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The indirect effect of the Russian-Ukrainian war through international linkages: early evidence from the stock market

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Abstract
We study how firms' international linkages to Russia and Ukraine have affected investors' expectations following the outbreak of the Russian-Ukrainian war. We perform an event study around the Russian invasion into Ukraine on February 24, 2022. We find that having trade linkages to Russia in the top decile is associated with a decrease in the cumulative return by 2.16 percentage points and having an affiliate in Russia with a decrease by 3.12 percentage points. Having an affiliate in Ukraine has, however, no effect on firms' stock market returns. The total impact of trade linkages on the aggregate stock market performance of third countries was on average 0.8 percentage points and of multinational linkages was on average 0.73 percentage points. The losses were largest in European countries.

Key words: Russia-Ukraine war, trade linkages, multinationals, stock market, event study

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1 Introduction

The war in Ukraine, which started on February 24th 2022, has had devastating human consequences. On November 1st 2022, eight months after the beginning of the conflict, the Office of the UN High Commissioner for Human Rights estimates the civilians casualties to 16,296 and the refugees from Ukraine in Europe to 7,786,195. On top of these, Ukraine incurred tremendous immediate economic losses that are likely to have severe long-term effects. The consequences of this war are also being felt far beyond Ukraine's borders. Since the beginning of the conflict, inflation exacerbated worldwide and Europe is experiencing a severe energy crisis. It is crucial to understand the global impact of the war. Quantifying the extent of the indirect economic impact of the war is, however, challenging at this stage.

Studying the stock market response is a way to get insights in market anticipation of the extent of spillovers and potential damages worldwide. Share prices are set by the information available to market participants at any given point in time and capture expectations about the future profitability of individual companies and sectors. The war in Ukraine, given its scope, is likely to have affected agents expectations about firms' performance. International linkages are known to be major vectors through which shocks spread on a global scale, hence one would expect that countries and industries with strong links to Russia and Ukraine are more prone to suffer the consequences. Understanding whether this was determinant in market participants' expectations is central for assessing the impact of the war. Of course, market participants may be wrong, and share price movements might not correctly capture the overall impact of such event. But given the information aggregation function of stock markets, share price reactions capture the 'consensus view' of a large number of well-informed economic actors such as banks, insurance companies and investment funds.

In this paper, we add to the growing literature on the short run effect of the war worldwide by studying whether firms' international linkages to Ukraine and Russia are an important determinant of the stock market response to the war. Starting from the World Input Output Database (WIOD), we construct a data set of 19,774 firms listed in 29 countries with detailed information on their dependence on Russia through trade and dependence on Russia and Ukraine through multinational linkages. We find that firms with a stronger dependence to Russia experienced a significant decrease in cumulative returns following the start of the Ukraine war. These results are robust to the inclusion of physical distance to Russia as well as firm size and market controls. After controlling for the proximity penalty, we find that trade exposure at the industry level and affiliate linkages to Russia matter. On the other hand, we do not find any effect of affiliate linkages to Ukraine on cumulative returns.

The focus of our paper is on how international linkages of firms to Russia and Ukraine affect stock returns. Other papers have found that exposure to globalization generally, country-level trade exposure to Russia (Boubaker et al. 2022; Sun and Zhang 2022) and proximity to Russia (Boungou and Yatié 2022) negatively affected returns in the aftermath of the escalation of the Russian-Ukrainian conflict. We provide new evidence highlighting that differential exposure of industries *within* a country negatively affected cumulative stock returns. We find that the most exposed industries to trade with Russia are the ones experiencing significant losses in stock returns. As the WIOD does not cover Ukraine, we cannot analyze this channel for Ukraine.

Our paper is most closely related to Federle et al. (2022). They identify a proximity penalty in the stock market response using both country-level and firm-level data. Their key finding is that shorter distance to Ukraine both at the country level, and at the firm-level (within countries), is associated with a lower return. Federle et al. (2022) control for trade exposure to Russia and Ukraine at the country level and measure exposure at the firm level using the past correlation of firm stock prices with Russia and Ukraine. We follow their approach and additionally show that differential industry exposure to trade with Russia is crucial in understanding observed changes in stock prices even after controlling for proximity to Russia.

Our second contribution is to analyze how the stock markets differed between multinationals that owned an affiliate in Russia and the Ukraine. We show that multinationals with an affiliate in Russia experience negative cumulative returns, but not those with an affiliate in Ukraine. Other papers studying the response in stock prices to the Russian-Ukrainian conflict use data collected by Jefferey Sonnenfeld and his team on the decision to leave Russia and compare leaving firms with staying firms. We contribute by using the network of affiliates from Orbis data and by showing that having an affiliate in Russia by itself is associated with lower stock returns.

Our third contribution is to highlight in an aggregation exercise that the effects were heterogeneous across countries. The aggregate losses of dependence on Russia through trade linkages and of having an affiliate in Russia were economically significant with about 0.8 percentage points, on average, and concentrated in Europe. On the other hand, the effects were more modest in large economies such as Australia, Canada, China and the US that have less intense linkages to Russia.

More broadly, we relate to a literature that studies the effects of conflicts on stock prices (Leigh et al. 2003; Schneider and Troeger 2006; Guidolin and La Ferrara 2007; Zussman et al. 2008; Guidolin and La Ferrara 2010; Caldara and Iacoviello 2022). This study also relates to the real transmission of wars through trade linkages to not directly involved countries and firms (for example, Glick and Taylor 2010; Couttenier et al. 2022; Korovkin and Makarin 2022).

The rest of this paper is structured as follows. Section 2 presents the methodology used to analyze the stock market response. Section 3 describes the data we used and presents summary statistics. Section 4 exposes our results as well as a number of robustness checks. Section 5 concludes.

