

Cross-Border Producer Price Transmission in North American Manufacturing: Evidence from Canada–United States Industry Networks*

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Abstract

Prices in Canadian and U.S. manufacturing move together, but the sources of this co-movement remain unclear. Using monthly prices for 21 matched industries in each country from 2004 to 2025 and the connectedness measures of [Diebold and Yilmaz \(2012\)](#), we quantify cross-border price connectedness and identify its sources. Industries in the other country account for about one fifth of producer price variance in both countries, although the sources differ across industries. Connectedness between different industries follows input–output linkages, and prices move more closely with those of an industry’s main suppliers. By contrast, connectedness between the same industry across countries reflects competition in a common market for similar goods rather than trade in inputs. In addition, the exchange rate accounts for 13 to 19 percent of the price variance of Canadian transportation equipment, machinery, and computer and electronics, against 4 percent for the average Canadian industry. Finally, cross-border connectedness stayed within its usual range under the U.S. metal tariffs of 2018–2019 and 2025–2026.

JEL Codes: C32, E31, F14, F15, F41.

Keywords: Price connectedness, producer prices, manufacturing, Canada, United States, input–output linkages, commodity prices, exchange rate, tariffs.

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1 Introduction

Manufacturing prices in Canada and the United States move together. Between 2004 and 2025, the average producer price growth across manufacturing industries is correlated at 0.66 between the two countries for monthly growth and at 0.86 for 12-month growth. For the same industry in the two countries, the correlation averages 0.39 for monthly growth and 0.70 for 12-month growth. The monthly correlation ranges from 0.90 in petroleum and coal to 0.10 in leather (Figure 1). This co-movement is striking given the evidence that national borders separate consumer prices (Engel and Rogers, 1996). Two mechanisms can then account for it. First, integrated production chains transmit price changes across the border. Production is fragmented across countries, most visibly in the automotive industry (Timmer et al., 2015); intermediate goods cross borders several times before final sale (Johnson and Noguera, 2012, 2017); and shocks travel along such input linkages (Acemoglu et al., 2012; Boehm et al., 2019). Second, common exposure to world commodity prices can move producer prices in both countries without any cross-border transmission.¹ Distinguishing these mechanisms matters because only the first makes one country's trade and industrial policy a source of the other's producer price inflation. Yet observed price co-movement alone cannot separate them. We address this gap by measuring connectedness across 21 matched manufacturing industries and isolating the components associated with world commodity prices and the exchange rate.

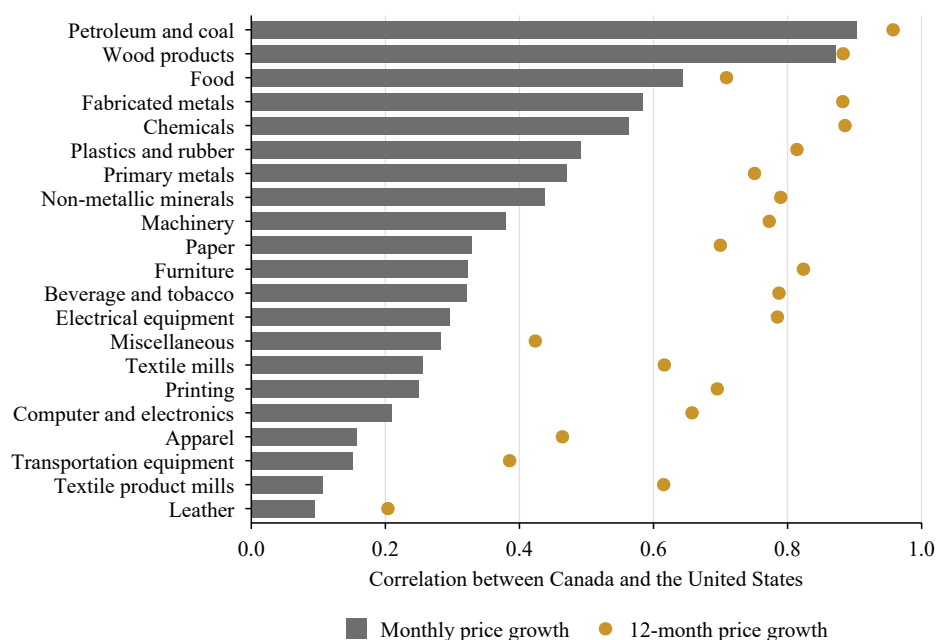


Figure 1: Correlation of PPI Growth between Canada and the United States, by Industry

Notes: This figure shows the correlation between the growth of the producer price index (PPI) of an industry in Canada and of the same industry in the United States. Each bar reports the correlation for monthly growth, and each point the correlation for growth over 12 months. The correlations of 0.66 (monthly) and 0.86 (12-month) quoted in the text are between the unweighted means of the 21 industries of each country. Sample: January 2004 to January 2025. Sources: Statistics Canada, Bureau of Labor Statistics.

¹The exchange rate can also make prices co-move. A movement in the exchange rate changes the Canadian-dollar price of goods priced in U.S. dollars, so that Canadian prices can follow U.S. prices through the currency alone.

The question has become urgent as U.S. tariffs on selected Canadian products and Canadian counter-measures disrupted North American trade in 2018–2019 and again from 2025. Tariffs pass through to import prices (Amiti et al., 2019b; Fajgelbaum et al., 2020; Cavallo et al., 2021, 2025), and their effects can extend across borders through trade in intermediate inputs. Steinberg (2020) shows that terminating the North American Free Trade Agreement would sharply reduce regional trade and lower welfare in all three member countries. Assessing how trade-policy changes affect producer prices requires understanding the extent of cross-border price connectedness, its underlying sources, and how it evolves over time. How much of producer price variation is connected across the border, and does this relationship differ between Canada and the United States? To what extent does this connectedness reflect common movements in world commodity prices, input–output linkages between industries, or competition between producers in the same product market? How does the exchange rate contribute to producer price variation in each country, and how have cross-border price relationships evolved since the early 1990s and during periods of changing trade policy, particularly the 2018–2019 and 2025–2026 tariff episodes?

We use monthly producer price indices for the 21 manufacturing industries of each country, from December 2003 to January 2025, together with the bilateral exchange rate. We estimate a vector autoregression (VAR) in the 42 price series and the exchange rate with Elastic Net regularization (Zou and Hastie, 2005), which makes estimation feasible when each equation has more regressors than observations, and derive the connectedness measures of Diebold and Yilmaz (2012) from its generalized forecast error variance decomposition. These measures quantify the spillover between any two industries, the exposure of each industry to shocks that originate elsewhere, its contribution to the variance of other industries, and the share of price variance in the system that comes from other variables. We compute them over the full sample and on rolling windows. For each industry, we decompose the variance that comes from other variables by source: industries of the same country, industries of the other country, the exchange rate, and, in an extended specification, global commodity prices.

Connectedness measures do not, by themselves, distinguish bilateral transmission from common exposure. This distinction matters for co-movement across industries (Foerster et al., 2011) and countries, where correlated shocks can generate co-movement that resembles transmission through production networks (Huo et al., 2025). Oil prices illustrate the problem. As a major commodity exporter, Canada is exposed to commodity price shocks that propagate through its production network (Cao and Dong, 2025). Because the generalized variance decomposition does not orthogonalize shocks (Koop et al., 1996; Pesaran and Shin, 1998), a common oil price shock can generate correlated shocks to Canadian and U.S. refining prices, which the decomposition records as bilateral spillovers even when neither industry’s price causes the other’s to move. This confounds cross-border transmission with common exposure, particularly in industries strongly affected by commodity prices.

We address this problem in two ways. First, we add world prices of oil, base metals, food, timber, and fertilizers to the system, allowing these prices to account for part of the variation otherwise attributed to industry spillovers. Second, we remove the variation explained by these commodity prices from every series and re-estimate the system using the residual series. This second approach is more conservative: it attributes to commodity prices all the variation they can explain, so the connectedness that remains cannot reflect

common exposure to commodities. We complement both by examining the correlations between the VAR residuals and identified oil supply and demand shocks ([Baumeister and Hamilton, 2019](#); [Känzig, 2021](#)), to assess how much of what the VAR treats as an industry shock is a shock to the world oil market.

Our analysis delivers five findings. First, cross-border price connectedness is substantial and nearly symmetric. Industries in the United States account for 21.6 percent of the 12-month forecast error variance of the average Canadian industry's price, while Canadian industries account for 22.8 percent for the average U.S. industry. By comparison, industries of the same country account for 29.3 and 33.0 percent. These links are especially strong in resource-based industries. In petroleum and coal, wood products, and food, prices in the other country account for more of an industry's price variance than prices in domestic industries do.²

Second, common commodity shocks explain much of the cross-border connectedness in some industries, but not in others. Removing the variation explained by world commodity prices leaves the average cross-border shares largely unchanged, at 20.9 percent for Canada and 20.5 percent for the United States. In petroleum and coal, primary metals, and chemicals, however, the share falls from 35.1 to 17.3 percent, and the spillover between the two countries' primary metals industries almost disappears, from 9.7 to 0.5 percent of the Canadian industry's price variance. Cross-border connectedness in wood products and food manufacturing remains substantial, indicating that common commodity exposure does not account for all bilateral price co-movement.

Third, the sources of connectedness differ across industry pairs. Between different industries, prices co-move more strongly when the industries are linked through input purchases, and this relationship survives the commodity controls. Between the same industry in the two countries, however, connectedness reflects the nature of the product more than bilateral input purchases. The U.S. wood products industry accounts for 38.1 percent of the forecast error variance of Canadian wood product prices despite limited direct input trade, whereas the U.S. transportation equipment industry accounts for only 0.5 percent of the variance of its Canadian counterpart despite the largest bilateral input flow in the data. These contrasts show that common-market competition drives cross-border co-movement in industries that produce similar goods, such as wood products.

Fourth, the exchange rate is the largest single source of spillovers in the system, particularly for differentiated goods. Canadian transportation equipment, machinery, and computer and electronics industries derive 13 to 19 percent of their price variance from exchange rate movements while receiving relatively little from U.S. industries. Their exposure reflects the role of the Canadian dollar in transmitting external shocks to domestic producer prices, consistent with the commodity-currency mechanism ([Chen and Rogoff, 2003](#)) and the dominant currency paradigm ([Gopinath et al., 2020](#)).

Fifth, cross-border connectedness has not risen with trade integration, and the tariffs did not raise it. For the 13 industries with data since 1992, the share of price variance that comes from the other country shows no upward trend. It rises when a large disturbance hits both countries, such as the 2008–2009 crisis or the 2021–2022 inflation surge, and it falls back afterwards. Under the tariffs of 2018–2019 and 2025–2026, it

²In Canada, U.S. industries account for 46.3 percent of the variance of petroleum and coal prices, 42.4 percent for wood products, and 33.1 percent for food, against 19.4, 9.0, and 16.1 percent for other Canadian industries. In the United States, Canadian industries account for 46.9, 45.9, and 29.1 percent, against 17.9, 12.5, and 25.4 percent for other U.S. industries. Figure 3 reports these shares for all industries.

stayed within the range of changes observed at other dates, and the share of the exchange rate did not change.

These findings show that cross-border price co-movement has several sources. It reflects a combination of common commodity shocks, competition in shared product markets, exchange rate exposure, and input–output linkages. For policymakers, the distinction matters because global commodity shocks, exchange rate movements, and competition in common markets can generate similar movements in producer prices while operating through different economic channels.

Related Literature. This paper relates to three strands of the literature. The first measures connectedness using forecast error variance decompositions. The framework of [Diebold and Yilmaz \(2009, 2012\)](#) quantifies spillovers in economic time series, while [Diebold and Yilmaz \(2014\)](#) interpret the resulting measures as a weighted, directed network. Methodological extensions combine the framework with LASSO-type penalized estimation to accommodate large systems ([Demirer et al., 2018](#)) and time-varying parameter VARs to capture changes in connectedness ([Antonakakis et al., 2020](#)). Applications span financial markets and macroeconomic interdependence across countries ([Greenwood-Nimmo et al., 2021](#); [Pham and Sala, 2022](#); [Mao Takongmo and Touré, 2023](#)). We extend this framework to industry-level producer prices in Canada and the United States. Unlike applications that report connectedness for a system as a whole, we distinguish cross-border from domestic exposure and examine the sources of industry-level price connectedness.

The second strand examines producer price connectedness within countries. [Bilgin and Yilmaz \(2018\)](#) for the United States and [Jia et al. \(2022\)](#) for China show that input–output linkages shape price spillovers across industries. Their results build on the literature on the propagation of sectoral shocks through production networks ([Acemoglu et al., 2012](#); [Baqae and Farhi, 2019](#); [Carvalho and Tahbaz-Salehi, 2019](#); [Rubbo, 2023](#)), and on the evidence that sectoral linkages change over time and differ across countries ([Gaggl et al., 2026](#); [Avoumatsodo and Leunga Noukwe, 2025, 2026](#)).³ These studies observe one country at a time. We measure connectedness between the industries of two countries. We show that input–output linkages shape it across the border as they do within each country, and that the strongest cross-border links, between the same industry in the two countries, reflect competition in a common market.

The third strand studies international inflation spillovers. Inflation co-moves across countries through input linkages, global factors, and commodity prices ([Ciccarelli and Mojon, 2010](#); [Auer et al., 2019](#); [Forbes, 2019](#); [di Giovanni et al., 2022](#); [Mao Takongmo and Touré, 2023](#)), and through exchange rates ([Chen and Rogoff, 2003](#); [Gopinath et al., 2020](#)), while the Canada–U.S. border separates consumer prices ([Engel and Rogers, 1996](#)).⁴ This literature examines aggregate inflation or broad sectors. We examine how producer prices are connected across industries in Canada and the United States, how much of this connection reflects world commodity prices and exchange-rate movements, and how it relates to input–output linkages and competition in common markets.

To the best of our knowledge, this paper is the first to analyze industry-level producer price connectedness between the Canadian and U.S. manufacturing sectors. It brings these strands together to quantify price

³On production networks, see also [Hulten \(1978\)](#), [Jones \(2011\)](#), [Acemoglu et al. \(2016\)](#), [Barrot and Sauvagnat \(2016\)](#), and [Boehm et al. \(2019\)](#). On changes in sectoral linkages, see also [Sposi \(2019\)](#) and [Foerster et al. \(2022\)](#).

⁴See also [Amiti et al. \(2019a\)](#) on the response of domestic prices to international shocks, [Kardasz and Stollery \(2001\)](#) on exchange rate pass-through in Canadian manufacturing, and [Ceglowski \(2003\)](#) and [Gorodnichenko and Tesar \(2009\)](#) on prices across the Canada–U.S. border.

connectedness between the industries of the two countries, identify the domestic and foreign sources of industry-level price variance, and trace changes in connectedness over time. We show that the interpretation of cross-border spillovers depends on their underlying sources. Input–output linkages matter between different industries, while common commodity shocks, competition in common markets, and exchange rate exposure account for other patterns of price co-movement.

Outline. The remainder of the paper is structured as follows. Section 2 describes the data and the empirical framework. Section 3 presents the results: how much of the variation in producer prices is shared across the border, how much of it reflects world commodity prices and the exchange rate, how it relates to input–output linkages, how it has changed over time, and how it behaved under the tariffs of 2018–2019 and 2025–2026. Section 4 reports what the estimation selects and how robust the results are. Section 5 concludes and draws the policy implications.

2 Data and Empirical Framework

Our aim is to measure how much of an industry’s price variation is shared with industries in the other country and to identify the sources of this cross-border connectedness. To this end, we combine monthly producer price indices for 21 manufacturing industries in Canada and the United States with the bilateral exchange rate. We estimate a regularized vector autoregression (VAR) using Elastic Net and derive connectedness measures from forecast error variance decompositions. We then relate these measures to commodity price exposure and input–output linkages to distinguish common price shocks from transmission through production networks.

2.1 Data

The analysis combines producer price indices and the exchange rate, which enter the VAR, with four supplementary datasets used to interpret the connectedness measures: world commodity prices, identified oil shocks, input–output tables, and tariffs. Appendix Table A.1 reports the sources and coverage of all series.

We use monthly producer price indices for 21 three-digit manufacturing industries classified under the North American Industry Classification System (NAICS), listed in Appendix Table A.2. Because NAICS codes are common to Canada and the United States, each Canadian industry is matched to its U.S. counterpart. The Canadian series are the Industrial Product Price Index (IPPI) by industry from Statistics Canada. The IPPI measures prices received by Canadian manufacturers when goods leave the plant. It excludes indirect taxes and costs incurred between the plant and the final user, such as transportation and distribution margins. It covers domestic sales and exports, with prices quoted in foreign currencies converted into Canadian dollars. Exchange rate movements therefore enter directly into the index for industries whose prices are set in U.S. dollars. The U.S. series are industry-level Producer Price Indices (PPIs) from the Bureau of Labor Statistics, retrieved from the Federal Reserve Economic Data (FRED) database. These indices measure prices received by domestic producers for output sold outside the producing industry. Both datasets thus measure producer prices at the factory gate, rather than prices paid by consumers.

The exchange rate is the monthly average spot rate, expressed as Canadian dollars per U.S. dollar, from FRED. An increase represents a depreciation of the Canadian dollar. We treat the exchange rate as an endogenous variable, giving the baseline VAR 43 variables: 21 Canadian industry indices, 21 U.S. industry indices, and the exchange rate.

The price indices run from December 2003 to January 2025. This starting date reflects data availability. Twelve of the 21 U.S. industry indices begin in December 2003, when the PPI adopted the NAICS classification.⁵ We seasonally adjust the 42 price indices⁶ and take monthly log differences, yielding 253 observations of price growth from January 2004 to January 2025. The exchange rate enters as a monthly log change and is not seasonally adjusted.

