The Real Meaning of the Fed Information Effects: Good and Bad News for Europe

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Abstract

The Fed information effects play a distinct role in transmitting the central bank's influence overseas, although their real economic meaning as demand shocks has been largely overlooked. I study through a panel local projection model how heterogeneity in euro area industries' trade exposure vis-à-vis the US influences how the European industries experience the Fed information effects as a foreign demand shock. In doing so I resort to the theoretical work of the production network literature and account for input-output linkages that are decisive for the predictions of the shock's international influence, hidden in the aggregate response. The empirical results reveal that the Fed information effects identified from US high-frequency stock price responses extend to real economic outcomes across the Atlantic, yet the impact depends crucially on the trade partner's exposure to the US economy. The results are not solely attributable to the expenditure-switching effects of the exchange rate, which lends support to the notion that the Fed information effects capture the state of the US economy. From a European perspective, the Fed information shocks appear as US demand shocks with effects that are qualitatively similar to changes in US employment and consumer confidence. In contrast, I find no equivalent support for exogenous US monetary policy's influence over euro area production that is driven by trade linkages.

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1 Introduction

By now, a vast strand of the empirical monetary policy literature acknowledges that the commonly used high-frequency identified (HFI) monetary shocks may be confounded with other economic forces that systematically coincide with monetary policy action, such as macroeconomic news introduced to the public simultaneously with policy action. There are competing theories on the nature of these confounding forces; among these a long-standing one is the 'central bank information channel' through which the central bank emits economic surprises to the public, not as monetary policy stance surprises but as information releases of the state of the economy. The theory goes that the macroeconomic information is introduced to the public simultaneously with monetary policy action, thus systematically fitting into the same time window with the policy announcements. These information releases then result in real economic and financial reactions to monetary policy announcements that cannot be reconciled with standard monetary models if the central bank announcement is thought to contain news solely about monetary policy action.

The economic meaning of the central bank information shocks as distinct demand shocks is generally overlooked in the existing literature, as the central bank information effects have received research interest that is secondary to the effects of 'pure monetary shocks', a topic that is evergreen in macroeconomics. As such, the central bank information shocks are generally treated as a "catch all" concept for any monetary policy surprises that generate a counterintuitive public reaction according to standard monetary models. This paper sets out to study the economic significance of these shocks from an international, real economic standpoint, namely the potential of the US Federal Reserve to affect European economic activity through its 'information shocks' about the US economic outlook. In doing so it resorts to the methodology of the production network literature to measure comprehensively the trade exposure of European industries and applies the production network measures in a local projection interacting the network measures with the Fed shocks. The empirical analysis addresses the theorised nature of the central bank information effects by asking: Do these 'other-than-pure-monetary-policy' shocks have a real economic meaning? In other words, it investigates whether the demand shock type implied by the shock classification scheme is consistent with how the economy will develop. In macroeconomic terms, if a central bank information channel prevails, the ensuing real economic outcomes should be distinct from the effects of pure monetary shocks as the information shock should represent a demand shock of an opposite sign.

It is not obvious that the Fed information shocks could yield real economic effects in low frequency macroeconomic data, given that the most standard identification strategy of the shocks (and the one addressed in this paper) distils them from high-frequency financial data and relies on rather strong assumptions on the public's ability to process the central bank signals appropriately for asset valuation. A strand of the HFI studies base classification schemes of central bank shocks on additional variables' movements during central bank announcements besides interest rate derivatives. This is the approach followed also by Jarocinski and Karadi (2020) who disentangle the Fed information shocks from pure monetary shocks

devising high-frequency data on the stock markets' response during the Fed announcements. The identification strategy relies crucially on the ability of the stock markets to interpret the Fed announcements and translate them into equity valuation that accurately corresponds to the state of the US economy. Will the real economy follow suit? In theory, macroeconomic news should pass through to stock valuation, but in practice a mix of forces besides economic fundamentals are reflected in stock prices. This paper therefore contributes to the strand of literature centered around high-frequency variables' responses during central bank announcements by testing whether the Fed information shock materialises in a consistent way with its identification assumptions, and in line with the presumed nature of the demand shock as interpreted from stock price movements.