2 Methodology

We use cumulative returns for a two-week window centered around the event to proxy for the market-response to the event. We calculate the cumulative return as multiplication of daily returns at the firm-level. For a given event window of τ trading days the cumulative return of firm i is given by:

$$CR_i(t-\tau, t+\tau) = \prod_{j=-\tau}^{j=\tau} (1 + r_{i,t+j}), \tag{1}$$

where $1 + r_{i,t+j}$ is the daily return between trading days t+j and t+j-1.[1]

In the main analysis we choose τ equal to 14 as in Federle et al. (2022), because the war was not a totally unanticipated event. While many observers were still surprised by the invasion, early signs for the invasion with the benefit of hindsight include the prior build-up of Russian military near the Ukrainian border and the recognition of two Russian-controlled regions in eastern Ukraine. To test, whether international exposure to Russia and Ukraine through international linkages is relevant in understanding the reaction of cumulative returns to the event, we specify the following regression:

$$\begin{aligned} CR_i(t-\tau, t+\tau) = \mu &+ \beta_{dep} \times \mathbb{1}(\text{Total Dep. on Russia in top decile}_{jc}) \\ &+ \delta_{Aff,Rus} \times \mathbb{1}(\text{Affiliate in Russia}_i) + \lambda_{Aff,Ukr} \times \mathbb{1}(\text{Affiliate in Ukraine}_i) \\ &+ \gamma \times X_i + \eta_j + \lambda_c + \varepsilon_{ijc}. \end{aligned} \tag{2}$$

The coefficient β_{dep} captures the association between the total dependence on Russia in the top decile and the cumulative return. We chose the top decile as main treatment variable, because the distribution of the dependence measure is highly skewed with a skewness of 35.65 (see also section 3). We find that the effect of total dependence on Russia is non-linear and monotonically increasing as we discuss in section 4. We include two dummies equal to one if a firm is a global ultimate owner of an affiliate in Russia (coefficient $\delta_{Aff,Rus}$) and Ukraine (coefficient $\lambda_{Aff,Ukr}$), respectively. Furthermore, we control for other variables in the vector X_i including a dummy equal to one, if the firm announced

[1] We winsorize the dependent variable at the 1 and 99 percent level. The results are robust to not winsorizing.

to take actions with respect to its Russian operations. We include the firm-level distance to Moscow to control for the proximity penalty identified by Federle et al. (2022).[2]

The remaining control variables are common in the literature. We account for size dependent effects by including the logarithm of firm market capitalization and the logarithm of total assets as additional controls.[3] We add leverage as control to measure the financial risks of firms. Finally, we include country and industry fixed effects to control for country-specific and industry-specific reactions to the event. We cluster the standard errors at the level of the industry to account for cross-sectional dependence.

3 Data

3.A Data Sources

In our study, we consider all firms in Orbis that are listed on the stock market and located in a country covered by the World Input-Output Database. We make use of five different types of data sources to construct the dependent and independent variables.

Orbis We identify stock listed companies in Orbis and their ticker symbol. Additionally, we downloaded rich information on the structure of the international affiliates on March 11th 2022.[4] We know how many affiliates are owned by a multinational and where they are located. In particular, we are interested in whether a firm has an affiliate in Russia or Ukraine. The information spans the network of all international affiliates as covered by Orbis. We also gather information on firm size measured by total assets and current and non-current liabilities to calculate firms' leverage. Finally, we use information on the headquarter location of the company (i.e. the city name and country).

Bloomberg We use the ticker in Orbis to retrieve stock prices of listed companies between March 30th 2021 and March 24th 2022.[5] Additionally, we obtain data on market capitalization in the last two weeks of December 2021. We only keep in our sample companies with an average market capitalization above 10 million US dollar in this time span similarly to Deng et al. (2022).[6]

[2]Federle et al. (2022) use the shortest distance to Ukraine as control. We use the distance to Moscow as the WIOD contains information on trade linkages to Russia only. The correlation between the firm-level distances to Kyiv and Moscow is 0.99.

[3]We use total assets as measure of size to maximize the sample. The results are robust to using employment or sales as measures of size.

[4]We define an affiliate as more than 50 percent global ultimate ownership of an entity in a country other than the firm's headquarter.

[5]If multiple companies have the same ticker symbol in a given country in Orbis, we identify them individually in Bloomberg.

[6]We do so to avoid our results to be driven by penny stocks.

World Input-Output Database We use the latest version of the World Input-Output Database (WIOD) described in Timmer et al. (2015) to construct the trade dependence of country-industry pairs on Russia prior to the start of the conflict. The trade dependence is computed using information from the 2014 World Input-Output Table, which is the most recent table available in WIOD. Our matched dataset contains data from 29 countries of which 21 are European countries and 8 other major economies including the US and China (see Table A.1 for the full list of countries). For a given country-industry pair, we take the sum of its intermediate use from Russia and its exports to Russia and scale them by its gross output. Formally, let $M_{jv,cR}$ denote the expenditure on Russian inputs from industry v by industry j in country c, $X_{jv,cR}$ denote the exports of industry j in country c to industry v in Russia, and Y_{jc} the gross output of industry j in country c. We then define *Total Dependence on Russia* for industry j in country c as:

$$\text{Total Dependence on Russia}_{jc} = \frac{\sum_v M_{jv,cR}}{Y_{jc}} + \frac{\sum_v X_{jv,cR}}{Y_{jc}}. \tag{3}$$

28.74 percent of firms in our sample operates in multiple industries. For firms operating in a single industry, we assign the dependence of this industry in the headquarter location as the dependence on Russia. For firms operating in different industries, the dependence on Russia is measured as the average over all industries in which the firm operates. The World Input-Output Tables do not provide any data for Ukraine and our analysis of trade linkages therefore focuses on Russia. As Table A.2 shows Russia was on average a more important trading partner for all countries in our sample. The average total dependence on Russia at the country level is six-times as high as the average total dependence on Ukraine at the country level. The correlation between the total dependence on Russia and Ukraine at the country level is 0.95. Taken together, this suggests that trade with Ukraine is likely to matter less for the average firm and that trade with Ukraine is highly correlated with trade with Russia, likely also at the firm-level.

Distance measures We use information from Orbis to obtain the name of the city in which a firm's headquarter is located. We use two publicly available data sources to construct the firm-level location. We obtain the latitude and longitude of cities from Simplemaps. For those cities that we could not match in Simplemaps, we accessed data on latitudes and longitudes from Geonames as second data source. We complete the collection of firms' location using Google maps for those cities that we cannot uniquely identify using the aforementioned data.[7] We then calculate the geodetic distance between each firm and the capital Moscow.

[7] When there are multiple cities with the same name in one country, we check the firm's location individually.

Company's actions with respect to Russia We obtain the list of companies taking action with respect to their operations in Russia provided by Jeffrey Sonnenfeld and his team following the beginning of the war.[8] The list was compiled using an extensive list of public sources from 166 countries and non-public sources such as information from company insiders. We match the firms in our sample by their name.[9]

3.B Summary statistics

Our final sample contains 19,974 firms with headquarters in 29 countries. Most firms are located in Asia (48.31 percent), followed by the Americas (28.48 percent) and Europe (17.06 percent). The average firm has 263.17 million US dollar of total assets[10], 354.84 million US dollar of market capitalization and a leverage of 46.68 percent.[11] There are 8,651 multinational firms in our sample, which represent 43.75 percent of firms and 77.05 percent of total assets. A multinational firm owns on average 22.44 affiliates abroad in 7.16 countries. Table 1 provides detailed descriptive statistics for our main variables.