To assess the role of common commodity price movements, we use five monthly series of world prices published by the World Bank: the price of crude oil and the price indices of base metals, food, timber, and fertilizers. All are denominated in nominal U.S. dollars and enter as monthly log changes. These series cover major raw materials used in the industries studied, including energy, metals, agricultural products, wood, and chemical inputs.

We also examine the relationship between industry price residuals and structural shocks to the world oil market identified outside our model. The first set comprises the four monthly shocks of [Baumeister and Hamilton \(2019\)](#): oil supply, economic activity, oil consumption demand, and oil inventory demand. The second is the oil supply news shock of [Känzig \(2021\)](#), constructed from changes in oil futures prices around announcements by the Organization of the Petroleum Exporting Countries (OPEC). We use these shocks from January 2005 to January 2025, the period for which the baseline VAR produces residuals.

To measure cross-border and domestic production linkages, we use the 2014 Inter-Country Input-Output Tables from the OECD’s 2021 edition. The year 2014 is the midpoint of our price sample, and the linkage shares among the Canadian and U.S. industries we study change little between 2005 and 2018, the years covered by the tables.⁷ The tables report purchases between industries within and across countries, in U.S. dollars, as well as industry gross output.

Finally, to measure the tariffs that the United States applies to Canadian goods, we use monthly U.S. imports for consumption from Canada and the duties collected on those imports, by three-digit NAICS industry, from the U.S. Census Bureau. The data run from January 2010 to August 2026. We calculate the effective tariff rate as duties divided by import value.

2.2 VAR and Elastic Net Estimation

Let $Y_t = (y_{1,t}, \dots, y_{k,t})'$ collect the price growth rates of the 21 Canadian and 21 U.S. manufacturing industries and the change in the bilateral exchange rate, with $k = 43$. We model these variables as a vector

⁵Longer series exist for some industries. For 13 industries, U.S. price indices are available from 1992, and we use them to extend the analysis back to February 1992 (Appendix C). For the tariff analysis, we extend the sample through August 2026. This extension has 20 industries per country because the U.S. index for leather and allied products is no longer published. Both extensions use the same transformations as the baseline sample.

⁶We use X-13ARIMA-SEATS, the seasonal adjustment program of the U.S. Census Bureau, with automatic model selection.

⁷Across the 1,722 pairs of these industries, the correlation between the linkage shares of 2014 and those of each year from 2005 to 2018 is at least 0.90, and at least 0.96 for the 882 cross-border pairs.

autoregression of order p :

$$Y_t = c + A_1 Y_{t-1} + A_2 Y_{t-2} + \cdots + A_p Y_{t-p} + \varepsilon_t, \quad (1)$$

or, using the lag operator L ,

$$A(L)Y_t = c + \varepsilon_t, \quad A(L) = I_k - A_1 L - A_2 L^2 - \cdots - A_p L^p, \quad (2)$$

where c is a $k \times 1$ vector of intercepts and each A_ℓ is a $k \times k$ coefficient matrix. The element (i, j) of A_ℓ measures how the price growth of industry i depends on the price growth of industry j at a lag of ℓ months. The model allows each industry's price growth to depend on its own history, the histories of all other industries in both countries, and the exchange rate. The shocks ε_t have mean zero, covariance matrix $\Sigma = [\sigma_{ij}]$, and no serial correlation. The diagonal elements of Σ are the variances of the shocks, while its off-diagonal elements capture their contemporaneous covariation. We set $p = 12$, allowing price growth to respond to information from the preceding year, consistent with the possibility of delayed price adjustment under contracts.

The model is high-dimensional relative to the sample. With 43 variables and 12 lags, each equation contains 516 lagged regressors, and the full system has 22,188 slope coefficients. Each equation has only 241 usable observations, making unrestricted ordinary least squares unsuitable. We therefore estimate the equations using Elastic Net (Zou and Hastie, 2005), which penalizes coefficient magnitudes and can shrink some coefficients exactly to zero.

The i th equation of the VAR in equation (1) can be written as $y_{i,t} = c_i + x'_t \beta_i + \varepsilon_{i,t}$, where $x_t = (Y'_{t-1}, \dots, Y'_{t-p})'$ contains the 516 lagged variables and β_i collects the corresponding coefficients from the i th rows of $A_1, \dots, A_p$. Elastic Net solves

$$\min_{c_i, \beta_i} \frac{1}{2T} \sum_t (y_{i,t} - c_i - x'_t \beta_i)^2 + \lambda_i \left(\alpha_i \|\beta_i\|_1 + \frac{1 - \alpha_i}{2} \|\beta_i\|_2^2 \right), \quad (3)$$

where T is the number of observations, $\|\beta_i\|_1$ is the sum of the absolute coefficients, and $\|\beta_i\|_2^2$ is the sum of their squares. The tuning parameter λ_i controls the overall penalty, while $\alpha_i \in [0, 1]$ determines its composition. At $\alpha_i = 1$, the estimator reduces to the lasso (Tibshirani, 1996), which can set coefficients exactly to zero. At $\alpha_i = 0$, it reduces to ridge regression (Hoerl and Kennard, 1970), which shrinks coefficients toward zero without setting them exactly to zero. The combination is useful here because prices across related industries and successive lags are correlated. Unlike the lasso, which may select one variable from a group of correlated regressors and discard the others, Elastic Net can retain groups of related variables.

As in Demirer et al. (2018), we estimate the VAR by penalized regression and choose the penalty by cross-validation. We select the tuning parameters separately for each equation. For each candidate $\alpha_i \in \{0, 0.1, \dots, 1\}$, we use 10-fold cross-validation on the mean absolute error to select λ_i , applying the one-standard-error rule, which chooses the largest λ_i whose cross-validated error lies within one standard error of the minimum. We then select the value of α_i whose fitted equation has the lowest in-sample mean absolute error. The estimated coefficients form the matrices $A_1, \dots, A_p$, and we estimate Σ from the

covariance matrix of the residuals.

2.3 Connectedness Measures

The connectedness measures of [Diebold and Yilmaz \(2012\)](#) are based on forecast error variance decompositions. The estimated VAR has the moving average representation

$$Y_t = \mu + \sum_{h=0}^{\infty} B_h \varepsilon_{t-h}, \quad B_h = \sum_{\ell=1}^p A_{\ell} B_{h-\ell}, \quad (4)$$

with $B_0 = I_k$ and $B_h = 0$ for $h < 0$. This representation expresses each variable in terms of current and past shocks. The element (i, j) of B_h describes the response of variable i to a shock to variable j after h months. The H -step-ahead forecast error made at date t is $\sum_{h=0}^{H-1} B_h \varepsilon_{t+H-h}$. Its variance for variable i is $\sum_{h=0}^{H-1} e_i' B_h \Sigma B_h' e_i$, where e_i is the i th unit vector.

Variance decomposition. A variance decomposition measures the contribution of shocks to variable j to the forecast error variance of variable i . When the shocks of the VAR are correlated, however, the decomposition based on orthogonalized shocks depends on the variable ordering. With 43 variables, no ordering of industry prices is readily defensible. We therefore use the generalized forecast error variance decomposition of [Pesaran and Shin \(1998\)](#), which does not depend on the ordering and accounts for correlations among shocks. The contribution of shocks to variable j to the H -step forecast error variance of variable i is

$$\Omega_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e_i' B_h \Sigma e_j)^2}{\sum_{h=0}^{H-1} e_i' B_h \Sigma B_h' e_i}. \quad (5)$$

The denominator is the forecast error variance of variable i . The numerator captures the contribution associated with shocks to variable j , accounting for their covariance with the other shocks. Because the shocks are not orthogonalized, these contributions need not sum to one across j . Following [Diebold and Yilmaz \(2012\)](#), we normalize them by row:

$$\theta_{ij}(H) = \frac{\Omega_{ij}(H)}{\sum_{m=1}^k \Omega_{im}(H)}, \quad (6)$$

so that $\sum_{j=1}^k \theta_{ij}(H) = 1$ for every i and $\sum_{i,j} \theta_{ij}(H) = k$. We interpret $\theta_{ij}(H)$ as the normalized share of the forecast error variance of variable i attributed to shocks to variable j , and $\theta_{ii}(H)$ as the corresponding own share. We set $H = 12$ months and express the measures in percent.

Pairwise and aggregate connectedness measures. The matrix $[\theta_{ij}]$ is the connectedness table. Row i records the sources of the forecast error variance of variable i , while column j records the contributions of shocks to variable j across the system. Diagonal elements are own shares; off-diagonal elements measure spillovers. We summarize the table using four measures.

The first is pairwise connectedness, θ_{ij} , which measures the contribution of shocks to variable j to the

forecast error variance of variable i . It is directional because, in general, $\theta_{ij} \neq \theta_{ji}$. The second is the exposure of variable i , or connectedness from others:

$$C_{i \leftarrow \bullet}(H) = \sum_{j \neq i} \theta_{ij}(H). \quad (7)$$

This is the sum of the off-diagonal elements in row i and equals $100 - \theta_{ii}$ percent. The third is the influence of variable i , or connectedness to others:

$$C_{\bullet \leftarrow i}(H) = \sum_{j \neq i} \theta_{ji}(H). \quad (8)$$

It is the sum of the off-diagonal elements in column i . Since it aggregates contributions to the forecast error variances of different variables, it is measured in percentage points and can exceed 100. The fourth is system-wide connectedness, defined as average exposure:

$$C(H) = \frac{1}{k} \sum_{i=1}^k \sum_{j \neq i} \theta_{ij}(H). \quad (9)$$

It measures the average share of each variable's forecast error variance attributed to shocks in other variables. It is zero if all off-diagonal contributions are zero and approaches 100 percent as own shares approach zero.

Domestic and cross-border connectedness. Our main object is exposure decomposed by the country of the source. Let $\mathcal{D}_i$ denote the set of industries in the country of industry i , $\mathcal{F}_i$ the set of industries in the other country, and x the exchange rate. Grouping the sources in equation (7) into these blocks, following [Greenwood-Nimmo et al. \(2021\)](#), gives

$$C_{i \leftarrow \bullet}(H) = \underbrace{\sum_{j \in \mathcal{D}_i, j \neq i} \theta_{ij}(H)}_{\text{domestic}} + \underbrace{\sum_{j \in \mathcal{F}_i} \theta_{ij}(H)}_{\text{cross-border}} + \underbrace{\theta_{ix}(H)}_{\text{exchange rate}}. \quad (10)$$

The domestic component measures the share attributed to shocks in other industries in the same country; the cross-border component measures the share attributed to shocks in industries in the other country. We average the latter across industries to obtain each country's cross-border share, the paper's main measure. We decompose influence by destination in the same way, using θ_{ji} in place of θ_{ij} to distinguish contributions to the variances of industries in the source industry's own country, industries in the other country, and the exchange rate.

The numerator of equation (5) depends on Σ , so θ_{ij} measures the variation that the prices of i and j share within the month together with the response of one to the other. A high θ_{ij} therefore records the co-movement of the two prices, whatever its source. It can be a response of one price to the other or a common factor that moves both.

The measures above summarize connectedness over the full estimation sample. To examine how it changes over time, we re-estimate the VAR and recompute the connectedness table over rolling 84-month

windows, dating each estimate by the final month of its window.⁸

2.4 Input–Output Linkages

We measure input–output linkages using expenditure shares, the standard approach in input–output models (Uy et al., 2013; Caliendo and Parro, 2015; Sposi, 2019). For industry i , input intensity is the share of intermediate input expenditure in gross output:

$$\delta_i = \frac{\sum_k Z_{ki}}{X_i}, \quad (11)$$

where Z_{ki} is the value of inputs that industry i purchases from industry k , and X_i is its gross output. The rows of the input–output table identify selling industries and its columns identify buying industries. We also measure the share of industry i ’s intermediate input expenditure accounted for by supplier j :

$$\gamma_{ij} = \frac{Z_{ji}}{\sum_k Z_{ki}}. \quad (12)$$

The subscripts of γ_{ij} follow those of θ_{ij} : i is the purchasing industry and j the source. The input intensity δ_i measures how much industry i spends on intermediate inputs relative to output, while γ_{ij} measures how that expenditure is distributed across suppliers. The linkage shares sum to one across suppliers in all countries and the rest of the world, and their product, $\delta_i \gamma_{ij}$, is the cost share of input j in the output of industry i .

We compute these measures from the OECD Inter-Country Input-Output Tables, which record purchases between industries across countries. The 17 manufacturing industries in the tables, classified under the International Standard Industrial Classification, map into 15 groups of our 21 NAICS industries. Industries within the same group therefore share the same input–output coefficients. We exclude pairs belonging to the same group and country.

To compare input linkages with price connectedness, we normalize connectedness across source industries within each country block. Let $\tilde{\theta}_{ij}$ denote the share of industry i ’s connectedness from a given country accounted for by industry j :

$$\tilde{\theta}_{ij} = \begin{cases} \theta_{ij} / \sum_{m \in \mathcal{D}_i, m \neq i} \theta_{im} & \text{if } j \in \mathcal{D}_i, \\ \theta_{ij} / \sum_{m \in \mathcal{F}_i} \theta_{im} & \text{if } j \in \mathcal{F}_i. \end{cases} \quad (13)$$

Thus, $\tilde{\theta}_{ij}$ sums to one across domestic sources and separately across cross-border sources. This normalization allows us to compare the distribution of price connectedness across industries with the distribution of input purchases across suppliers.

⁸An 84-month window covers seven years. A longer window gives more precise estimates but adapts more slowly to changes in connectedness; a shorter one adapts faster but rests on fewer observations. With 12 lags, each window leaves 72 observations per equation, and Elastic Net makes estimation feasible with 516 lagged regressors. Estimates with 60-month windows follow the same pattern (Appendix Figure B.1).

3 Results

Our analysis proceeds from measurement to explanation and then to changes over time. We first establish how much producer price variation is accounted for by industries within the same country and across the border (Subsection 3.1). We then examine what accounts for cross-border connectedness, distinguishing the role of global commodity prices and exchange rate movements from the role of input–output linkages between industries (Subsections 3.2 and 3.3). Finally, we trace changes in connectedness over time, using both the baseline sample and a longer historical sample, and examine how connectedness evolved around the U.S. tariff episodes (Subsections 3.4 and 3.5).

3.1 Static Connectedness

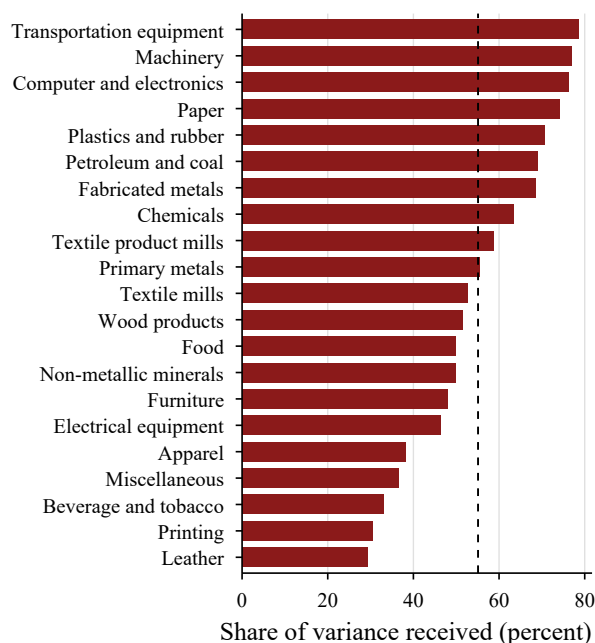
We begin by measuring connectedness over the full sample. More than half of the variation in an industry’s price is shared with other variables in the system, and the part shared with the industries of the other country is of similar size in Canada and in the United States. This cross-border part is concentrated in resource-based industries. By contrast, the prices of Canadian transportation equipment, machinery, and computer and electronics move closely with other Canadian prices and with the exchange rate, and little with U.S. prices. We first examine the extent of connectedness and its distribution across industries, and then separate its domestic and cross-border parts.

The Extent and Distribution of Price Connectedness. Across the joint Canada–U.S. system, connectedness is 56.6 percent. On average, shocks to other variables account for more than half of each variable’s 12-month forecast error variance. Yet this aggregate masks an important distinction between estimating the two countries separately and estimating them jointly. When we estimate the model using only Canadian industries, connectedness is 40.7 percent; for U.S. industries alone, it is 43.8 percent. In the joint system, these values rise to 55.1 percent for Canadian industries and 56.9 percent for U.S. industries. Including the other country’s industries and the exchange rate therefore raises measured connectedness by 13 to 14 percentage points.

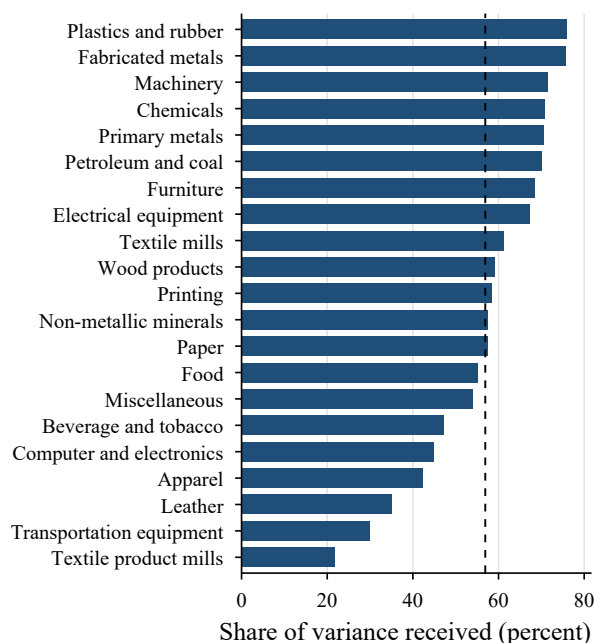
This increase does not simply add a foreign component to an unchanged pattern of domestic connectedness. In the joint system, other industries in the same country account for 29.3 percent of the forecast error variance of Canadian industry prices and 33.0 percent of that of U.S. industry prices. These shares are about 11 percentage points below the corresponding single-country estimates. Some of the co-movement attributed to domestic industries in a single-country model is therefore captured by cross-border industries and the exchange rate when these variables enter the system. The joint specification reveals a broader set of sources behind producer price movements.