The paper takes a new approach with respect to the existing literature on the central bank information channel as it assesses the real economic effects of central bank policies from the response of trade partners' activity. Input-output linkages work to generate ambiguity for a given demand shock, which the analysis addresses by making use of international data. Specifically, it utilises the asymmetric exposure that certain foreign trade partners have to the source of the shock, which for them either represents changes in the demand for their output or changes in the demand for their inputs, depending on which side their trade exposure is. When the shock stirs both types of effects via input-output linkages (as likely is the case for a domestic industry or a foreign industry fully integrated in global value chains) it becomes more difficult to distil a clear response. The main advantage of using industry-level data from an economic region like the euro area is the cross-sectional heterogeneity in US-trade links of individual industries, which reflects diversity in the industrial structure across the member states and sufficiently close economic ties with the United States – providing *some* trade exposure yet not *full* economic integration with the US economy, which allows studying the Fed information shock as a demand shock affecting exporters and importers distinctly. Studying the effects of Fed information shocks through real economic variables such as industrial production is of interest in its own right. Real economic variables have additionally an advantage over financial variables in that they ought to be less prone to volatility due to e.g. sentiments.

The paper brings forth new evidence that the Fed information shocks represent potent demand shocks for the (ultimate) trade partners of the US in the euro area. The empirical results document a divergence in European production in response to the Fed information shocks determined by the industry's US-trade links: the US driven demand, conveyed by the Fed, boosts the production of European ultimate exporters to the US economy, while the higher demand for inputs raises prices globally, exerting a harmful influence on industries that rely on these inputs in their production. Given that European suppliers of the US economy are boosted by the Fed information shock that simultaneously harms those European industries that are ultimately customers of American firms, the Fed information effects foretell a two-speed economy for Europe, in which the ultimate exporters share some of the business cycle conditions of the US and diverge from the ultimate importers that are knocked in the opposite direction.

The Fed information effects are likely to result from benign business cycle conditions in the US that are expenditure-augmenting, as the effects are not explained away by expenditure-switching behavior due to the exchange rate response to the Fed announcements. In fact, from the European perspective, the positive Fed news bear resemblance to positive changes in US employment and US consumer confidence as a representation of the state of the US economy. The "twin shock" accompanying the Fed information shock – the pure Fed monetary policy shock – generates responses in European production that mirror the Fed information effects on the aggregate, hence appearing as an antonym to the Fed information shock. With the distinct responses of ultimate EA exporters and importers, the empirical results suggest that the Fed information shocks are consistent with a positive sign of demand in the US economy for foreign goods and goes in the opposite direction of a theory-predicted response to a pure monetary policy shock. Perhaps surprisingly in the light of the established evidence for the Fed's global impact through financial channels, I find no equivalent support for the pure monetary shocks' ability to stir a real economic response in Europe through trade links that account for global value chains. This stands in stark contrast with the empirical evidence gathered for the Fed information effects in the euro area, and it points to adverse effects of the Fed monetary tightening arising through absolute and relative prices affecting European industries more broadly and not predicated by the industry's input-output constellation.

The next section reviews the related literature. The empirical strategy with key variables and model specification is laid out in Section 2. The results are presented in Section 3, followed by further discussion in Section 4. Section 5 concludes.

1.1 Related literature

This paper is in between the immense literature on international spillovers of the Fed policies and the literature on central bank shocks that are other than 'pure monetary policy'. The Fed has been pointed out as a source of global shocks (prominently in Rey (2013), Miranda-Agrippino and Rey (2020)), affecting particularly emerging market economies (Kalemli-Özcan (2019)). A debate centrally related to this paper is therefore the Federal Reserve's role as a global central bank (see Bernanke (2015)).

