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Financial market information flows when counteracting rogue states: The indirect effects of targeted sanction packages

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ABSTRACT

This study investigates how financial sanctions packages targeting Russia influenced traditional information flow dynamics with other international financial markets and products. While providing empirical evidence regarding the use of payment systems and finance as weapons of war, it is crucial to understand if the market's response to international sanctions diminished as expectations shifted over time. Results, supported by robustness testing procedures, indicate important dynamic information flows relating to specific sanctions after the onset of the Russia-Ukraine war. In particular, those sanctions relating to the exclusion of Russia from the SWIFT payment system and those targeting banks and private wealth resulted in significant contagion effects sourced from all Russian markets examined. Such influence, however, is found to moderate and dilute as investors reconstruct their expectations and valuations. While targeted sanctions appear to impose intended market isolation, it is also associated with significant contagion effects. Although such secondary effects dissipate, they should be seen as important when implementing further targeted sanction packages.

1. Introduction

The use of international economic and financial sanctions has evolved as both a viable deterrent to the escalation of conflict and aggression by rogue nations and, indeed, as an alternative to the movement of physical infrastructure and personnel in response to attempts to provoke armed conflict. Several nations, such as North Korea and Russia, have built perceptions of government persona aligned to seek conflict through the ongoing development and use of advanced weaponry or the movement of military personnel for strategic purposes. In particular, Russia's ongoing campaign to "de-nazify" Ukraine has provoked much international outrage since it entered a phase of serious escalation in 2014.[2] The Russian decision to invade Ukraine on 24 February 2022 was met not only

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[2] Following the removal of pro-Russian Ukrainian President Viktor Yanukovych in February 2014, pro-Russian unrest erupted throughout the country's eastern and southern areas. In the Ukrainian territory of Crimea, Russian forces seized important locations and infrastructure without the presentation of military insignia. In addition, Russia helped orchestrate a disputed referendum that, in March 2014, resulted in the annexation of Crimea in April 2014. This was followed by the war

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by international condemnation but a level of counter-resistance by Ukrainian forces that embarrassed the Russian government due to their initial intention to finish the war within 'days', with many considering that the Russian leadership incorrectly assumed that their nation was "too big to fail". Despite much international outrage, additional external physical support would directly escalate the conflict; therefore, the imposition of severe packages of international sanctions upon the Russian economy was deemed to be the most effective route to demonstrate that the actions of a rogue nation cannot be tolerated. The scale of such packages was largely unprecedented, manifesting in several concerns about what unintentional side effects might result. This research, using novel techniques to focus on traditional information flows and price discovery across international financial markets, sourced from a range of Russian-based financial and derivative products, specifically investigates how packages of financial-based sanctions also generated international contagion effects.

The path selected by the Russian state to generate international economic turmoil as a result of the invasion of Ukraine was relatively straightforward and based on four immediately observable dimensions: i) destabilisation of international energy markets in an attempt to increase inflation; ii) threatening regional and international food security; iii) increasing international financial market volatility in an attempt to further destabilise amid the COVID-19 pandemic; and iv) broad disruption to the international banking sector and financial system. Although not backed by all countries, a series of international sanctions were imposed, including a decision to exclude Russia from SWIFT, which made interbank payment transactions significantly more complex and hindered the national ability to trade goods and exchange currencies. Other decisions were made to limit and evolve sanctions as Russia continued its assault on Ukraine. Specifically, the Russian banking sector was exposed to several types of sanctions, primarily those relating to the further blocking of Russian institutions from the SWIFT platform, along with those deemed to be specific to banking institutions, those targeting the Russian economy, those explicitly targeting the Russian financial system, sanctions targeting luxury products, and those targeting the private wealth of oligarchs. In the research presented here across each type of sanction, differential behaviour of information flows across traditional relationships with stock markets and banking indices in Australia, Canada, China, Europe, the United Kingdom, and the United States are examined using specific time-varying information shares (IS), component shares (CS), and information leadership shares (ILS), respectively.[3] Examining the differential information flows can further our understanding of the unique interactions between the financial markets of these countries, providing unique information for regulators and policy-makers. Still, it can also identify helpful information for market participants through identifying opportunities for diversification.

It is important to note that while the Russian invasion of Ukraine on 24 February 2022 acted as a major escalation of an operation that began in 2014 through the annexation of Crimea, there is much evidence to suggest that the financial market effects of the "special operation" had been implicitly accounted for a period before the latest escalation. Such evidence can be identified through observation of two distinct factors: a) a sharp discontinuity in construction-related statistics as Ukrainians deferred future projects due to the escalating threat of armed conflict, as presented in Fig. 1, and b) a marked elevation in international gas prices as presented in Fig. 2, far in advance of the Russian "special operation", and largely observed as a preemptive strike by the Kremlin to disrupt international energy markets to generate the most significant negative economic repercussions. The resultant international counter-response and overall cohesion and cooperation of implemented packages agreed by several concerned parties appear to be far more synchronised than various sanctions implemented in the past. Despite this cohesion, however, broad unease remained regarding how negative contagion effects could persist worldwide (Shahzad et al., 2023; Steinbach, 2023). While the influence of COVID-19 upon international gas prices throughout 2020 and 2021 is evident (Corbet et al., 2020; Ahmed and Sarkodie, 2021; Chen et al., 2022; Tiwari et al., 2022), the sharp escalation of prices in line with the beginning of the Russia-Ukraine conflict can be clearly attributed to the acute market disconnection experienced.

While providing empirical evidence concerning the impact of war on the international banking sector and the use of payment systems and finance as the tools of wars, this research also attempts to address another important question: whether the market response to international sanctions attenuated over time as expectations adjusted. This was a strongly debated point as many international governments struggled to obtain direct support for additional sanctions while confronting sharply increasing costs of living due to the continued escalation of the conflict and the heavy reliance of some economies upon Russian oil and gas. Such sanctions appeared to be only as effective as the credibility that underpinned them.

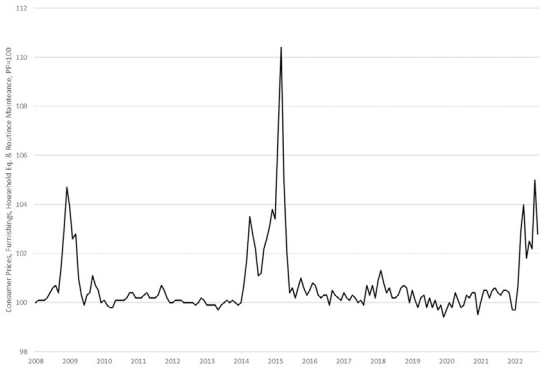
Results indicate that the effects of the Russia-Ukraine war and subsequent sanctions on the Russian economy had a substantial influence on information flows between Russian and international financial markets. Information flows relating to sanctions based on SWIFT and those imposed on banks and private wealth are found to be particularly pronounced, especially those information flows sourced from Russian banking indices. Results indicate that sanctions generated significant contagion effects from all Russian

in Donbas, leading to the establishment of two separatist quasi-states, the Donetsk People's Republic and the Lugansk People's Republic. Neither was internationally recognised.

[3] Such recent sanctions imposed by the European Union, for example, develop upon those already existing through the "Council Regulation (EU) No 833/2014 of 31 July 2014 concerning restrictive measures because of Russia's actions destabilising the situation in Ukraine" (available here). This work builds upon previous research which focused on shifting informational dynamics between financial products as a result of acute shocks, by analysing shifts in IS, CS, and ILS measures respectively (Putniņš, 2013; Jin et al., 2018; Dimpfl and Peter, 2021; Bandyopadhyay and Rajib, 2023). In response to Russia's war of aggression against Ukraine and its illegal annexation of Ukrainian territories, the European Union (EU) has implemented a comprehensive array of sanctions. These measures encompass targeted restrictive measures, economic sanctions, and visa measures. The economic sanctions are designed to impose substantial consequences on Russia, deterring its actions and effectively impeding its capacity to sustain aggression. Specifically, individual sanctions are directed towards individuals who bear responsibility for supporting, financing, or executing actions that undermine Ukraine's territorial integrity, sovereignty, and independence and those who derive benefits from such actions. Furthermore, the EU has extended its sanctions to other countries, including Belarus, due to its involvement in the invasion of Ukraine and Iran concerning the manufacture and supply of drones. Implementing these sanctions reflects the EU's commitment to address and respond to threats against Ukraine and maintain regional stability.

i) Business Surveys, Expectations of Investment in Construction, Next 12 Months

ii) Consumer Prices, Household Equip. and Routine Maint., PP=100



iii) Loans, Households, Lending for House Purchase, UAH

Note: Data is obtained from Thomson Reuters Eikon. From Q2 2014 onwards, as a consequence of the socio-political situation in the company, economic statistics were published excluding the temporarily occupied territories, including Crimea and Sevastopol, due to an inability to collect data in these regions. As a result, these regions are excluded when referring to "the whole country". Above, the consumer price index indicates changes at the time of prices and tariffs for commodities and services being purchased by the population for unproductive consumption. The estimation of CPI is based on data about the changes in prices obtained through the monthly registration of prices and tariffs in the consumer market and data about the structure of the consumer money expenses of the total population, received according to the data from the sample survey of the households living conditions.

Fig. 1. Ukrainian construction-related statistics.

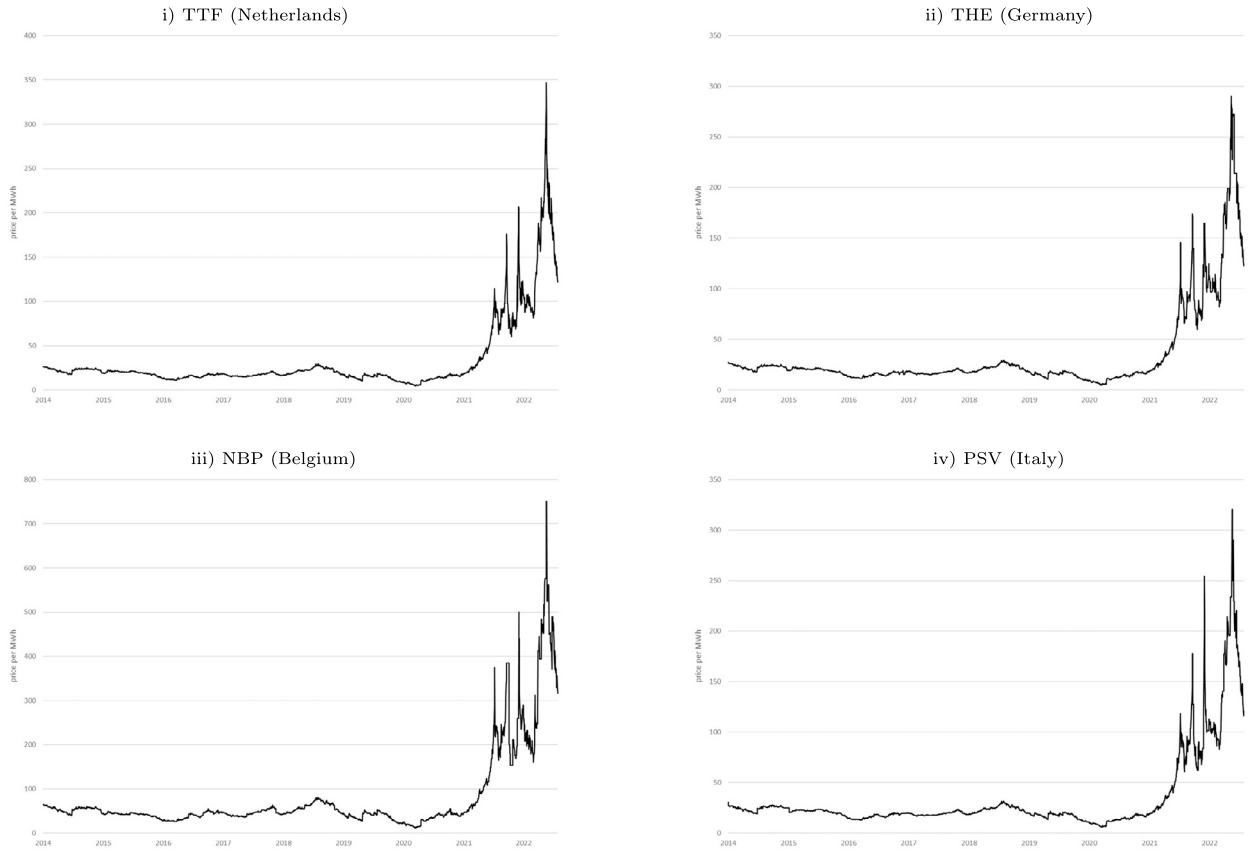
markets examined, irrespective of the type of financial product, upon other international banking systems. Looking at the effects over time, however, such influence is found to largely moderate and dilute as investors re-balance their expectations. Finally, focusing on the country-specific effects, Australian and Canadian markets exhibit resilience against shocks sourced from Russia, whereas markets in the UK, US and Europe are susceptible and vulnerable to those shocks. These results are found to be robust across a variety of secondary procedures. While targeted sanctions appear to impose the intended market isolation, it is also associated with contagion effects that negatively influence non-targeted countries and markets. Such secondary influence, although dissipating, should be considered in the further implementation of targeted sanction packages.

This study marks a significant advancement in academic research by applying innovative methodologies to investigate the largely unexplored influence of financial sanctions packages on global financial markets. It provides a nuanced understanding of the evolution of market response to sanctions. It delivers valuable insights into the transnational contagion effects generated by these sanctions across international financial markets, yielding several implications for global investment strategies while emphasising the necessity to reconsider diversification approaches while bolstering risk management protocols. It further sheds light on the unanticipated secondary impacts of sanctions on the performance and efficiency of global stock markets and international banking sectors.

The remainder of this paper is structured as follows: the previous literature and theories that guide the development of our research are summarised in Section 2. Section 3 presents a thorough explanation of the wide variety of data used in this analysis, while Section 4 presents a concise overview of the methodologies used. In Section 5, we present the results from analyses that investigate the differential behaviour of information dynamics in response to the many international sanction packages that have been imposed upon Russia, with distinct analysis and discussion provided based on what specific interaction effects were observed across the international banking sector, and whether such effects deteriorated over time. Section 6 concludes.

2. Previous literature

The influence of international sanctions upon financial markets and international economies has been analysed on several occasions. Wang et al. (2019) identified that economic sanctions significantly influence the target countries' exchange rate volatilities,

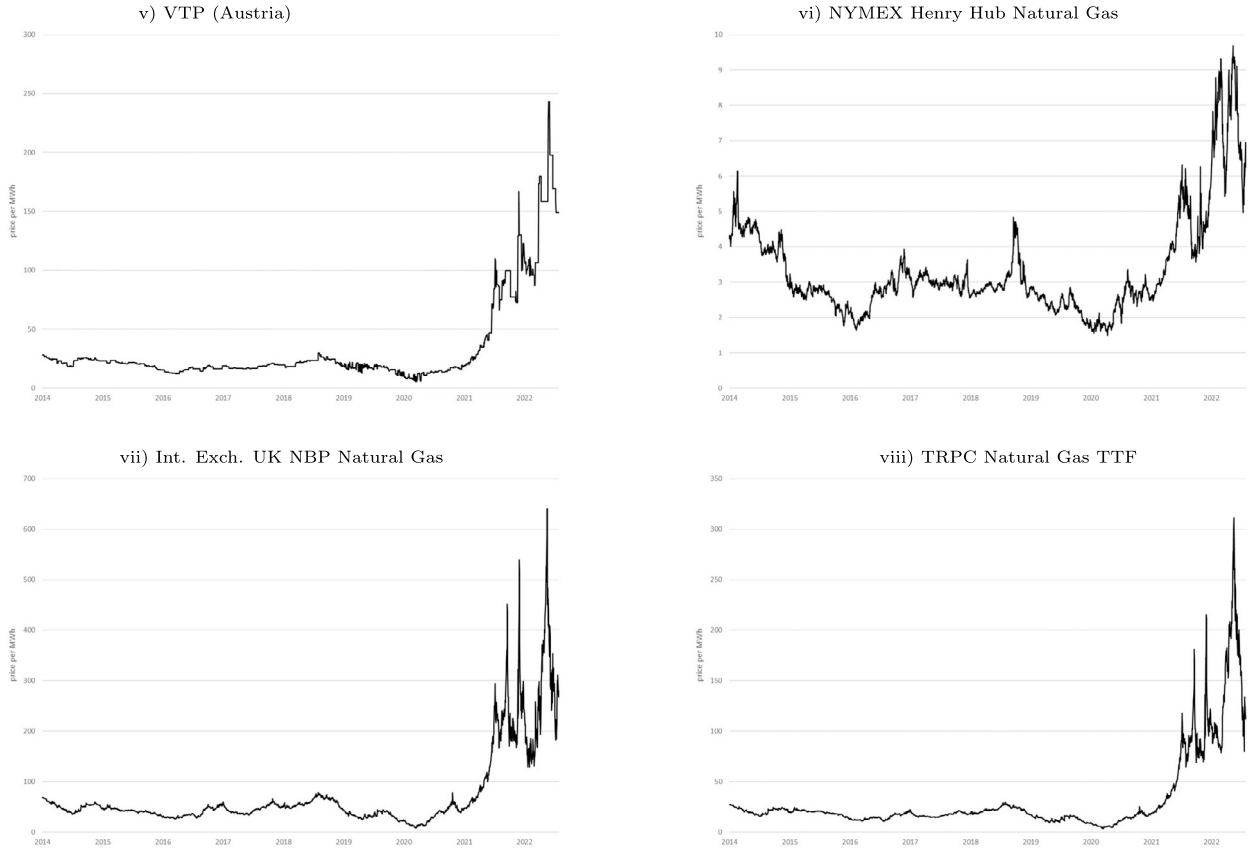


Note: Data is obtained from Thomson Reuters Eikon.