Our estimate for U.S. industries alone, 43.8 percent, is close to the 38.2 percent reported by [Bilgin and Yilmaz \(2018\)](#) for 17 U.S. manufacturing industries over 1960–2016 using the same forecast horizon. By contrast, [Jia et al. \(2022\)](#) report 69.5 percent for China in a system combining 25 producer price indices with four consumer price indices.⁹ Our joint-system estimate of 56.6 percent falls between these values. It is

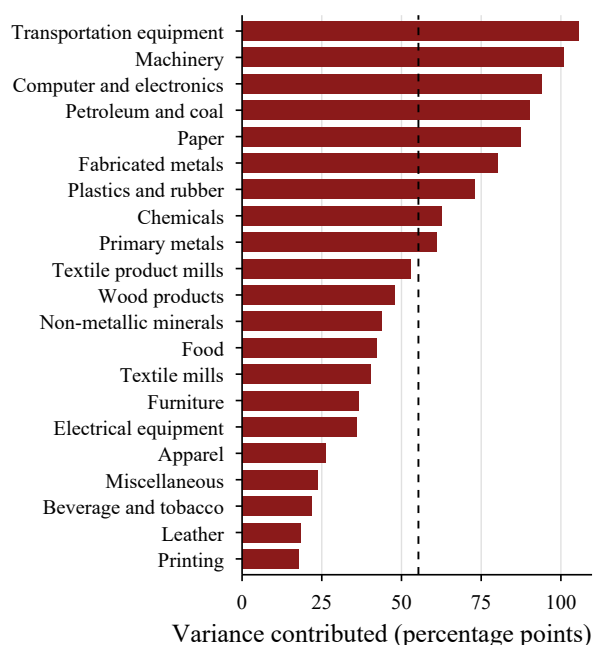
⁹Both studies use monthly price changes and a generalized variance decomposition. [Bilgin and Yilmaz \(2018\)](#) estimate a VAR



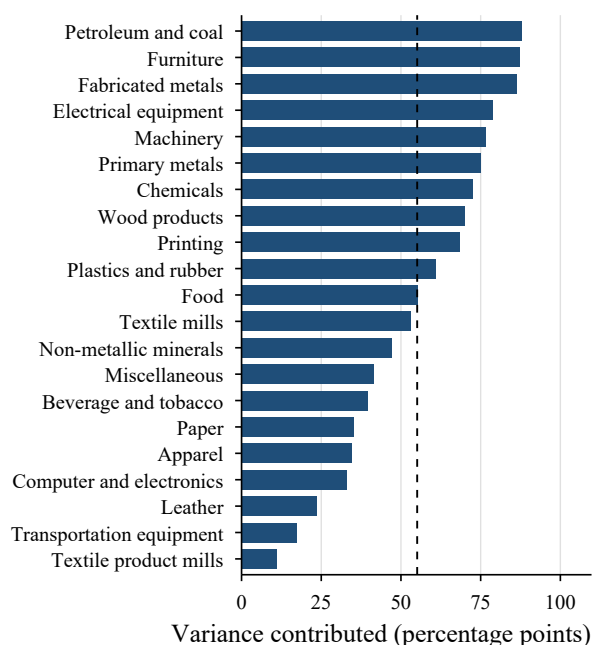
(a) Exposure, Canadian industries



(b) Exposure, U.S. industries



(c) Influence, Canadian industries



(d) Influence, U.S. industries

Figure 2: Exposure and Influence of Each Industry

Notes: This figure shows the exposure and the influence of each industry over the full sample. Panels (a) and (b) report the share, in percent, of the 12-month forecast error variance of an industry's price growth that comes from shocks to all other variables in the system (connectedness from others). Panels (c) and (d) report the sum, in percentage points, of the shares of the variance of all other variables that come from shocks to the industry (connectedness to others), which can exceed 100. Industries are ranked within each country, and the two panels of a row share the same horizontal scale. The dashed line in each panel marks the average across the industries of the country. The exchange rate, not shown, receives 79.6 percent of its variance from other variables and contributes 113.1 percentage points to them, more than any industry. Sample: January 2004 to January 2025.

also comparable in magnitude to the international price synchronization documented by [Auer et al. \(2019\)](#), who find that a global component accounts for 51 percent of producer price inflation variance in the median country in their sample. They attribute this synchronization primarily to common sectoral shocks amplified by input–output linkages. Our results similarly show substantial shared price variation, but the industry-level decomposition shows that cross-border connectedness is unevenly distributed rather than common across manufacturing.

Figure 2, panels (a) and (b), ranks industries by exposure to shocks elsewhere in the joint system. In Canada, transportation equipment (78.6 percent), machinery (77.0 percent), computer and electronics (76.2 percent), and paper (74.1 percent) have the highest exposure. Leather (29.4 percent) and printing (30.4 percent) have the lowest. In the United States, plastics and rubber (76.0 percent) and fabricated metals (75.8 percent) rank highest, while textile product mills (21.8 percent) and transportation equipment (29.9 percent) rank lowest. For the most exposed industries, own shocks account for about one-quarter or less of forecast error variance; their prices largely co-move with developments elsewhere in the system. For the least exposed, industry-specific shocks account for most of the variance.

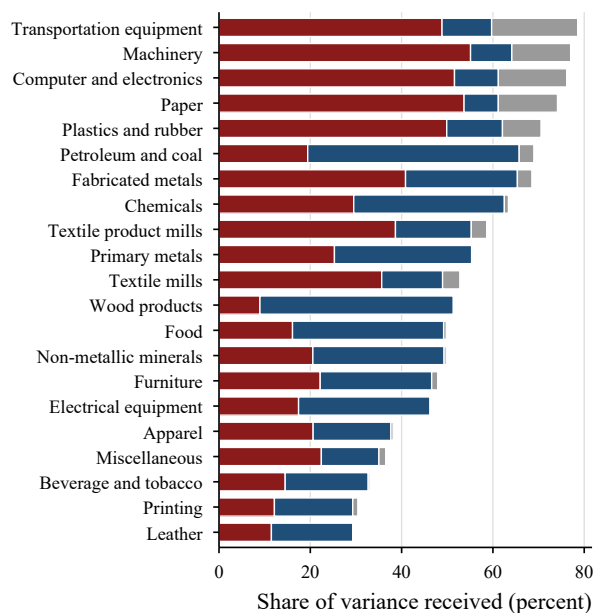
Average exposure is similar in the two countries, at 55.1 percent for Canadian industries and 56.9 percent for U.S. industries. The more striking difference is across industries. Transportation equipment and computer and electronics rank among the most exposed industries in Canada but among the least exposed in the United States. Similar aggregate exposure thus hides different industry-level patterns. The decomposition below shows that the exchange rate helps account for this contrast.

Panels (c) and (d) of Figure 2 rank industries by their contribution to connectedness in the rest of the system. Canadian transportation equipment has an influence of 105.6 percentage points, followed by machinery at 101.0 and computer and electronics at 93.8. Petroleum and coal is also a major source in both countries, contributing 90.2 percentage points in Canada and 88.0 in the United States. In the United States, furniture (87.4) and fabricated metals (86.5) follow. At the other end, U.S. textile product mills contribute 11.0 percentage points, U.S. transportation equipment 17.4, and Canadian printing 17.7. The exchange rate, omitted from the figure, contributes 113.1 percentage points and has the largest influence in the system.

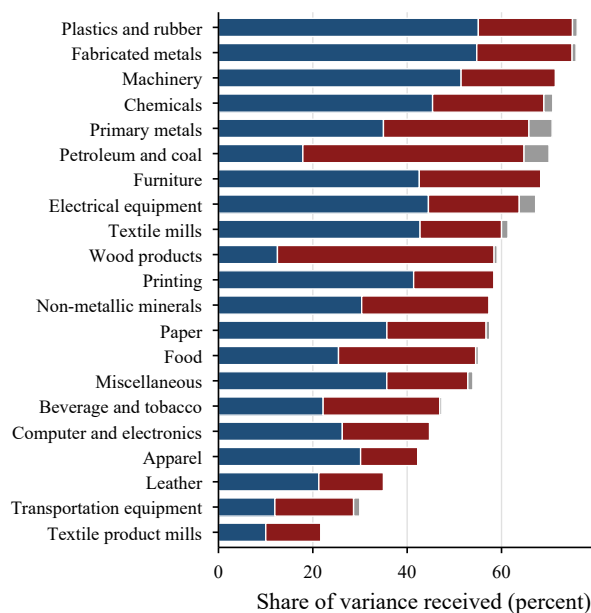
Domestic and Cross-Border Connectedness. Aggregate connectedness masks an important distinction between domestic and cross-border sources. Averaged across industries, other Canadian industries account for 29.3 percent of a Canadian industry’s forecast error variance, U.S. industries for 21.6 percent, and the exchange rate for 4.2 percent. For U.S. industries, the corresponding shares are 33.0 percent from other U.S. industries, 22.8 percent from Canadian industries, and 1.2 percent from the exchange rate. Panels (a) and (b) of Figure 3 show these shares for each industry. Cross-border exposure is therefore similar in magnitude in both directions, but exchange rate exposure is substantially greater for Canadian producer prices.

Cross-border exposure is concentrated in resource-based industries, not in those with the highest total exposure. In Canada, U.S. industries account for 46.3 percent of the forecast error variance of petroleum and coal prices, 42.4 percent for wood products, 33.1 percent for food, 33.0 percent for chemicals, and 30.1 percent for primary metals. The pattern is similar in the United States. Canadian industries account for

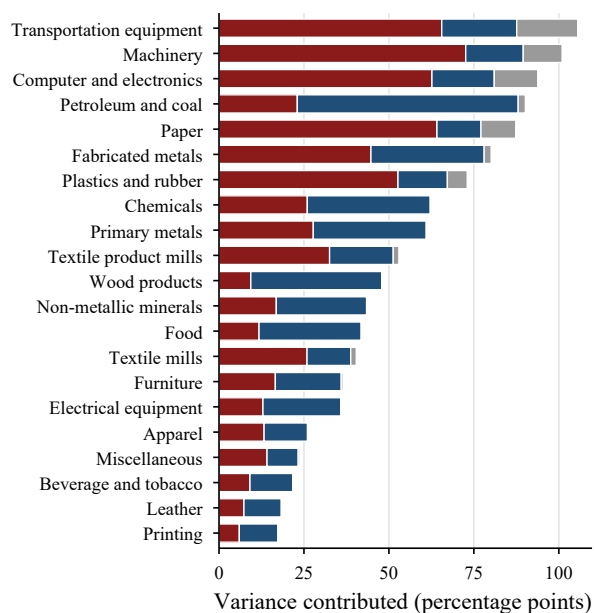
of order two by least squares; [Jia et al. \(2022\)](#) estimate a VAR with a lasso penalty over 2007–2019.



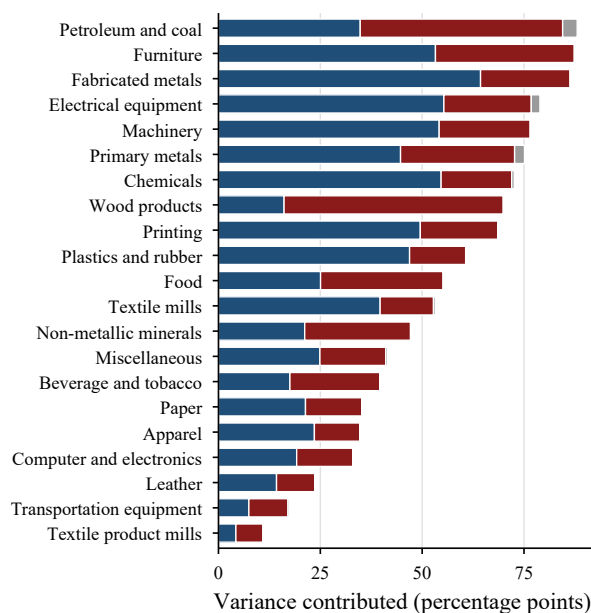
(a) Exposure of Canadian industries, by source



(b) Exposure of U.S. industries, by source



(c) Influence of Canadian industries, by destination



(d) Influence of U.S. industries, by destination

■ Canada ■ United States ■ Exchange rate

Figure 3: Domestic and Cross-Border Connectedness by Industry

Notes: This figure shows the connectedness of each industry by source and by destination. Panels (a) and (b) split the share of an industry's 12-month forecast error variance that comes from other variables into three sources: Canadian industries (red), U.S. industries (blue), and the exchange rate (grey). Panels (c) and (d) split in the same way the variance that shocks to an industry contribute to other variables, in percentage points, by destination. Industries are ranked by the total.

46.9 percent of the variance of petroleum and coal prices, 45.9 percent for wood products, 30.8 percent for primary metals, and 29.1 percent for food. These links often run between the same industry on either side of the border. The U.S. wood products industry accounts for 38.1 percent of the variance of Canadian wood product prices, while the Canadian industry accounts for 32.5 percent of the variance of U.S. prices. The corresponding shares are 25.0 and 24.3 percent for petroleum and coal, and 20.6 and 18.4 percent for food.

At the other end, cross-border exposure is lowest in Canada's most exposed industries in Figure 2. Industries in the United States account for only 10.9 percent of the variance of Canadian transportation equipment prices, 9.0 percent for machinery, 9.6 percent for computer and electronics, and 7.5 percent for paper. Instead, these industries are more exposed to other Canadian industries and the exchange rate. The exchange rate accounts for 18.9 percent of transportation equipment's variance, 12.9 percent for machinery, 15.0 percent for computer and electronics, and 13.0 percent for paper. The exchange rate itself receives 68.2 percent of its forecast error variance from Canadian industries.

The influence measures in panels (c) and (d) of Figure 3 reinforce this distinction. For the average Canadian industry, influence on U.S. industries is 22.8 percentage points, compared with 29.3 points on other Canadian industries. For the average U.S. industry, influence on Canadian industries is 21.6 points, compared with 33.0 points on other U.S. industries. Yet several resource-based industries direct a large share of their influence across the border. Canadian petroleum and coal sends 65.0 of its 90.2 points to U.S. industries, while Canadian wood products sends 38.5 of 47.9. In the other direction, U.S. wood products sends 53.8 of its 70.2 points to Canadian industries, and U.S. petroleum and coal sends 49.7 of 88.0. By contrast, Canada's most influential industries transmit mainly within Canada. Transportation equipment sends 65.5 of its 105.6 points to Canadian industries, machinery sends 72.6 of 101.0, and paper sends 64.1 of 87.3.

The results show two distinct patterns. In resource-based industries, such as fuel, lumber, food, and metals, prices on one side of the border move with prices on the other, in both directions. In the rest of manufacturing, prices move mainly with conditions at home. In the United States, producer prices follow other domestic industries, while the prices of Canada's most exposed manufacturers, such as vehicles, machinery, and electronics, follow other Canadian industries and the value of the Canadian dollar rather than their U.S. counterparts. The next two subsections examine whether commodity prices and input-output linkages account for these patterns.

3.2 Global Commodity Prices, the Exchange Rate, and Cross-Border Connectedness

About one fifth of industry price variation is connected to industries in the other country. This cross-border connectedness can reflect transmission between Canadian and U.S. industries, or common responses to global price shocks. The generalized variance decomposition records both in the same way. Since it does not orthogonalize shocks, contemporaneously correlated price shocks generate measured connectedness when both countries respond to the same global shock.

We examine the role of world commodity prices using two specifications. Let g_t be the 5×1 vector of monthly log changes in world commodity prices. The first specification adds g_t to the baseline VAR, expanding the system from 43 to 48 variables. Commodity prices can then account directly for forecast error

variance, alongside domestic and foreign industries, and the exposure of an industry has four components,

$$C_{i \leftarrow \bullet}(H) = \underbrace{\sum_{j \in \mathcal{D}_i, j \neq i} \theta_{ij}(H)}_{\text{domestic}} + \underbrace{\sum_{j \in \mathcal{F}_i} \theta_{ij}(H)}_{\text{cross-border}} + \underbrace{\theta_{ix}(H)}_{\text{exchange rate}} + \underbrace{\sum_{j \in \mathcal{G}} \theta_{ij}(H)}_{\text{world commodities}}, \quad (14)$$

where $\mathcal{G}$ is the set of the five commodity prices and the first three components are those of equation (10). The second specification removes commodity price variation before estimating connectedness. For each of the 43 baseline series, we estimate by least squares

$$y_{i,t} = a_i + \sum_{s=0}^3 b'_{i,s} g_{t-s} + u_{i,t}, \quad (15)$$

and we estimate the VAR using the residuals $\hat{u}_{i,t}$. Whereas the first specification measures the contribution of commodity prices within the system, the second asks whether cross-border connectedness persists after removing variation explained by commodity prices over the current month and preceding three months.

Controlling for commodity prices lowers average cross-border connectedness only slightly (Table 1). In the baseline, U.S. industries account for 21.6 percent of the forecast error variance of Canadian industry prices, and Canadian industries for 22.8 percent of that of U.S. industry prices. When commodity prices enter the VAR, these shares fall to 19.6 and 21.0 percent, while commodity prices directly account for 7.1 percent of Canadian and 6.5 percent of U.S. industry price variance. When commodity price variation is removed before estimating the VAR, the shares are 20.9 and 20.5 percent.¹⁰ The network in Figure 4 shows where the decline occurs. A line joins two variables when the spillover between them, averaged over the two directions, is at least 3 percent of forecast error variance, and black lines mark links between industries of the two countries. Each variable has the same position in the baseline and net of commodity prices. In the baseline, black lines tie the petroleum and coal, chemicals, and primary metals industries of the two countries to one another, and 24 links cross the border. Net of commodity prices, 16 links cross the border, and the links among these three industries disappear except the one between the two petroleum and coal industries. The links between the two wood products industries and between the two food industries remain about as strong as before.

