
	1.71*	0.94	2.01*	1.44	3.03**	2.62**	1.55	2.09*	0.48	1.55

AR(4)	0.06	0.06	0.05	0.05	0.03	0.03	−0.02	0.00	0.06	0.06
	*2.37**	*2.50**	*2.89***	*1.91**	*1.20*	*0.69*	*0.50*	*0.07*	*3.10***	*7.03***
AR(5)	−0.002	−0.01	0.05	0.05	0.03	0.03	0.01	0.01	0.02	0.02
	0.10	*0.32*	*2.47**	*1.96**	*1.53*	*0.94*	*0.50*	*0.74*	*0.77*	*1.17*
AR(6)	0.05	0.06	0.07	0.06	0.06	0.06	0.04	0.02	0.03	0.03
	*2.25**	*2.29**	*2.86***	*2.29**	*2.55**	*2.53**	*2.50**	*1.56*	*1.48*	*3.11***
AR(7)	0.04	0.04	0.00	0.00	0.04	0.04			0.05	0.05
	1.64	*1.45*	*0.15*	*0.13*	*1.90**	*1.35*			*1.98**	*3.17***
AR(8)	0.06	0.07	0.07	0.07	0.04	0.06			0.06	0.08
	*2.71***	*3.04***	*5.38***	*3.12***	*2.01**	*2.71***			*2.86***	*7.90***
n	2123	2123	2035	2047	2231	2245	2394	2409	2137	2140
Log likelihood	−2657.316	−2659.23	−1101.58	−1107.2	−2780.59	−2793.03	−403.98	−436.95	−2586.41	−2590.91
AIC (Stata)	5368.631	5372.46	2243.163	2254.44	5605.182	5630.067	851.965	917.8943	5220.821	5229.814
AIC (normalized)	2.5288	2.5306	1.1023	1.1013	2.5124	2.5078	0.3559	0.3810	2.4431	2.4438
Jarque-Bera kurtosis statistic	3.489	3.467	4.022	4.137	4.342	4.284	21.98	17.39	3.739	3.72
Kolmogorov-Smirnov test *p*-statistic	0.389	0.151	0.768	0.897	0.164	0.162	0.00	0.00	0.04	0.04
Q test *p*-statistic	0.57	0.55	0.56	0.56	0.38	0.38	0.23	0.22	0.49	0.49
Distribution	Student's T	GED	GED	GED	Student's T	GED	Student's T	Student's T	GED	GED

Note: absolute values of t-stats are under the coefficients, with * signifying significance at the 10% level and ** at the 1% level.

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