Fig. 2. International gas prices.

thereby generating economic uncertainty. When focusing on cross-border financial flows, Besedeš et al. (2017) identified evidence of strong, immediate negative effects on financial flows with the country that has been sanctioned, specifically finding that sanctions imposed by the European Union alone, compared to those imposed by the United Nations, present evidence of consistent evasion. Evidence suggests that flows with major trading partners of sanctioned countries increase, deviating from the intended sanctions. Neuenkirch and Neumeier (2016) found that over thirty years of examination, sanctions generate a 3.6% larger poverty gap in the target country, with evidence further supporting that the severity of sanctions exacerbates such effects. Afesorgbor and Mahadevan (2016) found that the imposition of sanctions deleteriously affects income inequality. In contrast, Neuenkirch and Neumeier (2015) identified that a target country's annual real per capita GDP growth rate fell by more than 2% following UN sanctions' imposition. Further regionally-focused analyses have concentrated on the imposition of sanctions in Iran (Farzanegan, 2011), Russia (Dreger et al., 2016), and Myanmar (Holliday, 2005). Recent research based on the recent events in Ukraine and the side-effects associated with the implementation of sanctions has focused on entrepreneurship (Zahra, 2022), effects on the international banking sector (Girardone, 2022), supply chain interruptions (Cui et al., 2023), dividend policy (Ershova et al., 2023), and the effects on the global green transition (Crowley-Vigneau et al., 2023).

Substantial focus has been placed on the influence of war and international conflict on various financial markets. Focusing specifically on the invasion of Ukraine, Chortane and Pandey (2022) identified a negative impact on the value of global currencies, where the influence of sanctions is a leading influential factor. Broad international market connectedness is identified to have become stronger since the beginning of the war (Adekoya et al., 2022). Russian commodity market volatility has also been linked with increased domestic geopolitical uncertainty (Costola and Lorusso, 2022). Such interaction is also of interest when considering the exposure of the Russian economy to other geopolitical risks that it has been exposed to, such as the pricing war with Saudi Arabia that took place in March 2020. Ma et al. (2021) found that this pricing war impacted futures markets, with effects that were negatively correlated with the time-to-maturity of the futures market investigated. Such conflict is also found to generate a significant decline in overall happiness or national morale (Coupe and Obrizan, 2016), where such negative perceptions and economic outlook can generate further negative knock-on effects regarding national investment and willingness to take risk (Tausch and Zumbuehl, 2018). Rigobon and Sack (2005) found that increases in war risk generated significant declines in Treasury yields and equity prices. Further, the authors identified evidence of a widening of lower-grade corporate spreads, a fall in the dollar compared to other international currencies, and a rise in oil prices. Further, significant influence is found to be sourced from the destruction costs of conflict (Smith et al., 2014). Manela and Moreira (2017) created the News Implied Volatility Index (NVIX) to account for geopolitical issues such



Note: Data is obtained from Thomson Reuters Eikon.

Fig. 2. (*continued*)

as war, as measured by the front page of the Wall Street Journal since 1890. However, the comparability of such shocks is, in some cases, not explicitly found to represent extraordinary movements when comparing the DJIA Index in a semi-parametric test based on conditional heteroscedasticity modelling. When focusing on the influences of war upon domestic inventory through a focused analysis based on the civil war in Columbia, Jola-Sanchez and Serpa (2021) found that companies replace physical assets with fungible assets, providing a fragile operational buffer, generating operational inflexibility. Therefore, implementing international sanctions should theoretically further reduce such operational stagnation.

3. Data

To investigate the contagion effects of international sanctions imposed upon the Russian economy as a result of the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. These data are used in the following research to examine, by type of imposed sanction, the differential behaviour of information flows across traditional relationships with stock markets and banking indices in Australia, Canada, China, Europe, the United Kingdom, and the United States using specific time-varying information shares, component shares, and information leadership shares, respectively. Stock market and banking sector interactions are examined separately. While providing empirical evidence concerning the impact of war on the international banking sector and the use of payment systems and finance as the tools of wars, this research also attempts to address another important question: whether the market response to international sanctions attenuated over time as expectations adjusted. Specifically, to focus on the direct effects upon the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system,[4] along with specific sanctions targeting the Russian banking system, the Russian economy, those

[4] The Society for Worldwide Interbank Financial Telecommunication (SWIFT) is a Belgian cooperative organisation that offers services relating to the execution of financial transactions and payments between banks throughout the world. Its primary function is to serve as the principal message network for initiating international payments.

specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth.[5] A list of the sanctions used to analyse each of these six dimensions is provided in Table 1.

In this study, we collect prices at hourly intervals from Thomson Reuters Eikon for Russian financial markets and major stock markets in the global financial systems. In the research presented here, we use closing prices at hourly intervals. Primarily, the rapidly changing dynamic nature of deteriorating relations and conditions between Ukraine and Russia provides much support to the selection of a higher data frequency of analysis than daily data. When considering the threat of escalation of the conflict, even before the eventual invasion of Ukraine, news fluidity represented multiple dynamic changes within a single day of observation, many of which would be diluted using daily data.[6] The appropriateness of data frequency for studying information transmission and efficiency of financial markets has been discussed in the literature, and the conclusions as to the best choice on time intervals of data rest with the specific research questions, methodological contexts as well as anticipated inference. It has been acknowledged that there is a trade-off between data at high frequencies, such as minutely data and data at low frequencies, such as daily data, for the issues of information transmissions and linkages of financial markets. According to the discussions in Wu et al. (2005), employing high-frequency tick data has the merit that information taking place within the short passage of time and relating to the activities of high-frequency trading can be better captured, whereas there is an apparent drawback that such data suffers from trading frictions and market microstructure biases to a more considerable extent than low-frequency data. The situation is more difficult when the questions of information transmissions and spillovers are addressed. Moreover, there is another problem of periodicity in data at second and minute time intervals, which may result in inaccurate estimation results. On the other hand, low-frequency data, represented by daily data employed in a large body of prior studies, is advantageous over high-frequency data, where daily data is less affected by trading frictions and market microstructure biases. Nonetheless, the use of daily data is undermined because it fails to capture information about high-frequency trading activities conducted by informed traders, which may further impair the estimation result as to information transmissions and flows. To mitigate the adverse impacts of both kinds of data and reach a relatively optimal choice on frequency selection, we choose data at hourly intervals in this study with the belief that such choice may capture information regarding high-frequency, informed trading as well as avoiding some extent the impairment from trading frictions and market microstructure biases on estimation results. Data relating to the levels for each of these markets are presented in Figs. 3. As seen in Fig. 3, there are large drops in price series following the invasion, which are observed across the markets analysed.[7]

The Russian financial markets within the sample include the Russian stock market index (namely, the Moscow Stock Exchange (MOEX) index), MOEX 10 index consisting of the top 10 stocks in the Russian stock market, MOEX Government Bond index, MOEX Corporate Bond index, and MOEX Russian Volatility Index that tracks the ongoing volatility level of the Russian stock market. Also, four stock sectors in Russia are considered for the sample, which includes MOEX Financials Index, MOEX Consumer Index, MOEX blue-chip Index and MOEX Innovation Index. The counterpart markets considered for modelling against Russian ones include stock market indices in six countries, which are Australia, Canada, the United Kingdom (UK), the United States (US), Europe and China.

In addition, we also collect data from banking sectors in the stock markets of these countries for analysis. Definitions relating to the variables used are identified in Table 2, while summary statistics relating to each of the variables analysed are presented in Table 3. As observed, most of the means of return series under analysis present negative values during the whole sample period. The mean returns of Russian stock indices are similar to those in selected domestic stock indices in magnitude. Moreover, it is found that the volatilities of the Russian stock indices are not dissimilar to those in the selected regions. Meanwhile, the skewness and kurtosis between the Russian markets and the other counterparts differ in sign and size, whereas the Russian markets exhibit larger skewness and kurtosis. Note that the selection of regional stock markets modelled against the Russian ones reflects the most liquid and active trading venues for global investors. We choose to employ banking sector data for analysis because the imposition of sanctions against Russia following the Russia-Ukraine war heavily relates to the well-known international systems of money transfer across countries, such as SWIFT, which comprises a core business of banks. Furthermore, we examine the interactions between the Russian financial markets and the global stock indices. We collect the price series of the World Index and World Banking Index in our sample from nine Russian financial markets and fourteen major international stock markets.

To model the time-varying information share measures, we match one Russian market price series with one counterpart market price series to construct pairwise samples connecting price observations at the same trading time for both markets examined. This

[5] We have also considered the intricate nature of differentiating between the immediate impacts of a geopolitical event such as an invasion and the economic ramifications of ensuing sanctions, particularly when they are temporally proximate. Both events represent distinct shocks to the financial system, but their overlapping timelines can make it challenging to disentangle their individual effects. An invasion, by its nature, introduces immediate geopolitical risks, leading to market reactions influenced by anticipatory behaviour, fear, and uncertainty. On the other hand, sanctions, especially when rolled out incrementally, present a series of economic disruptions, with each wave potentially compounding or altering market sentiments. Our choice of using hourly data, as opposed to minutely data or that of higher granularity, is a considered one. While minutely data could theoretically provide a finer lens to discern immediate reactions, such granularity introduces a higher risk of statistical noise, which can detract from discerning genuine market trends and responses. The use of hourly data, in our view, balances the need for granularity with the imperative to reduce transient market noise. It affords a window into the market's evolving responses without becoming overly susceptible to short-term fluctuations that may not have long-term significance. Lastly, the distinction we draw between the effects of the invasion and the sanctions doesn't imply a complete isolation of their impacts. Rather, it represents an analytical approach to delineate their relative influences on global financial markets during the time frames under scrutiny. We acknowledge that in the real-world scenario, these influences are deeply intertwined, with the reactions to sanctions potentially being modulated by the overarching geopolitical context set by the invasion itself.

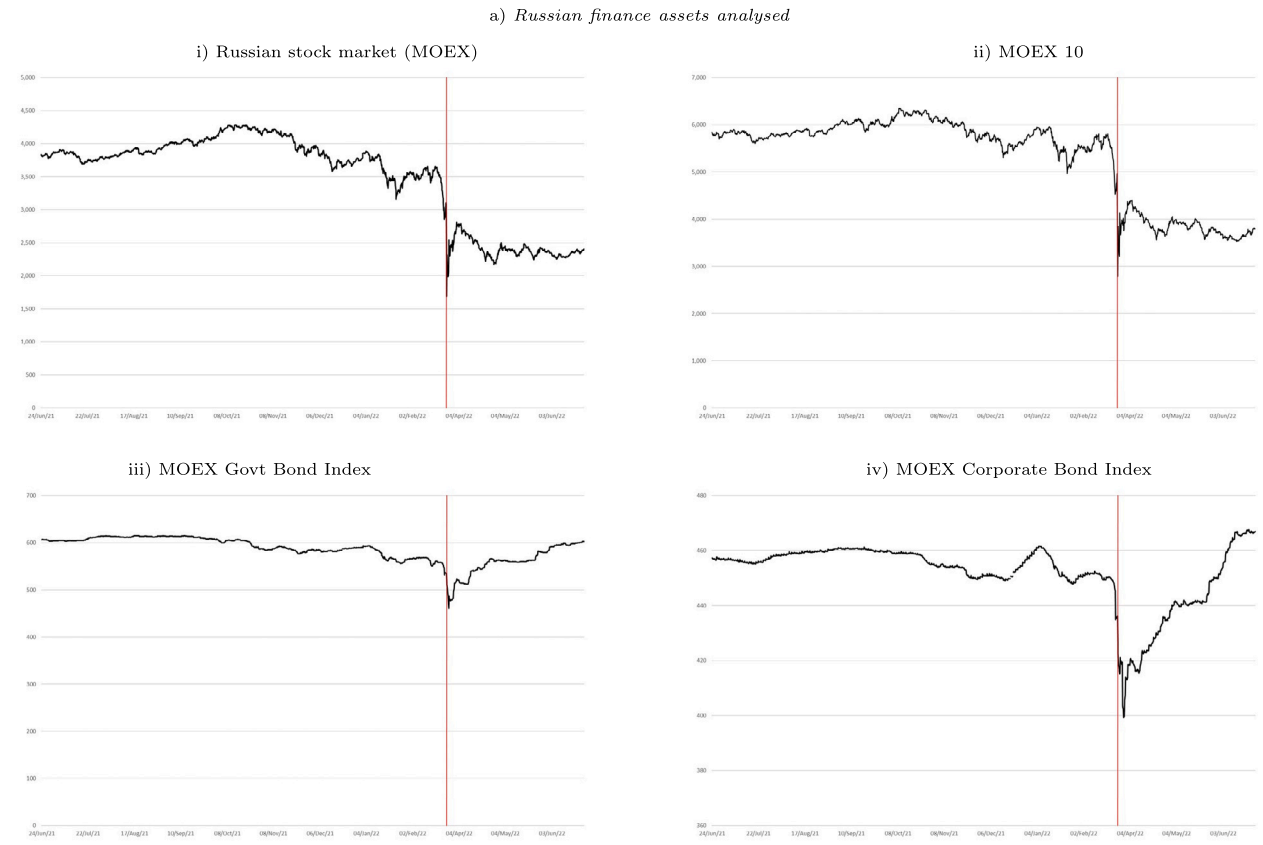
[6] Various alternative frequencies of analysis were considered, but for the range of conflict-specific issues, we present our analysis based on daily data. Other methodological variants are omitted for brevity of presentation but are available from the authors upon request.

[7] Figure A1 of the Online Appendices also shows that there are more substantial oscillations of data series during the period where the war is ongoing, which is observed for all the series. The changing patterns of data are worth further investigation.

Table 1
International sanctions against the Russian economy by type.

Date	Countries	Area Targeted	Description
22-Feb	EU	Econ., Pr.Wealth	The EU agreed to new sanctions on Russia that will blacklist more politicians, lawmakers and officials, ban EU investors from trading in Russian state bonds, and target imports and exports with separatist entities
23-Feb	Japan	Econ., Fin.	Japan imposes sanctions on Russia over actions in Ukraine
25-Feb	Australia	Pr.Wealth	Australia announces sanctions on wealthy Russian individuals
27-Feb	Norway	Econ., Fin.	Norway says its sovereign fund will divest from Russia
27-Feb	Multiple	Econ., Fin.	Russian banks' access to the SWIFT international payment system blocked
28-Feb	UK	Econ., Fin.	Britain freezes assets in UK of Russian national wealth fund
28-Feb	Multiple	Pr.Wealth	EU, U.S., Canada, Japan and others announce travel bans, asset freezes on wealthy Russian individuals
28-Feb	Singapore	Banking	Singapore will impose "appropriate sanctions and restrictions" on Russia.
28-Feb	S.Korea	SWIFT	South Korea bans exports of strategic items to Russia, joins SWIFT sanctions
28-Feb	Multiple	Econ., Fin.	U.S., EU, Britain, and Japan ban transactions with the Russian central bank, Ministry of Fin., national wealth fund
01-Mar	EU	Econ., Fin., Luxury	EU to ban steel imports from Russia, luxury goods exports to Moscow
01-Mar	Japan	Econ., Fin.	Japan to freeze assets of 3 Belarusian banks, ban more exports to Russia
01-Mar	UK	Econ., Fin.	UK sanctions Russian lawmakers who supported Ukraine breakaway regions
01-Mar	Multiple	Econ., Fin.	Allies join G7's WTO stance towards Russia - EU trade chief
01-Mar	EU	Econ., Fin., Luxury	EU blacklists Abramovich, targets energy, luxury sectors with new Russia sanctions
01-Mar	Japan	Econ., Pr.Wealth	Japan will impose sanctions on 15 Russian individuals and nine organisations
01-Mar	UK	Econ., Fin.	UK sanctions Alfa, Gazprombank and Lavrov's stepdaughter
03-Mar	Japan	Econ., Fin.	Japan to freeze assets of four more Russian banks from April 2
04-Mar	Switz.	SWIFT	Switz. adopts EU measures regarding Russian banks' access to SWIFT and assets of prominent wealthy Russian individuals
04-Mar	Switz.	Econ., Fin.	Switz. bans transactions with the Russian central bank, freezes its assets overseas
05-Mar	Italy	Pr.Wealth	Italy seizes property and yachts of wealthy Russian individuals
07-Mar	Canada	Pr.Wealth	Canada sanctions 10 individuals close to Putin, says Trudeau
07-Mar	NZ	Pr.Wealth	New Zealand expands sanctions on Russia over Ukraine invasion
08-Mar	Japan	Pr.Wealth	Japan unveils new sanctions on Russians, bans refinery equipment exports
09-Mar	EU	SWIFT, Pr.Wealth	EU hit Russia, Belarus with more sanctions, set to snub Ukraine on swift membership
10-Mar	UK	Pr.Wealth	UK imposes asset freezes on Chelsea owner Abramovich, Rosneft boss Sechin
11-Mar	Canada	Pr.Wealth	Canada sanctions Russian billionaire Abramovich, others
11-Mar	US	Pr.Wealth	U.S. imposes new sanctions on Vekselberg, Putin spokesman's family
11-Mar	Multiple	Econ., Fin.	U.S., European allies intensify economic pressure on Russia
14-Mar	EU	Pr.Wealth	EU agrees to freeze Roman Abramovich's assets
15-Mar	Japan	Pr.Wealth	Japan imposes sanctions on 17 more Russians, including billionaire
15-Mar	UK	Pr.Wealth	UK announces 350 new sanctions listings on Russia
18-Mar	Australia	Pr.Wealth	Australia sanctions Russian billionaires with mining industry links
24-Mar	Switz.	Pr.Wealth	Swiss freeze more than $6 billion worth of sanctioned Russian assets
24-Mar	US	Pr.Wealth, Fin.	U.S imposes sanctions against dozens of defence companies, 328 members of the Duma legislative body and the chief executive of Sberbank
29-Mar	Japan	Luxury	Japan to ban Russia-bound exports of luxury cars, goods from April 5
01-Apr	Japan	Econ., Fin.	Japan MOF panel recommends revoking Russia's most-favoured-nation status
01-Apr	US	Econ.	The U.S. Internal Revenue Service has suspended information exchanges with Russia's tax authorities.
01-Apr	UK	Econ.	Britain froze the assets of Russia's largest bank Sberbank and sanctioned eight oligarchs.
01-Apr	Switz.	Econ., Pr.Wealth	Switz. has so far frozen 7.5 billion Swiss francs ($8.03 billion) in funds and assets under sanctions against Russians, including money in frozen bank accounts and properties in four Swiss cantons
01-Apr	Australia	Econ.	Australia adds 14 Russian state-owned enterprises to its list of sanctions, targeting names such as Gazprom, Kamaz, SEVMASH and United Shipbuilding Corp
01-Apr	Poland	Econ.	Poland sanctions Gazprom among 50 Russian firms and oligarchs
01-Apr	Switz.	Econ., Fin.	Swiss implement further EU sanctions against Russia, Belarus
06-Apr	US	Banking	U.S. sanctions Putin's daughters and more Russian banks
14-Apr	UK	Pr.Wealth	Britain sanctioned two close associates of Chelsea owner Roman Abramovich in response to Russia's invasion of Ukraine, saying the men had been subjected to the largest asset freeze ever imposed by the government
21-Apr	UK	Pr.Wealth	Britain set out 26 new sanctions on Thursday targeting Russian military generals responsible for what it called atrocities in Ukraine
01-May	UK	Econ.	UK bans services exports to Russia, sanctions Russian media outlets
20-May	Canada	Luxury	Canada said it was imposing additional sanctions on Russian oligarchs and banning the import and export of targeted luxury goods from Russia
01-Jun	EU	Econ.	EU agrees on Russia oil embargo, gives Hungary exemptions; Zelenskiy vows more sanctions
01-Jun	Multiple	Econ.	Britain, the United States, Japan and Canada will ban new imports of Russian gold
29-Jul	UK	Pr.Wealth	UK sanctions Russian oligarch Vladimir Potanin, described by London as Russia's second-richest man and who has been buying assets from firms exiting Russia over the invasion of Ukraine

Note: To investigate the contagion effects of international sanctions imposed upon the Russian economy as a result of the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. Specifically, to focus on the direct effects on the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system, along with specific sanctions targeting the Russian banking system and the Russian economy, those sanctions specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth.