Cross-border connectedness therefore remains close to one fifth of industry price variation under both approaches. Global commodity prices account for part of the measured connectedness, but controlling for them does not eliminate it. The remaining connectedness reflects transmission through cross-border industry linkages, other common shocks, or both. We next examine how this average is distributed across sectors.

The average effect masks substantial differences across industries. Appendix Table A.3 shows that commodity prices account for much of the cross-border connectedness in petroleum and coal, primary metals, and chemicals. Across these six industry-country series, the average cross-border share falls from 35.1 percent in the baseline to 17.3 percent net of commodity prices. Commodity prices explain 61 percent of the variance of these series, compared with 18 percent for the other 36. The largest change is in primary

¹⁰The result is not sensitive to the lag length in the first-stage regression. With only contemporaneous commodity prices, the cross-border shares are 22.3 percent for Canada and 21.6 percent for the United States. With six lags, they are 19.0 and 20.1 percent.

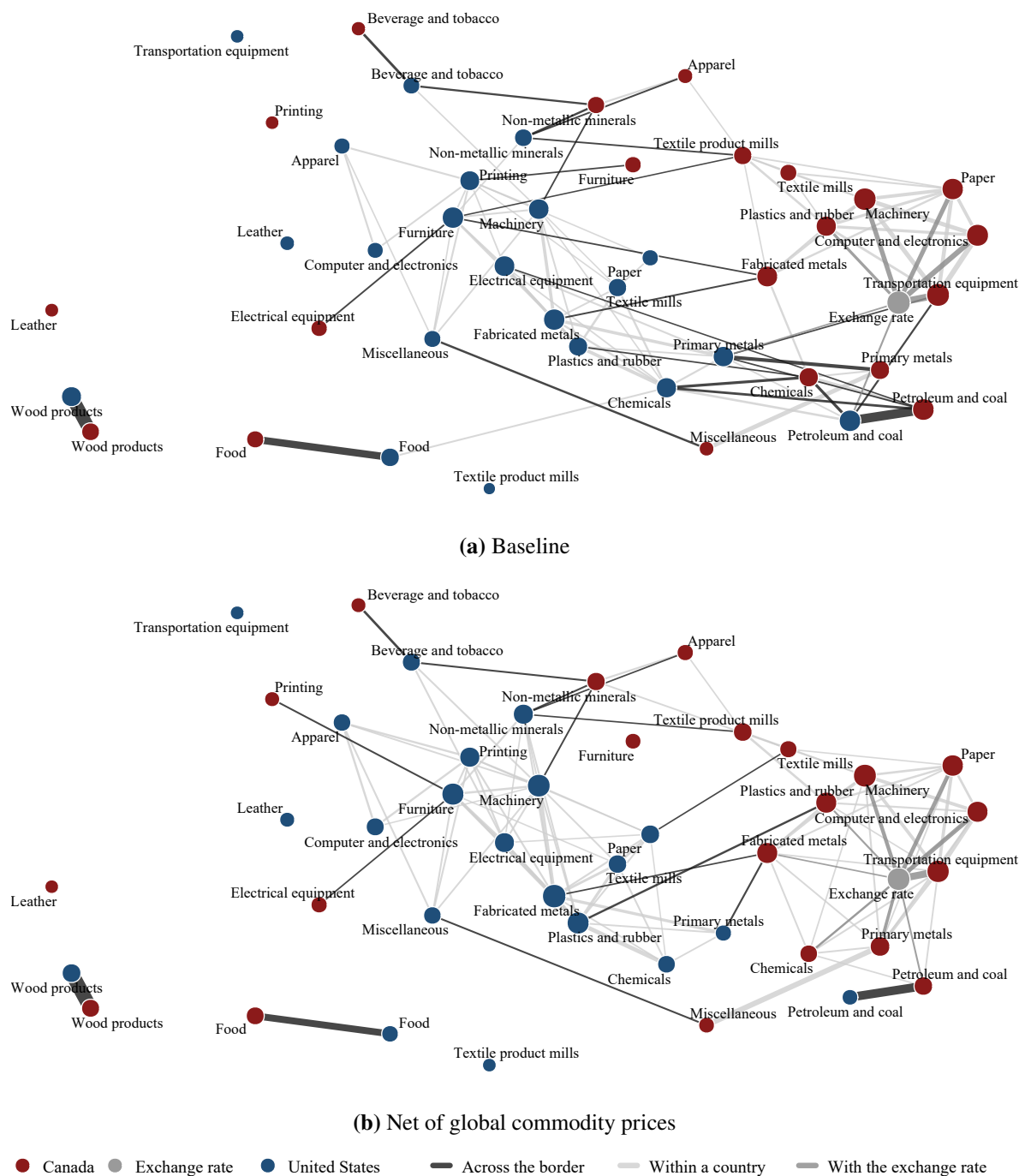


Figure 4: The Network of Producer Price Connectedness

Notes: This figure shows the links between the 42 industries and the exchange rate. Each point is an industry of Canada (red) or of the United States (blue), or the exchange rate (grey); its size increases with the influence of the variable. A line joins two variables when the spillover between them, averaged over the two directions, is at least 3 percent of 12-month forecast error variance, and its width increases with the spillover. Black lines join industries of different countries, light grey lines industries of the same country, and dark grey lines an industry and the exchange rate. Every variable has the same position in the two panels, and variables whose prices move together are placed close to one another. Sample: January 2004 to January 2025.

Table 1: Sources of Industry Price Variance, With and Without Global Commodity Prices

	Own shocks	Domestic industries	Cross-border industries	Exchange rate	Global commodities
<i>Panel A. Canadian industries</i>					
Baseline	44.9	29.3	21.6	4.2	–
Commodity prices in the VAR	42.7	26.8	19.6	3.8	7.1
Net of commodity prices	43.2	31.2	20.9	4.7	–
<i>Panel B. U.S. industries</i>					
Baseline	43.1	33.0	22.8	1.2	–
Commodity prices in the VAR	41.3	30.0	21.0	1.1	6.5
Net of commodity prices	43.2	36.1	20.5	0.2	–

Notes: This table shows the sources of the variance of industry prices in three specifications. Each row reports the average share, in percent, of the 12-month forecast error variance of an industry’s price growth that comes from its own shocks, from other industries of the same country, from industries of the other country, from the exchange rate, and from global commodity prices. Rows sum to 100. *Baseline* is the 43-variable system of Section 3.1. *Commodity prices in the VAR* adds five World Bank commodity price series to the VAR. *Net of commodity prices* estimates the baseline system on residuals from regressions of each series on the current value and three lags of the five commodity price changes. Sample: January 2004 to January 2025.

metals. The share of Canadian primary metal price variance attributed to U.S. industries falls from 30.1 to 5.1 percent, while the pairwise spillover from U.S. to Canadian primary metals falls from 9.7 to 0.5 percent (Appendix Table A.5). The measured link reflects the response of the two industries to common world metal prices. Chemicals show a similar pattern. Their cross-border shares fall by half in the United States and by two thirds in Canada.

Petroleum and coal is less clear-cut. Its cross-border share falls from 46.3 to 24.5 percent in Canada and from 46.9 to 36.5 percent in the United States. The correlation between the two countries’ residuals also declines, from 0.90 to 0.68. Crude oil prices thus account for part, but not all, of the shared price variation. The remaining co-movement reflects an integrated North American market for refined products. Identified shocks to the world oil market confirm the role of oil prices. The oil supply and demand shocks of Baumeister and Hamilton (2019) and the oil supply news shocks of Känzig (2021) together explain 57 percent of the Canadian and 51 percent of the U.S. petroleum and coal residual variation (Appendix D).

The results differ for wood products and food manufacturing. Their cross-border exposure persists net of commodity prices. For wood products, the share changes from 42.4 to 42.9 percent in Canada and from 45.9 to 48.1 percent in the United States. For food, it changes from 33.1 to 35.3 percent in Canada and from 29.1 to 27.1 percent in the United States. Pairwise spillovers between the same industries remain similarly stable (Appendix Table A.5). The commodity indices used here therefore do not account for these links. In the case of wood products, the World Bank timber index tracks tropical logs and sawnwood, whereas softwood lumber prices are formed in a North American market. The persistence of the wood link reflects a common North American market, in which producers of both countries respond to the same demand, U.S. housing construction above all.¹¹ Across the 36 industries outside petroleum, metals, and chemicals, the average

¹¹We know of no separate world price of softwood lumber that would capture this bilateral market.

cross-border share rises from 20.0 percent in the baseline to 21.3 percent net of commodity prices.¹²

The Exchange Rate. The exchange rate provides a different explanation for the high connectedness of several Canadian industries. Appendix Table D.1 shows that the exchange rate and Canadian transportation equipment, computer and electronics, and machinery respond to oil shocks with signs opposite to petroleum and coal. An increase in oil prices tends to appreciate the Canadian dollar, consistent with evidence for commodity-exporting currencies (Chen and Rogoff, 2003) and with the positive response of the Canadian dollar to energy prices since the early 1990s (Issa et al., 2008). This appreciation can lower the Canadian-dollar value of goods priced in U.S. dollars, in line with the dominant-currency invoicing documented by Gopinath et al. (2020). Exchange rate pass-through in Canadian manufacturing also tends to increase with export intensity (Kardasz and Stollery, 2001), which is high in these industries.

These industries sell largely at prices set in U.S. dollars, so a depreciation of the Canadian dollar raises their prices measured in Canadian dollars. The exchange rate accounts for 13 to 19 percent of price variance in these three industries, compared with 4.2 percent for the average Canadian industry. It is also the largest single source of spillovers in the system, with a contribution of 113.1 percentage points to the variance of the other 42 variables. In Figure 4, it sits among the Canadian industries, next to transportation equipment, machinery, computer and electronics, and paper. A simple regression of monthly Canadian price growth on the exchange rate change provides a complementary illustration (Appendix Figure B.2). A 1 percent depreciation of the Canadian dollar is associated with a 0.58 percent increase in transportation equipment prices within the month, and the exchange rate alone accounts for 89 percent of the monthly variation of these prices. By comparison, the estimate is 0.03 percent for wood products, and U.S. transportation equipment prices show almost no response, with an estimate of 0.02.

Taken together, the results distinguish two sources of cross-border co-movement. Commodity prices account for much of the measured link in petroleum and coal, primary metals, and chemicals, while cross-border connectedness in wood products and food persists after these controls. Meanwhile, the high total connectedness of several Canadian industries reflects common exposure to the exchange rate rather than links between industries. Transportation equipment, machinery, computer and electronics, and paper draw most of their domestic connectedness from one another, and the price growth of each moves closely with the exchange rate. The next subsection examines whether cross-border connectedness is aligned with input–output linkages between industries.

3.3 Input–Output Linkages and Connectedness

Beyond common exposure to commodity prices and the exchange rate, industry prices can move together because industries buy inputs from one another. A price increase in a supplying industry raises the costs of the industries that buy from it. If this channel operates, connectedness should be greater between industries with stronger input–output links. We test this implication using the linkage share γ_{ij} , input intensity δ_i , and normalized connectedness $\tilde{\theta}_{ij}$ defined in Section 2.4.

¹²Variance shares are normalized to sum to 100 for each industry. Removing commodity-related variation raises the relative weight of the co-movement that remains, so cross-border shares can rise in industries with limited commodity exposure.

Panel (a) of Figure 5 plots normalized connectedness against input–output linkages for different-industry pairs, grouped into 20 equal-sized bins. Connectedness rises with the strength of the linkage for both domestic and cross-border pairs. An industry’s price is more connected to the prices of industries that supply a larger share of its inputs. The rank correlations are 0.15 for domestic pairs and 0.19 for cross-border pairs. The regressions in Appendix Table A.6 yield a similar pattern. A one-standard-deviation increase in the linkage raises the source industry’s share of the receiving industry’s connectedness by 0.73 percentage points for domestic pairs and 1.25 points for cross-border pairs, against respective means of 5.0 and 4.8 percent. The cross-border relationship is more robust. It survives controlling for commodity price variation and adding fixed effects for the receiving and source industries, whereas the domestic relationship weakens with fixed effects. Input intensity δ_i adds little explanatory power. The distribution of input purchases across suppliers thus matters more than the overall importance of intermediate inputs in production. These results extend the domestic input–output patterns documented by Bilgin and Yilmaz (2018) and Jia et al. (2022) to cross-border industry pairs.

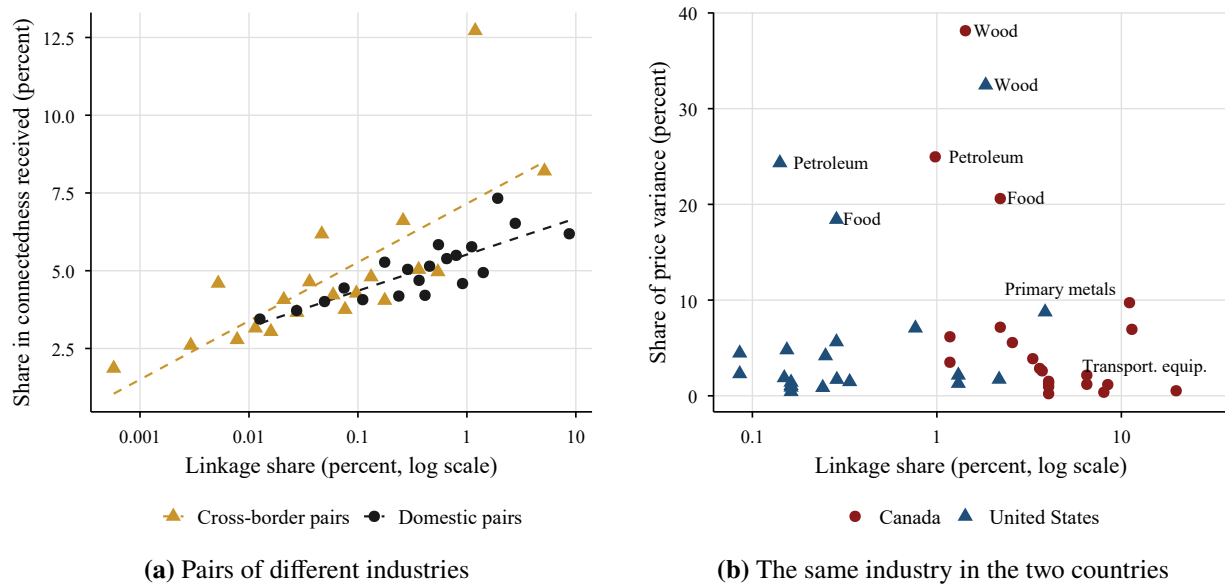


Figure 5: Input–Output Linkages and Price Connectedness

Notes: This figure shows the relationship between input–output linkages and price connectedness. The horizontal axis of both panels is the linkage share, the share of industry j in the intermediate input expenditure of industry i (equation 12), on a logarithmic scale. Panel (a) groups the pairs of different industries into 20 bins of equal size by linkage share, separately for the 804 domestic pairs and the 882 cross-border pairs, and reports for each bin the mean share of industry j in the connectedness that industry i receives from the industries of j ’s country; dashed lines are linear fits to the binned means. Panel (b) has one point for each of the 42 industries. Its horizontal axis is the share of the industry’s intermediate inputs that it buys from the same industry in the other country, and its vertical axis is the share of the industry’s 12-month forecast error variance that comes from that industry. Colours and symbols indicate the country of the industry. Input–output data: OECD Inter-Country Input-Output Tables, 2014.

The relationship is different for the same industry in the two countries. Section 3.1 showed that some of the strongest cross-border links occur between industry counterparts, yet these links do not increase with the corresponding input–output linkages. Panel (b) of Figure 5 plots, for each industry, the share of its price variance that comes from the same industry in the other country against the share of its inputs that it buys from that industry. The two are not positively related. The rank correlation is -0.12 in the baseline

and -0.24 net of commodity prices. The contrast between transportation equipment and wood products is instructive. Canadian transportation equipment purchases inputs worth 14 percent of its output from its U.S. counterpart, the largest bilateral input flow in the table, yet U.S. transportation equipment accounts for only 0.5 percent of the variance of Canadian prices. By contrast, Canadian wood products purchases inputs worth just 1 percent of its output from U.S. wood products, which accounts for 38.1 percent of the variance of Canadian wood product prices.

This pattern is not confined to Canada. In the single-country system studied by [Bilgin and Yılmaz \(2018\)](#), own shocks account for 89.6 percent of the variance of U.S. wood product prices, leaving little connectedness with other U.S. manufacturing industries. In our joint system, Canadian industries account for 45.9 percent of the variance of U.S. wood product prices. Across all industries, the same industry in the other country accounts for 29 percent of cross-border connectedness. These comparisons show that same-industry links across the border reflect forces other than direct input purchases.

The two patterns reflect different economic relationships. Between different industries, connectedness increases with the strength of supplier–buyer links. Production networks transmit price changes between them, in line with evidence that vertical linkages with foreign-owned producers, largely from the United States, raise the productivity of Canadian manufacturing plants ([Lileeva, 2010](#); [Wang, 2010](#)). Between industry counterparts, however, input purchases offer little explanation. Producers of similar goods compete in an integrated market. A Canadian sawmill and a U.S. sawmill do not generally supply one another; instead, they sell similar products to overlapping buyers. Because buyers can substitute between suppliers, the two prices move together even without direct input flows. The persistent cross-border links in wood products, food, and petroleum products reflect this common market.

Transportation equipment, machinery, and electronics present a contrasting case. Their industries exchange substantial amounts of inputs, but their prices show relatively little same-industry cross-border connectedness. Specialized parts traded within supply chains do not face the same direct price competition as standardized commodities, and contractual arrangements, intra-firm trade, and infrequent price adjustment further weaken monthly price co-movement. In these industries, the exchange rate instead accounts for a substantial share of Canadian price variation, as shown in [Section 3.2](#).