The average cumulative return for the window of 14 trading days around the beginning of the war is -4.51 percentage points, but this hides significant cross-sectional variation. The standard deviation of cumulative returns of firms in our sample is 13.39 percentage points.

Only a minority of firms in our sample have a direct ownership link with either Ukraine or Russia: 1.37 percent of firms own an affiliate in Ukraine, 3.78 percent of firms own an affiliate in Russia, and 0.99 percent of firms own both an affiliate in Russia and in Ukraine. On average, affiliates in Russia account for 0.58 percent of the total number of a multinationals' affiliates and affiliates in Ukraine for 0.18 percent.

Among the firms active in Russia in our sample, only a few have announced to take action with respect to their operations there. 66 firms, representing 8.8 percent of firms active in Russia, are part of the list put together by Jefferey Sonnenfeld and his team.

While not all firms have direct ownership links, most of the firms in our sample are dependent on operating in sector and country pairs that depend on Russia through trade. The total dependence on Russia is on average 0.25 percent: 0.15 percent is due to import dependence and 0.10 percent is export dependence.

This average masks significant heterogeneity across firms as the median dependence is

[8] We accessed the list on the 11th of March, i.e. two weeks after the outbreak of the war. Source: https://som.yale.edu/story/2022/over-1000-companies-have-curtailed-operations-russia-some-remain.

[9] The literature has found ambiguous results as to whether firms' announcements to reduce their activity in Russia deteriorates (for example, Basnet et al. 2022; Berninger et al. 2022; Huang and Lu 2022) or improves firms' stock performance (for example, Sonnenfeld et al. 2022; Tosun and Eshraghi 2022).

[10] We obtain value on total assets for the accounting years 2020 and 2021. We control for the year in which the value of total asset was reported last.

[11] Three firms report negative liabilities, which is why the minimum leverage is negative.

0.06 percent, the 75th percentile is 0.20 percent, and the 90th percentile is 0.54 percent. The average total dependence on Russia in the EU is 0.80 percent, whereas it is much lower in the US with 0.06 percent. Table 2 shows the ten industries that are most dependent on Russia in the EU. The most exposed industry is directly linked to raw materials from Russia, namely coke and refined petroleum products. Other industries highly dependent on Russia are mostly in manufacturing and include energy intensive sectors such as chemicals and chemical products.

4 Results

4.A Baseline Results

Before estimating equation (2), we present evidence suggesting that firms linkages to Russia were an important determinant of cumulative returns around the start of the war. Figure 1 plots the average cumulative returns of firms with high versus low linkages to Russia in the window of 14 days centered around the beginning of the war. The figure shows that cumulative returns of firms with greater international linkages to Russia either through trade (Panel A) or through ultimate ownership (Panel B) are significantly lower in the vicinity of the start of the war.

Table 3 presents the result of estimating equation (2) with cumulative returns computed for a window of four weeks centered around the beginning of the war. In column (1), we only include variables related to economic links to Russia and Ukraine through ownership and trade. We progressively add controls in the subsequent columns. We include the distance to Moscow in column (2), and further add proxies for the size of the firm (firm market capitalization, total assets) as well as leverage in column (3). We add estimates from a CAPM regression for the firm-level intercept, the MSCI Russia, and the PFTS in Ukraine in column (4) (see Appendix for more details). All columns include country and industry fixed effects to control for country-specific and industry-specific reactions to the event. Standard errors are clustered at the industry level.

A firm in the top decile of the total dependence on Russia experienced a decrease in returns of 2.16 percentage points. This coefficient is robust to the introduction of distance to Moscow as well as controls of firm size and CAPM coefficient estimates. While having an affiliate in Ukraine does not seem to affect significantly cumulative returns, having an affiliate in Russia seems to significantly reduce cumulative returns. More specifically, the coefficient in column (4) indicates that stocks of firms with an affiliate in Russia experienced cumulative returns 3.1 percentage points lower than firms without an affiliate in Russia with the full set of controls. We do not find any evidence for the proximity penalty as bigger distance is insignificantly associated with lower returns. Larger assets are signif-

icantly associated with a higher cumulative return, whereas a higher market capitalization is significantly associated with a lower cumulative return. The firms' leverage negatively correlates with the cumulative return but the coefficient is insignificant. The firms' sensitivities with respect to the world, Russia, and Ukraine are negatively and significantly associated with the cumulative return.

We chose firms with total dependence on Russia in the top decile as treatment, because we find that the effect of dependence on Russia is monotonous and non-linear as shown in Table 4. We introduce linear dependence on Russia in column (1) and we allow for non-linearity in the effect of the dependence measure by introducing dummies splitting firms in two groups at different levels of the distribution. We split firms based on the value of the dependence of the median firm in column (2) and based on the value of the firm at the top quartile in column (3). The results in Table 4 show that there is an insignificant effect for the linear dependence on Russia (column 1) and for firms in the top half (column 2). The dependence of firms to Russia affects cumulative returns differently for firms at the top of the distribution: the dummy is significant only for the top quartile at the ten percent level. Taken together with the results in Table 3 this suggests that the effect of total dependence on Russia on cumulative returns is increasing monotonically in its dependence and only statistically significant at the very top of the distribution. By choosing the top decile we balance the tradeoff between including enough firms in the treatment variable and exploiting the non-linearity of the effects.

In Table 5, we allow dummies for the top decile of import and export dependence on Russia to enter separately in the regression. The columns are otherwise similar to Table 3. It is interesting to see that the import dependence seems to be the main driver of the response in cumulative returns throughout the different specifications.[12] This suggests that investors expect firms to suffer more severely from difficulties to substitute intermediate inputs in the short-run in comparison to finding new markets when their sales to the Russian market decrease.

To better understand the role of direct ownership linkages with Russia and Ukraine, we measure the intensity of their link to Russia and Ukraine by the share of affiliates that the firms has in the respective countries out of all her affiliates. We replace the shares with zero for firms that have no affiliates abroad.[13] Table 6 shows the result of the estimation of our baseline specification. The share of affiliates in Russia is important but not for Ukraine. The higher their ownership link to Russia, the lower their cumulative returns around the event window. The finding is in line with the dummy specification used in previous tables.

[12]We find negative and significant effects for the import dependence on Russia when using the linear import and export dependence on Russia as control variables.

[13]We also control for the log of the number of affiliates in the regression. We add one to the number of affiliates before taking the log to include domestic firms. The results are similar when controlling for the number of affiliates in levels.