The real economic international spillovers of the Fed's monetary policy are covered empirically at least by Degasperi et al. (2023), Kim (2001), Dedola et al. (2017), Georgiadis (2016), Bräuning and Sheremirov (2019) and Iacoviello and Navarro (2019). These papers perform a country-level analysis of a wide range of advanced and emerging economies and examine a range of economic indicators on exchange rate regime, financial conditions, capital flows and trade. With a more global view, they generally bear a message of globally contractionary real economic effects of US monetary policy tightening and heterogeneous patterns difficult to pin down by a single country feature. [1] Their results on the importance of trade links for cross-border monetary transmission are mixed, with more support (Bräuning and Sheremirov (2019)) or less

[1] The results of Degasperi et al. (2023) contrast the findings of heterogeneous patterns of the other studies as they find remarkably similar effects globally, except for a subset of EMEs.

support (Kim (2001)) for its significance (Iacoviello and Navarro (2019) attribute a large effect to trade in AEs but small in EMEs). This paper takes a different approach as it is focused on trade related input-output linkages and takes a closer perspective on the heterogeneous industries within a block of advanced economies belonging to the same monetary union, the euro area. It also follows a rather different methodology for addressing trade exposure or identifying the Fed shocks[2]. The effects of purged Fed monetary shocks on the EA real activity are covered at least in Degasperi et al. (2023), Jarociński (2022) and Ca'Zorzi et al. (2020) who find adverse effects of Fed monetary policy shocks when the response is on aggregate production.

Research taking methodologically a more similar approach to this paper, with an empirical sector-level analysis and intersecting with the production network literature include Ozdagli and Weber (2017), di Giovanni and Hale (2021), Ghassibe (2021) and di Giovanni and Rogers (2022). The outcome of interest is stock prices in Ozdagli and Weber (2017) and di Giovanni and Hale (2021), sectoral consumption in Ghassibe (2021) and investment in di Giovanni and Rogers (2022). These papers pertain to monetary policy shocks only and differ in their approach to the identification method of the shock. Theoretical contributions to monetary policy shock propagation in a multi-sectoral New Keynesian setting include among others Pasten et al. (2020), Carvalho (2006), Nakamura and Steinsson (2010), La'O and Tahbaz-Salehi (2020) and Wei and Xie (2020).

The literature on central bank information effects is smaller and newer than that of monetary policy. Besides the literature studying the central bank information effects per se, numerous other works feature the channel by taking the approach of controlling for the information channel while examining the transmission of 'pure' monetary policy itself. The demand shocks that are under study in this paper – the Fed information shocks of Jarocinski and Karadi (2020) – are attributed to the central bank information channel, as it is the most prominent among the theories explaining the non-textbook-like public reaction to central bank announcements. Miranda-Agrippino and Ricco (2021) and Cieslak and Schrimpf (2019) follow methodologically similar identification strategies. The central bank information channel goes back at least to Romer and Romer (2000) and is subsequently addressed in the more recent influential papers of Campbell et al. (2012), Melosi (2017) and Nakamura and Steinsson (2018). A strand of this literature addresses the information channel in connection with forward guidance and involves Campbell et al. (2012), Andrade et al. (2019) and Andrade and Ferroni (2021). As this paper, Jarociński (2022) and Nunes et al. (2022) also relate macroeconomic news release surprises to central bank information shocks.

Close to the objective of this paper, Jarocinski and Karadi (2020) and Hansen and McMahon (2016) assess real macroeconomic implications of the Fed information shocks on output, but for the domestic economy. With the same series of shocks as studied here Jarocinski and Karadi (2020) observe opposite sign US GDP response to Fed information and monetary shocks in their BVAR. Hansen and McMahon (2016) assess real economic effects of different Fed shocks but relying on a textual analysis with a different identi-

[2]Among them, Degasperi et al. (2023) is closest to this paper's monetary policy shocks. Bräuning and Sheremirov (2019) also examine monetary shock transmission through trade networks, but without targeting input-output linkages as this paper does.

fication approach embedded in their FAVAR; they observe generally expansionary effects of a positive Fed information shock on US real activity, albeit with much uncertainty.