Input–output linkages therefore help explain why prices move together across different industries, but they do not explain the strongest links between industry counterparts. Those links reflect competition in a common market, while the exchange rate accounts for an important part of the price variation in several Canadian industries. Cross-border price connectedness thus reflects more than the transmission of cost shocks through production networks.

3.4 Dynamic Connectedness

The full-sample measures average connectedness over two decades, masking changes in production linkages and the shocks affecting them ([Gaggl et al., 2026](#); [Avoumatsodo and Leunga Noukwe, 2025, 2026](#)). We therefore re-estimate the model over rolling 84-month windows, following [Diebold and Yılmaz \(2012\)](#), to examine how connectedness has evolved within the sample. The first window ends in December 2010 and the last in January 2025, yielding 170 estimates. We first examine aggregate connectedness, then distinguish

the patterns for Canadian and U.S. industries, and finally use a longer historical sample to assess whether cross-border connectedness has trended upward since the early years of North American trade integration. The next subsection examines connectedness around the U.S. tariff episodes of 2018–2019 and 2025–2026.

Figure 6 shows substantial variation in total connectedness. It is about 65 percent for windows ending between 2010 and 2013, falls to between 57 and 59 percent for windows ending between 2015 and 2020, and reaches a minimum of 56.4 percent in April 2017. This decline coincides with the exit of the late-2008 commodity price collapse from the estimation window.¹³ Connectedness subsequently rises, reaching 72.8 percent in March 2022, when the window includes the post-pandemic increase in producer prices and the associated global supply-chain pressures (di Giovanni et al., 2022). It remains between 65 and 68 percent in the final windows.

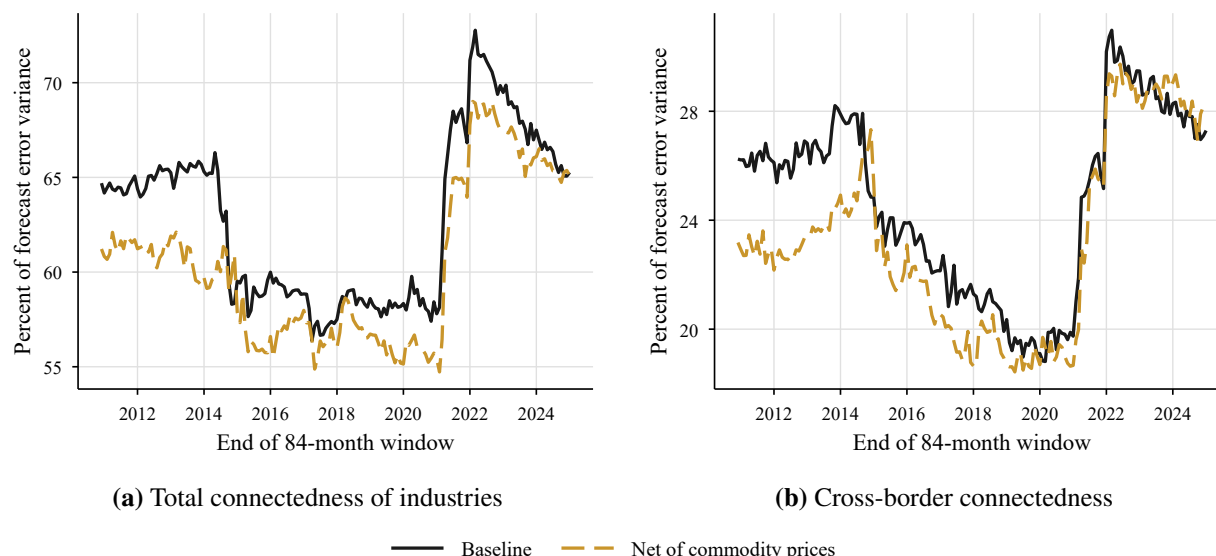


Figure 6: Rolling-Window Connectedness

Notes: This figure shows connectedness estimated on rolling windows. Panel (a) reports the average share, in percent, of the 12-month forecast error variance of the 42 industry prices that comes from other variables. Panel (b) reports the average share that comes from industries of the other country. Each point is estimated on the 84 months that end at the date on the horizontal axis. The solid line is the baseline system. The dashed line is the system estimated after removing from every series the variation explained by the current value and three lags of five global commodity price changes.

Cross-border connectedness follows a similar path, with larger relative changes. Averaged over the windows that end in each year (Appendix Table A.9), its share is between 26 and 27 percent before 2015, falls to 19.5 percent in 2019, and rises to 29.9 percent in 2022. The movement is more pronounced for Canadian industries. The share of their forecast error variance attributed to U.S. industries declines from about 25 percent to 16.0 percent in 2019 before rising to 31.2 percent in 2022. The corresponding share for U.S. industries, attributed to Canadian industries, remains between 22.9 and 29.2 percent.

The dashed lines in Figure 6 show the same measures net of commodity prices, as in Section 3.2. The two series move closely together, with correlations of 0.94 for total connectedness and 0.92 for the cross-border

¹³With 12 lags, the first usable observation in each window occurs one year after its first month. Observations from late 2008 therefore leave the estimation sample for windows ending from late 2014 onward.

share. Netting out commodity prices lowers total connectedness by 2.5 percentage points on average and cross-border connectedness by 1.4 points, and the difference is concentrated in windows containing the 2008 commodity price collapse. Commodity prices thus account for part of the high connectedness in the earlier windows, but do not explain the rise after 2021.

The dates attached to the estimates mark the ends of the windows, so a change reflects an event that enters or leaves the 84 months before that date. The rolling estimates average 62.8 percent across the 42 industry prices, compared with 56.0 percent in the full-sample model. The rolling model is estimated on fewer observations, so we compare its levels across windows. The pattern is the same with 60-month windows (Appendix Figure B.1). The two sets of estimates correlate 0.77 for total connectedness and 0.93 for the cross-border share, and neither shows a peak in cross-border connectedness around the 2018 tariffs.

Dynamics of Canadian Industries' Connectedness. The aggregate movements mask three patterns among Canadian industries (Appendix Figures B.4 and B.5). We compare windows ending in 2010–2014, 2015–2020, and 2021–2025. First, machinery, computer and electronics, transportation equipment, and paper remain tied to the domestic economy. In each period they receive between 48 and 61 percent of their forecast error variance from other Canadian industries and between 10 and 16 percent from the exchange rate, and the U.S. share of transportation equipment falls from 14.9 to 9.1 percent. Second, resource-based industries become more exposed to U.S. industries. The U.S. share rises from 40.6 to 53.6 percent for petroleum and coal and from 28.8 to 43.0 percent for wood products. Third, cross-border exposure falls in the middle period and recovers afterwards in fabricated metals (36.9, 9.6, and 35.4 percent), electrical equipment, apparel, leather, furniture, and primary metals. These industries account for the decline and recovery of Canada's aggregate cross-border share. Influence follows the same division. Transportation equipment, machinery, and computer and electronics contribute mainly to other Canadian industries, whereas petroleum and coal, wood products, chemicals, and food each contribute 41 to 62 percentage points to U.S. industries in the last period.

Dynamics of U.S. Industries' Connectedness. Cross-border connectedness is concentrated in the same resource-based industries in the United States, but its direction of change differs (Appendix Figures B.6 and B.7). The share of U.S. wood product price variance attributed to Canadian industries rises from 31.3 to 46.4 percent between the first and the last period, so the wood products link strengthens in both directions. For petroleum and coal, the share falls from 54.2 to 41.7 percent while Canadian exposure to U.S. industries rises, and for primary metals it falls from 40.5 to 25.6 percent. Food remains stable at about 35 percent. Most other U.S. industries turn toward domestic sources in the last period. The domestic share reaches 59.4 percent for plastics and rubber and for fabricated metals, and for transportation equipment it rises from about 10 to 46.9 percent while the share attributed to Canadian industries falls from 35.0 to 20.3 percent. The aggregate series therefore reflects shifts in the composition of connectedness across industries, not a common movement shared by all sectors.

Connectedness over a Longer Sample. Finally, we extend the analysis to 13 industries with earlier U.S. price data to assess whether cross-border connectedness has increased since the early years of North

American trade integration (Appendix C). The extended sample runs from February 1992 to August 2026. The cross-border share shows no clear upward trend. The fitted linear trend in the rolling estimates is 0.008 percentage points per year and is slightly negative net of commodity prices. The average share is 25.3 percent for windows ending in 1999–2003, 27.4 percent in 2009–2014, 20.5 percent in 2015–2020, and 27.7 percent in 2021–2026. The share rises in windows containing the commodity boom, the 2008–2009 crisis, or the 2021–2022 inflation surge, then returns toward its earlier level. Estimated on sub-periods, the cross-border share is lower in 2004–2026 than in 1992–2003, at 20.4 against 21.8 percent for Canadian industries and 23.4 against 25.1 percent for U.S. industries. Cross-border price connectedness has not increased with North American trade integration.

3.5 Tariffs and Connectedness

Tariffs between Canada and the United States changed in two episodes during our sample: 2018–2019 and from March 2025 onward. We examine how cross-border producer price connectedness changed during these episodes and whether prices in the protected market moved differently from prices in the partner country and on world markets. To include the second episode, we extend the sample through August 2026.¹⁴

We measure U.S. tariffs on Canadian goods using the effective rate paid by U.S. importers: duties collected on imports from Canada in an industry divided by the value of those imports.¹⁵ Panel (a) of Appendix Figure B.3 shows the two episodes. From June 2018 to May 2019, the effective rate on primary metals averaged 8.0 percent and remained close to zero in other industries. From March 2025 to August 2026, it averaged 18.3 percent for primary metals, 12.7 percent for fabricated metals, and 7.6 percent for transportation equipment, remaining below 6 percent elsewhere (Appendix Table A.7).

For each episode, we estimate the model on two samples that start on the same date and end just before the tariffs and at the end of the episode, so that the two samples differ only by the months under the tariffs. For the second episode, the samples run from September 2019 to January 2025 and to August 2026. For the first, they run from June 2012 to February 2018, the month before the tariffs were announced, and to May 2019. In each case the longer sample has 84 months, the length of our rolling windows.

Cross-border connectedness does not rise in either episode (Table 2). In the second, the average cross-border share is 29.2 percent before the tariffs and 25.4 percent at the end of the episode; in the first, it is 22.3 and 19.3 percent. Net of commodity prices, the shares are 25.3 and 22.9 percent in the second episode and 24.4 and 19.6 percent in the first. The share of Canadian industry price variance attributed to the exchange rate does not change. It is 5.6 and 5.8 percent in the first episode, and 3.3 and 3.4 percent in the second.

These changes are within the usual range of the measure. Extending a sample by a year and a half changes the cross-border share at other dates as well, because the added months bring new shocks and the estimates rest on more observations. We therefore repeat the comparison at every date of the sample, with two samples that start 84 months before the date and end 15 or 19 months apart, the lengths of the two tariff

¹⁴The extended sample has 20 industries per country because the U.S. price index for leather and allied products is no longer published. It runs from January 2004 to August 2026.

¹⁵The data are monthly imports for consumption and calculated duties by three-digit NAICS industry, from the U.S. Census Bureau, for January 2010 to August 2026. The measure covers ordinary and additional tariffs. It excludes anti-dumping and countervailing duties, which apply to softwood lumber throughout the period.

Table 2: Sources of Industry Price Variance Before and During the Tariff Episodes

Sample	Canadian industries				U.S. industries			
	Own shocks	Domestic industries	Cross-border	Exchange rate	Own shocks	Domestic industries	Cross-border	Exchange rate
<i>Panel A. Tariffs of 2018–2019</i>								
June 2012 – February 2018	31.4	44.6	18.4	5.6	46.1	26.1	26.2	1.7
June 2012 – May 2019	35.8	42.3	16.1	5.8	50.2	26.0	22.5	1.4
<i>Panel B. Tariffs of 2025–2026</i>								
September 2019 – January 2025	37.3	30.1	29.3	3.3	28.4	41.6	29.1	1.0
September 2019 – August 2026	42.9	28.8	24.9	3.4	35.9	37.4	25.9	0.9

Notes: This table shows the sources of the variance of industry prices before and at the end of each tariff episode. Each row reports the average share, in percent, of the 12-month forecast error variance of an industry's price growth that comes from its own shocks, from other industries of the same country, from industries of the other country, and from the exchange rate. Rows sum to 100 within a country. In each panel, the two samples start on the same date; the first ends before the tariffs and the second at the end of the episode. The system has 20 industries per country.

comparisons. Across the 189 dates, the cross-border share changes on average by -1.3 percentage points over 15 months and by -1.7 points over 19 months, and 90 percent of the changes lie between -3.6 and 4.3 points and between -4.5 and 4.8 points, respectively. The changes measured in the two tariff episodes lie within these ranges, and so do the changes in the shares of own shocks and of domestic industries.¹⁶ Across industries, the change in the cross-border share is unrelated to the effective tariff rate (Appendix Table A.7).

The prices of primary metals show what the tariffs did when they took effect (Appendix Figure B.3, panel b). By May 2025, two months after the tariffs began, the U.S. price had increased by 14.1 percent from January, compared with 4.2 percent for Canada and 1.2 percent for world base metal prices. This divergence is consistent with evidence that tariffs are passed through to prices paid in the importing country (Amiti et al., 2019b; Fajgelbaum et al., 2020; Cavallo et al., 2021, 2025). World prices then rose, and Canadian prices increased more rapidly than U.S. prices. By January 2026 the Canadian index was 29 percentage points above the U.S. index. The U.S. index caught up afterwards. By August 2026, the world, Canadian, and U.S. series stood 43.6, 41.2, and 38.3 percent above their January 2025 levels, respectively. The national prices end relatively close together, but their paths differ substantially during the episode. In the first episode, between May 2018 and May 2019, the world price fell by 16 percent and the Canadian price by 4 percent, while the U.S. price stayed at its level.

Cross-border connectedness stayed within its usual range in both episodes. The sources of connectedness identified in Sections 3.2 and 3.3 explain this stability. The tariffs fell mainly on primary metals, whose cross-border link reflects common world metal prices rather than bilateral transmission, and on transportation equipment, whose Canadian prices follow the exchange rate rather than U.S. prices. The tariffs could move U.S. prices away from world prices for a time, but there was little bilateral transmission for them to interrupt.

The Canadian counter-tariff on U.S. steel and aluminum took effect in March 2025. Canadian primary metal prices show no discernible increase in the following spring and continue to track world base metal

¹⁶At the two tariff dates, this exercise gives changes of -2.7 and -2.0 points, against -3.0 and -3.8 points in Table 2. The difference comes from the random assignment of months to the folds of the cross-validation that selects the penalty.

prices. The counter-tariff left no visible mark on Canadian prices.

Taken together, cross-border producer price connectedness stayed within its usual range under the tariffs of both episodes, and the exchange rate share did not change. In primary metals, the U.S. price rose relative to the Canadian price and the world price when the tariffs of 2025 took effect.

4 Robustness and the Nature of the Measure

Our results depend on two choices: regularizing a large VAR with Elastic Net and measuring connectedness through generalized forecast error variance decompositions. This section examines what the regularization selects, how sensitive the estimates are to alternative specifications, and what the resulting measures capture.

The estimated lag structure is sparse in most equations. The procedure selects the lasso penalty in 19 of the 43 equations, the ridge penalty in 6, and an intermediate mix in the remaining 18. The six ridge equations retain all 516 coefficients, shrunk toward zero. In the other 37 equations, the median number of non-zero coefficients is one, the mean is 8.3, and 15 equations retain no lagged variables. Selection is concentrated in own lags in U.S. equations. In these equations, 20.1 percent of own-lag coefficients are non-zero, compared with 4.4 percent of coefficients on other U.S. industries and 1.3 percent of those on Canadian industries. In Canadian equations, the corresponding shares are 1.3 percent for own lags, 0.1 percent for other Canadian industries, and 0.3 percent for U.S. industries. Cross-border lags are therefore rarely selected, and are no more prevalent than domestic cross-industry lags in Canadian equations. Selection also declines with lag length, from 6.9 percent of first-lag coefficients to 2.3 percent at the third lag and 0.2 percent at the twelfth.

The limited lag structure helps explain why the connectedness estimates change little with the forecast horizon. At a one-month horizon, the generalized variance decomposition depends on the covariance matrix of the VAR residuals. Total connectedness of the 42 industry prices is already 53.7 percent, close to the 56.0 percent estimated at twelve months. About 96 percent of measured connectedness is thus already present within the month. The cross-border shares are also similar, at 21.3 percent for Canadian industries and 21.4 percent for U.S. industries at one month, compared with 21.6 and 22.8 percent at twelve months. The small difference indicates that extending the forecast horizon adds relatively little to measured connectedness. At six and twenty-four months, total connectedness is 55.7 and 56.0 percent, respectively, and the rankings of industry-level measures have correlations of at least 0.99 with the twelve-month baseline.

The results are also robust to several alternative regularization choices (Appendix Table A.8). Imposing a common mixing parameter across equations, ranging from ridge to lasso, leaves total connectedness between 56.4 and 58.3 percent, the Canadian cross-border share between 22.1 and 23.3 percent, and the U.S. share between 22.2 and 23.1 percent. The ranking of industries by cross-border exposure has a rank correlation of at least 0.95 with the baseline. Estimates with one, three, or six lags yield total connectedness between 54.9 and 56.1 percent, with rank correlations of at least 0.94. The main sensitivity concerns the strength of the penalty. Using the cross-validation minimum rather than the selected penalty retains an average of 247 coefficients per equation. Total connectedness then falls to 52.6 percent, the Canadian cross-border share to 17.5 percent, and the U.S. share rises to 24.4 percent; the rank correlation with the baseline is 0.86. Despite this sensitivity, the estimates continue to indicate substantial cross-border connectedness, with

shares generally around one fifth.