Note: To investigate the effects of sanctions on the Russian economy on information flows and price discovery, data is obtained for the period 24 June 2021 through 23 June 2022 from Thomson Reuters Eikon. The line in each graphic on 24 February 2022 indicates the date of the illegal physical invasion of Ukraine by armed Russian forces.

Fig. 3. Price levels of investigated assets.

gives us 126 sample pairs for analysis. To investigate the effects of sanctions on the Russian economy on information flows and price discovery, the sample path is chosen from 24 June 2021 to 23 June 2022. The sample size varies across differing sample pairs, where we maintain sufficient observations for model estimation.

4. Methodology

4.1. An extended VEC-DCC-GARCH-SNP model

The bivariate conditional distribution of return series is specified by a vector error correction model (VECM) for conditional means, as well as a bivariate dynamic conditional correlation (DCC), generalised autoregressive conditional heteroscedasticity (GARCH) model for the specification of the conditional variance-covariance matrix. The VECM is employed to specify conditional means of return series since price series are tested to be integrated at order 1, and further, the cointegration test suggests that there exists a cointegrating relation for all the sample pairs under examination.[8] Specifically, the VECM is presented as:

$$\Delta c_t = ec_c u_{t-1} + \sum_{i=1}^{p} a_i^{11} \Delta c_{t-i} + \sum_{i=1}^{p} a_i^{12} \Delta r_{t-i} + e_{1,t}. \tag{1}$$

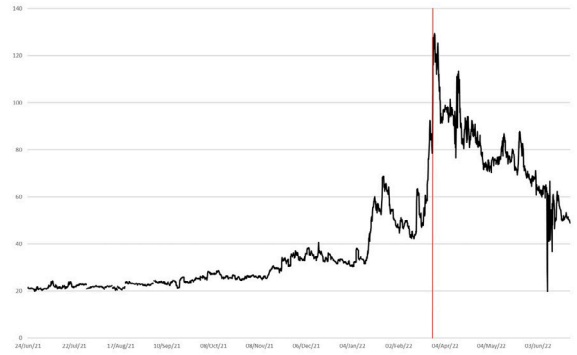
$$\Delta r_t = ec_r u_{t-1} + \sum_{i=1}^{p} b_i^{21} \Delta c_{t-i} + \sum_{i=1}^{p} b_i^{22} \Delta r_{t-i} + e_{2,t}, \tag{2}$$

where Δc_t and Δr_t are returns series of one counterpart market and one Russian market at time t, respectively. u_{t-1} is the lagged error correction term of the cointegrating equation. ec_c and ec_r are error correction coefficients for Δc_t and Δr_t, respectively. The error correction coefficients examine how fast one market responds to any deviation from the long-run disequilibrium in the past between

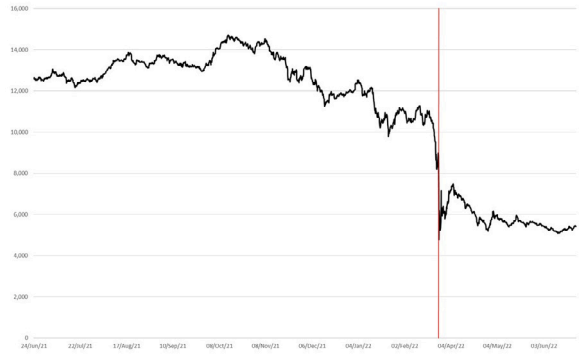
[8] We employ the Augmented Dickey-Fuller test and Phillips-Perron test to examine the stationarity of price series. The Johanson test is used to test the cointegration. Test results are available upon request.

a) *Russian finance assets analysed*

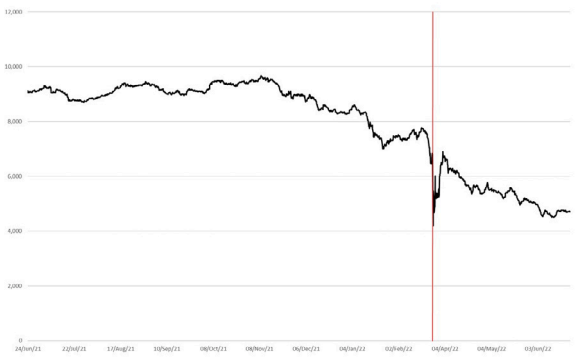
v) Russian Volatility Index



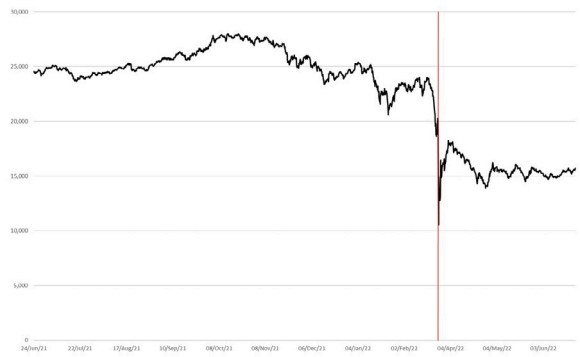
vi) Russian banking sector



vii) Russian consumer index



viii) Russian blue-chip index



Note: To investigate the effects of sanctions on the Russian economy on information flows and price discovery, data is obtained for the period 24 June 2021 through 23 June 2022 from Thomson Reuters Eikon. The line in each graphic on 24 February 2022 indicates the date of the illegal physical invasion of Ukraine by armed Russian forces.

Fig. 3. (*continued*)

Table 2
Description of key variables used in this analysis.

Variable	Ticker	Issuer
Russian Stock Market	MOEX	MOEX Russia Index
MOEX10	MOEX10	Top 10 MOEX Corporations
MOEX Govt Bond Index	MCXRGBITR	MOEX Govt Bond Index
MOEX Corporate Bond Index	RUCBITR	MOEX Corp Bond Index
Russian Volatility Index	RVI	MOEX Russian Volatility Index
Russian banking sector	MOEXFN	MOEX Financials Index
Russian consumer index	MOEXCN	MOEX Consumer Index
Russian blue-chip index	MOEXBC	MOEX blue-chip Index
Russian innovation index	MOEXINN	MOEX Innovation Index
Australia Stock Market	AXJO	S&P/ASX 200
Australia Bank Sector	dMIAU0CB00PUS	MSCI Australia Banks Industry Price Index USD
Canada Stock Market	GSPTSE	TSX-Toronto Stock Exchange 300 Composite Index
Canada Bank Sector	dMICA0CB00PUS	MSCI Canada Banks Industry Price Index USD
China Stock Market	CSI300	Shanghai Shenzhen CSI 300 Index
China Bank Sector	dMICN0CB00PUS	MSCI China Banks Industry Price Index USD
Europe Stock Market	STOXX50	STOXX Europe 50 Index
Europe Bank Sector	dMIEU0CB00PUS	MSCI Europe Banks Industry Price Index USD
UK Stock Market	FTSE	FTSE 100 Index
UK Bank Sector	dMIGB0CB00PUS	MSCI United Kingdom Banks Industry Price Index USD
US Stock Market	SPX	S&P500 Index CBOE
US Bank Sector	dMIUS0CB00PUS	MSCI United States Banks Industry Price Index USD
World Stock Market Index	MIWD00000PUS	MSCI All Country World Price Index USD
World Bank Sector Index	MIWO0BK00PUS	MSCI World Banks Industry Group Price Index USD

Note: The above table describes the variables and source of the data for a sample period running from 24 June 2021 through 23 June 2022 used in this analysis.

b) *International indices analysed*

Note: To investigate the effects of sanctions on the Russian economy on information flows and price discovery, data is obtained for the period 24 June 2021 through 23 June 2022 from Thomson Reuters Eikon. The line in each graphic on 24 February 2022 indicates the date of the illegal physical invasion of Ukraine by armed Russian forces.

Fig. 3. (*continued*)

Table 3
Summary statistics relating to the key variables used in this analysis.

Asset Analysed	Mean	Variance	Skewness	Kurtosis	Minimum	Maximum	Observations
Russian stock market (MOEX)	-0.0001	0.0002	4.66	385.25	-0.288	0.372	2,173
MOEX 10	-0.0001	0.0002	5.95	392.88	-0.259	0.382	2,107
MOEX Govt Bond Index	0.0001	0.0001	3.70	234.79	-0.040	0.057	2,161
MOEX Corporate Bond Index	0.0001	0.0000	-9.13	260.41	-0.035	0.016	2,115
Russian Volatility Index	0.0014	0.0033	21.63	772.34	-0.537	2.045	3,539
Russian banking index	-0.0003	0.0002	0.48	244.98	-0.288	0.299	2,107
Russian consumer index	-0.0002	0.0002	5.02	314.90	-0.240	0.302	2,107
Russian blue-chip index	-0.0001	0.0002	5.59	410.81	-0.302	0.412	2,107
Russian innovation index	-0.0001	0.0002	4.24	179.14	-0.214	0.267	2,107
Australia Stock Market	-0.0001	0.0001	-2.48	28.89	-0.049	0.019	2,049
Australia Bank Sector	-0.0001	0.0002	-1.57	20.22	-0.051	0.025	2,391
Canada Stock Market	-0.0001	0.0001	-0.29	15.80	-0.032	0.033	2,113
Canada Bank Sector	-0.0001	0.0002	0.19	15.75	-0.028	0.040	2,361
China Stock Market	-0.0001	0.0002	-0.87	19.13	-0.051	0.032	1,937
China Bank Sector	0.0001	0.0002	-0.85	13.10	-0.033	0.025	2,133
Europe Stock Market	-0.0001	0.0003	-1.78	17.77	-0.048	0.031	2,334
Europe Bank Sector	-0.0001	0.0004	-1.47	16.29	-0.053	0.041	3,445
UK Stock Market	0.0001	0.0001	-1.58	17.94	-0.035	0.023	2,261
UK Bank Sector	-0.0001	0.0003	-1.16	11.68	-0.044	0.035	3,147
US Stock Market	-0.0001	0.0002	-1.07	14.51	-0.050	0.031	2,216
US Bank Sector	-0.0001	0.0004	-0.04	12.11	-0.052	0.054	2,377

Note: The above table reports descriptive statistics of the daily change of the analysed variables for a sample period from 24 June 2021 through 23 June 2022.

b) *International indices analysed*

v) United Kingdom

vi) United States

vii) World Index

Note: To investigate the effects of sanctions on the Russian economy on information flows and price discovery, data is obtained for the period 24 June 2021 through 23 June 2022 from Thomson Reuters Eikon. The line in each graphic on 24 February 2022 indicates the date of the illegal physical invasion of Ukraine by armed Russian forces.

Fig. 3. (*continued*)

the two-price series under investigation, which identifies which series first absorbs new shocks and which series subsequently follows the correction process in the long term. The lag order p in the equations is chosen based on the Akaike Information Criterion (AIC). It should be noted that neither Eq. (1) nor (2) includes an intercept because the cointegration test suggests cointegration exists with null drifts in the price series.

To further investigate the time-varying features inherent in the error correction coefficients, which contribute to time variation in information share measures, we employ Legendre polynomials to estimate how the coefficients change across time. In doing so, the coefficients ec_c and ec_r in Eqs. (1) or (2) are further specified by the Legendre polynomials, where they are conditioned on a set of time functions. The reasons why the Legendre polynomials are used to gauge time-varying error correction coefficients are discussed below. The Legendre polynomials are first employed to gauge the time-varying effects of conditional volatilities on crude oil returns by Joo and Park (2017). They find that the Legendre polynomials can precisely capture the linear and non-linear effects of time on a variable where the factors that drive the variable remain unknown. Henceforth, the polynomials enable a smooth functional form for forecasting a variable that potentially changes hinging on time with high accuracy and flexibility. Hou et al. (2019) further find evidence that the Legendre polynomials fit financial time series data well when there are time-varying volatility spillovers in a more complicated model specification. A recent study by Corbet et al. (2021) finds that the Legendre polynomials can estimate time-varying error correction coefficients when the restrictions on the values of the cointegrating vector apply. The evidence suggests that the time-varying error correction coefficients can be estimated by the polynomials, which further facilitates the estimation of the information share (IS), and information leadership share (ILS), measures of Hasbrouck (1995) and Putniņš (2013). These previous results support the application of the Legendre polynomials in this research to estimate the time-varying features inherent in the error correction coefficients of the cointegrating relationship between the Russian financial markets and international counterparts. In this sense, ec_c and ec_r in Eqs. (1) and (2) can be extended as $ec_{c,t}$ and $ec_{r,t}$, respectively. $ec_{c,t}$ and $ec_{r,t}$ are specified as below:

$$ec_{c,t} = \sum_{k=0}^{K} \lambda_{c,k} l(k,t), \quad \text{and} \quad ec_{r,t} = \sum_{k=0}^{K} \lambda_{r,k} l(k,t), \tag{3}$$

c) *International banking indices analysed*

Note: To investigate the effects of sanctions on the Russian economy on information flows and price discovery, data is obtained for the period 24 June 2021 through 23 June 2022 from Thomson Reuters Eikon. The line in each graphic on 24 February 2022 indicates the date of the illegal physical invasion of Ukraine by armed Russian forces.

Fig. 3. (*continued*)

where $t = 1, 2, \ldots, T$ and T is sample size. $l(k,t)$ $(k = 0, 1, 2, \ldots, K)$ is a set of the Legendre polynomials up to order K. The value of K is chosen according to the AIC, adjusted R-square and model log-likelihood. In this study, we choose K to be four as per those criteria. Henceforth, when K is four, then we have:

$$l(0,t) = 1;\ l(1,t) = t;\ l(2,t) = 0.5(3t^2 - 1);\ l(3,t) = 0.5(5t^3 - 3t);\ l(4,t) = 0.125.(35t^4 - 30t^2 + 3) \tag{4}$$

In turn, we modify Eqs. (1) and (2) by nesting with Eq. (4) as

$$\Delta c_t = ec_{c,t}u_{t-1} + \sum_{i=1}^{p} a_i^{11}\Delta c_{t-i} + \sum_{i=1}^{p} a_i^{12}\Delta r_{t-i} + e_{1,t}, \tag{5}$$

$$\Delta r_t = ec_{r,t}u_{t-1} + \sum_{i=1}^{p} b_i^{21}\Delta c_{t-i} + \sum_{i=1}^{p} b_i^{22}\Delta r_{t-i} + e_{2,t}, \tag{6}$$

We check the validity of the structure of the cointegrating vector when the Legendre polynomials extend the error correction coefficients. Typically, we examine whether the cointegrating vector u_{t-1} holds (1,-1) under the time-varying error correction coefficients. In doing so, we employ a likelihood ratio test for that purpose. The null hypothesis that the cointegrating vector is (1,-1) is not rejected at any conventional level.[9] It suggests that the VECM with time-varying error correction coefficients is not deviating from the (1,-1) assumption on the cointegrating vector, which is the prerequisite assumption for information share. The result supports the validity of the Legendre polynomials for estimating time-varying error correction coefficients in the VECM. The model estimation results can be further used to estimate information share and information leadership share measures.

Next, we specify a bivariate DCC-GARCH model for the conditional variance-covariance matrix of Δc_t and Δr_t. Let $e_t = \begin{bmatrix} e_{1,t} \\ e_{2,t} \end{bmatrix}$, then we have:

[9] Associated test results are available from the authors upon request.

c) *International banking indices analysed*

v) United Kingdom

vi) United States

vii) World Index

Note: To investigate the effects of sanctions on the Russian economy on information flows and price discovery, data is obtained for the period 24 June 2021 through 23 June 2022 from Thomson Reuters Eikon. The line in each graphic on 24 February 2022 indicates the date of the illegal physical invasion of Ukraine by armed Russian forces.