The central bank information channel relies on the revelation of central bank's private information about the state of the economy. Alternative mechanisms have been proposed for how the central bank may surprise the public during the monetary policy announcement with shocks other than purely exogenous monetary policy. Bauer and Swanson (2023) argue that the central bank responds to the same macro news as the markets do, but the information asymmetry is in the central bank's reaction function that is not perfectly predictable, generating an abrupt repricing of financial assets. Cieslak and Schrimpf (2019) emphasises the role of central bank news affecting financial risk premia. Sastry (2021) adds to the existing theories with the public's different confidence in public signals. Uribe (2022) introduces a different line of reasoning for expansionary interest rate increases through the Neo-Fisher effect that arises in New Keynesian models with expectations of permanent monetary policy shocks. This paper is not positioned to provide answers on where the information asymmetries between the central bank and the public lie. Noting that alternative theories are plausible, the non-monetary shocks under study are nonetheless labelled as 'Fed information shocks' as this term speaks to most of the relevant literature.

International effects of the Fed information shocks are present in papers studying the link between the central bank information shocks and the exchange rate: Gürkaynak et al. (2021), Stavrakeva and Tang (2019), Franz (2020) and Pinchetti and Szczepaniak (2023); and the spillovers of Fed information shocks through capital flows, risk and financial channels: Hoek et al. (2022), Bekaert et al. (2024), Pinchetti and Szczepaniak (2023), Georgiadis and Jarocinski (2023), Jarociński (2022) and Cesa-Bianchi and Sokol (2022). Besides this paper, few other works touch on Fed information shocks' cross-border real economic impact, with the exceptions of Jarociński (2022), Georgiadis and Jarocinski (2023) and Pinchetti and Szczepaniak (2023) whose focus lies elsewhere than on transmission through trade links. They find generally an expansionary effect of the Fed information shock on foreign real activity. This paper contributes to this body of evidence documenting a more nuanced effect depending on the industry's status as ultimate importer or exporter vis-à-vis the US, and shows that EA industries are hit by the shock also through the traditional expenditure-augmenting effect. The findings are consistent with the Fed information shock representing a positive demand shock with a global reach, reading by the global price responses it stirs.

2 Empirical strategy

The main empirical analyses of this paper employ a panel local projections model first put forth by Auerbach and Gorodnichenko (2013), who build on the local projections methodology introduced in Jordà (2005). The local projection method has the advantage of being readily applicable to a panel setting. The estimation methodology exploits both between- and within-industry variation; the time dimension of the panel allows estimating the dynamic effects of the shock transmission, while the cross sectional variation in the

time-fixed trade-related variables (backward and forward participation) provide information on how these industry-level features matter for the response to the central bank shock, which I capture by including interaction terms of the shock with the trade-related variables. The external identification of the shocks grants not having to restrict the coefficients of the impulse response functions further from the original central bank shock identification scheme that relies on sign restrictions. This section first describes the key variables of the empirical model which is specified at the end of the section.

2.1 The central bank shocks

The Fed shocks of Jarocinski and Karadi (2020) have become part of the standard toolkit of empirical macroeconomists, making them an object of interest for this paper. The identification strategy relies on stock price reactions during the FOMC announcements to disentangle the two shocks in a sign restricted VAR, where the sign of the interest rate response is restricted by the positive stock price comovement for the 'central bank information shocks' and negative comovement for the 'pure monetary policy shocks'. The interest rate surprises are measured from the three-month federal funds future contracts, as the three-month horizon reflects the shift in the expected federal funds rate following the next policy meeting, considering that typical interval between policy meetings is six weeks. As such, the surprises involve the effect of actual policy rate changes as well as the very near-term forward guidance. The interest rate surprises are originally from the Gürkaynak et al. (2005) database and are measured in a time window starting 10 minutes before the announcement and ending 20 minutes after, adjusted from the original paper to reflect also the Fed press conferences. The stock price surprises of Jarocinski and Karadi (2020) are measured as the change in the S&P 500 index of 500 large US companies, also 10 minutes before and 20 minutes after the Fed announcement, which is considered to be a time frame invariant to anticipatory movements in pricing, such as the "pre-FOMC announcement drift" (Lucca and Moench (2015)).