The frequency of price changes matters more than these alternative VAR specifications. Using year-over-year rather than monthly price changes raises total connectedness to 75.2 percent, the Canadian cross-border share to 25.4 percent, and the U.S. share to 40.9 percent. The rank correlation between industry-level exposure under this specification and the monthly baseline falls to 0.57. Year-over-year changes smooth short-term fluctuations and give greater weight to persistent movements shared across industries, including the adjustment of prices to input costs. However, consecutive year-over-year changes overlap in eleven of their twelve monthly observations, mechanically inducing serial correlation. This overlap changes the dynamics entering the VAR and complicates the interpretation of its variance decomposition. We therefore retain monthly changes as the baseline. The year-over-year results show that measured connectedness is sensitive to the frequency and construction of price changes, rather than providing a clean estimate of connectedness at a lower frequency.

These results have two implications for interpretation. First, the measures primarily describe contemporaneous co-movement in monthly price changes. The one-month estimates are close to those at longer horizons, while the sparse estimated lag structure provides limited evidence of additional propagation over subsequent months.

Second, the difference between an industry's influence and its exposure reflects its place in the correlation structure of prices. At a one-month horizon, the generalized variance decomposition is determined by the covariance matrix of the residuals. For a pair of industries, the unnormalized contribution is proportional to the squared correlation between their residuals; normalization by the receiving industry's total contribution makes the connectedness matrix asymmetric. An industry consequently appears as a net transmitter when its residuals co-move with industries whose price changes have fewer other correlates.

5 Conclusion and Policy Implications

Canadian and U.S. producer prices are connected, but the sources of this connectedness differ across industries. Industries in the other country account for about one fifth of the forecast-error variance of the average industry in both countries. A model estimated for each country separately attributes part of this cross-border connectedness to domestic industries. Despite three decades of trade integration, cross-border connectedness shows no sustained upward trend. Nor did cross-border connectedness increase during the 2018–2019 and 2025–2026 tariff episodes.

World commodity prices account for much of the cross-border connectedness in petroleum and coal, primary metals, and chemicals. Controlling for these prices cuts cross-border connectedness in these industries by about half. In wood products and food, connectedness persists after the commodity controls, consistent with producers competing for the same buyers in a common North American market. These links do not follow direct input purchases. By contrast, connectedness between different industries increases with input–output linkages, both within and across countries.

The exchange rate provides another route for external shocks to reach producer prices, particularly in Canadian transportation equipment, machinery, and computer and electronics. In these industries, Canadian-

dollar prices track the exchange rate more closely than the prices of U.S. counterparts. Including currency movements, total foreign exposure is similar in Canada and the United States, at 25.8 and 24.0 percent, respectively, but the sources differ: Canada's exposure runs more strongly through the exchange rate.

These findings show why the source of price co-movement matters for policy. Where prices follow world commodity markets, as in petroleum and coal, primary metals, and chemicals, bilateral trade measures cannot insulate either country from global price movements. Tariffs can temporarily separate U.S. prices from world and Canadian prices, as occurred in primary metals in 2025, but they do not eliminate exposure to world markets.

Where producers compete in a common market, as in wood products and food, bilateral trade measures act directly on an established cross-border price relationship. Where connectedness follows input–output linkages, disruptions can spread from suppliers to the industries that buy from them, both within and across countries. Diversified sourcing and inventories can help firms manage this exposure.

For Canada, the exchange rate is particularly important in transportation equipment, machinery, and computer and electronics. A depreciation of the Canadian dollar raises their Canadian-dollar prices, while an oil price increase can lower them through currency appreciation. Inflation forecasting and monetary policy should therefore account for exchange-rate exposure in these industries rather than treating U.S. producer prices as their main external reference.

Extending the analysis to Mexico would show how trade-policy changes reshape price connectedness across the Canada–United States–Mexico Agreement region, including whether a tariff on one partner redirects co-movement toward the other.

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A Additional Tables

Table A.1: Data Sources

Data	Source	Coverage
Canadian producer prices, 21 industries	Statistics Canada, Industrial Product Price Index by industry (table 18-10-0267-01)	Monthly, December 2003 to January 2025
U.S. producer prices, 21 industries	Bureau of Labor Statistics, Producer Price Index by industry, retrieved from FRED	Monthly, December 2003 to January 2025
Exchange rate, Canadian dollars per U.S. dollar	Board of Governors of the Federal Reserve System, retrieved from FRED	Monthly average, December 2003 to January 2025
Producer prices and exchange rate, extended	Statistics Canada (tables 18-10-0267-01, 33-10-0163-01, 10-10-0009-01); Bureau of Labor Statistics	Monthly, to August 2026; from January 1992 for 13 industries
World commodity prices: crude oil, base metals, food, timber, fertilizers	World Bank, Commodity Price Data	Monthly, to August 2026
Oil supply and demand shocks	Baumeister and Hamilton (2019)	Monthly, January 2005 to January 2025
Oil supply news shocks	Känzig (2021)	Monthly, January 2005 to January 2025
Input–output flows and gross output	OECD, Inter-Country Input-Output Tables, 2021 edition	Annual, 2014
U.S. imports from Canada and calculated duties, by industry	U.S. Census Bureau, international trade data	Monthly, January 2010 to August 2026

Notes: This table shows the data used in the paper, with their sources and their coverage. Industries are the three-digit manufacturing industries of the North American Industry Classification System listed in Table A.2. Coverage is the period used in the paper.

Table A.2: Manufacturing Industries

NAICS	Industry	Label in figures
311	Food manufacturing	Food
312	Beverage and tobacco product manufacturing	Beverage and tobacco
313	Textile mills	Textile mills
314	Textile product mills	Textile product mills
315	Apparel manufacturing	Apparel
316	Leather and allied product manufacturing	Leather
321	Wood product manufacturing	Wood products
322	Paper manufacturing	Paper
323	Printing and related support activities	Printing
324	Petroleum and coal product manufacturing	Petroleum and coal
325	Chemical manufacturing	Chemicals
326	Plastics and rubber products manufacturing	Plastics and rubber
327	Non-metallic mineral product manufacturing	Non-metallic minerals
331	Primary metal manufacturing	Primary metals
332	Fabricated metal product manufacturing	Fabricated metals
333	Machinery manufacturing	Machinery
334	Computer and electronic product manufacturing	Computer and electronics
335	Electrical equipment, appliance and component manufacturing	Electrical equipment
336	Transportation equipment manufacturing	Transportation equipment
337	Furniture and related product manufacturing	Furniture
339	Miscellaneous manufacturing	Miscellaneous

Notes: This table shows the three-digit manufacturing industries of the North American Industry Classification System (NAICS) used in the analysis. Each industry is observed in Canada and in the United States.

Table A.3: Cross-Border Exposure by Sector

	Share of variance (percent)			
	Baseline	Commodity prices in the VAR		Net of commodity prices
	Cross-border	Cross-border	Commodities	Cross-border
Petroleum and coal, Canada	46.3	32.2	27.2	24.5
Petroleum and coal, United States	46.9	35.7	24.7	36.5
Primary metals, Canada	30.1	21.6	23.3	5.1
Primary metals, United States	30.8	25.8	17.1	15.4
Chemicals, Canada	33.0	26.9	13.8	10.7
Chemicals, United States	23.6	20.9	15.4	11.9
Wood products, Canada	42.4	41.2	2.5	42.9
Wood products, United States	45.9	43.5	5.2	48.1
Food, Canada	33.1	30.3	2.0	35.3
Food, United States	29.1	28.8	7.4	27.1
Mean, petroleum, metals, chemicals (6)	35.1	27.2	20.2	17.3
Mean, other industries (36)	20.0	19.2	4.5	21.3
Mean, all industries (42)	22.2	20.3	6.8	20.7

Notes: This table shows cross-border exposure by sector, with and without global commodity prices. *Cross-border* is the share, in percent, of an industry's 12-month forecast error variance that comes from industries of the other country. *Commodities* is the share that comes from the five commodity prices added to the VAR. Group means are unweighted. Appendix Table A.4 reports all 42 industries.

Table A.4: Cross-Border Exposure With and Without Global Commodity Prices, All Industries

Country	Industry	Baseline	Commodity prices in the VAR		Net of commodity prices	First-stage R^2
			Cross-border	Commodities		
Canada	Petroleum and coal	46.3	32.2	27.2	24.5	0.80
Canada	Wood products	42.4	41.2	2.5	42.9	0.08
Canada	Food	33.1	30.3	2.0	35.3	0.25
Canada	Chemicals	33.0	26.9	13.8	10.7	0.45
Canada	Primary metals	30.1	21.6	23.3	5.1	0.56
Canada	Electrical equipment	28.8	28.0	3.4	29.3	0.15
Canada	Non-metallic minerals	28.7	29.0	0.1	32.0	0.07
Canada	Fabricated metals	24.5	23.7	3.5	24.9	0.26
Canada	Furniture	24.4	24.6	1.0	27.0	0.14
Canada	Beverage and tobacco	18.2	18.1	1.6	26.0	0.04
Canada	Leather	17.9	18.2	1.3	16.0	0.11
Canada	Printing	17.2	17.0	2.0	30.3	0.07
Canada	Apparel	17.0	17.0	1.8	21.6	0.06
Canada	Textile product mills	16.6	16.4	1.7	20.3	0.07
Canada	Textile mills	13.3	13.3	2.7	21.4	0.08
Canada	Miscellaneous	12.6	12.2	2.3	9.6	0.10
Canada	Plastics and rubber	12.2	10.8	8.9	23.1	0.25
Canada	Transportation equipment	10.9	8.3	15.6	4.4	0.42
Canada	Computer and electronics	9.6	8.0	14.0	7.1	0.35
Canada	Machinery	9.0	7.8	10.8	13.5	0.30
Canada	Paper	7.5	6.6	8.7	13.6	0.24
United States	Petroleum and coal	46.9	35.7	24.7	36.5	0.73
United States	Wood products	45.9	43.5	5.2	48.1	0.12
United States	Primary metals	30.8	25.8	17.1	15.4	0.54
United States	Food	29.1	28.8	7.4	27.1	0.34
United States	Non-metallic minerals	27.0	26.3	1.3	24.4	0.11
United States	Furniture	25.7	25.1	2.0	22.7	0.20
United States	Beverage and tobacco	24.7	24.4	0.6	24.2	0.08
United States	Chemicals	23.6	20.9	15.4	11.9	0.60
United States	Paper	21.0	20.1	5.7	18.7	0.26
United States	Fabricated metals	20.2	18.5	9.9	16.7	0.40
United States	Machinery	20.0	19.0	3.0	19.6	0.20
United States	Plastics and rubber	20.0	17.9	8.4	17.1	0.46
United States	Electrical equipment	19.3	17.2	11.4	14.8	0.34
United States	Computer and electronics	18.5	18.6	0.8	24.4	0.07
United States	Textile mills	17.3	15.4	6.0	13.5	0.31
United States	Miscellaneous	17.2	16.3	5.6	18.6	0.13
United States	Printing	17.1	16.7	2.2	16.9	0.14
United States	Transportation equipment	16.7	15.8	4.4	13.3	0.16
United States	Leather	13.7	12.5	3.9	18.7	0.11
United States	Apparel	12.2	12.1	1.0	14.7	0.06
United States	Textile product mills	11.7	11.4	0.7	13.5	0.08

Notes: This table shows the cross-border exposure of each industry, with and without global commodity prices. The three *cross-border* columns report the share, in percent, of an industry's 12-month forecast error variance that comes from industries of the other country in the baseline system, in the system with the five commodity prices added to the VAR, and in the system net of commodity prices. *Commodities* is the share that comes from the five commodity prices. *First-stage* R^2 is from the regression of the industry's price growth on the current value and three lags of the five commodity price changes.

Table A.5: Same-Industry Cross-Border Spillovers

	U.S. to Canada		Canada to U.S.		Residual correlation	
	Baseline	Net	Baseline	Net	Baseline	Net
Wood products	38.1	39.2	32.5	37.8	0.89	0.89
Petroleum and coal	25.0	19.7	24.3	26.7	0.90	0.68
Food	20.6	17.1	18.4	19.5	0.64	0.60
Primary metals	9.7	0.5	8.8	0.7	0.47	0.12
Chemicals	6.9	2.6	7.1	2.7	0.40	0.25

Notes: This table shows the spillovers between the same industry in the two countries. *U.S. to Canada* is the share, in percent, of the Canadian industry's 12-month forecast error variance that comes from the same industry in the United States; *Canada to U.S.* is the reverse. *Residual correlation* is the correlation between the two industries' VAR residuals. *Net* refers to the specification net of commodity prices.

Table A.6: Input–Output Linkages and Pairwise Connectedness

	Domestic pairs		Cross-border pairs	
	(1)	(2)	(3)	(4)
<i>Panel A. Baseline connectedness</i>				
Linkage share	0.73*** (0.22)	0.43* (0.26)	1.25*** (0.44)	1.70*** (0.56)
Input intensity	0.10* (0.06)		0.01 (0.05)	
R^2	0.02	0.21	0.03	0.12
<i>Panel B. Net of commodity prices</i>				
Linkage share	0.45*** (0.16)	0.33* (0.19)	1.02*** (0.36)	1.53*** (0.48)
Input intensity	0.07* (0.04)		0.01 (0.04)	
R^2	0.01	0.31	0.02	0.09
Receiving-industry fixed effects	No	Yes	No	Yes
Source-industry fixed effects	No	Yes	No	Yes
Observations	804	804	882	882

Notes: This table shows regressions of pairwise connectedness on input–output linkages. The dependent variable is the share, in percent, of industry j in the connectedness that industry i receives from the industries of j 's country. *Linkage share* is the share of industry j in the intermediate input expenditure of industry i (equation 12); *Input intensity* is the share of intermediate inputs in the gross output of industry i (equation 11), which the receiving-industry fixed effect absorbs. Both regressors are standardized. The sample is the pairs of different industries, within a country in columns (1) and (2) and across the border in columns (3) and (4). Panel A uses the connectedness table of Section 3.1; Panel B uses the table estimated net of commodity prices. Standard errors clustered by receiving industry are in parentheses. Input–output data: OECD Inter-Country Input-Output Tables, 2014. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$.

Table A.7: Effective Tariff Rates and Change in Cross-Border Exposure

	Effective tariff rate		Canadian industry		U.S. industry	
	2018–19	2025–26	Exposure	Change	Exposure	Change
Primary metals	8.0	18.3	30.2	−9.0	21.6	−5.4
Fabricated metals	0.4	12.7	36.7	−2.1	22.3	−0.5
Transportation equipment	0.1	7.6	15.2	−7.8	20.7	−4.2
Textile product mills	1.0	5.7	26.1	−6.5	29.6	−2.9
Computer and electronics	0.1	3.8	13.2	−1.1	24.0	14.6
Machinery	0.1	3.8	12.7	−3.2	37.7	−8.2
Electrical equipment	0.4	3.7	28.5	−5.1	36.6	−21.8
Furniture	0.0	3.3	43.4	−9.5	23.3	−1.9
Apparel	0.3	2.3	25.6	−8.0	15.8	−6.7
Wood products	0.0	2.2	42.8	2.0	45.9	−2.4
Textile mills	0.2	1.7	27.7	−4.9	29.3	−2.8
Beverage and tobacco	0.6	1.5	30.7	−3.6	37.8	−5.5
Miscellaneous	0.1	1.2	18.4	−4.1	16.6	−5.4
Non-metallic minerals	0.1	0.8	44.0	−3.0	31.8	−3.3
Plastics and rubber	0.1	0.7	21.6	−4.2	33.7	−0.1
Food	0.1	0.6	42.9	−6.8	28.4	−4.3
Chemicals	0.1	0.6	34.3	6.2	30.4	0.5
Printing	0.0	0.5	23.2	−9.4	17.4	−2.3
Paper	0.0	0.4	21.1	−4.8	34.8	−3.1
Petroleum and coal	0.0	0.1	48.2	−2.8	43.5	2.1
Mean	0.6	3.6	29.3	−4.4	29.1	−3.2

Notes: This table shows effective tariff rates and the change in cross-border exposure, by industry. *Effective tariff rate* is the duties collected on U.S. imports from Canada as a percentage of the value of these imports, for June 2018 to May 2019 and for March 2025 to August 2026. *Exposure* is the share, in percent, of the industry's 12-month forecast error variance that comes from industries of the other country in the sample from September 2019 to January 2025; *Change* is the difference, in percentage points, with the sample from September 2019 to August 2026. Industries are ranked by the 2025–26 tariff rate. Leather is excluded because its U.S. price index is no longer published.

Table A.8: Robustness of Full-Sample Connectedness

	Total	Cross-border share		Rank	Non-zero
	connectedness	Canada	United States	correlation	coefficients
Baseline	56.0	21.6	22.8	1.00	79.1
<i>Forecast horizon</i>					
1 month	53.7	21.3	21.4	0.96	
6 months	55.7	21.6	22.6	0.99	
24 months	56.0	21.6	22.8	1.00	
<i>Mixing parameter, same value in all equations</i>					
$\alpha = 0$ (ridge)	58.3	23.3	23.1	0.97	516.0
$\alpha = 0.25$	56.9	22.2	22.7	0.98	7.0
$\alpha = 0.50$	56.7	22.2	22.5	0.96	4.5
$\alpha = 0.75$	56.6	22.2	22.3	0.95	3.2
$\alpha = 1$ (lasso)	56.4	22.1	22.2	0.95	2.4
<i>Penalty and lag length</i>					
Penalty at the cross-validation minimum	52.6	17.5	24.4	0.86	247.3
1 lag	56.1	21.1	22.8	0.94	9.8
3 lags	54.9	20.4	22.8	0.98	24.3
6 lags	55.5	21.3	22.0	0.96	53.0
<i>Frequency of price changes</i>					
Year-over-year changes	75.2	25.4	40.9	0.57	

Notes: This table shows connectedness under alternative choices of estimation. *Total connectedness* is the average share, in percent, of the forecast error variance of the 42 industry prices that comes from other variables. *Cross-border share* is the average share that comes from industries of the other country. *Rank correlation* is the Spearman correlation, across the 42 industries, between cross-border exposure in the row's specification and in the baseline. *Non-zero coefficients* is the average number per equation, out of 516 in the baseline. The baseline uses a horizon of 12 months, 12 lags, a mixing parameter selected equation by equation, and the largest penalty within one standard error of the cross-validation minimum.