So far we have treated the dependence measure on Russia and multinational linkages separately. However, there may be important interaction effects between them, if affiliates operate vertically. The results in Table 7 study the interaction between the dependence measure on Russia and multinational linkages and show a negative and significant interaction that is significant at the 5 percent level. This suggests the presence of some vertical linkages between Russian affiliates and their multinational parents. In unreported results, we find that the negative interaction is driven by the interaction between import dependence in Russia and vertical linkages to affiliates. This suggests that market participants expect an additional loss as there is dis-integration from Russia and as a result internal trade between the affiliates and parents is likely reduced.

4.B Robustness Checks

This section presents the results of robustness exercises with respect to the event window, the treatment variable, and the sample used.

To make sure that our event window is accurately defined, we estimate our baseline specification (Table 3, column 4) for alternative windows. The results are displayed in Table A.3. The columns (1) to (3) consider shorter windows around the event. More specifically, in column (1) cumulative returns are defined in the window [-1,+7], in column (2) in a 2-week window centered around the event, and in column (3) in the window [-1, +14]. Columns (4) considers a shift to our window one day before the event and four weeks after. Columns (5) considers a much broader window: the cumulative returns are defined in a 8-week window around the event. While our results seems to be robust to the use of shorter windows and to windows shifted after the event, it seems that our dependence measure is no longer significant in column (4). As shown in Table 1, cumulative returns are much more volatile as the length of the time windows increases. This may explain the lack of significance of our estimate.

We used the average dependence measure across industries as our main measure. To check that our results are not driven by this choice, we estimate our baseline specification replacing our main dependence measure by a dependence measure which is computed based on the core industry code in which the firm operates.[14] As shown in Table A.4 in the Appendix, our results are robust to the use of this alternative definition.

Almost half of the firms in our sample are in Asia and for these firms linkages to Russia may not be as pronounced as for European firms. The regression in column (1) in Table A.5 excludes firms from Asia and the point estimates for both the dependence measure on Russia and having an affiliate in Russia increase in magnitude suggesting that the linkages matter more outside Asia.

[14]The core code reflects the main activity of the company in the respective industry classification.

4.C The Aggregate Effect Across Countries

In order to shed light on the extent of the war spillovers, we use our estimates to compute the aggregate effect of dependence on Russia and of affiliates in Russia on third countries. We estimate the aggregate stock market losses of being highly dependent on Russia and of having an affiliate in Russia by country. In doing so, we assume that an investor investing in a given country c holds stock proportional to the market capitalization in the end of 2021 for the listed firms in our sample. Equation (4) shows the aggregation for the total dependence on Russia.

$$\text{Total Effect}_c = \frac{\text{Market cap. of firms with Total Dep. on Russia in top decile}_{jc}}{\text{Market cap. of firms}_c} \times \widehat{\beta_{dep}}. \tag{4}$$

The aggregation for having an affiliate in Russia by country is done correspondingly using the estimate for $\delta_{Aff,Rus}$.

The resulting aggregate effects are displayed in Table 8. The average loss for the effect of total dependence on Russia across countries is 0.8 percentage points and the median loss is 0.47 percentage points. The average loss for the effect of having an affiliate in Russia across countries is 0.73 percentage points and the median loss is 0.52 percentage points. The war spillover seems non-negligible. Interestingly, both channels considered are equally important. There are, however, important differences across countries.

As shown in Table 8, the losses for both channels are concentrated in Europe. The figures in column (1) show that the top 5 countries in terms of the effect of the total dependence on Russia are all in Europe. Three of the top 5 countries are in Eastern Europe suggesting that proximity plays an important role. The losses amount to approximately 2 percentage points for Luxembourg, Estonia, and the Czech Republic. As for the aggregate effects of having an affiliate in Russia, the figures in column (2) highlight that the top 5 countries in terms of aggregate losses are also in Europe. Even large economies such as Germany, the United Kingdom, and Italy experienced an aggregate drop of around 1.5 percentage points. The largest losses were seen in Luxembourg and Switzerland with more than 2.3 percentage points. This suggests that proximity matters in terms of aggregate effects.

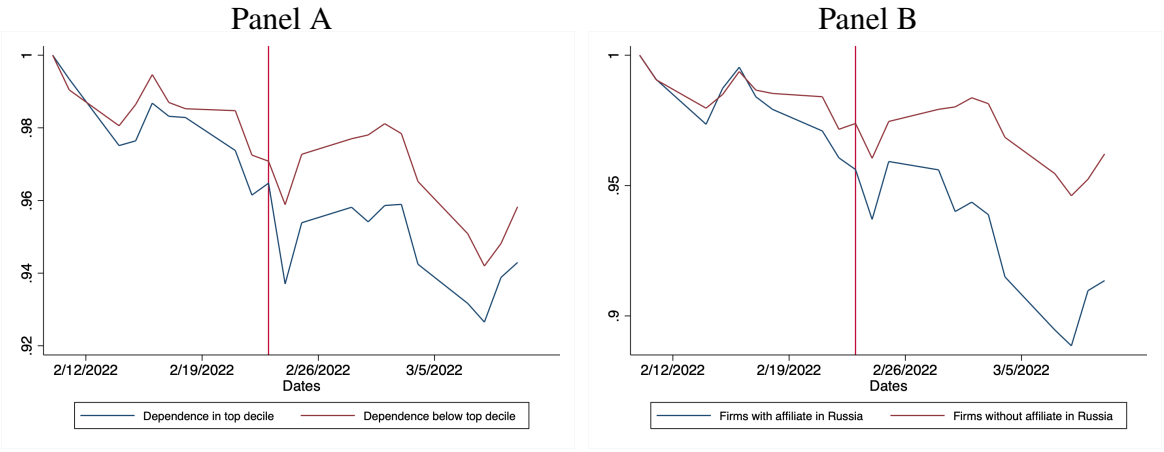
On the other hand, large economies were unaffected by both channels. For example, as for trade dependence in column (1) large economies such as Brazil, Indonesia, and the US are unaffected as no firm in these countries is in the top decile in terms of dependence on Russia. The effect is also modest in China with 0.01 percentage points. As to the affiliate channel in column (2), there is no effect this channel in Bulgaria, the Czech Republic, and Indonesia as according to the data no firm ultimately owns an affiliate in Russia. The channel is also modest in large economies such as Australia (0.02 percentage points), Canada

(0.06 percentage points), and China (0.08 percentage points) that do not have significant foreign direct investment in Russia.