In the shock classification scheme of Jarocinski and Karadi (2020), the theory of the central bank information channel is supported by a stock market reaction that runs counter to the standard textbook intuition of the demand dampening effect of monetary policy: occasionally monetary policy tightening leads to an *appreciation* of equity prices, despite the fact that corporate cash flows should be diminished by a monetary policy-dampened demand and those cash flows are discounted with interest rates that rise with policy rate tightening, which taken together should unambiguously depress equity prices. A plausible explanation behind the puzzling market reaction is that monetary policy announcements produce two types of shocks to the public: one that surprises the markets by the central bank's monetary policy action (a 'pure monetary policy shock'), and another that surprises the markets by the revelation of the central bank's outlook on the economy (a 'central bank information shock'). An appreciation of stock prices upon a monetary tightening can be rationalised as a reflection of an upswing in economic activity, predicting higher corporate cash flows that boost equity prices despite the countering monetary policy action, while the opposite holds true

for monetary easing that depresses equity prices.

For the stock market reaction around FOMC announcements to be taken as a reliable beacon of the underlying state of the economy, two conditions need to be met. First, the Fed needs to be correct about the state of the economy and, second, stock markets must be able to interpret the announcement and translate it accurately into equity valuation. That is, the stock market analysts receiving simultaneously the two *countering signals* that accompany Fed information shocks, one towards a stock price rise (given the positive economic outlook) and another towards a stock price fall (given the monetary offsetting), need to be able to evaluate which effect dominates in the equity valuation.

Given the challenge of this task, what we read as news about economic fundamentals based on stock price reactions could be just a residual component of the HFI monetary policy shocks that bears no clear significance for economic outcomes. Arguably, stock prices are devisive for the identification of the shock type as equity valuation has a clear theoretical link to corporate performance and thus also to the state of the macroeconomy. Moreover, stock prices can be measured at a high frequency, as are the interest rate changes within the monetary announcement window. However, being financial variables stock prices are prone to sentiments that can produce overreactions and rapid reversals in the data, which can be mistaken for signals of economic fundamentals. Given these limitations, stock price movements may produce noisy signals about the public's interpretation of the central bank announcements, which calls into question whether the outcomes in the real economy will eventually match our readings of the high-frequency stock market movements during central bank announcements.

The Fed information shocks' identification strategy of Jarocinski and Karadi (2020) is consistent with alternative explanations for the puzzling public reaction to central bank policies besides the central bank information channel, such as 'Fed response to news channel' of Bauer and Swanson (2023) or the Neo-Fisher effect of Uribe (2022). This paper takes an agnostic view of whether the central bank has superior inside information about the state of the economy over the markets, or whether the abrupt interest rate adjustment upon the Fed announcements derives from another form of information misalignment between the central bank and markets on how macroeconomic news be translated into interest rate changes. The bottom line is that the stock repricing during monetary announcements is associated with the arrival of new macroeconomic information and indicative of the markets' perception of changes in the underlying aggregate economy under the hypothesis that there is a strong link between the real economy and equity valuation.

2.2 Trade links

The outcome of interest is euro area industries' response to the Fed shocks, conditional on the industries' trade links with the US. The trade exposure to the US economy is measured through the industry's 'forward participation' and 'backward participation'. It is worth emphasising that the backward and forward partic-

ipation measures of the euro area industries are computed with respect to the United States specifically, such that they measure to what extent a given EA industry is ultimately a supplier or a customer of US firms. The measures of trade exposure to the US comprises direct trade between the EA and the US, as well as indirect trade of value added through countries other than the EA and the US. The analysis accounts for indirect trade noting that almost half of global trade today involves global value chains and thus indirect trade in value added (World Bank (2020)). Hence, not accounting for indirect trade likely leaves us with an incomplete understanding of the EA trade exposure. Considering the role of the United States and its central bank in the global economy, indirect trade is included in the analysis such that spilled over US demand that propagate to the euro area via 'third countries', is accounted for.