Fig. 3. (*continued*)

$$e_t|\Omega_{t-1} \sim F(0, H_t), \tag{7}$$

where Ω_{t-1} represents the information set up to time t-1. $F(.)$ denotes a flexible bivariate conditional distribution. H_t is the conditional variance-covariance matrix for e_t. The literature has proposed several model specifications for H_t. Among them, we adopt the DCC-GARCH model developed by Engle (2002), which has been widely applied in the previous literature. A key issue addressed by the literature is that the DCC-GARCH model tends to dominate the estimation and forecasting of the multivariate conditional correlation matrix given its higher accuracy and capability to ensure positive-definiteness (Tse and Tsui, 2002). Under the DCC-GARCH model, H_t is specified as:

$$H_t = D_t R_t D_t, \tag{8}$$

where D_t is a diagonal matrix of individual conditional variances and R_t is a conditional correlation matrix. We further have:

$$D_t = \begin{pmatrix} h_{11,t}^{1/2} & 0 \\ 0 & h_{22,t}^{1/2} \end{pmatrix}, \tag{9}$$

$$R_t = \text{diag}\left\{Q_t^{-1/2}\right\} Q_t \text{diag}\left\{Q_t^{-1/2}\right\}, \tag{10}$$

where $h_{11,t}$ and $h_{22,t}$ are conditional variances of counterpart and Russian markets' returns, respectively. In particular, they are specified by an exponential GARCH (EGARCH) (1,1) model as

$$log(h_{ii,t}) = \gamma_{i,1} + \gamma_{i,2}\left|\frac{e_{i,t-1}}{\sqrt{h_{ii,t-1}}}\right| + \gamma_{i,3}\frac{e_{i,t-1}}{\sqrt{h_{ii,t-1}}} + \gamma_{i,4}\log(h_{ii,t-1}), \tag{11}$$

where $\gamma_{i,2}$ captures the effect of new shocks while $\gamma_{i,4}$ measures persistence in variance. $\gamma_{i,3}$ examines the asymmetry in the volatility responding to lagged negative shocks. For the positivity and stationarity of $h_{ii,t}$, $\gamma_{i,4} < 1$. Further, Q_t is the conditional variance-covariance matrix of standardised innovations ε_{it} where $\varepsilon_{it} = \frac{e_{it}}{\sqrt{h_{ii,t}}}$ $(i = 1, 2)$. Q_t is then specified as:

$$Q_t = (1-\alpha-\beta)\bar{Q} + \alpha\varepsilon_{t-1}\varepsilon'_{t-1} + \beta Q_{t-1}, \tag{12}$$

where $\varepsilon_t = \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \end{bmatrix}$. $\bar{Q}$ is the unconditional variance-covariance matrix of ε_t where $\bar{Q} = E[\varepsilon_t\varepsilon'_t]$. α measures the effect of recent shocks on correlation whereas β captures persistence in correlation. For positive definiteness of Q_t, we must ensure $\alpha > 0,\ \beta > 0,$ and $\alpha + \beta < 1$.

To estimate the DCC-GARCH model, we employ a semi-non-parametric (SNP) approach. The SNP approach extends the normal distribution of financial time series by directly attaching the marginal skewness and excess kurtosis of each series to the normal probability density function (PDF) when the normality assumption does not hold, as discussed in Del Brio et al. (2011) and Ñíguez and Perote (2016). Addressing non-normality in estimating the GARCH family of models is critical since the literature has identified that financial time series exhibit asymmetry and fat tails, as discussed in Bollerslev (1986, 1987) and Engle and Gonzalez-Rivera (1991).

Under the SNP approach, the natural logarithmic equation of the bivariate PDF for the standardised innovations is shown as:

$$\begin{aligned} l_t &= -\frac{1}{2}\ln|R_t| - \frac{1}{2}\epsilon'_t R_t^{-1}\varepsilon_t + \ln\left\{\sum_{i=1}^{1}\kappa_i^{-1}\tau_i^2(x_{it})\right\}, \\ \kappa_i &= 1 + s_i^2 + k_i^2, \\ \tau(x_{it}) &= 1 + s_i(x_{it}^3 - 3x_{it}) + k_i(x_{it}^4 - 6x_{it}^2 + 3), \\ x_t &= (x_{1t}, x_{2t}) = R_t^{1/2}\varepsilon_t, \\ \epsilon_t &= \left[\varepsilon_{1t}, \varepsilon_{2t}\right]', \end{aligned} \tag{13}$$

where s_i $(i = 1,2)$ is the parameter of marginal skewness and k_i $(i = 1,2)$ is the parameter of marginal excess kurtosis. R_t is the conditional correlation matrix defined in the DCC-GARCH model. The estimates of the DCC -GARCH model are obtained by maximising the following equation:

$$L = \sum_{t=1}^{T} l_t(\Theta), \tag{14}$$

where T is the sample size and Θ is a vector of parameters. The estimation process through Eqs. (13) and (14) include two steps: firstly, the estimates of the conditional mean model (VECM) and the individual EGARCH model are derived via Quasi MLE (QMLE) assuming normal distribution; secondly, the parameters for the conditional correlation matrix and marginal skewness and excess kurtosis are obtained via maximisation of the log-likelihood equation of the bivariate SNP PDF of standardised innovations.

4.2. Information share measures

To investigate the information share between the markets under question, we let Y_t be a 2×1 vector of the price series of two markets that are I(1) series. If the two price series are cointegrated at order zero, which means Y_t contains one common stochastic trend or one common efficient price, then Y_t can be specified in the following bivariate vector error correction model (Engle and Granger, 1987):

$$\Delta Y_t = \Pi Y_{t-1} + \sum_{i=1}^{k} A_i \Delta Y_{t-i} + \varepsilon_t, \tag{15}$$

where $\Pi = \alpha\beta^T$. Both $\alpha = \left[\alpha_1, \alpha_2\right]'$ and $\beta = [1, -\beta]'$ are 2×1 vectors. α_1 and α_2 are the error correction coefficients, measuring responses of two series to deviations of the long-run equilibrium in the past. From Eqs. (5) and (6), we know that α_1 and α_2 in the error correction coefficient vector α are expanded as time-varying coefficient series. That is, α_1 is extended to $ec_{c,t}$ in Eq. (5) and α_2 is extended to $ec_{r,t}$ in Eq. (6), respectively. In this sense, we link Eq. (15) to Eqs. (5) and (6) by setting $\alpha = \left[ec_{c,t}, ec_{r,t}\right]'$. It should be noted that the structure of the cointegrating vector β in Π is not affected when α is extended to be time-varying. β is the cointegrating coefficient, while Δ is the first-order difference operator. ε_t is a 2×1 vector of innovations, where the lag order k is chosen as per the Akaike Information Criterion (AIC). According to Hasbrouck (1995), Eq. (15) can be transformed into the following vector moving average (VMA) model:

$$Y_t = Y_0 + \Psi(1)\sum_{s=1}^{t}\varepsilon_s + \Psi(L)\varepsilon_t, \tag{16}$$

where $\Psi(1)\varepsilon_t$ represents the long-run impact of innovations on the price series. Define Ω be the covariance matrix of ε_t and let Ψ denote either $\Psi(1)$ or $\Psi(2)$ which is one row in $\Psi(1)$. Given a general case where Ω is not diagonal, the Information Share (IS) of market j (j = 1,2) is given by Hasbrouck (1995) as:

$$S_j = \frac{([\Psi F]_j)^2}{\Psi\Omega\Psi'}, \tag{17}$$

where F is the Cholesky factorisation of Ω such that $\Omega = FF'$. $[\Psi F]_j$ is the jth element of the vector ΨF. Due to the ordering of the price series j in Y_t in the process of Cholesky factorisation, the upper (lower) bound of the series j's information share arises if

series j is the first (last) variable in Y_t. It has been widely adopted in the literature that the IS of market j can be represented by a mid-point of IS upper and lower bounds (Booth et al., 2002; Putniņš, 2013). Following the literature, we calculate two IS bounds for each market and take the simple average as a resultant IS. The IS of market j is the contribution of market j to the total variance of the common efficient price or permanent impact. Yan and Zivot (2010) further point out that IS carries information, compared to a mixture of the relative noise level and relative leadership in reflecting new information in the fundamental value (Putniņš, 2013). Hence, a more purified metric is needed to measure information leadership of price series that solely refers to the capability to impound new shocks into the fundamental value.

Next, we introduce the component share (CS) developed by Gonzalo and Granger (1995). The two price series in Y_t, if cointegrated, can be decomposed into the following form:

$$Y_t = Af_t + \tilde{Y}_t, \tag{18}$$

where Y_t is comprised of one permanent component, f_t, and one transitory component, $\tilde{Y}_t$. f_t is a so-called common factor that is a non-stationary series while $\tilde{Y}_t$ is stationary. Two assumptions underlying the validation of (18) are (i) f_t is a linear function of the series in Y_t; (ii) $\tilde{Y}_t$ does not Granger cause f_t in the long run. In other words, the justification for Eq. (18) requires:

$$f_t = \theta' Y_t, \tag{19}$$

where θ is the 2×1 permanent component coefficient vector. It should be noted that the dimension of the permanent component is one since cointegration suggests one common stochastic trend in Y_t. Booth et al. (2002) and Harris et al. (2002) develop normalised coefficients in θ' that convey information with respect to contributions to the common factor f_t. Such information is interpreted as the series' contribution to the price discovery process. Let $\theta = [\theta_1, \theta_2]'$, where θ is orthogonal to α. Then we can estimate the component share (CS) as follows

$$\theta_1 = \frac{\alpha_2}{\alpha_2 - \alpha_1}, \qquad \theta_2 = 1 - \theta_1, \tag{20}$$

where θ_1 and θ_2 are the component shares of the first and second series in Y_t, respectively. Yan and Zivot (2010) interpret CS as the noise level in one price series relative to the other.

Yan and Zivot (2010) further reveal that, given two price series in matrix Y_t, the CS measure is a function of the dynamic responses of the two series to transitory shocks only, whereby transitory shocks are represented by noise due to market trading frictions. Meanwhile, IS is a function of the dynamic response of the two series to both transitory and permanent shocks. In this case, IS and CS may give inaccurate information regarding price discovery in some circumstances due to their dependence on the noisy impact from transitory shocks (Putniņš, 2013). To address this problem, Yan and Zivot (2010) propose the information leadership share (ILS) to generate a purified contribution of the series to the price discovery process as follows:

$$IL_1 = \left| \frac{IS_1}{IS_2} \frac{CS_2}{CS_1} \right|, \qquad IL_2 = \left| \frac{IS_2}{IS_1} \frac{CS_1}{CS_2} \right|, \tag{21}$$

where IS_1 and IS_2 are the mid-points of the information share of the two price series in Y_t while CS_1 and CS_2 are component share of the two price series in Y_t. Putniņš (2013) proposes normalised metrics based on Eq. (21) so that the range of ILS can be limited to between 0 and 1. Hence, we have the following:

$$ILS_1 = \frac{IL_1}{IL_1 + IL_2}, \qquad ILS_2 = \frac{IL_2}{IL_1 + IL_2}. \tag{22}$$

As can be seen from the equation above, ILS combines both CS and IS so that the impact from misleading responses to transitory shocks is removed and a clean measure of relative informational leadership is achieved. In this paper, not only do we examine traditional static CS, IS and ILS measures, but we also consider time-varying features inherent in these metrics. The way we obtain time-varying CS, IS, and ILS measures are as follows. First, we obtain time-varying error correction coefficients in the vector α in Eq. (15) through the estimates of the Legendre polynomials. Then, the time-varying coefficients are used to calculate time-varying CS, IS and ILS measures. Second, the variance and covariance of innovations in the matrix Ω are replaced by the estimated series of the conditional variance and correlation obtained from the DCC-GARCH-SNP model. In our procedure, the error correction coefficients and the variance-covariance matrix of innovations, which carry vital information for information share measures, are both estimated to be time-dependent. Moreover, to present a clearer view of the relative informational role of the international counterpart and Russian markets in the long-run price discovery process, we calculate natural logarithmic ratios of the time-varying information share measures as follows:

$$TVCS\,ratio = log\left(\frac{CS_{c,t}}{CS_{r,t}}\right), \quad TVIS\,ratio = log\left(\frac{IS_{c,t}}{IS_{r,t}}\right), \quad TVILS\,ratio = log\left(\frac{ILS_{c,t}}{ILS_{r,t}}\right), \tag{23}$$

where $log(.)$ denotes the natural logarithm. $CS_{c,t}$ and $CS_{r,t}$ are the component share of the international counterpart and Russian markets, respectively. $IS_{c,t}$ and $IS_{r,t}$ are mid-points of the information share of the international counterpart and Russian markets, respectively. $ILS_{c,t}$ and $ILS_{r,t}$ are information leadership shares of the international counterpart and Russian markets, respectively. Note that a positive log ratio suggests that the international counterpart dominates in the long-run price discovery process, while a negative value suggests the Russian market dominates in the long-run price discovery process. To specifically analyse the effects of international sanctions on information flows, we develop a GARCH(1,1) methodology which has the following specifications:

$$I_t = a_0 + \sum_{j=1} b_j I_{t-j} + \gamma D_t + \varepsilon_t. \quad (24)$$

I_{t-j} represents the lagged value of the estimated information shares, which are separately denoted as IS, CS, and ILS, respectively, while D_t represents each individual dummy variable used to analyse the specific effects of sanctions packages as delineated through the blocking of Russian institutions from the SWIFT platform, along with those deemed to be specific to banking institutions, those targeting the Russian economy, those explicitly targeting the Russian financial system, sanctions targeting luxury products, and those targeting the private wealth of oligarchs. This analysis allows for the specific testing of the direction and significance of the change in IS, CS, and ILS measures due to international sanction packages. Further, testing such relationships in a time-varying manner allows for analysis of whether such effects are found to diminish as markets expect further sanction packages. To complete this final analysis, we let D_t equal unity in each month analysed across a range of separate GARCH(1,1) analyses based on IS, CS, and ILS, respectively, therefore allowing us to investigate whether imposed informational relationships declined or were maintained between the initial range of sanctions imposed and those implemented at a later stage. This latter analysis is critical to uncover whether such tools exhibited diminished effectiveness as the international response to Russia's invasion intensified.

5. Results

5.1. Understanding dynamic changes in information flow due to international sanctions on Russia

Dynamic changes in the behavioural interactions based on the flows of IS, CS and ILS between the Russian MOEX exchange and each selected country are presented in the Online Appendices.[10] The domestic indices of the selected countries are first analysed, presenting a baseline upon which we can compare and contrast the specific influence and informational contagion effects of imposed international sanctions upon major international banking indices. The grey shaded areas represent the period inclusive of the illegal invasion of Ukraine by Russian forces on Thursday, 24 February 2022. Interaction effects between both the domestic indices and the world index are presented first, followed by each of the respective banking indexes analysed. A decline in the information share indicates that the Russian MOEX index has increased as a source of informational flow, or more specifically, events specifically affecting Russian financial markets are found to present more substantial pass-through effects and influence upon other analysed financial markets and banking indices.

When focusing on dynamic changes in information flows[11] there are clear and immediate responses in transmitting information shocks due to the Russian invasion of Ukraine. In particular, Australia, Canada, China, Europe, and the United Kingdom exhibit evidence of a sharp reception of information influence from the Russian MOEX. The United States exhibits relative shelter from interaction effects, however. When focusing on the influence of the MOEX information share flows upon the banking indices of these countries, a number of interesting observations are identified. While the Australian and Canadian banking sectors are found to be relatively sheltered from information shocks sourced in Russian financial markets, the Chinese, European, and United Kingdom banking sectors exhibit sharp information received from the Russian MOEX. The World Banking Index is also found to exhibit evidence of a sharp informational response, indicating the sharp reverberations of fear throughout the sector due to Russian aggression. It is also particularly interesting to note that although the United States does not present evidence of an immediate response, approximately three months later, similarly to Australian, Canadian, United Kingdom, and the World Index, a sharp elevation of information flows from the Russian MOEX is identified.[12]

Table 4 presents the results of information share differential as a result of Russian sanctions imposed on Russia. Concerning the effects of the invasion on stock market information flows, it is observed that the relative price discovery process fell in the cases of Australia, Canada, China, Europe and the UK. Considering long-run interactions between the Russian markets and the US stock market, despite less evidence showing an enhanced informational role of the Russian markets in CS and IS measures, the ILS of the Russian markets is increased relative to the US. One significant observed exception is the ILS relationship between Russian markets

[10] Further representation of the interactions between the selected, analysed countries and each of the selected Russian-related variables, as separated by IS, CS and ILS, respectively, are omitted for brevity of presentation and are available from the authors upon request.

[11] As presented in Figure A2 of the Online Appendices.

[12] In Figure A3 of the Online Appendices, we observe significant differentials in the component share of information measures. While influence is observed upon all of the analysed indices, the response of the banking sectors is particularly interesting. Each Australian, United Kingdom, and world banking index exhibits immediate reception regarding the component share of information, whereas the United States and Canada present evidence of a more delayed response in the aftermath of the initial invasion. While initially acting as a receiver to the component share of information, the Australian banking index becomes quite isolated, presenting evidence supporting its relative medium-term shelter. In contrast, Chinese banking indices appear relatively unchanged except for multiple events that changes within the Chinese banking sector itself can explain. Finally, in Figure A4 of the Online Appendices, we observe the changing dynamics regarding information leadership share. European, United Kingdom and World Banking Indices appear to be the most receptive to information leadership shocks sourced from the Russian MOEX, while the Australian, Canadian, Chinese, and United States banking sectors appear to be initially sheltered but exhibit delayed responses in the periods thereafter. Overall, data presented in the Online Appendices provides evidence of an immediate response to shocks from the Russian MOEX to banking sectors in Europe and the United Kingdom, as well as a delayed response for banking sectors in the United States, Australia and Canada, following the Russian invasion. The reasons why those results take place are worth discussing. The explanations may be related to some institutional factors that drive information flows between the Russian stock market and banking sectors under analysis. One possible factor is the changing behaviour of institutional investors, who are often deemed informed traders and can affect price discovery in response to the war. The receptive role of banking sectors may result from the reaction of institutional investors to the provoked fears of the war and unforeseen subsequent uncertainties associated with international banking businesses. The immediate response of the European and United Kingdom's banking sectors, compared to the relative lateness of response in the United States, Australia and Canada, may be related to the closer economic linkages between Russia and European regions based upon which the institutional investors respond faster to the outbreak of the war.

Table 4
Changes of information transition as a result of the illegal invasion of Ukraine.