5 Conclusion

The Russian-Ukrainian war is likely to have long-lasting effects on the landscape of globalization. In order to get a first assessment of whether market participants expect that dependence through international linkages on Russia will harm firms, we used an event-study around the invasion of Russia into the Ukraine. We find that total dependence on Russia reduces cumulative returns on average and that the decrease is driven by firms in the top decile of total dependence on Russia and by the import dependence on Russian inputs. Importantly, our results hold after controlling for the proximity penalty due to military spillover risks. Having an affiliate in Russia is also associated with a decrease in the cumulative return, whereas having an affiliate in Ukraine is not associated with a significant decrease in the cumulative return. The findings highlight that investors expect significant distributional consequences of international dis-integration from Russia between firms and industries within a given country based on their international linkages to Russia.

Figure 1: Cumulative Stock Market Returns



Notes: Both panels show the cumulative returns starting on the 10th of February for a four week window. The left panel shows the average return of firms in the top decile of total dependence on Russia relative to the average return of firms below the top decile. The right panel shows the average return of firms with at least one affiliate in Russia relative to the average return of firms without an affiliate in Russia.

Table 1: Summary Statistics

		Mean	Std. dev.	Min	Max
Dependent variables	Description				
CR(t-14, t+14)	Cumulative return for window of 14 days around the 24th of February, 2022	-0.0451	0.1339	-0.3959	0.4454
CR(t-1, t+7)	Cumulative return for window of 1 day before and 7 days after the 24th of February, 2022	0.0078	0.0838	-0.2344	0.3235
CR(t-7, t+7)	Cumulative return for window of 7 days around the 24th of February, 2022	-0.0159	0.0991	-0.3108	0.3322
CR(t-1, t+14)	Cumulative return for window of 1 day before and 14 days after the 24th of February, 2022	-0.0136	0.1103	-0.2998	0.4231
CR(t-1, t+28)	Cumulative return for window of 1 day before and 28 days after the 24th of February, 2022	0.0191	0.1451	-0.3200	0.5991
CR(t-28, t+28)	Cumulative return for window of 28 days around the 24th of February, 2022	0.0136	0.1825	-0.4313	0.7323
Independent variables	Description				
$\mathbb{1}$(Affiliate in Ukraine$_i$)	Dummy equal to one, if the firm has an affiliate in Ukraine	0.0137	0.1163	0	1
$\mathbb{1}$(Affiliate in Russia$_i$)	Dummy equal to one, if the firm has an affiliate in Russia	0.0378	0.1907	0	1
ln(number affiliates$_i$+1)	Log of the number of foreign affiliates	0.8801	1.3107	0	7.1444
Share Affiliates in Russia$_i$	Share of affiliates in Russia as of all foreign affiliates	0.0028	0.0332	0	1
Share Affiliates in Ukraine$_i$	Share of affiliates in Ukraine as of all foreign affiliates	0.00065	0.01621	0	1
$\mathbb{1}$(Action Russia$_i$)	Dummy equal to one, if the firm has announced to reduce its activities in Russia by the 10th of March	0.0033	0.0577	0	1
Total Dependence on Russia$_{jc}$	Dependence on imports from and exports to Russia scaled by output	0.0025	0.0102	9.52×10^{-7}	0.8123
Dependence on Russian Exports$_{jc}$	Dependence on exports to Russia scaled by output	0.0010	0.0072	0	0.7750
Dependence on Russian Imports$_{jc}$	Dependence on inputs from Russia scaled by output	0.0015	0.0060	9.47×10^{-7}	0.3057
Total Dependence of core Industry on Russia$_{jc}$	Total dependence of core industry on Russia scaled by output	0.0027	0.0108	9.52×10^{-7}	0.8123
ln(Distance to Moscow$_i$)	Log of firm-level distance to Moscow	8.7414	0.5457	6.5775	9.6122
ln(total assets$_i$)	Log of firm-level total assets in units of thousand US dollar	5.5728	2.3467	-6.9078	13.3025
ln(market capitalization$_i$)	Log of firm-level market capitalization in units of million US dollar	5.8717	2.0163	2.3037	14.8764
leverage$_i$	Firm-level leverage	0.4668	0.2575	-0.0385	1
$\hat{\alpha}_i$	Firm-level intercept from the CAPM regression	-0.0032	0.0361	-0.9892	1.2919
$\hat{\beta}_{world}$	World market coefficient from the CAPM regression	0.6485	1.7865	-51.3668	45.6722
$\hat{\beta}_{ukraine}$	Russian market coefficient from the CAPM regression	-0.0043	0.7957	-24.9882	28.5771
$\hat{\beta}_{russia}$	Ukrainian market coefficient from the CAPM regression	0.2281	56.0484	-1891.139	2312.418

Notes: The table shows means, standard deviations, minima, and maxima of the dependent and independent variables. The dependent variables are presented in percent.

Table 2: Top 10 industries in the EU by total dependence on Russia for the

Industry	Total Dependence on Russia
Manufacture of coke and refined petroleum products	14.64
Printing and reproduction of recorded media	8.06
Fishing and aquaculture	3.61
Manufacture of motor vehicles, trailers and semi-trailers	3.54
Manufacture of basic metals	3.51
Manufacture of chemicals and chemical products	3.41
Electricity, gas, steam, and air conditioning supply	2.91
Manufacture of other non-metallic mineral products	2.36
Manufacture of machinery and equipment n.e.c.	2.21
Mining of coal and lignite	2.17

Notes: The table shows the average total dependence on Russia across firms in the EU for the ten industries with the highest dependence.

Table 3: The association between cumulative returns and international linkages to Russia

Outcome	(1) CR(t-14, t+14)	(2) CR(t-14, t+14)	(3) CR(t-14, t+14)	(4) CR(t-14, t+14)
$\mathbb{1}$(Total Dependence on Russia in top decile$_{jc}$)	−0.0221***	−0.0221***	−0.0220***	−0.0216***
	(0.0054)	(0.0055)	(0.0057)	(0.0056)
$\mathbb{1}$(Affiliate in Ukraine$_i$)	−0.0027	−0.0029	−0.0039	−0.0037
	(0.0103)	(0.0104)	(0.0103)	(0.0103)
$\mathbb{1}$(Affiliate in Russia$_i$)	−0.0291***	−0.0292***	−0.0312***	−0.0312***
	(0.0078)	(0.0078)	(0.0078)	(0.0076)
$\mathbb{1}$(Action Russia$_i$)	0.0019	0.0020	0.0017	0.0013
	(0.0119)	(0.0119)	(0.0120)	(0.0118)
ln(Distance to Moscow$_i$)		−0.0158	−0.0100	−0.0078
		(0.0187)	(0.0187)	(0.0189)
ln(total assets$_i$)			0.0077***	0.0076***
			(0.0015)	(0.0014)
ln(market capitalization$_i$)			−0.0073***	−0.0074***
			(0.0017)	(0.0016)
leverage$_i$			−0.0078	−0.0081
			(0.0060)	(0.0059)
$\hat{\alpha}_i$				0.2156***
				(0.0552)
$\hat{\beta}_{world}$				−0.0071***
				(0.0018)
$\hat{\beta}_{ukraine}$				−0.0102**
				(0.0047)
$\hat{\beta}_{russia}$				−0.000078*
				(0.000041)
R^2	0.119	0.119	0.124	0.129
Number of firms	19,774	19,774	19,774	19,774