The WIOD data used to construct the trade related variables are annual, and the measures constructed using the WIOD data (industry's backward and forward participation) are held fixed over time at the average values over the years of data availability (2000-2014). This simplification is done noting that the results are robust using just the latest (year 2014) values of the trade measures or annually varying values. It therefore seems to be the case that the industry's relative trade exposure vis-à-vis the US are rather structural features of the industries that do not fluctuate much over the maximum time period considered in the empirical analysis (2000-2019) at the industry-level of aggregation.[3] This implies that global value chain configuration does not have an endogenous response to the central bank shocks and we can consider the trade-linkages across industries as exogenous.

2.2.1 Trade exposure to the US: backward and forward participation

The forward participation measure of the country-industry *ir* with respect to country *j* (through any intermediate countries *m,k* and industries *l,t*) is computed as:

$$FW_{ij}^{r} = \frac{\sum_{s=1}^{S} F_{ij}^{rs}}{VA_{i}^{r}} + \frac{\sum_{k=1}^{K}\sum_{l=1}^{L}\sum_{s=1}^{S} a_{ik}^{rl} F_{kj}^{ls}}{VA_{i}^{r}} + \frac{\sum_{m=1}^{M}\sum_{k=1}^{K}\sum_{l=1}^{L}\sum_{t=1}^{T}\sum_{s=1}^{S} a_{ik}^{rl} a_{km}^{lt} F_{mj}^{ts}}{VA_{i}^{r}} + \dots \tag{1}$$

where $a_{ik}^{rl} = \frac{Z_{ik}^{rl}}{Y_{k}^{l}}$, i.e. value added ($Z_{ik}^{rl}$) from country-industry *ir* to country-industry *kl*, as a share of the *importing* industry's output, (Y_{k}^{l}), and $F_{ij}^{rs} \equiv$ final goods produced in country-industry *ir* and absorbed in country-industry *js*.

The forward participation measure indicates how much an industry exports its value added to other industries, i.e. to what extent an industry is a supplier of goods to other industries, which makes it a measure of a given EA industry's exposure to country *j* through direct and indirect trade in value added trough its exports. The final destination is fixed to *j=US* and ultimate source is fixed as *i* = {Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal} for the forward partic-

[3] Some of these trade links that are considered structural until end-2019 may have changed after 2019, by either being temporarily disrupted during the Covid-19 pandemic or by becoming permanently severed in geopolitically motivated reorganisation of trade relations.

ipation measure. The value added from EA ultimately exported to the US is normalised by the *exporting* (EA industry's) total value added, VA_i^r in order to normalise by the industry size such that the measure reflects the proportional significance of the value added that ends up in the US, out of the entire value added created by the EA country-industry.

Similarly, the backward participation measure of the country-industry *js* with respect to country *i* is defined as:

$$BW_{ij}^s = \frac{\sum_{s=1}^{S} F_{ji}^{sr}}{VA_j^s} + \frac{\sum_{k=1}^{K}\sum_{l=1}^{L}\sum_{s=1}^{S} a_{jk}^{sl} F_{ki}^{lr}}{VA_j^s} + \frac{\sum_{m=1}^{M}\sum_{k=1}^{K}\sum_{l=1}^{L}\sum_{t=1}^{T}\sum_{s=1}^{S} a_{jk}^{sl} a_{km}^{lt} F_{mi}^{tr}}{VA_j^s} + \dots \tag{2}$$

The backward participation measure indicates to what extent an industry imports value added from other industries. The final destination is fixed to j = {Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal} and ultimate source is fixed as *i=US* for the backward participation measure. The measure is normalised with the *importing* (EA) country-industry's total value added,VA_j^s, to reflect the proportional significance of ultimate US imports from the perspective of the EA industry. Details of the construction of these trade exposure measures are relegated into the Appendix A.1.