Asset Analysed	Australia	Canada	China	Europe	UK	US	World
International Stock Markets							
Information Share (IS)							
Russian SE (MOEX)	-2.3385	-4.0496	-2.4949	-1.4130	-2.6723	0.1819	-1.9664
MOEX 10	3.2502	-2.1763	0.4249	0.2680	-2.9331	-0.2029	0.3773
MOEX Govt Bond Index	0.2847	-0.3326	-0.8450	-1.3186	-1.4211	0.7088	-4.6875
MOEX Banking Index	0.5792	-2.9881	-2.2628	1.0587	-2.2106	-0.4136	-2.3211
Component Share (CS)							
Russian SE (MOEX)	-0.2252	-0.0910	-0.1304	0.3347	-0.1036	0.4728	-0.4825
MOEX 10	-0.8917	-0.1077	-1.7279	0.0468	-0.1010	-2.4140	0.0105
MOEX Govt Bond Index	1.8065	-0.1099	-0.6930	0.0726	-0.8080	0.8182	-0.9859
MOEX Banking Index	0.0544	-7.8201	-4.6484	-2.5573	-4.5784	0.2157	-3.3840
Information Leadership Share (ILS)							
Russian SE (MOEX)	3.0362	-0.7970	1.9199	-0.6021	-1.1383	0.4921	-2.8529
MOEX 10	1.2868	-5.6269	-4.3051	1.3936	-3.1270	-0.8968	0.4211
MOEX Govt Bond Index	0.2294	-3.5058	-3.6605	-3.5868	-3.4418	-0.3164	-6.5480
MOEX Banking Index	-0.3608	-8.4804	-4.1350	-3.0712	-4.9958	-0.2107	-3.6678
International Banking Sectors							
Information Share (IS)							
Russian SE (MOEX)	0.3547	-0.1468	0.7895	-2.5760	-0.6187	0.3633	-2.3761
MOEX 10	0.4645	-0.0641	0.4400	-1.3933	-2.1993	0.1273	-0.2549
MOEX Govt Bond Index	0.0671	-3.3804	0.2374	-1.9622	-3.3287	1.3328	-1.5916
MOEX Banking Index	-4.2710	0.2410	-1.4244	-2.9746	-2.6323	1.5999	-1.2732
Component Share (CS)							
Russian SE (MOEX)	-0.6301	-1.0295	0.0251	0.4292	0.2426	-0.5829	-0.5382
MOEX 10	0.4356	0.4455	-0.1481	-0.3247	0.1192	-0.0940	0.0210
MOEX Govt Bond Index	-0.2694	-1.9659	0.0509	0.0927	-0.5302	-1.6937	0.0500
MOEX Banking Index	1.8460	-0.6622	14.8362	-4.7528	-1.3604	0.5876	-4.5303
Information Leadership Share (ILS)							
Russian SE (MOEX)	-3.3112	-0.9405	-0.2975	0.3679	-0.3804	-1.2780	1.4216
MOEX 10	-7.0177	0.0297	1.0885	-5.1917	-4.7623	2.3756	-2.8919
MOEX Govt Bond Index	-7.3553	-1.5934	-1.4812	-6.3969	-3.9126	-2.6134	-6.0439
MOEX Banking Index	3.1728	0.6293	-0.2518	-2.1591	-1.7712	-1.7712	-2.8530

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. Results based on analyses relating to the MOEX Corporate Bond Index, Russian Volatility Index, Russian Consumer Index, Russian blue-chip Index, and Russian Innovation Index are omitted for brevity of presentation but are available from the authors upon request.

and Australia, presenting evidence of potential safe-haven opportunities. Considering the impacts of the war on the information flows between the Russian financial markets and banking sector indices of selected regions analysed, we find evidence indicating enhanced IS interactions upon Australian, Chinese and US banking sectors, indicating that the price discovery process strengthened after the invasion. Further, Table 5 presents the change in relative information share measures after the imposition of banking sanctions, where the effects are identified to be positive across all national exchanges and banking indices examined when considering the MOEX. However, strongly differential effects are identified when considering the CS and ILS measures. Particularly, Russian markets are found to generate substantial effects on Canadian, Chinese and European stock markets and banking indices. Such behavioural differentials might imply a dynamic shift in trading preferences after the implementation of international sanctions packages.

In the next stage of our analysis, we utilise a GARCH(1,1) methodology to measure the specific change in information flows upon the dates when international sanctions are levelled upon the Russian economy. For brevity of presentation, only those IS, CS, and ILS information flow interactions between the Russian MOEX, Russian banking series, and Russian volatility indices are provided in this section.[13] Dynamic changes in information flow during the illegal invasion of Ukraine are presented in Table 6. Focusing firstly on the information flows from the Russian MOEX, Russian banking series, and Russian volatility indices upon international banking indices, results indicate no significant negative estimates for either Australia or Canada, indicating that each banking sector remained resilient against the influence of Russian-sourced market panic on the date upon which the invasion of Ukraine began. Substantial informational inflows are identified across almost all analysed measures relating to the World Banking Index. Each of the banking

[13] Results relating to interaction changes between each selected international index and the MOEX 10, MOEX Govt Bond Index, MOEX Corporate Bond Index, Russian Consumer Index, Russian blue-chip index, and Russian Innovation Index do not present evidence of significant informational influence and are omitted to for brevity of presentation. These results and several methodological variations are available from the authors upon request. In our selection, other competitive models included EGARCH, TGARCH, Asymmetric Power ARCH (APARCH), Component GARCH (CGARCH) and the Asymmetric Component GARCH (ACGARCH). The optimal model was chosen according to three information criteria, namely the Akaike (AIC), Bayesian (BIC) and Hannan-Quinn (HQ) criteria.

Table 5
Changes of information transition as a result of major banking sanctions placed upon Russia.

Asset Analysed	Australia	Canada	China	Europe	UK	US	World
International Stock Markets							
Information Share (IS)							
Russian SE (MOEX)	0.81	3.11	2.59	0.68	2.05	0.66	2.16
MOEX 10	-0.08	1.90	-1.39	-0.31	1.38	0.12	2.57
MOEX Govt Bond Index	-1.62	2.01	0.55	2.29	-0.77	-0.12	2.35
MOEX Banking Index	-1.04	1.60	0.93	-0.81	1.33	0.45	2.47
Information Leadership Share (ILS)							
Russian SE (MOEX)	0.36	-0.23	-0.38	0.01	-0.16	0.21	0.29
MOEX 10	0.24	0.31	-0.02	-0.12	-0.24	-0.21	0.77
MOEX Govt Bond Index	-0.31	-0.14	-0.04	0.80	-0.34	0.27	0.10
MOEX Banking Index	-0.62	-0.30	-0.05	-0.10	-0.24	0.06	0.17
Information Leadership Share (ILS)							
Russian SE (MOEX)	-0.05	6.68	5.93	1.33	4.42	0.92	3.73
MOEX 10	-0.64	3.19	-2.73	-0.38	3.24	0.67	3.61
MOEX Govt Bond Index	-2.61	4.31	1.18	2.98	-0.86	-0.78	4.49
MOEX Banking Index	-0.85	3.80	1.95	-1.42	3.13	0.78	4.59
International Banking Sectors							
Information Share (IS)							
Russian SE (MOEX)	0.06	0.61	3.99	1.00	-0.95	-0.09	0.81
MOEX 10	-1.53	-0.28	-0.30	0.75	1.87	0.59	0.71
MOEX Govt Bond Index	1.92	1.58	-4.02	1.65	1.80	3.53	0.39
MOEX Banking Index	3.25	0.62	-0.03	1.44	2.18	-0.44	0.95
Information Leadership Share (ILS)							
Russian SE (MOEX)	0.21	0.22	0.00	-0.06	-0.26	0.09	-0.32
MOEX 10	-1.98	0.19	-0.33	-0.33	-0.19	0.41	2.78
MOEX Govt Bond Index	1.59	-0.47	0.01	0.20	-0.08	3.46	-1.03
MOEX Banking Index	0.28	0.47	0.03	-0.33	-0.41	0.43	0.03
Information Leadership Share (ILS)							
Russian SE (MOEX)	-0.30	0.79	0.61	2.14	-1.38	-0.36	2.26
MOEX 10	0.89	-0.94	-1.67	2.15	4.11	0.36	-4.13
MOEX Govt Bond Index	0.66	4.12	0.40	2.89	3.76	0.13	2.83
MOEX Banking Index	5.94	0.30	-0.02	3.54	5.18	-1.73	1.86

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. Results based on analyses relating to the MOEX Corporate Bond Index, Russian Volatility Index, Russian Consumer Index, Russian blue-chip Index, and Russian Innovation Index are omitted for brevity of presentation but are available from the authors upon request.

and domestic indices for Europe, the UK, and the US exhibit sharp information reception across the IS, CS, and ILS measures. The Chinese banking sector is broadly exposed to information flows from the Russian MOEX and Russian volatility index. Moreover, the Chinese stock index receives abundant information from the Russian MOEX and Russian banking index, with some evidence of information reception identified with regard to the ILS measures sourced from the Russian volatility index. Overall, Table 6 shows some differences in the effects of the invasion on information flows with respect to the selected stock indices and banking sectors across countries. Shelter behaviour is evidenced for Australia and Canada, whereas receptive behaviour is evidenced for the rest of the regions, including the World Index. One possible explanation for this is the dependence of the domestic currency and returns on equity in Australia and Canada on prices of natural resources (Chaban, 2009; Chen and Rogoff, 2003). The differential findings may be due to the changing preferences of international institutional investors, which are a typical representative of informed traders, on the trading venues worldwide in response to the outbreak of the Russia-Ukraine war. As reflected by the evidence, one may expect that their preferences towards trading venues in Australia and Canada are levelled up due to some institutional features of those markets, such as relatively low total market size and scale, relatively low inclusion of global diversification strategies, low coverage by the global investment analyses, and pricing dynamics that are more affected by order flows, among other factors. Differential behaviour experienced by Australian and Canadian markets when compared to other examined dynamic relationships can be explained as a result of factors such as: i) geographical proximity, or a lack thereof, resulting in trading and cultural differentials; ii) trading volumes and market interdependence where Australian and Canadian markets possess reduced trading volumes in comparison to Russia and that of Europe, the UK, and the US; iii) differing economic structure, where Australia and Canada are more reliant upon commodities, whereas other examined economies are more diverse in nature; iv) political alignment between the countries; v) the specific nature of the sanctions imposed; and vi) differential levels of foreign direct investment. In reacting to the impacts of the war, informed traders may increase their weights on securities in both Australian and Canadian markets while reducing weights on securities in the rest of the selected markets to mitigate the adverse consequences and better deal with shocks of black swan events. This may further result in relative investment shelter in these two markets.

Table 6
Information differentials sourced from Russian markets due to Ukrainian invasion.

	Australia	Canada	China	Europe	UK	US	World
International Banking Indices							
Information dynamics sourced from Russian MOEX							
IS	1.193***	0.766***	0.236***	-2.169***	-2.049***	-0.921	-0.973
	(7.63)	(8.54)	(5.42)	(-5.88)	(-6.48)	(-0.55)	(-0.62)
CS	0.478	2.251	-1.605***	-0.811***	-2.266***	0.301***	-2.099*
	(1.07)	(1.11)	(-3.45)	(-5.40)	(-9.71)	(3.91)	(-2.53)
ILS	1.832***	0.192	-2.744***	-1.471***	-2.324***	-1.156*	-3.024***
	(4.74)	(1.94)	(-6.03)	(-12.30)	(-6.52)	(-2.39)	(-8.07)
Information dynamics sourced from Russian banking indices							
IS	0.851	0.766	0.228	-0.635***	-0.811***	-0.983*	-0.597***
	(1.34)	(1.54)	(0.33)	(-6.04)	(-6.01)	(-2.14)	(-7.11)
CS	0.748	0.251	-0.498***	-1.570***	-1.663***	-1.100***	-1.895***
	(1.58)	(0.11)	(-9.49)	(-10.09)	(-4.47)	(-12.62)	(-9.22)
ILS	1.891***	0.578	0.019	-1.868***	-1.278***	-2.229***	-2.109***
	(9.23)	(1.56)	(0.94)	(-6.54)	(-7.75)	(-5.52)	(-9.20)
Information dynamics sourced from Russian volatility indices							
IS	0.381***	1.390***	-0.588	-1.045***	0.702***	-1.533***	-0.750***
	(7.21)	(4.88)	(-1.69)	(-22.72)	(4.31)	(-8.94)	(-13.72)
CS	3.293***	2.193***	0.015*	-1.151	-0.737	-1.486	-1.692***
	(3.38)	(4.18)	(2.41)	(-0.41)	(-1.58)	(-0.93)	(-5.98)
ILS	0.314	1.090***	-4.267***	-4.768***	-4.030***	-1.043***	-1.933***
	(0.35)	(-6.33)	(-5.49)	(-9.79)	(-5.19)	(-5.43)	(-6.16)
International Stock Indices							
Information dynamics sourced from Russian MOEX							
IS	1.236***	0.807***	-3.550***	-0.376***	-2.147***	-1.545***	-0.819*
	(6.36)	(4.09)	(-21.41)	(-9.10)	(-6.05)	(-5.21)	(-2.25)
CS	0.337***	1.926	-1.511***	0.107***	-2.149***	-0.667***	-1.464***
	(12.26)	(1.05)	(-4.13)	(8.31)	(-9.99)	(-11.59)	(-5.62)
ILS	1.562	0.401***	-2.108***	-2.180***	-2.341***	-1.347***	-1.267***
	(1.31)	(3.35)	(-7.97)	(-6.23)	(-3.07)	(-11.84)	(-12.71)
Information dynamics sourced from Russian banking indices							
IS	1.615***	0.807***	0.053	-1.135***	-2.244***	-0.153***	-0.840***
	(7.57)	(4.09)	(0.84)	(-3.56)	(-11.29)	(-11.02)	(-7.79)
CS	0.759	0.926***	-0.313***	-1.151***	-1.652***	-2.381***	-1.342***
	(1.12)	(1.05)	(6.99)	(-5.25)	(-9.16)	(-8.84)	(-7.77)
ILS	2.942***	2.401***	-0.100**	-1.940***	-0.871***	-1.581***	-1.744***
	(4.12)	(6.35)	(-3.23)	(-5.79)	(-4.13)	(-6.10)	(-6.22)
Information dynamics sourced from Russian volatility indices							
IS	0.922***	1.045***	-0.024	-0.593***	-0.875***	-0.484***	-0.805
	(5.35)	(7.72)	(-0.33)	(-5.81)	(-10.10)	(-11.35)	(-0.37)
CS	1.120***	0.993	1.036	-1.110***	-1.420***	-1.871***	-1.656***
	(3.52)	(0.79)	(0.57)	(-14.24)	(-6.70)	(-7.40)	(-4.15)
ILS	0.774***	1.090***	-4.419***	-3.583***	-5.889***	-4.245***	-0.863
	(12.37)	(6.33)	(-4.82)	(-8.15)	(-7.72)	(-4.71)	(-0.55)

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. To investigate the contagion effects of international sanctions imposed upon the Russian economy due to the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. Specifically, to focus on the direct effects on the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system, along with specific sanctions targeting the Russian banking system and the Russian economy, those sanctions specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth. A concise list of the sanctions used to analyse these six dimensions is provided in Table 1. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

5.2. Dynamic information flows differentials from Russian markets to International Banking Indices due to sanction packages

In Table 7, we present the direct changes in IS, CS, and ILS between the Russian MOEX and selected national banking indices as a result of international sanctions. Several interesting observations can be made. First, when focusing on IS, we observe that Australian and Canadian banking indices present evidence of shelter from the information transmission resulting from the imposition of international sanctions in Russia. Estimates relating to each sanction type were identified as positive, indicating no pass-through influence and, in some cases, are found to be insignificant. When considering IS effects, the Chinese banking sector is found to be

Table 7
Russian MOEX information differential due to sanctions (with international banking indices).