Notes: Estimates of equation (2). The outcome variable in all columns is the cumulative return for a time window of four weeks around the Russian invasion into Ukraine. All regressions control for country and industry fixed effects. The regression in column (4) includes coefficient estimates for the firm-level coefficients from a CAPM regression for the firm-level intercept, the MSCI World, MSCI Russia and the PFTS in Ukraine. The standard errors are clustered at the industry-level.

Table 4: The association between cumulative returns and international linkages to Russia - alternative measures

Outcome	(1) CR(t-14, t+14)	(2) CR(t-14, t+14)	(3) CR(t-14, t+14)
Total Dependence on Russia$_{jc}$	–0.2247		
	(0.1579)		
$\mathbb{1}$(Total Dependence on Russia in top half$_{jc}$)		–0.0037	
		(0.0070)	
$\mathbb{1}$(Total Dependence on Russia in top quartile$_{jc}$)			–0.0125*
			(0.0065)
$\mathbb{1}$(Affiliate in Ukraine$_i$)	–0.0049	–0.0048	–0.0045
	(0.0102)	(0.0103)	(0.0104)
$\mathbb{1}$(Affiliate in Russia$_i$)	–0.0316***	–0.0316***	–0.0316***
	(0.0077)	(0.0077)	(0.0076)
$\mathbb{1}$(Action Russia$_i$)	0.0012	0.0014	0.0012
	(0.0119)	(0.0120)	(0.0120)
ln(Distance to Moscow$_i$)	–0.0070	–0.0074	–0.0078
	(0.0188)	(0.0184)	(0.0188)
ln(total assets$_i$)	0.0077***	0.0077***	0.0076***
	(0.0014)	(0.0014)	(0.0014)
ln(market capitalization$_i$)	–0.0074***	–0.0074***	–0.0074***
	(0.0017)	(0.0017)	(0.0016)
leverage$_i$	–0.0083	–0.0084	–0.0079
	(0.0059)	(0.0060)	(0.0057)
$\hat{\alpha}_i$	0.2182***	0.2192***	0.2160***
	(0.0548)	(0.0542)	(0.0548)
$\hat{\beta}_{world}$	–0.0071***	–0.0071***	–0.0071***
	(0.0018)	(0.0018)	(0.0018)
$\hat{\beta}_{ukraine}$	–0.0104**	–0.0105**	–0.0102**
	(0.0047)	(0.0047)	(0.0047)
$\hat{\beta}_{russia}$	–0.000077*	–0.00077*	–0.000078*
	(0.000041)	(0.000041)	(0.000041)
R^2	0.128	0.128	0.128
Number of firms	19,774	19,774	19,774

Notes: Estimates of equation (2). The outcome variable in all columns is the cumulative return for a time window of four weeks around the Russian invasion into Ukraine. The three columns show the effect of total dependence on Russia, total dependence on Russia in the top half, and in the top quartile on the cumulative return for a window of four weeks. All regressions control for country and industry fixed effects. The standard errors are clustered at the industry-level.

Table 5: The association between cumulative returns and export and import dependence

Outcome	(1) CR(t-14, t+14)	(2) CR(t-14, t+14)	(3) CR(t-14, t+14)	(4) CR(t-14, t+14)
$\mathbb{1}$(Dependence on Russian Exports$_{jc}$ in top decile)	−0.0024	−0.0022	−0.0008	−0.0003
	(0.0054)	(0.0055)	(0.0056)	(0.0056)
$\mathbb{1}$(Dependence on Russian Imports$_{jc}$ in top decile)	−0.0241**	−0.0243**	−0.0245**	−0.0240**
	(0.0093)	(0.0094)	(0.0095)	(0.0093)
$\mathbb{1}$(Affiliate in Ukraine$_i$)	−0.0027	−0.0028	−0.0039	−0.0038
	(0.0104)	(0.0104)	(0.0104)	(0.0103)
$\mathbb{1}$(Affiliate in Russia$_i$)	−0.0290***	−0.0291***	−0.0311***	−0.0311***
	(0.0076)	(0.0076)	(0.0077)	(0.0075)
$\mathbb{1}$(Action Russia$_i$)	0.0012	0.0013	0.0009	0.0005
	(0.0120)	(0.0120)	(0.0122)	(0.0120)
ln(Distance to Moscow$_i$)		−0.0163	−0.0107	−0.0085
		(0.0189)	(0.0189)	(0.0191)
ln(total assets$_i$)			0.0077***	0.0077***
			(0.0015)	(0.0015)
ln(market capitalization$_i$)			−0.0073***	−0.0074***
			(0.0017)	(0.0016)
leverage$_i$			−0.0075	−0.0078
			(0.0057)	(0.0056)
$\hat{\alpha}_i$				0.2143***
				(0.0554)
$\hat{\beta}_{world}$				−0.0071***
				(0.0018)
$\hat{\beta}_{ukraine}$				−0.0103**
				(0.0047)
$\hat{\beta}_{russia}$				−0.000075*
				(0.000041)
R^2	0.120	0.120	0.125	0.129
Number of firms	19,774	19,774	19,774	19,774

Notes: Estimates of equation (2). The outcome variable in all columns is the cumulative return for a time window of four weeks around the Russian invasion into Ukraine. The variables of interest are export and import dependence on Russia. All regressions control for country and industry fixed effects. The regression in column (4) includes coefficient estimates for the firm-level coefficients from a CAPM regression for the firm-level intercept, the MSCI World, MSCI Russia and the PFTS in Ukraine. The standard errors are clustered at the industry-level.