As the interest ultimately lies in studying the impact of the Fed shock under a *strong one-sided trade exposure* of the EA industry to the US economy, dummies are created based on the top-quartile of the industry distribution of a given trade related variable (backward or forward participation), separating the heavily imports or exports exposed EA industries into their own categories. The dummies serve the purpose of utilising the industries' asymmetric input-output linkages to describe the nature of the given Fed shock, which should represent a demand shock of a positive or negative sign (or potentially neither). Hence, I compare the top-25% most forward and most backward participating industries vis-à-vis the US against the rest, since these industries are very exposed to the US either via exports or via imports (relative to the rest of EA industries), making them likely to experience the Fed shock distinctly given this feature.

2.3 The main panel local projection specification

The main local projection (LP) model is a series of regressions run for different horizons $h = 0, 1, \dots, H$ of the form:

$$\begin{aligned} x_{t+h,ir} - x_{t-1,ir} = \beta_h^{\epsilon}\epsilon_t + \beta_h^{fw} fw_{ir} + \beta_h^{bw} bw_{ir} + \phi_h^{fw}\{fw_{ir}\epsilon_t\} + \phi_h^{bw}\{bw_{ir}\epsilon_t\}\dots \\ + \psi_{sh}' \boldsymbol{z}_{s,t,ir} + \tau_{h,ir} + \eta_{t+h,r}, \end{aligned} \tag{3}$$

where t indexes time, *ir* indexes a country-industry pair, s indexes the lag, $x_{t+h,ir} \equiv$ the industry outcome variable of interest at horizon h, $\epsilon \equiv$ the Fed shock of interest, $bw \equiv$ backward participation dummy, $fw \equiv$ forward participation dummy, $\boldsymbol{z} \equiv$ a vector of control variables, including linear, quadratic and cubic trends, $\tau_{h,ir} \equiv$ country-industry fixed effects and $\eta_{t+h,r} \equiv$ the residual.

The industry outcome variable of interest is the EA industrial production index (IP-index), which de-

scribes the EA industry-level real economic performance. The control variables comprise: (i) Euro Stoxx 50 volatility index, (ii) Eonia-rate, (iii) EA non-financial corporate credit spreads of Gilchrist and Mojon (2017), (iv) EA industrial confidence, (v) EA real activity factor of Scotti (2016), as well as lagged values of the dependent variable and the shock, all variables with lags of up to 6 months prior to the shock's occurrence. The focus of the paper is on the transmission of the Fed information shocks through real trade linkages, which is the rationale for including Euro Stoxx 50 volatility index, Eonia-rate and EA non-financial corporate credit spreads as controls that represent the transmission of Fed shocks through risk sentiment and financial channels (such as the 'global financial cycle'-type of effects proposed by Miranda-Agrippino and Rey (2020)). Controls are also included to address potential reverse causality from euro area driven demand reflected in the Fed shocks by adding the EA macroeconomic variables: EA industrial confidence and EA real activity index of Scotti (2016) (constructed from a dynamic factor model involving EA GDP, industrial production, unemployment, retail sales and purchase managers' index). The Eonia rate was the main overnight interbank lending rate in the EA during the time period covered, and as such it serves to control also for both endogenous and exogenous components of the EA monetary policy.

The time dimension spans from 2000m1 to 2017m12 and the frequency is monthly, with a total of 216 observation periods. The time span is set to end at end-2017 due to the trade wars and tariffs set between the US and EU starting from 2018 during the Trump presidency in the United States. A robustness test re-running the main results of Section 3.1.1 until end-2019 in Appendix B.1.3 confirms that the addition of the 2018 and 2019 data do not alter the results, however, the last date of the Fed shocks available is June 2019. The empirical analysis is not extended beyond end-2019 considering that the Covid-19 pandemic and the related supply chain disruptions likely severely affected the trade links under study.