Sanction Type	Australia	Canada	China	Europe	UK	US	World
Information share change with selected banking indices							
SWIFT	1.047***	1.284	0.504***	-2.265***	-1.709***	-1.182***	-0.088
	(4.67)	(1.26)	(4.48)	(-5.93)	(-4.12)	(-11.12)	(-0.82)
Banking	1.153***	0.916***	0.403***	-2.242***	-1.785***	-1.191***	-0.231**
	(8.32)	(5.69)	(9.07)	(-9.07)	(-5.72)	(-7.33)	(-3.08)
Economic	0.047	0.721***	0.406***	-1.342***	-0.481***	-0.244***	-0.0487
	(0.51)	(4.05)	(7.58)	(-3.44)	(-5.52)	(-5.78)	(-0.44)
Financial	0.044**	0.267***	0.303***	-2.206***	-1.992***	-0.556***	-0.0486
	(2.79)	(5.14)	(4.17)	(-5.40)	(-7.98)	(-6.78)	(-0.30)
Luxury	0.123**	0.773***	0.202***	-1.464***	-1.336***	-0.435***	-1.228***
	(2.96)	(5.35)	(4.19)	(-6.61)	(-6.51)	(-8.62)	(-6.16)
Private wealth	0.097***	0.381***	0.059	-1.409***	-1.967***	-0.543***	-0.756***
	(6.63)	(9.44)	(1.21)	(-11.14)	(-5.52)	(-10.79)	(-5.62)
Component share change with selected banking indices							
SWIFT	0.769	2.190	-1.274	-0.803***	-1.480***	0.329***	-1.686***
	(1.84)	(1.90)	(-0.88)	(-8.43)	(-3.36)	(4.52)	(-7.16)
Banking	0.662	2.064	-1.625***	-0.898***	-0.924	0.362***	-0.644
	(1.12)	(0.99)	(-6.17)	(-8.88)	(-0.49)	(3.69)	(-1.52)
Economic	0.797	2.076	-1.630***	-0.824***	-2.388***	0.393***	-1.785***
	(1.88)	(1.14)	(-5.72)	(-4.67)	(-9.03)	(6.46)	(-5.60)
Financial	0.094	0.668	-1.634***	-0.827***	-2.239***	0.309***	-1.705***
	(0.74)	(1.51)	(-4.59)	(-4.69)	(-5.90)	(6.74)	(-9.01)
Luxury	-0.82	2.017	-1.639***	-0.777***	-2.435***	0.808***	-1.308***
	(-1.38)	(1.08)	(-5.88)	(-3.86)	(-7.69)	(3.85)	(-5.97)
Private Wealth	0.699	2.143	-2.473***	-1.023***	-2.241***	0.338***	-1.284***
	(1.09)	(1.21)	(-6.99)	(-5.40)	(-8.40)	(5.84)	(-8.64)
Information leadership share change with selected banking indices							
SWIFT	1.393*	0.542***	-2.417***	-2.191***	-2.284***	-3.420***	-3.298***
	(2.15)	(5.56)	(-5.12)	(-4.31)	(-5.76)	(-6.08)	(-6.19)
Banking	1.848***	0.242	-2.384***	-3.069***	-2.044***	-3.381***	-2.893***
	(4.63)	(0.32)	(-4.63)	(-4.52)	(-7.30)	(-4.68)	(-5.64)
Economic	0.808	0.384	-2.808***	-2.245***	-2.402***	-1.975***	-2.379***
	(1.40)	(1.01)	(-4.01)	(-4.93)	(-4.80)	(-8.67)	(-4.53)
Financial	1.015***	1.127***	-2.897***	-2.245***	-3.577***	-2.246***	-2.996***
	(4.89)	(3.40)	(-3.80)	(-4.93)	(-4.76)	(-5.47)	(-10.49)
Luxury	1.468***	0.271***	-2.736***	-2.286***	-2.593***	-1.815***	-3.145***
	(5.83)	(6.16)	(-4.93)	(-6.05)	(-11.09)	(-9.08)	(-1.51)
Private Wealth	1.449	0.359***	-1.610***	-2.006***	-0.973***	-1.145***	-1.374***
	(1.28)	(6.49)	(-5.10)	(-10.82)	(-4.85)	(-6.39)	(-21.75)

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Specifically, we investigate the differential results between each denoted international banking index and the Russian MOEX. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. To investigate the contagion effects of international sanctions imposed upon the Russian economy due to the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. Specifically, to focus on the direct effects on the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system, along with specific sanctions targeting the Russian banking system and the Russian economy, those sanctions specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth. A concise list of the sanctions used to analyse these six dimensions is provided in Table 1. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

sheltered but received significant informational contagion when considering both CS and ILS for all types of analysed sanctions, except for the banning of the Russian banking system from SWIFT. This result might be partially explained by a wide-reaching news story where the Russian financial system would seek alternatives through the use of the alternative Rouble-based payment system called the System for Transfer of Financial Messages (SPFS) and China's Cross-Border Inter-bank Payment System (CIPS), which processes payments in Chinese yuan. Similarly, US banking is found to be quite moderately influenced by the contagion effects of international sanctions when considering CS, but IS and ILS estimates present evidence of sharp informational pass-through when considering all types of Russian sanctions, in particular the imposition of sanctions relating to SWIFT and specific bank-related sanctions. Each of Europe, the UK, and the World banking indices are found to have received significant information influence from Russian stock markets from all types of sanctions analysed and across each of the measures for IS, CS, and ILS. Such results specifically indicate that the broad shock surrounding the subsequent sanctions that followed resulted in sharp informational transmission across the world banking sector but, in particular, that of Europe and the UK.

Table 8
Russian banking indices information differential due to sanctions (with international banking indices).

Sanction Type	Australia	Canada	China	Europe	UK	US	World
Information share change with selected banking indices							
SWIFT	1.859	1.284	0.564	-1.908***	-1.833***	-2.162***	-2.188***
	(1.61)	(1.26)	(1.61)	(-5.18)	(-4.66)	(-9.49)	(-1.33)
Banking	1.864	0.916	1.224	-3.510***	-1.820***	-1.962***	-2.404**
	(2.57)	(2.69)	(1.18)	(-3.66)	(-4.55)	(-13.12)	(-3.18)
Economic	1.232	0.721	-0.008	-0.881***	-0.588***	-0.570***	-0.097***
	(1.56)	(1.05)	(0.31)	(-10.22)	(-6.30)	(-7.67)	(-0.89)
Financial	1.28	1.267	0.156	-1.768***	-0.709***	-0.534***	-0.291***
	(1.97)	(1.14)	(-0.02)	(-4.52)	(-10.20)	(-11.83)	(-4.38)
Luxury	0.765	0.773	-0.212	-0.446**	-0.963***	-0.997***	-0.242***
	(1.75)	(1.35)	(-0.94)	(-3.03)	(-4.14)	(-9.18)	(-4.82)
Private Wealth	0.787	0.729	-0.357	0.228	-0.500	-0.873***	-0.797***
	(1.29)	(1.91)	(-1.00)	(-1.47)	(-4.39)	(-8.17)	(-5.71)
Component share change with selected banking indices							
SWIFT	0.126	-0.064	-0.171***	-1.781***	-1.223**	-1.086**	-1.924***
	(1.05)	(-0.99)	(-4.57)	(-4.49)	(-3.04)	(-3.12)	(-12.61)
Banking	0.818	-0.190	0.102	-1.728***	-2.169***	-1.108***	-1.927***
	(1.74)	(-1.90)	(0.31)	(-8.38)	(-9.98)	(-9.43)	(-6.41)
Economic	0.880	0.076***	-0.626***	-1.570***	-2.760***	-1.172***	-1.372***
	(1.42)	(-4.14)	(-8.22)	(-10.09)	(-5.02)	(-7.44)	(-8.18)
Financial	0.718	-0.278	-0.503***	-1.765***	-2.487***	-1.144***	-1.582***
	(1.82)	(-1.87)	(-7.67)	(-20.30)	(-8.10)	(-5.34)	(-4.45)
Luxury	-0.116	0.017***	-0.352	-1.548***	-1.533***	-1.146***	-1.522***
	(-1.94)	(7.08)	(-0.52)	(-3.96)	(-6.18)	(-4.19)	(-4.98)
Private Wealth	-0.287	0.143***	-0.178***	-2.021***	-2.171***	-1.069***	-1.888***
	(-1.33)	(4.21)	(-4.40)	(-9.81)	(-4.82)	(-5.48)	(-5.59)
Information leadership share change with selected banking indices							
SWIFT	1.784***	2.542***	-0.235	-1.652***	-0.892***	-2.436***	-2.807***
	(11.67)	(5.56)	(-1.40)	(-3.43)	(-7.68)	(-8.25)	(-6.54)
Banking	1.068***	2.924*	0.033	-1.515***	-0.273**	-2.261***	-2.254***
	(4.43)	(1.97)	(0.15)	(-3.29)	(-3.06)	(-4.56)	(-5.28)
Economic	1.457***	2.384***	0.001	-1.485***	-1.276***	-1.337***	-3.282***
	(8.54)	(11.01)	(1.63)	(-4.75)	(-4.57)	(-3.56)	(-6.53)
Financial	1.843***	2.575***	0.968***	-1.949***	-1.896***	-1.548***	-3.221***
	(5.55)	(6.59)	(3.99)	(-9.46)	(-8.05)	(-5.90)	(-7.06)
Luxury	2.233***	2.271***	1.264	-1.717***	-1.061***	-0.922***	-2.753***
	(3.57)	(6.16)	(1.61)	(-4.12)	(-3.67)	(-3.70)	(-10.87)
Private Wealth	1.276***	2.381***	0.679*	-2.650***	-2.544***	-1.376***	-2.480***
	(10.07)	(9.44)	(2.02)	(-9.41)	(-5.37)	(-10.32)	(-8.99)

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Specifically, we investigate the differential results between each denoted international banking index with that of the utilised Russian banking index. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. To investigate the contagion effects of international sanctions imposed upon the Russian economy due to the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. Specifically, to focus on the direct effects on the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system, along with specific sanctions targeting the Russian banking system and the Russian economy, those sanctions specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth. A concise list of the sanctions used to analyse these six dimensions is provided in Table 1. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

In Table 8, we observe specific changes in information dynamics between the Russian banking sector and that of the same set of international banking indices. Shelter from sanction-related shocks is again identified across each IS, CS, and ILS measure analysed in the Australian, Canadian and Chinese banking indices. Such results indicate that as the Russian banking system began to be sharply negatively influenced by the imposition of international sanctions, banking indices in Australia, Canada, and China do not appear to have attracted significant negative informational effects, presenting evidence of the existence of multiple opportunities for portfolio diversification should further sectoral restrictions continue due to the actions of the Russian state. Such results are in sharp contrast to the estimated results using the World Banking Index, where IS measures present evidence of strong negative effects due to both SWIFT and banking-related sanctions, while all types of sanctions are found to generate negative influence at a 1% level of significance. Each of the European, UK, and US banking sectors is found to have received significant informational shocks from the Russian banking sector in all investigated circumstances. Estimates using IS interactions show that banking-related sanctions are identified to have quite a pronounced, substantive influence on European banking, while the banning of Russia from SWIFT generated a significant shock to the US banking sector. It is interesting to note that when analysing ILS interactions, those

Table 9
Russian volatility indices information differential due to sanctions (with international banking indices).

Sanction Type	Australia	Canada	China	Europe	UK	US	World
Information share change with selected banking indices							
SWIFT	0.079	1.128***	0.102*	-1.835***	-0.837*	-2.031***	-0.861***
	(0.10)	(10.51)	(2.19)	(-23.05)	(-2.47)	(-7.96)	(-8.21)
Banking	0.883*	1.550***	-0.827	-1.963***	-0.830***	-2.094***	-0.598***
	(2.05)	(7.68)	(-0.96)	(-22.86)	(-8.15)	(-18.47)	(-6.70)
Economic	0.055	1.124***	-0.514	-1.232	0.714***	-1.122	-0.549***
	(0.78)	(4.92)	(-0.80)	(-1.46)	(6.73)	(-1.68)	(-21.07)
Financial	0.035	1.173***	-0.188	-1.994***	0.232***	-0.145	-0.315***
	(0.18)	(8.21)	(-0.33)	(-13.16)	(3.32)	(-1.26)	(-8.48)
Luxury	0.018	0.202***	-0.274	-1.089***	0.527***	-0.408*	-0.315***
	(0.19)	(4.89)	(-0.03)	(-5.92)	(3.97)	(-2.33)	(-5.85)
Private Wealth	0.567	0.139***	-0.515	-2.316***	0.072	-1.090***	-0.293***
	(0.32)	(7.11)	(-0.34)	(-12.55)	(0.83)	(-5.29)	(-3.88)
Component share change with selected banking indices							
SWIFT	3.267***	2.151***	0.012*	-1.973***	1.247***	-1.244	-1.627***
	(3.44)	(7.08)	(2.49)	(-5.31)	(8.18)	(-1.08)	(-4.33)
Banking	1.523**	2.154***	-0.108	-0.991***	-0.457***	-1.644***	-2.139***
	(2.62)	(4.77)	(-0.88)	(9.48)	(-23.38)	(-6.28)	(-10.62)
Economic	3.293***	2.184***	-0.052***	-1.578***	-0.261	0.789***	-0.772***
	(5.38)	(5.28)	(-4.30)	(-5.90)	(-0.47)	(7.01)	(-8.20)
Financial	3.297***	2.204***	-0.142	-1.967***	-1.340***	0.0803	-1.582***
	(6.67)	(5.13)	(-1.92)	(-11.06)	(-11.55)	(0.45)	(-4.45)
Luxury	3.234***	2.765***	-0.170***	-2.066***	-2.403	-0.522***	-2.65***
	(9.27)	(9.41)	(-5.85)	(-5.61)	(-0.93)	(-5.30)	(-17.87)
Private wealth	3.255***	2.24***	-0.059***	-2.928***	-3.752***	0.414**	-0.784***
	(7.22)	(5.40)	(-8.12)	(-6.97)	(-21.95)	(2.81)	(-10.84)
Information leadership share change with selected banking indices							
SWIFT	0.110	1.537***	-3.656***	-3.327***	-5.155***	-4.344***	-1.933***
	(0.38)	(-5.14)	(-7.19)	(-7.22)	(-6.41)	(-5.17)	(-5.16)
Banking	0.862	1.822***	-4.955***	-3.248***	-5.473***	-5.326***	-1.390***
	(1.06)	(-8.81)	(-5.21)	(-5.64)	(-4.27)	(-4.07)	(-6.89)
Economic	0.789***	1.290***	-3.933***	-3.048***	-3.733***	-4.125***	-2.194***
	(5.15)	(-20.58)	(-8.59)	(-6.27)	(-5.97)	(-9.97)	(-11.46)
Financial	0.122***	1.331***	-3.410***	-3.433***	-4.018***	-4.066***	-1.740***
	(9.28)	(-9.16)	(-4.43)	(-3.38)	(-6.94)	(-4.66)	(-7.62)
Luxury	0.113***	1.839***	-2.590***	-1.886***	-5.474***	-2.017***	-2.322***
	(4.06)	(-8.47)	(-11.47)	(-11.48)	(-5.06)	(-5.13)	(-6.53)
Private wealth	0.987	2.393***	-1.258***	-2.052***	-4.220***	-4.446***	-1.956***
	(1.56)	(-5.14)	(-3.75)	(-8.07)	(-9.19)	(-4.42)	(-5.19)

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Specifically, we investigate the differential results between each denoted international banking index with that of the utilised Russian volatility index. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. To investigate the contagion effects of international sanctions imposed upon the Russian economy due to the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. Specifically, to focus on the direct effects on the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system, along with specific sanctions targeting the Russian banking system and the Russian economy, those sanctions specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth. A concise list of the sanctions used to analyse these six dimensions is provided in Table 1. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

sanctions targeting the movement and storage of private wealth are found to generate very negative, significant influence upon both the European and UK banking systems.

Informational interaction effects between selected international banking indices and Russian volatility indices are presented in Table 9. Australian and Canadian banking indices are again found to behave differently to other major international markets, with this particular result adding further robustness to the view that both of these countries provide significant diversification opportunities even when considering forward-looking market expectations. Chinese markets are identified to present limited response in terms of IS measures to international sanctions; however, both CS and ILS measures indicate sharp estimated responses. Chinese banking indices are found to be sharply influenced by Russian volatility indices (-4.27), while the implementation of strict banking sanctions generates significant informational contagion (-4.96). Both European and UK banking indices are found to present informational flows significantly above that of the World banking indices in terms of estimated IS and ILS measures, while US-based interactions are identified to be most acute for sanctions relating to SWIFT, the Russian banking sector, and specifically targeted packages based on Russian banking, the Russian economy, and the storage and movement of Russian private wealth.

The results presented indicate that when considering the Russian stock, banking and volatility indices, sanctions imposed against Russia, irrespective of type, possessed substantial worldwide effects upon the international banking system with the exception of Australia and Canada, and in some scenarios, China and the US. However, broadly, each of Europe, the UK, and the World Banking Index exhibited immediate and substantial interaction effects across all examined measures across all types of sanction. Such effects are even more pronounced when considering forward-looking indices, indicating that investors expected the situation to deteriorate further, with an expectation of more restrictive measures being imposed. When considering the type of sanction, the removal of Russian banks from the SWIFT banking sector exhibited one of the largest shocks, particularly due to the scale of the decision being made. Among many options available at that point in time, in terms of rhetoric, this option generated the most hostile response from the Russian government due to the sharp negative economic implications that would immediately follow. Further, the sharp inflow of informational contagion identified due to sanctions based on private wealth and those identified through the UK banking indices warrant further attention from future research.

5.3. Dynamic information flows differentials from Russian markets to International Stock Indices due to sanction packages

Informational interactions between the Russian MOEX, Russian banking index, the Russian volatility index and the selected international stock indices are detailed in Tables 10, 11, and 12, respectively. It is apparent that while Australia and Canada were found to present significant evidence of clear informational separation concerning their respective banking sector, each stock index is also found to have presented clear informational separation with regard to international sanctions imposed on Russia. In Table 10, when considering interaction effects stemming from the Russian MOEX, each of the Chinese, European, US and World indices are found to have been receivers of informational contagion. The UK is identified to have been particularly exposed to informational contagion stemming from sanctions imposed upon Russia, with particular exposure identified for sanctions relating to SWIFT, targeted economic sanctions, and private wealth-based sanctions. When considering the interactions between the Russian banking index and each international index analysed, Table 11, the UK again presents pronounced informational interactions, identified to be far more acute than those identified relating to other countries, except for Russian banking sanctions possessing significant influence upon US market indices when considering CS results. Chinese and European market indices are found to have responded in a more moderated manner than the World index.

Finally, in Table 12, we present the estimated dynamic changes of IS, CS, and ILS between Russian volatility indices and our selected international stock indices as a function of the type of international sanction that has been imposed upon Russia. Volatility indices are a particularly interesting source of information due to the forward-looking nature of their construction based on the implied volatility of options markets. Focusing firstly on the informational influence of Russian volatility indices upon our selected international indices, we observe that significant differentials exist in almost all IS, CS, and ILS relationships investigated, but the scale and direction of such flows vary substantially. We first observe that in each of the Australian, Canadian, and Chinese informational relationships examined, the changes of IS and CS are predominantly moderate and significantly positive, indicating that the implementation of international sanctions upon Russia did not generate substantive influence upon these national indices. However, when focusing on dynamic changes in ILS, Chinese markets appear sharply influenced by each analysed event relating to implementing sanctions. It is worth noting some possible reasons why the effects of the subsequent sanctions placed on the Russian economy following the invasion on relative information share measures differ between the CS/IS measures and ILS measures regarding the interaction between the Russian volatility index and the Chinese stock market. The effects on the CS and IS measures are significantly positive, but the effect on the ILS is significantly negative. The institutional characteristics of the Chinese stock exchanges may be a reason for the differential results. As discussed in the literature, the Chinese stock markets possess several features that may result in substantial micro-structure biases, which may further lead to the differentials between the CS/IS and ILS measures. Those features include an investor structure such that retail investors are dominant, an order-driven market with restrictive policies on trading volume, stock holdings and short selling, and constraints on timely and swift trading concerning a $t+1$ trading rule, among others (Yang et al., 2012). One may expect that these special factors in the Chinese stock markets exacerbate the local trading frictions and market micro-structure biases, further widening the gap between the CS/IS and ILS measures. Hence, the effects of the war and its resultant sanctions on the three information share measures are expected to vary across the measures.