Table 6: The association between cumulative returns and international linkages to Russia - measurement of MNE linkages

Outcome	(1) CR(t-14, t+14)
$\mathbb{1}$(Total Dependence on Russia in top decile$_{jc}$)	–0.0217*** (0.0056)
Share Affiliates in Russia$_i$	–0.1454*** (0.0346)
Share Affiliates in Ukraine$_i$	–0.0052 (0.0599)
ln(number affiliates$_i$+1)	–0.0025** (0.0012)
$\mathbb{1}$(Action Russia$_i$)	–0.0130 (0.0111)
ln(Distance to Moscow$_i$)	–0.0080 (0.0187)
ln(total assets$_i$)	0.0078*** (0.0015)
ln(market capitalization$_i$)	–0.0075*** (0.0016)
leverage$_i$	–0.0078 (0.0059)
$\hat{\alpha}_i$	0.2152*** (0.0550)
$\hat{\beta}_{world}$	–0.0070*** (0.0018)
$\hat{\beta}_{ukraine}$	–0.0099** (0.0048)
$\hat{\beta}_{russia}$	–0.000078* (0.000041)
R^2	0.129
Number of firms	19,774

Notes: Estimates of equation (2). The outcome variable in column (1) is the cumulative return for four weeks around the Russian invasion into Ukraine. All regressions control for country and industry fixed effects. The specification controls for the share of affiliates in Russia and in the Ukraine, and the log of the number of foreign affiliates. The standard errors are clustered at the industry-level.

Table 7: The association between cumulative returns and international linkages to Russia - heterogeneity by affiliate linkages with Russia

Outcome	(1) CR(t-14, t+14)
$\mathbb{1}$(Total Dependence on Russia in top decile$_{jc}$)	–0.0221** (0.0101)
$\mathbb{1}$(Total Dependence on Russia in top decile$_{jc}$) × $\mathbb{1}$(Affiliate in Russia$_i$)	–0.0189** (0.0093)
$\mathbb{1}$(Affiliate in Ukraine$_i$)	–0.0074 (0.0098)
$\mathbb{1}$(Affiliate in Russia$_i$)	–0.0302*** (0.0068)
$\mathbb{1}$(Action Russia$_i$)	0.0033 (0.0131)
ln(Distance to Moscow$_i$)	0.0182*** (0.0035)
ln(total assets$_i$)	0.0090*** (0.0016)
ln(market capitalization$_i$)	–0.0075*** (0.0015)
leverage$_i$	–0.0073 (0.0058)
$\hat{\alpha}_i$	0.1960*** (0.0659)
$\hat{\beta}_{world}$	–0.0074*** (0.0021)
$\hat{\beta}_{ukraine}$	–0.0111* (0.0062)
$\hat{\beta}_{russia}$	–0.00070 (0.000043)
R^2	0.105
Number of firms	19,774

Notes: Estimates of equation (2). The outcome variable in all columns is the cumulative return for a time windows of four weeks around the Russian invasion into Ukraine. The regression in column (1) examines heterogeneity of the total dependence on Russia by whether the firm owns an affiliate in Russia. All regressions control for country and industry fixed effects. The standard errors are clustered at the industry-level.

Table 8: The aggregate losses across countries

Country	(1) Total Effect through Dependence on Russia	(2) Total Effect of having an affiliate in Russia
Australia	0.08	0.02
Austria	1.52	0.62
Belgium	0.35	0.30
Brazil	0	0.08
Bulgaria	0.47	0
Canada	0.30	0.06
China	0.01	0.08
Croatia	0.13	0.16
Cyprus	1.73	0.28
Czech Republic	1.91	0
Denmark	0.04	1.37
Estonia	0.28	0.41
Finland	1.38	1.22
France	0.93	1.30
Germany	1.19	1.50
Greece	0.24	0.11
Indonesia	0	0
Ireland	0.04	0.96
Italy	1.17	1.63
Japan	0.25	1.12
Latvia	1.97	0.52
Lithuania	1.47	0.01
Luxembourg	2.16	2.50
Poland	1.31	0.37
South Korea	0.44	1.11
Spain	0.28	0.41
Switzerland	1.19	2.31
United Kingdom	0.62	1.60
United States	0	0.81
Mean	0.80	0.73
Median	0.47	0.52

Notes: The Table shows in column (1) the aggregate losses of firms in the top decile in terms of total dependence on Russia and in column (2) of firms having an affiliate in Russia by country.

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6 Online Appendix

MSCI Country Indices We follow the approach by Federle et al. (2022) to control for the sensitivity of stock prices to events in the world, in Ukraine, and in Russia. We retrieved daily stock observations between March 30th 2021 and March 24th 2022 from `investing.com`. We use the PFTS index for Ukraine and the MSCI Russia to capture the sensitivity with respect to the two countries and the MSCI World as proxy for sensitivity with respect to with-respect to the world economy. For each firm we identified a firm specific intercept and three region-specific coefficients using the following regression:

$$ln(R_{i,t}) = \alpha_i + \beta_{world} \times ln(R_{world,t}) + \beta_{ukraine} \times ln(R_{ukraine,t}) + \beta_{russia} \times ln(R_{russia,t}) + \varepsilon_{i,t}, \tag{5}$$

where R_i represents $1 + r_{i,t}$ and correspondingly for the country-level and world-level returns. Following Federle et al. (2022), we calculate the returns as weekly returns comparing the first trading day of each working week.

Table A.1: Country distribution

Country	Total firms
Australia	1,215
Austria	43
Belgium	100
Brazil	274
Bulgaria	51
Canada	1,359
China	3,793
Croatia	51
Cyprus	28
Czech Republic	10
Denmark	81
Estonia	15
Finland	143
France	475
Germany	376
Greece	97
Indonesia	535
Ireland	8
Italy	289
Japan	3,405
Latvia	7
Lithuania	22
Luxembourg	3
Poland	334
South Korea	1,820
Spain	200
Switzerland	157
United Kingdom	884
United States	4,000
Total	19,974

Notes: The table shows the distribution of firms included in the sample across countries.

Table A.2: Trade exposure to Russia and Ukraine by country

Country	Total Dependence on Russia$_c$	Total Dependence on Ukraine$_c$
Australia	0.12	0.01
Austria	1.38	0.28
Belgium	1.71	0.23
Brazil	0.24	0.01
Bulgaria	4.77	1.37
Canada	0.10	0.01
China	0.76	0.09
Croatia	2.70	0.14
Cyprus	3.05	0.26
Czech Republic	3.33	0.82
Denmark	1.26	0.15
Estonia	9.44	0.92
Finland	5.04	0.12
France	0.55	0.08
Germany	1.37	0.21
Greece	2.03	0.28
Indonesia	0.22	0.10
Ireland	0.51	0.08
Italy	1.25	0.22
Japan	0.39	0.02
Latvia	15.83	1.36
Lithuania	7.42	2.84
Luxembourg	0.34	0.11
Poland	2.92	1.24
South Korea	1.47	0.04
Spain	0.42	0.17
Switzerland	0.92	0.24
United Kingdom	0.60	0.05
United States	0.12	0.01
Average	2.42	0.40

Notes: The table shows the share of export plus imports to Russia and Ukraine as of GDP in 2019 expressed as percentage points. The last row shows the average in the shares across countries. The country-level trade data come from the International Monetary Fund and the GDP data from the World Bank.