Table A.9: Rolling-Window Connectedness by Year

Windows ending in	Windows	Total connectedness	Cross-border share		
			All industries	Canadian industries	U.S. industries
2010	1	64.7	26.2	24.2	28.3
2011	12	64.5	26.3	24.5	28.0
2012	12	64.9	26.1	24.0	28.3
2013	12	65.4	26.9	24.8	28.9
2014	12	63.1	27.1	25.0	29.2
2015	12	59.0	23.8	22.2	25.4
2016	12	59.2	23.0	20.9	25.1
2017	12	57.4	21.6	18.8	24.5
2018	12	58.5	20.9	17.8	24.0
2019	12	58.1	19.5	16.0	23.0
2020	12	58.4	19.6	16.2	22.9
2021	12	65.3	24.4	24.3	24.4
2022	12	71.0	29.9	31.2	28.6
2023	12	68.3	28.6	30.7	26.6
2024	12	66.2	27.7	29.3	26.0
2025	1	65.3	27.3	27.5	27.1

Notes: This table shows the rolling-window connectedness of Figure 6, averaged over the windows that end in each year. Each window covers 84 months and is dated by its final month. *Total connectedness* is the average share, in percent, of the 12-month forecast error variance of the 42 industry prices that comes from other variables. *Cross-border share* is the average share that comes from industries of the other country: for all 42 industries, for the 21 Canadian industries (from U.S. industries), and for the 21 U.S. industries (from Canadian industries). Baseline system.

B Additional Figures

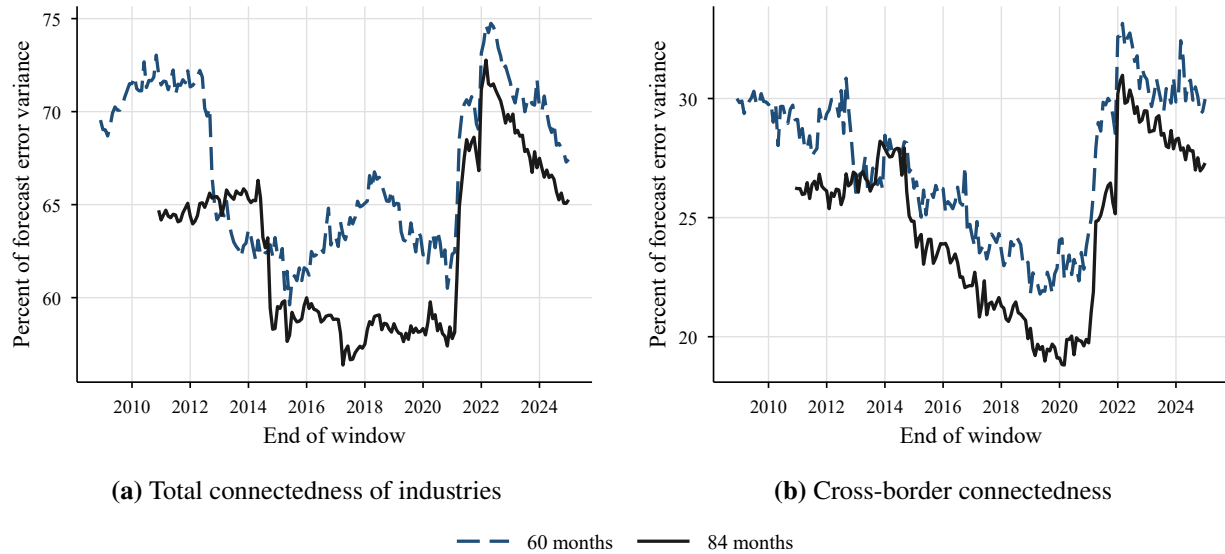
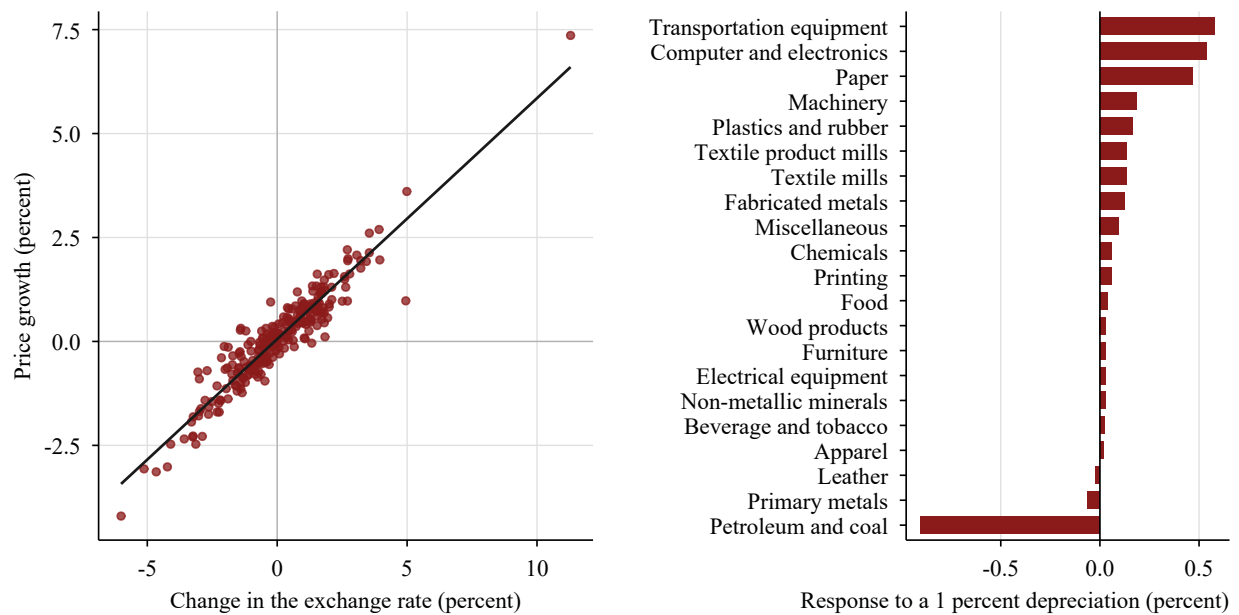


Figure B.1: Rolling-Window Connectedness with 84-Month and 60-Month Windows

Notes: This figure shows rolling-window connectedness estimated with windows of 84 and of 60 months. Panel (a) reports the average share, in percent, of the 12-month forecast error variance of the 42 industry prices that comes from other variables. Panel (b) reports the average share that comes from industries of the other country. Both panels use the baseline system. Each point is estimated on the 84 months (solid line) or the 60 months (dashed line) that end at the date on the horizontal axis.

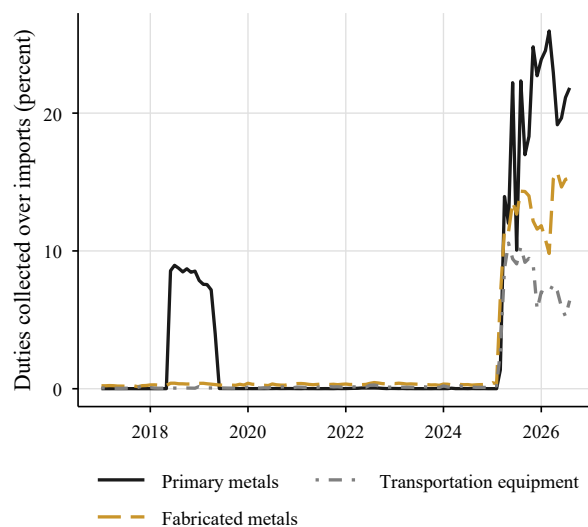


(a) Canadian transportation equipment

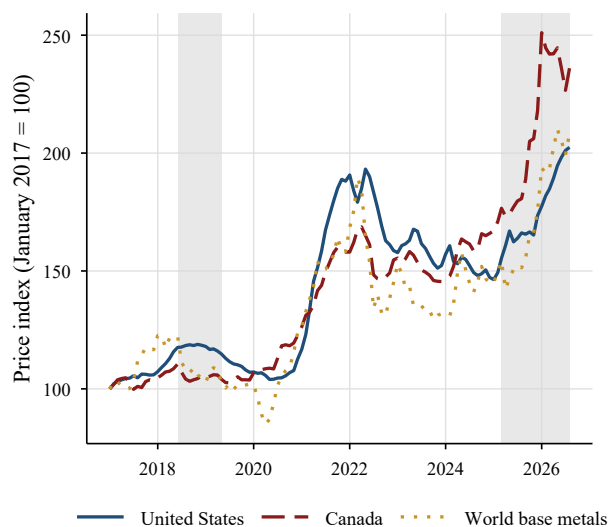
(b) All Canadian industries

Figure B.2: Canadian Producer Prices and the Exchange Rate

Notes: This figure shows the response of Canadian producer prices to the exchange rate. Panel (a) plots the monthly growth of the producer price of Canadian transportation equipment against the monthly change in the exchange rate, in Canadian dollars per U.S. dollar, so that a positive change is a depreciation of the Canadian dollar; the line is the least squares fit, with a slope of 0.58 and an R^2 of 0.89. Panel (b) reports, for each Canadian industry, the slope of the same regression. The slope is negative for petroleum and coal because an increase in the price of oil raises the price of refined products and appreciates the Canadian dollar. Sample: January 2004 to January 2025.



(a) Effective U.S. tariff rate on imports from Canada



(b) Primary metal prices

Figure B.3: Tariffs and Prices

Notes: This figure shows the U.S. tariff on imports from Canada and the prices of primary metals. Panel (a) reports the duties collected on U.S. imports from Canada as a percentage of the value of these imports, by month, for the three industries with the highest rates. Panel (b) reports the producer price of primary metals in the United States and in Canada and the World Bank index of base metal prices, each as an index equal to 100 in January 2017. The Canadian price is in Canadian dollars; the Canadian dollar lost 6 percent against the U.S. dollar in 2024 and gained 2 percent between December 2024 and August 2026. The shaded areas mark the two tariff episodes. Sources: U.S. Census Bureau, Bureau of Labor Statistics, Statistics Canada, World Bank.

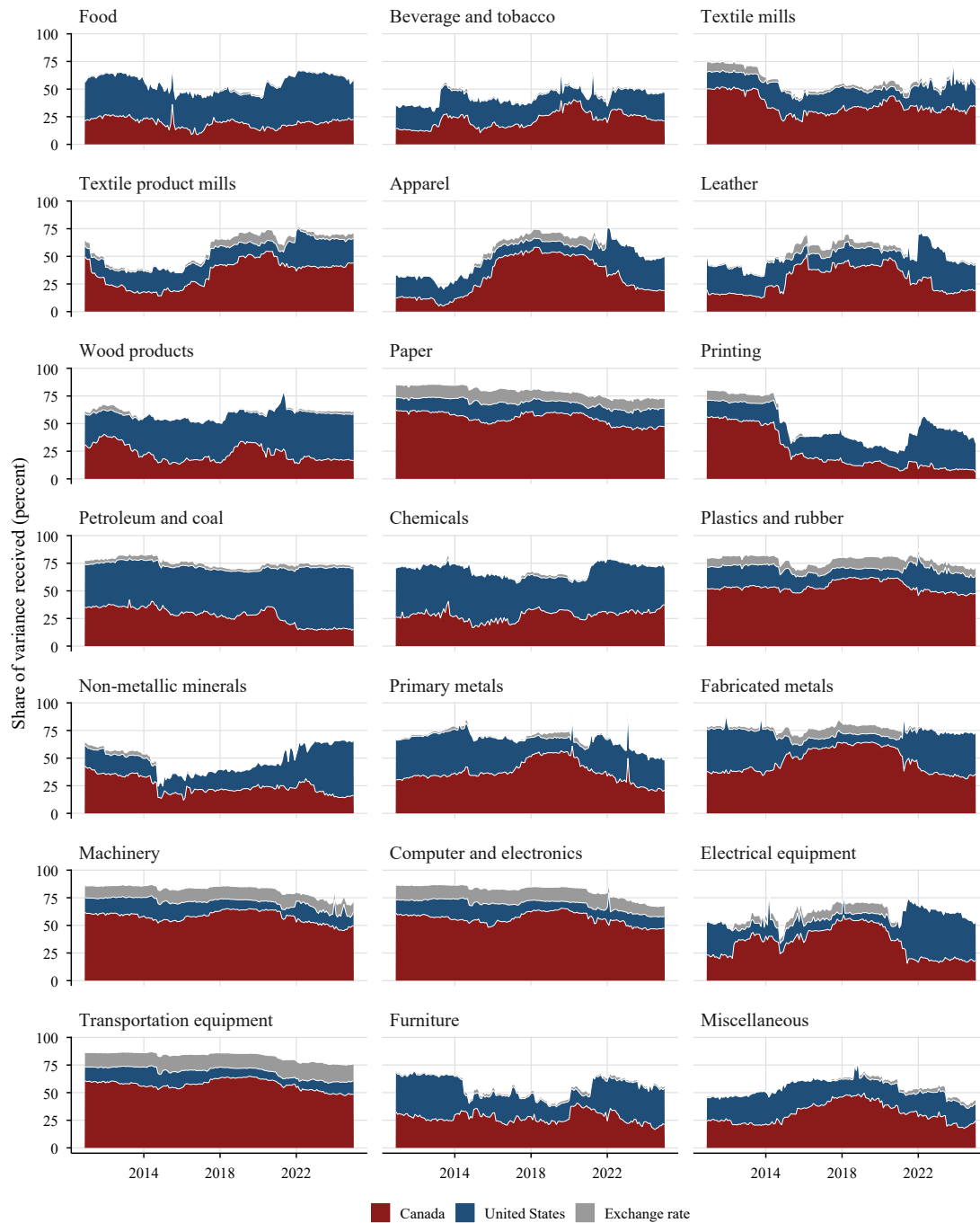


Figure B.4: Exposure of Canadian Industries over Time, by Source

Notes: This figure shows the exposure of each Canadian industry over time, by source. Each panel reports, for one Canadian industry, the share of the 12-month forecast error variance that comes from other Canadian industries (red), from U.S. industries (blue), and from the exchange rate (grey). Each point is estimated on the 84 months that end at the date on the horizontal axis.

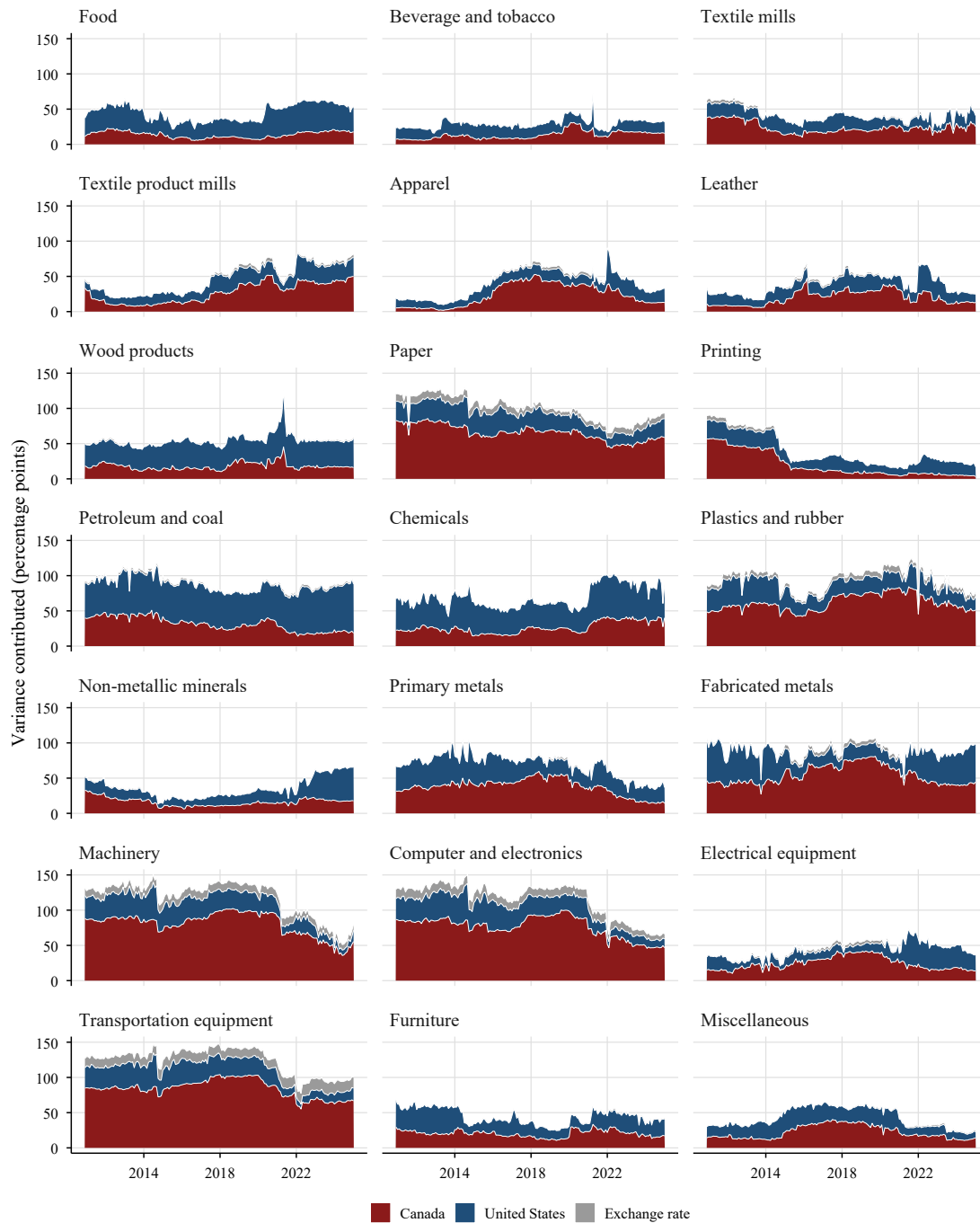


Figure B.5: Influence of Canadian Industries over Time, by Destination

Notes: This figure shows the influence of each Canadian industry over time, by destination. Each panel reports, for one Canadian industry, the variance that its shocks contribute, in percentage points, to other Canadian industries (red), to U.S. industries (blue), and to the exchange rate (grey). Each point is estimated on the 84 months that end at the date on the horizontal axis.