5.4. Have the effects of sanctions placed on Russia changed over time?

Finally, we examine whether information flows between Russian and international markets have changed significantly between the initial range of sanctions imposed and those implemented later.[14] Empirical results are presented in Table 13. This final phase of analysis is particularly important, as significant concerns have been raised about the ongoing effectiveness of the deterrent should international financial markets incorporate expectations of their further expansion and implementation within pricing expectations. Results indicate that when considering the differential behaviour between information flows, as sourced through IS, CS, and ILS measures stemming from Russian stock and banking indices, all estimates in Europe, the UK and the US are found to be significantly negative. Further, the scale of the decline in information transmission to the selected international banking sectors is found to be

[14] In additional analyses, we also examine links between the IS, CS and ILS information transmission measures and a set of variables capturing macroeconomic uncertainty. Results, detailed in the Online Appendix, Tables A1 and A2, indicate that the changes in IS, CS and ILS are linked to changes in the price of crude oil and the VSTOXX, the European market uncertainty index. These findings provide further support for the notion that information transmission is dynamic around the period of the illegal invasion of Ukraine.

Table 10
Russian MOEX information differential due to sanctions (with international stock indices).

Sanction Type	Australia	Canada	China	Europe	UK	US	World
Information share change with selected stock indices							
SWIFT	1.530***	0.744***	-3.729***	-1.973***	-2.655***	-1.922***	-0.240
	(6.74)	(7.37)	(-5.55)	(-7.32)	(-13.72)	(-6.16)	(-1.38)
Banking	1.156***	0.769***	-4.072***	-1.396***	-0.210***	-1.757***	-0.872***
	(4.97)	(5.78)	(-4.90)	(-41.43)	(-4.11)	(-5.62)	(-12.96)
Economic	1.038***	0.722***	-2.646***	-1.152***	-0.765***	-1.621***	-1.194***
	(3.22)	(4.67)	(-4.96)	(-18.84)	(-8.70)	(-6.99)	(-4.62)
Financial	0.373***	0.697***	-3.979***	-1.269***	-2.791***	-1.748***	-1.150***
	(3.34)	(8.58)	(-7.18)	(-4.63)	(-8.55)	(-5.92)	(-1.17)
Luxury	0.471***	0.847***	-2.039***	-1.563***	-1.515***	-1.346***	-0.404***
	(5.62)	(-5.91)	(-4.75)	(-6.20)	(-7.71)	(-5.05)	(-5.94)
Private wealth	0.297***	1.921***	-2.264***	-0.931***	-5.438***	-1.605***	-0.198
	(4.68)	(6.55)	(-8.80)	(-4.90)	(-8.69)	(-6.81)	(-1.23)
Component share change with selected stock indices							
SWIFT	0.205***	0.993	-1.449***	0.099***	-5.811***	-2.554***	-1.349***
	(3.47)	(-0.79)	(-11.88)	(8.92)	(-8.69)	(-3.60)	(-4.04)
Banking	0.294	1.189	-1.515***	0.119***	-2.176***	-0.908***	-1.386***
	(0.49)	(0.51)	(-6.07)	(5.39)	(-4.61)	(-4.61)	(-4.01)
Economic	0.778	2.039	-1.406***	0.179***	-5.707***	-0.913***	-0.847***
	(2.59)	(1.13)	(-8.63)	(5.20)	(-4.24)	(-9.76)	(-3.63)
Financial	0.093	1.905	-1.497***	0.117***	-2.177***	0.373***	-1.332***
	(1.54)	(1.56)	(-6.71)	(7.69)	(-9.28)	(4.31)	(-9.66)
Luxury	0.256	1.022	-1.688***	0.119***	-2.271***	-0.567***	-0.725***
	(1.51)	(1.41)	(-7.28)	(9.79)	(-9.73)	(-7.99)	(-5.46)
Private Wealth	0.17	1.063	-1.771***	0.130***	-5.196***	-0.924***	-1.301***
	(1.79)	(1.71)	(-9.42)	(4.93)	(-9.28)	(-7.22)	(-6.85)
Information leadership share change with selected stock indices							
SWIFT	1.596	0.649**	-3.491***	-3.394***	-2.768***	-2.619***	-2.776***
	(1.62)	(3.14)	(-5.20)	(-8.24)	(-6.03)	(-9.41)	(-7.20)
Banking	1.579	0.434***	-3.279***	-2.780***	-1.841***	-1.596***	-1.260***
	(1.49)	(3.03)	(-4.89)	(-6.31)	(-6.85)	(-12.67)	(-3.67)
Economic	0.831	0.435***	-1.913***	-2.734***	-1.846***	-1.365***	-1.108***
	(1.39)	(3.32)	(-5.18)	(-5.29)	(-7.68)	(-9.89)	(-9.34)
Financial	1.554	0.454***	-1.272	-2.697***	-2.076***	-1.355***	-1.598***
	(1.21)	(3.90)	(-0.52)	(-5.95)	(-10.22)	(-7.16)	(-22.10)
Luxury	0.961	0.324***	-1.122***	-2.527***	-1.563***	-1.443***	-2.394***
	(1.28)	(3.98)	(-3.94)	(-8.96)	(-4.24)	(-9.94)	(-8.46)
Private Wealth	1.590	0.406***	-2.960***	-3.138***	-5.637***	-1.292***	-1.361***
	(1.17)	(3.85)	(-9.53)	(-8.98)	(-4.53)	(-11.16)	(-12.41)

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Specifically, we investigate the differential results between each denoted international stock index with that of the Russian MOEX. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. To investigate the contagion effects of international sanctions imposed upon the Russian economy due to the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. Specifically, to focus on the direct effects on the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system, along with specific sanctions targeting the Russian banking system and the Russian economy, those sanctions specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth. A concise list of the sanctions used to analyse these six dimensions is provided in Table 1. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

substantially above that of the differentials for the corresponding equity indices. These results indicate that while the first phase of international sanctions imposed upon Russia generated significant differentials of information transmission from Russia to the other selected international regions, sanctions imposed during the final four weeks of the sampled period have significantly reduced influence upon the same information and price discovery relationships. Such results indicate that when considering European, UK, and US investors, in particular, market participants revised their expectations to incorporate further sanctions. Although significant influence is observed across all Russian markets examined, irrespective of the type of financial product, the contagion effects, as measured by information transmission, become more diluted. While targeted sanctions do impose significant damage, associated contagion effects are identified to be both significant and detrimental to broader international markets. However, such secondary effects are found to moderate thereafter.

5.5. Associated robustness testing procedures

Finally, we further substantiate our findings in two distinct ways. First, we investigate the information flows of different stock markets with contrasting characteristics against the Russian stock market across the same period consistent with the Russia-Ukraine

Table 11
Russian banking indices information differential due to sanctions (with international stock indices).

Sanction Type	Australia	Canada	China	Europe	UK	US	World
Information share change with selected stock indices							
SWIFT	2.087***	0.744***	0.184	-2.488***	-3.225***	-1.150***	-1.488***
	(6.41)	(7.37)	(1.85)	(-3.63)	(-7.97)	(-7.54)	(-5.65)
Banking	2.09***	0.769***	0.097	-1.494***	-2.256***	-1.154***	-1.252***
	(5.60)	(5.78)	(0.37)	(-5.13)	(-9.42)	(-5.59)	(-9.77)
Economic	1.901***	0.722***	0.088	-0.479***	-1.034***	-0.146***	-0.717***
	(6.14)	(4.67)	(1.28)	(-5.63)	(-5.21)	(-5.03)	(-11.05)
Financial	2.095***	0.697***	0.086	0.231*	-1.620***	-0.441***	-0.468***
	(4.40)	(8.58)	(0.89)	(2.17)	(-9.87)	(-7.05)	(-6.64)
Luxury	0.557***	0.847***	-0.547*	0.111	-2.021***	-0.124***	-0.276
	(5.15)	(4.91)	(-2.07)	(0.50)	(-48.31)	(-0.51)	(-1.94)
Private Wealth	1.834***	1.921***	-0.341***	-0.603***	-5.325***	0.210***	-0.725***
	(4.89)	(3.55)	(-3.30)	(-3.40)	(-24.34)	(-4.51)	(-4.75)
Component share change with selected stock indices							
SWIFT	0.968	0.835	-0.180***	-1.151***	-4.682***	-0.957***	-1.986***
	(1.43)	(1.22)	(6.89)	(-5.25)	(-9.89)	(-8.29)	(-3.68)
Banking	0.226	0.189	-0.151***	-1.092***	-2.216***	-6.033***	-1.922***
	(1.49)	(1.51)	(5.03)	(-5.01)	(-5.47)	(-2.99)	(-5.61)
Economic	0.957	0.439	-0.188***	-1.164***	-1.920***	-0.922***	-1.603***
	(1.01)	(1.13)	(4.86)	(-5.53)	(-7.94)	(-5.53)	(-7.82)
Financial	0.226	0.905	-0.164***	-1.106***	-0.421*	-0.938***	-1.893***
	(0.62)	(1.56)	(5.42)	(-4.23)	(-2.21)	(-3.46)	(-6.93)
Luxury	0.394	0.869	-0.192***	-1.164***	-0.475***	-0.248***	-0.116
	(0.29)	(1.16)	(9.12)	(-4.73)	(-4.42)	(-9.56)	(-1.96)
Private Wealth	0.215	1.063	-0.206***	-1.110***	-4.060***	-0.952***	-1.939***
	(0.83)	(1.37)	(8.61)	(-9.98)	(-8.26)	(-4.14)	(-7.17)
Information leadership share change with selected stock indices							
SWIFT	3.385**	3.374***	0.006	-1.069***	-0.389***	-1.617***	-1.745***
	(2.86)	(10.29)	(0.10)	(-5.18)	(-4.46)	(-5.75)	(-12.05)
Banking	0.482	2.434***	-0.066	-1.054***	-0.819***	-1.625***	-1.051***
	(1.00)	(3.03)	(-1.15)	(-4.72)	(-9.41)	(-4.13)	(-5.48)
Economic	-0.269	2.435***	0.038	-0.882***	-0.295**	-1.528***	-1.241***
	(-1.80)	(9.32)	(0.87)	(-4.04)	(-3.28)	(-3.53)	(-9.24)
Financial	0.052	2.454***	-0.070	-0.946***	-0.353***	-1.435***	-1.698***
	(0.19)	(11.90)	(-1.32)	(-5.73)	(-8.44)	(-6.35)	(-13.21)
Luxury	0.480	2.458***	-0.076	-1.153***	-0.346	-1.720***	-1.832***
	(1.68)	(3.06)	(-1.46)	(-6.06)	(-1.65)	(-10.26)	(-5.93)
Private Wealth	1.101***	2.406***	-0.073	-1.306***	-4.843***	-1.492***	-2.027***
	(3.69)	(7.85)	(-0.91)	(-3.66)	(-6.64)	(-4.13)	(-6.12)

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Specifically, we investigate the differential results between each denoted international stock index with that of the utilised Russian banking index. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as: $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. To investigate the contagion effects of international sanctions imposed upon the Russian economy due to the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. Specifically, to focus on the direct effects upon the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system, along with specific sanctions targeting the Russian banking system and the Russian economy; those sanctions specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth. A concise list of the sanctions used to analyse each of these six dimensions is provided in Table 1. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

war. We collect daily price observations of four alternative stock indices in Asia, including the Japanese Nikkei 225 index, the South Korean KOSPI index, the Indian CNX Nifty 50 index and the Taiwan Stock Exchange Capitalisation Weighted stock index. The four markets are chosen as we aim to examine whether the results of information flows of the markets that are less involved with imposing international sanctions following the beginning of the war yet are geographically close to Russia. We specifically test whether such markets provide similar results to the major international exchanges earlier examined. As previously outlined, under the modelling of the bivariate VECM-DCC-GARCH-SNP, we estimate the natural logarithmic ratios of the CS, IS and ILS measures of the four stock indices against the Russian MOEX index and MOEX banking sector (MOEX financials index). The impacts of the war on information flows are examined.

The time-varying ratios of information share measures are depicted in Figures B1, B2, and B3 of the Online Appendices. We note that the moving patterns in the figure visualise the dynamics of information share measures of the four alternative stock indices against either the MOEX index or the MOEX banking sector. We focus on the differentials of information flows running through to the beginning of the 24 February 2022 war. We find substantial changes in the regional indices' IS and ILS ratios are identified when

Table 12
Russian volatility indices information differential due to sanctions (with international stock indices).

Sanction Type	Australia	Canada	China	Europe	UK	US	World
Information share change with selected stock indices							
SWIFT	0.232	0.835***	0.811***	-0.271	-1.732***	-0.242***	-0.292***
	(1.52)	(6.05)	(6.09)	(-0.74)	(-6.15)	(-4.15)	(-3.42)
Banking	0.767***	0.963***	0.317***	-1.019***	-1.980***	-1.297	-1.831***
	(6.87)	(5.86)	(3.57)	(-7.36)	(-8.34)	(-0.40)	(-5.11)
Economic	0.588***	0.232	0.067	-0.955***	-0.671***	-0.347***	-0.406***
	(7.53)	(1.46)	(0.76)	(-12.92)	(-4.88)	(-7.07)	(-4.99)
Financial	0.57	0.331***	1.078***	-0.759***	-1.498***	-0.279***	-0.458***
	(1.31)	(9.16)	(6.99)	(-7.23)	(-13.58)	(-3.73)	(-4.54)
Luxury	0.987***	0.489***	0.834**	-0.660***	-2.439*	-0.931**	-1.316***
	(4.10)	(5.92)	(3.19)	(-4.30)	(-2.08)	(-3.06)	(-15.77)
Private Wealth	0.634*	0.316***	0.995***	-0.141	-4.265***	-0.488***	-1.222***
	(2.56)	(12.55)	(11.21)	(-1.15)	(-12.69)	(-6.33)	(-9.13)
Component share change with selected stock indices							
SWIFT	0.650***	1.247***	2.745***	-4.083***	-1.414***	-1.179***	-0.863
	(5.40)	(8.18)	(6.70)	(-23.94)	(-30.76)	(-9.99)	(-0.55)
Banking	0.766***	1.457***	1.036	-1.772***	-1.399***	-1.179***	-0.580
	(5.24)	(6.38)	(0.57)	(-19.44)	(-27.50)	(-9.99)	(-1.05)
Economic	0.849***	1.172***	2.302***	-1.777***	-0.460***	-1.687***	-1.164***
	(9.33)	(5.52)	(7.89)	(-13.44)	(-12.41)	(-6.56)	(-8.79)
Financial	0.142	1.340***	2.821***	-0.382	-0.475***	-0.472***	-1.310***
	(0.43)	(7.55)	(3.91)	(-0.77)	(-15.02)	(-6.37)	(-4.96)
Luxury	0.995***	0.403	0.872*	-1.072***	-0.754***	-0.808***	-0.624***
	(4.40)	(0.93)	(2.06)	(-5.92)	(-11.49)	(-6.75)	(-8.95)
Private wealth	1.203***	1.752***	2.617***	-1.575***	-4.471***	-0.594***	-1.111***
	(3.81)	(5.95)	(5.60)	(-7.96)	(-10.94)	(-7.74)	(-8.71)
Information leadership share change with selected stock indices							
SWIFT	1.457***	1.537***	-2.839*	-3.829***	-6.706***	-4.265***	-0.580
	(7.96)	(5.14)	(-2.38)	(-7.71)	(-5.31)	(-9.52)	(-1.05)
Banking	0.995***	1.822***	-4.439***	-5.899***	-7.870***	-3.444***	-3.802
	(8.90)	(8.81)	(-8.91)	(-6.65)	(-8.52)	(-4.37)	(-1.86)
Economic	0.618***	1.290***	-4.251***	-3.372***	-5.298***	-4.042***	-1.741***
	(9.84)	(6.58)	(-6.88)	(-7.18)	(-6.33)	(-9.08)	(-7.90)
Financial	0.859***	1.414***	-3.585***	-4.013***	-5.776***	-3.996***	-1.753***
	(7.68)	(6.46)	(-5.57)	(-7.43)	(-5.19)	(-7.71)	(-7.13)
Luxury	0.673**	1.839***	-4.009***	-4.034***	-4.272***	-4.515***	-3.895***
	(2.72)	(8.47)	(-7.33)	(-4.96)	(-7.36)	(-8.50)	(-7.43)
Private wealth	0.676***	1.393***	-3.716***	-3.801***	-5.426***	-3.996***	-1.731***
	(5.80)	(5.14)	(-8.78)	(-5.11)	(-6.44)	(-3.36)	(-8.68)

Note: This table reports descriptive statistics of the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures for a sample period running from 24 June 2021 through 23 June 2022. Specifically, we investigate the differential results between each denoted international stock index with that of the utilised Russian volatility index. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. To investigate the contagion effects of international sanctions imposed upon the Russian economy due to the illegal invasion of Ukraine on 24 February 2022, data is collated and separated using Reuters Graphics. Specifically, to focus on the direct effects upon the international banking system, we are particularly interested in sanctions relating to the banning of Russia from the SWIFT system, along with specific sanctions targeting the Russian banking system and the Russian economy; those sanctions specifically targeting financial movement, and those targeting luxury goods and both the movement and storage of private wealth. A concise list of the sanctions used to analyse each of these six dimensions is provided in Table 1. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

compared with both the MOEX index and the MOEX banking sector at the beginning of the Russia-Ukraine conflict. Specifically, the IS and ILS ratios fall substantially before reverting to higher levels. The results are evident across the relationships between the four stock indices and Russia, which are consistent with the changing patterns observed in the Online Appendices regarding the differentials in information flows of the seven international stock markets against the Russian one going across the war. Further, the effects of the war on the information share ratios are estimated via an AR(p)-GARCH model with a dummy controlling the ongoing period of the war in the conditional mean equation. The estimation results are shown in Table 14. As observed, negative estimates of the effects are statistically significant across the bilateral information flows. This indicates that the war directly influences the long-run informational roles of the four alternative stock markets in terms of price discovery processes sourced from Russia. The results are similar to those presented in Table 6. Therefore, it is found that for those markets that are not heavily involved in the international sanctions on Russia, stock indices are still impacted negatively by the beginning of the Russia-Ukraine war in terms of the relative informational role in price discovery and the subsequent package of international sanctions that followed.