Table A.3: The association between cumulative returns and international linkages to Russia - time windows

Outcome	(1) CR(t-1, t+7)	(2) CR(t-7, t+7)	(3) CR(t-1, t+14)	(4) CR(t-1, t+28)	(5) CR(t-28, t+28)
$\mathbb{1}$(Total Dependence on Russia in top decile$_{jc}$)	−0.0050*	−0.0116***	−0.0096**	−0.0088	−0.0178***
	(0.0027)	(0.0030)	(0.0037)	(0.0064)	(0.0061)
$\mathbb{1}$(Affiliate in Ukraine$_i$)	−0.0090	−0.0073	−0.0072	−0.0072	−0.0015
	(0.0062)	(0.0075)	(0.0076)	(0.0072)	(0.0093)
$\mathbb{1}$(Affiliate in Russia$_i$)	−0.0231***	−0.0202***	−0.0323***	−0.0287***	−0.0378***
	(0.0046)	(0.0059)	(0.0061)	(0.0062)	(0.0077)
$\mathbb{1}$(Action Russia$_i$)	−0.0086	0.0025	−0.0048	0.0023	−0.0074
	(0.0075)	(0.0111)	(0.0096)	(0.0112)	(0.0178)
ln(Distance to Moscow$_i$)	−0.0169**	−0.0273***	−0.0118	−0.0172	−0.0274
	(0.0076)	(0.0098)	(0.0134)	(0.0137)	(0.0200)
ln(total assets$_i$)	−0.0005	0.0026***	0.0028**	0.0032**	0.0144***
	(0.0009)	(0.0009)	(0.0011)	(0.0015)	(0.0020)
ln(market capitalization$_i$)	0.0026**	−0.0018*	−0.0016	−0.0014	−0.0099***
	(0.0010)	(0.0010)	(0.0013)	(0.0018)	(0.0024)
leverage$_i$	−0.0033	−0.0036	−0.0117**	−0.0112	−0.0094
	(0.0034)	(0.0037)	(0.0058)	(0.0072)	(0.0072)
$\hat{\alpha}_i$	0.0225	0.1827***	0.0141	−0.0796	−0.1311**
	(0.0497)	(0.0596)	(0.0496)	(0.0880)	(0.0634)
$\hat{\beta}_{world}$	0.0029**	−0.0051***	0.0021	0.0087***	0.0065***
	(0.0012)	(0.0016)	(0.0016)	(0.0019)	(0.0020)
$\hat{\beta}_{ukraine}$	0.0097***	−0.0093**	0.0085*	0.0223***	0.0188***
	(0.0032)	(0.0042)	(0.0044)	(0.0058)	(0.0052)
$\hat{\beta}_{russia}$	−0.000035	−0.000039	−0.000035	−0.000043	−0.0000021
	(0.000041)	(0.000043)	(0.000041)	(0.00072)	(0.0000462)
R^2	0.121	0.165	0.126	0.130	0.113
Number of firms	19,774	19,774	19,774	19,774	19,774

Notes: Estimates of equation (2). The outcome variable in columns (1) to (5) is the cumulative return for different time windows increasing in length from column (1) to column (5) around the Russian invasion into Ukraine. All regressions control for country and industry fixed effects. The standard errors are clustered at the industry-level.

Table A.4: The association between cumulative returns and international linkages to Russia - core industry code

Outcome	(1) CR(t-14, t+14)
$\mathbb{1}$(Total Dependence of core Industry on Russia in top decile$_{jc}$)	–0.0194*** (0.0060)
$\mathbb{1}$(Affiliate in Ukraine$_i$)	–0.0040 (0.0103)
$\mathbb{1}$(Affiliate in Russia$_i$)	–0.0313*** (0.0077)
$\mathbb{1}$(Action Russia$_i$)	0.0018 (0.0117)
ln(Distance to Moscow$_i$)	–0.0077 (0.0189)
ln(total assets$_i$)	0.0077*** (0.0014)
ln(market capitalization$_i$)	–0.0074*** (0.0016)
leverage$_i$	–0.0082 (0.0059)
$\hat{\alpha}_i$	0.2159*** (0.0552)
$\hat{\beta}_{world}$	–0.0071*** (0.0018)
$\hat{\beta}_{ukraine}$	–0.0102** (0.0047)
$\hat{\beta}_{russia}$	–0.000078* (0.000041)
R^2	0.129
Number of firms	19,774

Notes: Estimates of equation (2). The outcome variable in column (1) is the cumulative return for a time windows of four weeks around the Russian invasion into Ukraine. The dependence measure on Russia is calculated using the total dependence on Russia of the core industry associated with a firm in Orbis. All regressions control for country and industry fixed effects. The standard errors are clustered at the industry-level.

Table A.5: The association between cumulative returns and international linkages to Russia - excluding Asian firms

Outcome	(1) CR(t-14, t+14)
$\mathbb{1}$(Total Dependence on Russia in top decile$_{jc}$)	–0.0293*** (0.0070)
$\mathbb{1}$(Affiliate in Ukraine$_i$)	–0.0041 (0.0107)
$\mathbb{1}$(Affiliate in Russia$_i$)	–0.0382*** (0.0101)
$\mathbb{1}$(Action Russia$_i$)	–0.0136 (0.0156)
ln(Distance to Moscow$_i$)	0.0230 (0.0213)
ln(total assets$_i$)	0.0093*** (0.0020)
ln(market capitalization$_i$)	–0.0072*** (0.0022)
leverage$_i$	–0.0020 (0.0063)
$\hat{\alpha}_i$	0.1754*** (0.0619)
$\hat{\beta}_{world}$	–0.0079*** (0.0021)
$\hat{\beta}_{ukraine}$	–0.0099 (0.0061)
$\hat{\beta}_{russia}$	–0.000043 (0.000043)
R^2	0.177
Number of firms	10,219

Notes: Estimates of equation (2). The outcome variable in all columns is the cumulative return for a time windows of four weeks around the Russian invasion into Ukraine. The regression in column (1) excludes all firms in Asia from the estimation. All regressions control for country and industry fixed effects. The standard errors are clustered at the industry-level.

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