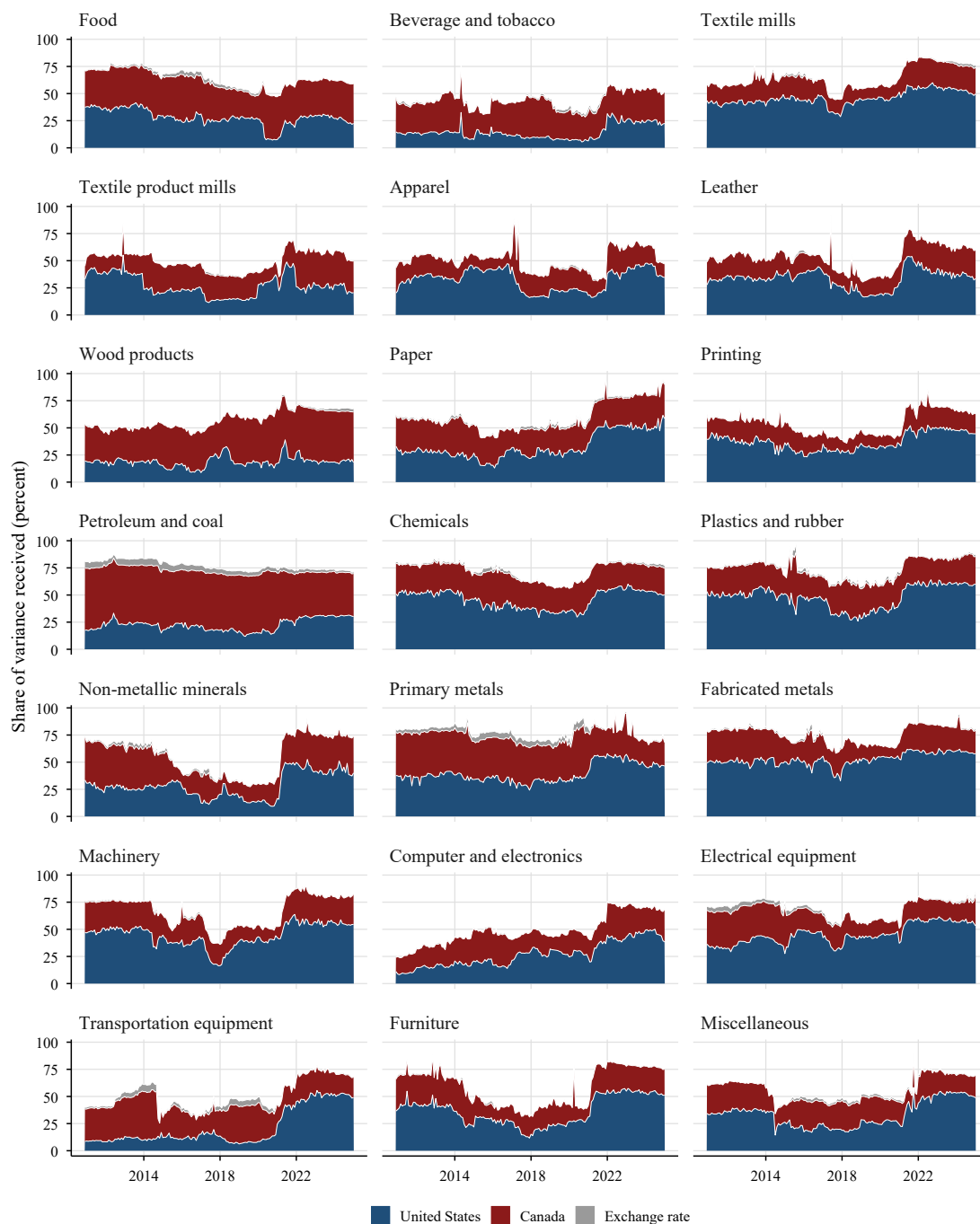


Figure B.6: Exposure of U.S. Industries over Time, by Source

Notes: This figure shows the exposure of each U.S. industry over time, by source. Each panel reports, for one U.S. industry, the share of the 12-month forecast error variance that comes from other U.S. industries (blue), from Canadian industries (red), and from the exchange rate (grey). Each point is estimated on the 84 months that end at the date on the horizontal axis.

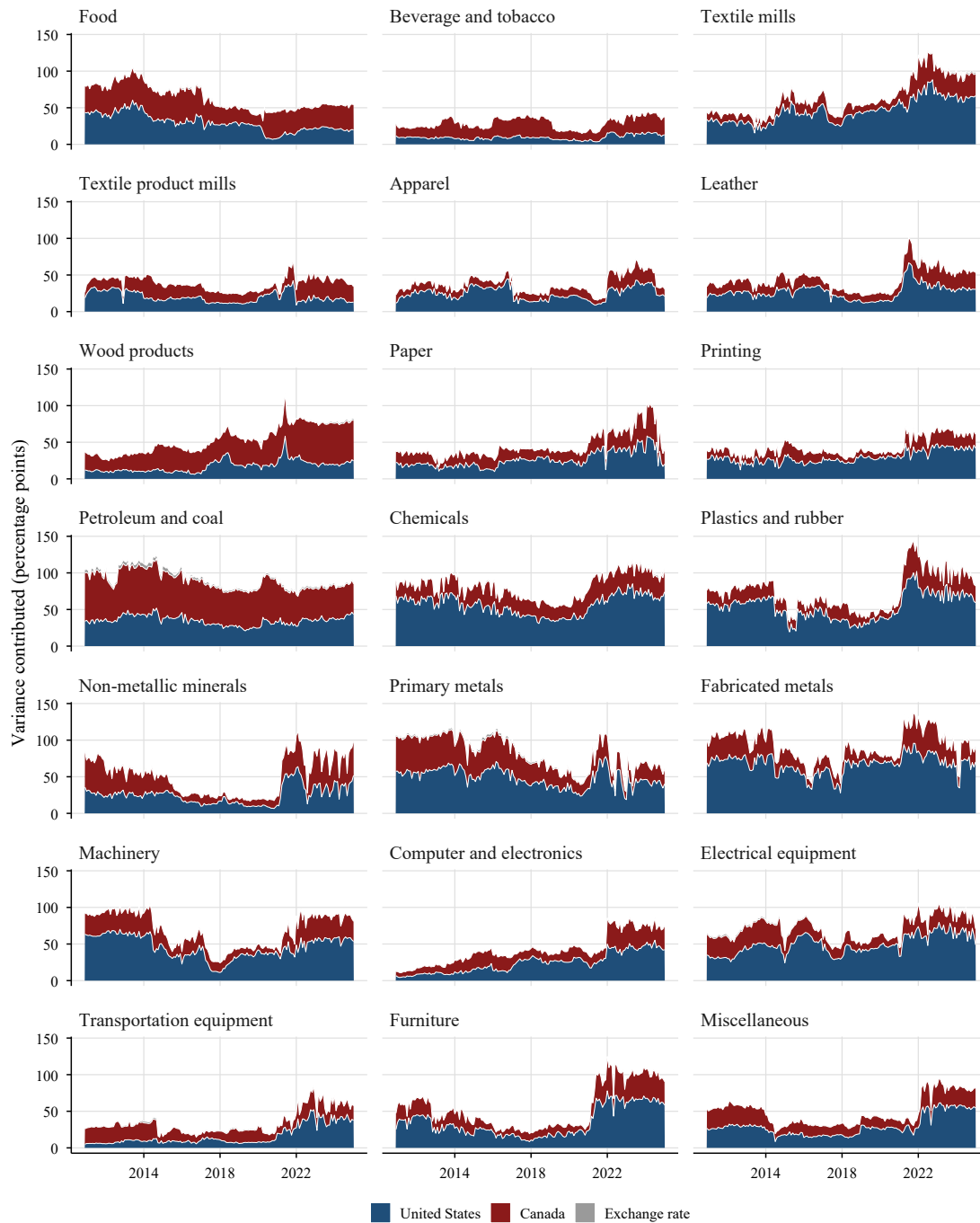


Figure B.7: Influence of U.S. Industries over Time, by Destination

Notes: This figure shows the influence of each U.S. industry over time, by destination. Each panel reports, for one U.S. industry, the variance that its shocks contribute, in percentage points, to other U.S. industries (blue), to Canadian industries (red), and to the exchange rate (grey). Each point is estimated on the 84 months that end at the date on the horizontal axis.

C A Longer Sample

The baseline sample starts in December 2003 because 12 of the 21 U.S. industry price indices start in that month, when the Bureau of Labor Statistics moved the Producer Price Index to the NAICS classification. Nine U.S. industries have indices that go back to the 1980s. One of them, leather, is no longer published. The other eight are food, petroleum and coal, chemicals, plastics and rubber, non-metallic minerals, primary metals, fabricated metals, and furniture. For five other industries, the Bureau of Labor Statistics publishes a price index of the corresponding product group over the whole period: wood products, paper, textile mills, machinery, and transportation equipment.¹⁷ The Canadian indices for all industries start in January 1992. For these 13 industries we can therefore build a panel of 27 variables, with the exchange rate, from February 1992 to August 2026. It covers the first years of the North American Free Trade Agreement, which the baseline sample does not, and it allows us to ask whether cross-border connectedness rose as trade integration deepened.

Table C.1: Connectedness in the 13-Industry Panel, 1992–2026

Sample	Months	Baseline			Net of commodity prices		
		Total	Cross-border share		Total	Cross-border share	
			Canada	U.S.		Canada	U.S.
February 1992 – August 2026	415	48.0	18.3	22.7	45.3	14.8	17.6
February 1992 – December 2003	143	50.3	21.8	25.1	50.3	19.2	22.5
January 2004 – August 2026	272	52.2	20.4	23.4	47.9	16.5	17.4
January 2004 – December 2014	132	57.1	23.0	25.8	51.7	16.5	19.6
January 2015 – August 2026	140	55.4	22.7	23.0	52.8	19.9	18.0

Notes: This table shows connectedness in the panel of 13 industries, by period. The panel contains the 13 industries with a U.S. price index available from 1992, in both countries, and the exchange rate. *Total* is the average share, in percent, of the 12-month forecast error variance of the 26 industry prices that comes from other variables. *Cross-border share* is the average share that comes from industries of the other country, for Canadian and for U.S. industries. In the right-hand columns, the current value and three lags of five global commodity price changes are removed from every series within each sample.

Table C.1 compares sub-periods. Between 1992–2003 and 2004–2026, the cross-border share falls from 21.8 to 20.4 percent for Canadian industries and from 25.1 to 23.4 percent for U.S. industries. Net of commodity prices, it falls from 19.2 to 16.5 percent for Canadian industries and from 22.5 to 17.4 percent for U.S. industries. Within the second period, the cross-border shares are highest in 2004–2014, the period of the commodity boom and of the 2008–2009 crisis, at 23.0 and 25.8 percent, and they are 22.7 and 23.0 percent in 2015–2026.

Figure C.1 reports the rolling-window estimates, which now start with the window that ends in January 1999. The cross-border share averages 25.3 percent for windows that end between 1999 and 2003, 23.9 percent for 2004–2008, 27.4 percent for 2009–2014, 20.5 percent for 2015–2020, and 27.7 percent for 2021–

¹⁷These are the commodity-based producer price indices for lumber and wood products (WPU08), pulp, paper, and allied products (WPU091), textile products and apparel (WPU03), general purpose machinery and equipment (WPU114), and transportation equipment (WPU14). Over 2004–2026, the correlation between the monthly changes of each index and those of the industry index is 0.97, 0.84, 0.84, 0.87, and 0.99, respectively. We use the product-group index over the whole period for these five industries.

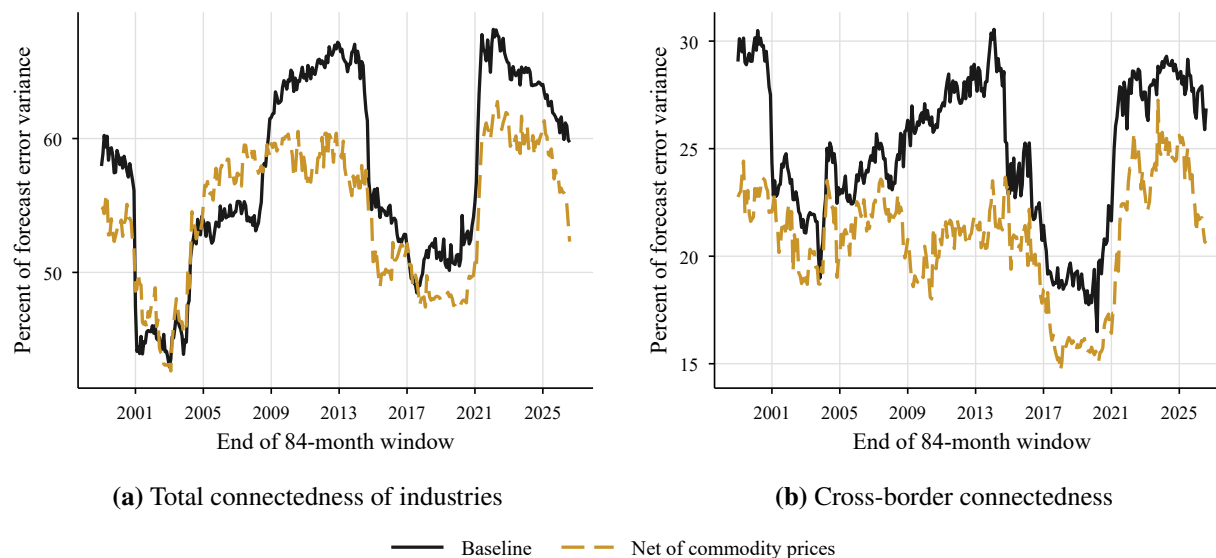


Figure C.1: Rolling-Window Connectedness in the 13-Industry Panel, 1999–2026

Notes: This figure shows rolling-window connectedness in the panel of 13 industries. Panel (a) reports the average share, in percent, of the 12-month forecast error variance of the 26 industry prices that comes from other variables. Panel (b) reports the average share that comes from industries of the other country. Each point is estimated on the 84 months that end at the date on the horizontal axis; the first window covers February 1992 to January 1999. The dashed line is estimated after removing from every series the variation explained by the current value and three lags of five global commodity price changes.

2026. It has no trend. A linear trend fitted to the series is 0.008 points per year. Net of commodity prices, the averages are 21.4, 21.7, 20.8, 17.5, and 23.3 percent, and the fitted trend is slightly negative. Cross-border connectedness is thus no higher three decades after the start of the free trade agreements than in the 1990s. Its movements are episodic. It rises in windows that contain the commodity boom, the 2008–2009 crisis, or the 2021–2022 inflation surge, and it returns to its earlier level afterwards. Deeper trade integration has left the co-movement of producer prices unchanged.

D Identified Oil Shocks

Identified shocks to the world oil market provide a check on the role of commodity prices. Table D.1 relates the baseline VAR residuals to the oil supply and demand shocks of [Baumeister and Hamilton \(2019\)](#) and the oil supply news shocks of [Känzig \(2021\)](#). Together, the five shocks explain 57 percent of the Canadian and 51 percent of the U.S. petroleum and coal residual variation. Thus, a substantial share of what the baseline VAR assigns to petroleum and coal shocks is associated with identified shocks to the world oil market. Outside petroleum and coal, the shocks explain little of the residuals, and less still net of commodity prices, which supports the interpretation that the commodity controls remove an important common component of price movements.

Table D.1: VAR Residuals and Identified Oil Shocks

	Baumeister–Hamilton				Känzig	Joint R^2
	Supply	Activity	Consumption	Inventory	Supply news	
Petroleum and coal, Canada	−0.56	0.30	0.59	0.12	0.57	0.57
Petroleum and coal, United States	−0.51	0.30	0.49	0.17	0.54	0.51
Exchange rate	0.37	−0.07	−0.39	−0.07	−0.47	0.27
Transportation equipment, Canada	0.32	−0.08	−0.35	−0.05	−0.44	0.22
Computer and electronics, Canada	0.29	−0.06	−0.34	−0.01	−0.38	0.17
Food, United States	−0.32	−0.01	0.18	−0.11	0.22	0.14
Plastics and rubber, Canada	0.24	0.05	−0.21	−0.16	−0.30	0.13
Machinery, Canada	0.25	−0.15	−0.26	0.02	−0.27	0.12
Mean joint R^2 , 42 industries						0.08
net of commodity prices						0.03

Notes: This table shows the relationship between the residuals of the VAR and identified oil shocks. The first five columns report the correlation between the residual of the baseline VAR equation named in the row and each shock series. *Supply*, *Activity*, *Consumption*, and *Inventory* are the oil supply, economic activity, oil consumption demand, and oil inventory demand shocks of [Baumeister and Hamilton \(2019\)](#). *Supply news* is the oil supply news shock of [Känzig \(2021\)](#). *Joint R^2* is from the regression of the residual on the five shocks. The table lists the eight residuals with the highest joint R^2 . With 241 observations, a correlation above 0.13 in absolute value is significant at the 5 percent level. Sample: January 2005 to January 2025.