Table 13
Overall differential information flows as a result of international sanctions.

Source	Russian MOEX			Russia Banking Index		
	IS	CS	ILS	IS	CS	ILS
	Differential of information flows to international stock indices					
Australia	-0.3141	-0.3755***	-0.2185***	-0.7879***	-0.8601***	0.1444
	(0.2244)	(0.1192)	(0.0164)	(0.2393)	(0.1918)	(0.1989)
Canada	-0.6635	0.0873	-1.5015***	-0.8617***	-0.0911	-0.5411***
	(0.4275)	(0.1938)	(0.1546)	(0.0183)	(0.1162)	(0.0348)
China	-0.0367	-0.2749***	-0.5235***	-0.5469***	-0.2361***	-0.6215***
	(0.2781)	(0.1018)	(0.1460)	(0.1689)	(0.0917)	(0.1251)
Europe	-0.9824***	-1.0674***	-0.8299***	-0.3709***	-0.4412***	-0.5578***
	(0.0139)	(0.0693)	(0.1177)	(0.0249)	(0.1269)	(0.1225)
UK	-1.5194***	-0.6448***	-1.7492***	-1.5481***	-1.5717***	-1.9527***
	(0.2160)	(0.1249)	(0.4322)	(0.1995)	(0.2282)	(0.1308)
US	-0.9838***	-0.6117***	-0.5124***	-0.8987***	-0.7869***	-0.1167***
	(0.2326)	(0.2137)	(0.1840)	(0.0942)	(0.0690)	(0.2016)
World	-0.9023***	-1.4269***	-0.2686	-0.9753***	-1.0096***	-0.5962***
	(0.2926)	(0.1677)	(0.3908)	(0.0209)	(0.1262)	(0.1369)
	Differential of information flows to international banking indices					
Australia	-0.2992***	0.0030	0.5630	-0.0460	0.2883	0.1970
	(0.0182)	(0.1902)	(0.3265)	(0.4355)	(0.3545)	(0.4902)
Canada	-0.5322***	-0.4835***	-0.0973	-0.5216***	-0.4013***	-0.2405***
	(0.1463)	(0.1129)	(0.0902)	(0.1820)	(0.1511)	(0.0512)
China	-0.3850	-0.1925	-0.1328	-0.0736***	-0.0543***	-0.0170
	(0.3212)	(0.2018)	(0.2614)	(0.0069)	(0.0171)	(0.2903)
Europe	-1.6816***	-1.7210***	-2.5211***	-1.7929***	-1.9822***	-2.5069***
	(0.1770)	(0.0875)	(0.3443)	(0.2208)	(0.1823)	(0.2884)
UK	-1.7507***	-1.3619***	-1.7777***	-1.5419***	-2.3092***	-2.2058***
	(0.1745)	(0.1163)	(0.1928)	(0.2183)	(0.1922)	(0.3289)
US	-1.1245***	-1.1252***	-0.4897***	-0.5007***	-0.2631	-0.2764
	(0.2370)	(0.1661)	(0.1041)	(0.0516)	(0.2847)	(0.3699)
World	-1.1413***	-1.6201***	-1.2725***	-0.7970***	-1.3157***	-0.5991***
	(0.1558)	(0.1193)	(0.3149)	(0.1895)	(0.1412)	(0.1310)

Note: This table reports the differential behaviour of the component share (CS), information share (IS), and information leadership share (ILS) measures between international sanctions implemented between the first four weeks beginning 24 February 2022, and the final four weeks of the sample analysed. Time-varying information share measures are estimated based on a bivariate VECM-DCC-GARCH-SNP model. We calculate natural logarithmic ratios of the time-varying information share measures as $CS\,ratio = log(CS_{c,t}/CS_{r,t})$, $IS\,ratio = log(IS_{c,t}/IS_{r,t})$, and the $ILS\,ratio = log(ILS_{c,t}/ILS_{r,t})$. Data relating to sanctions are collated and separated using Reuters Graphics. For brevity of presentation, only the Russian MOEX and banking index are included in the above table. Further analysis and results relating to the flow of information and price discovery from Russian financial markets are available from the authors upon request. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

We turn our attention now to an investigation of whether another critical event, the annexation of Crimea by Russia in 2014, had similar effects as the Russia-Ukraine war on the international stock markets. The results extend our understanding of the contagion effect of regional conflict on global financial markets. To do so, we collect a sample of daily price observations from 18 March 2012 through 18 March 2016. We must note that the sample allows for a two-year window around the formal annexation of Crimea by Russia on 18 March 2014. Moreover, the sample represents the same variables listed in Table 2, through which a bivariate VECM-DCC-GARCH-SNP model was applied to estimate the time-varying information share measures of IS, CS and ILS between the international stock indices and the Russian MOEX index. The natural logarithmic ratios are calculated for the three information share measures across the pairwise relations.

The time-varying log information share ratios are depicted in Figures C1, C2 and C3, located in the Online Appendices, representing the relationships identified during the Russia-Ukraine war, two observed differentials are particularly interesting. First, there are more inconsistent, changing patterns in the information flows of seven markets against the Russian comparison. Specifically, there is a rising trend across the event regarding the informational roles of the Canadian and world index against the Russian one regarding IS and ILS ratio dynamics. The informational roles of the remaining international indices against the MOEX index present a pronounced trough, running through the period surrounding the annexation of Crimea. This observation is comparable with that of the Russia-Ukraine war. Second, the extent to which information flows oscillate around the event is quite low in contrast to the war in 2022. This result indicates that the original period surrounding the annexation did not generate the same influence on information flows. To consider this, we further estimate the effects of the event on log ratios of information share measures via an AR(p)-GARCH model with a dummy indicating a one-week period following the annexation. The estimation results are shown in Table 15. As observed, despite the fact that the effects on the CS ratios are significantly positive for five of the seven paired information channels, the effects on the IS and ILS ratios are not significant for most of the channels investigated. The results suggest that the annexation of Crimea by the Russian government presented a much weaker impact on information flows than the beginning of the 2022 war did.

Table 14
The effects of the Russia-Ukraine war on information share measures between stock markets in Japan, South Korea, India and Taiwan and Russian stock indices.

	Japan	South Korea	India	Taiwan
Information dynamics sourced from Russian MOEX				
IS	0.1618	-0.0827	-0.1153	0.0819
	(0.34)	(1.04)	(0.29)	(1.01)
CS	0.0002***	-0.0094***	-0.1176***	0.0042
	(0.00)	(0.00)	(0.01)	(0.71)
ILS	0.1259	-0.5375	-1.1421***	0.0765
	(0.63)	(0.35)	(0.39)	(0.18)
Information dynamics sourced from Russian banking indices				
IS	-0.6652***	-0.1485	-1.0104***	-0.2461
	(0.15)	(1.83)	(0.32)	(0.22)
CS	0.0144***	-0.5003***	-0.0003	-0.0002
	0.00)	(0.00)	(0.00)	(0.00)
ILS	-5.9001***	-0.9748	-2.2510***	-0.6861*
	(0.29)	(10.93)	(0.60)	(0.42)

Note: This table reports the effects of the Russian-Ukraine war on the natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures. The stock indices for counterpart markets are the Japanese Nikkei 225 index, South Korean KOSPI index, Indian CNX NIFTY 50 index, and Taiwan Stock Exchange Capitalisation Weighted index. Russian stock indices include the MOEX index and the Russian Financials Index. An AR(p)-GARCH (1,1) model with three information share ratios as dependant variables and a dummy relating to one week following February 24, 2022, are estimated. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

Table 15
The impacts of the annexation of Crimea by Russia (2014) on information flows of stock markets between Russia and the rest of the world.

	Australia	Canada	China	Europe	UK	US	World
IS	0.1086	0.3033***	0.0963	-0.0336	0.0126	-0.0107	0.0729***
	(0.16)	(0.14)	(0.34)	(0.03)	(0.07)	(0.40)	(0.02)
CS	-0.0541***	0.0301***	0.0110***	-0.0005*	0.0001***	0.0001***	0.0007***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
ILS	-0.1571	-0.0328	0.2356	0.0408	0.1178	-0.2102	-0.0596*
	(0.36)	(0.41)	(0.48)	(0.16)	(0.10)	(0.78)	(0.03)

Note: This table reports the effects of the annexation of Crimea by the Russian government on March 18, 2014, on information share ratios of seven international stock market indices against the Russian MOEX index. The natural logarithmic ratios of component share (CS), information share (IS), and information leadership share (ILS) measures are obtained from a sample period of daily data running from 18 March 2012 through to 18 March 2016. The stock indices selected as counterpart series include the US S&P 500 index, the Australian S&P/ASX 200 index, the Canadian TSX 300 Composite index, the Chinese CSI 300 index, the European STOXX 50 index, the UK FTSE 100 index, and MSCI All Country World Price Index. An AR(p)-GARCH (1,1) model with three information share ratios as dependant variables and a dummy relating to one week following March 18, 2014, is estimated. Standard errors are in parentheses. ***, ** and * denote significance at the 1%, 5% and 10% levels, respectively.

One reason may lie in that the nature of the two events is significantly different, where the annexation of Crimea resulted in a deep political dispute with limited military interaction. In contrast, the Russia-Ukraine war involved very pronounced hostile military interventions between the countries. International investors reacted differently to both events, as sanctions during the annexation of Crimea were comparably limited to those imposed during the beginning of the 2022 Russia-Ukraine war regarding its effects on the information flows of international stock markets.[15]

[15] An intricate examination of country-specific financial market responses to geopolitical events, accounting for macroeconomic conditions and bilateral political and economic relationships, offers a rich avenue for future research. Such a study could shed light on the nuanced determinants of differential market behaviours and provide a more granular understanding of how individual economies process and react to global disruptions.

6. Conclusions

The scale of the international sanctions packages imposed on Russia in response to the invasion of Ukraine was largely unprecedented, resulting in high levels of concern about the possible unintentional side effects that could be generated. The research presented here, using novel techniques to focus on traditional information flows and price discovery across international financial markets as sourced from a range of Russian-based financial and derivative products, investigates how groups of financial-based sanctions generated international contagion effects. While providing considerable information regarding the impact of war on the international banking sector and the use of payment systems and finance as tools of war, this research also attempts to address another critical question: whether the market response to international sanctions was mitigated over time as expectations adjusted.

First, our results indicate that the country-varying effects of the Russia-Ukraine war and subsequent sanctions placed on the Russian economy affected information flows between Russian and international financial markets. Among the evidence, Australian and Canadian markets exhibit resilience against shocks sourced from Russia, whereas markets in the UK, US and Europe are susceptible and vulnerable to those shocks. Second, the effects on information flows are similar between the war and the sanctions, where some sanctions exert more substantial and pronounced effects on information flow, such as sanctions on SWIFT, banking, and private wealth. Moreover, the effects on information flow in respect of the selected banking indices are more substantive than those on information flows for the stock indices examined, despite the fact that these two kinds of effects resemble each selected region in terms of the sign of the effect. Our findings suggest changing behaviour by internationally informed traders regarding their preferences towards trading links and adjustments of the global investment strategies to better cope with uncertainties from the invasion and following sanctions. Finally, our results reveal that the sanctions imposed on the Russian economy disturb the information content of pricing dynamics of the stock indices and banking sectors in the UK, US, Europe, and China (in some scenarios) as well as globally. This suggests that a degree of the frailty of mainstream financial markets against the shocks sourced from the Russian markets was exposed in terms of responses to the invasion and subsequent sanctions.

Robustness testing procedures add further validity to the results presented. It is immediately evident that while Australia and Canada presented significant evidence of clear informational separation concerning their respective banking sectors, analogous findings are also detailed for their respective stock indices. The UK is repeatedly identified to have been particularly exposed to informational contagion stemming from sanctions imposed upon Russia, with particular exposure identified for sanctions relating to SWIFT, targeted economic sanctions, and private wealth-based sanctions. Since the implementation of sanctions, the UK has reportedly frozen a total of £18.4 billion pounds Sterling, in Russian assets, presenting evidence of a significant amount of money held in London, where UK Treasury had received 236 sanctions breach reports.

There are several possible reasons why the effects of sanctions subsequently placed on the Russian economy following the invasion on relative information share measures differ between the CS/IS measures and ILS measures, specifically considering the interactions between the Russian volatility index and the Chinese stock market. The effects on the CS and IS measures are significantly positive, but the effect on ILS is significantly negative. The reasons have been discussed above.

The scale of the decline in information transmission to the selected international banking sectors is found to be substantially above that of the differentials identified for international stock indices. These results indicate that while the first phase of international sanctions imposed upon Russia generated significant differentials of information transmission from Russia to the other selected international regions, sanctions imposed during the final four-week period of the period sampled here have significantly reduced influence upon the same information and price discovery relationships. Such results indicate two potential avenues of interaction: first, when considering European, UK, and US investors, market participants revised their expectations to incorporate further sanctions, influencing markets that remained open with investment opportunities remaining. Secondly, the implementation of sanctions eliminated capital flows over this period, therefore reducing the majority of interaction effects. Although significant influence is observed across all Russian markets examined, irrespective of the type of financial product, the contagion effects, as measured by information transmission, become more diluted. While targeted sanctions do impose significant damage, associated contagion effects are identified to be both significant and detrimental to broader international markets. However, such secondary effects are found to moderate thereafter.

Some implications rendered from our main results are worth discussing. The first relates to international diversification strategies and risk management. As the results reveal that information content and efficiency of some significant international stock markets and banking sectors are adversely impacted by the Russia-Ukraine war and resultant sanctions, it implies that there were unexpected changes in trading behaviours of informed international traders and ‘smart money’ in response to the unprecedented political and economic events. The varying behaviour of informed traders, which relates to their adjustments to global diversification strategies as well as directions of capital flows, sheds some light on which global marketplace is worthy of inclusion in financial portfolios in the light of changed levels of information efficiency following the occurrences of the Russian war and sanctions. On the other hand, our results also shed light on how the sanctions imposed on the Russian economy have some unanticipated “side effects” on international stock markets. Given that some significant sanctions relate to banking services and businesses, the results also reveal how they affect the performance and efficiency of the global banking sectors. The results provide a warning to policymakers relating to the use of sanctions, given that it is found that the information content of pricing dynamics is impaired in some large stock markets, such as those in the UK, Europe, and the US. In addition, banking stocks are heavily affected following the advent of banking-related sanctions in most developed economies under investigation. Our investigation clearly shows that the effectiveness and spillovers of imposing politically-led sanctions on Russia likely led to outcomes on global financial systems that were not fully anticipated. Furthermore, it is also clear that continued and continuous use of sanctions is unlikely to retain their potency.

Our findings reinforce the necessity for policymakers to reassess their usage and reliance upon sanctions, particularly considering their potential influence on financial markets. This necessitates the refinement of improved predictive tools and models that gauge the ramifications of sanctions and other forms of economic warfare, particularly due to the speed through which their implementation is required in high-stress, internationally-observed circumstances. The broader implications on information flows between international financial markets, as elucidated by our research, highlight the potential for contagion effects and thus underline the need for precautionary policies. Policymakers should bolster measures to shield domestic financial systems from these effects, which may require improved transparency, tightening risk management regulations, and endorsing more rigorous stress testing in directly exposed financial institutions. Furthermore, our results highlight the necessity for robust oversight of cross-border financial flows, especially those involving sanctioned countries, to thwart potential destabilising effects. Notably, the negative ripple effects on financial markets and banking sectors might call for governmental intervention to stabilise these sectors during periods of sanctions. Our research further underscores the need for robust international cooperation and dialogue to coordinate and manage the implications of sanctions on global financial systems effectively. Further, policymakers should endeavour to formulate policies that both anticipate and mitigate the unintended side effects of sanctions on domestic and international financial markets. The diminishing effects of sanctions over time, as suggested by our results, denote a requirement for policy reassessment over extended periods of sanctions. Policymakers should also strive towards diversifying economic ties and reducing reliance on historically volatile economies, thereby fostering more robust and resilient financial ecosystems.

These results underscore the need for developing comprehensive risk models. Policymakers and financial institutions should prioritise the construction of such models that encapsulate the potential for geopolitical events to disrupt the global financial system. Incorporating the potential contagion effects of sanctions into these models could prove invaluable for informed decision-making and advanced preparation for future events. Our research also underlines the necessity for governments and regulators to create and implement robust crisis management strategies to mitigate the adverse effects of financial shocks resulting from sanctions. Strategies could range from setting up emergency liquidity provisions to designing mechanisms that isolate affected segments of financial markets, thereby limiting wider systemic risks. Given the broader impacts on global financial systems, it is crucial that sanctions are applied in a highly targeted manner. Policymakers should focus on entities directly implicated in the behaviours that the sanctions intend to modify. This specificity level could ensure the sanctions' effectiveness while minimising the unintended adverse effects on the global financial system.

Several other transmission channels could influence the information flow model and are worthy of further investigation. One potential factor to consider is the common volatility movement. For instance, a sudden surge in market volatility across global markets, prompted by an unanticipated economic event, could distort the observed information flows. This could be controlled for in the model setup by integrating a measure of global market volatility, such as a COVOL component, as a control variable in the analysis. Another important factor could be the fluctuation in exchange rates, which could impact the information flow between markets. Particularly, sharp or unexpected movements in the currencies of the countries in focus could present challenges. Moreover, the influence of investor sentiment on information flow across markets cannot be understated.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. The article is the author's original work, hasn't received prior publication and isn't under consideration for publication elsewhere.

Data availability

Data will be made available on request.

Appendix A. Supplementary material

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jebo.2023.10.036.

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