The industries in the sample are from the initial 12 euro area countries[4]. These countries have been part of the euro area since its inception, which simplifies addressing the monetary policy and exchange rate regimes that affected these countries in the sample period. Given that the macroeconomic conditions of this set of EA countries have differed substantially and potentially affected the response to the US shocks, country-level fixed effects are included. Robustness test in Appendix **??** shows that the main results are not sensitive to the inclusion of both country and industry-level fixed effects. The number of industries from this set of countries for which IP-index data is available amounts to 218 country-industry units. The data for the IP-index covers mainly manufacturing industries. The volatility of the IP-index differs across the industries. To ensure that the results are not driven by excessively or inadequately volatile industrial production at the industry level, outliers are excluded based on the industry-level standard deviation of the IP-index, by cropping the 1%-tails of the cross-sectional distribution of industries' IP-index standard deviation. Removing a total of six outlier industries from the sample results in a number of industries included in the analysis equal to 212. Robustness test of Appendix B.1.4 reports the main results when no outliers are excluded from

[4]The countries are: Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy, Luxembourg, Greece, Netherlands, Portugal.

the sample.

Local projection models have by construction autocorrelated residuals, given that the residual is a moving average of the forecast errors from $t > 1$ to $t+h$. Moreover, with a cross-sectional dimension of the panel LP there is a possibility that observations are spatially correlated. To account for potential serial and spatial correlation of the residuals, I use Driscoll-Kraay robust (Driscoll and Kraay (1998)) standard errors (with a bandwidth of 4).

3 Empirical results

3.1 Fed information shocks

The empirical results presented in this section reveal that the Fed information shocks identified from high-frequency financial data stir real economic effects at the international level. Crucially, the impact depends on the industry's trade exposure to the US economy. Assessing by the aggregate picture (Figure 1) of the response of the EA industrial production to the positive Fed information shock, averaged across all EA industries, the Fed information effects appear positive from the European perspective. A key empirical finding of the paper is that this aggregate picture across all EA industries masks vast underlying heterogeneity in how EA industries experience the Fed information effects. When the input-output linkages are asymmetric across industries, the Fed information shock induces a drastically different response among the ultimate trade partners – in Europe a booming US economy is good news for some and bad news for others. This becomes apparent in Figure 2 which breaks down the response to the Fed information shock by the EA industries' asymmetric trade exposures to the US economy.

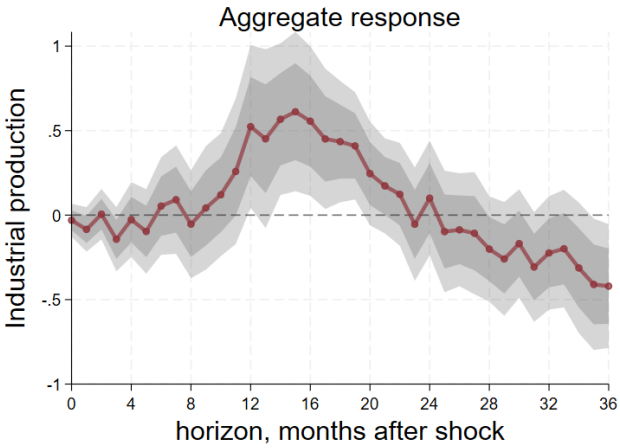


Figure 1: The response of EA IP-index to one standard deviation positive Fed information shock of 3 bps across all EA country-industry units. LP specification of Section 2.3 without variables *bw*, *fw*, *u* or related interaction terms. Impulse responses are reported as percent changes. 68% and 90% confidence bands.

3.1.1 Main results

Figure 2 displays the response of EA industrial production broken down by trade exposure to the US economy, comparing the EA industries that are particularly exposed to the US via imports but not exports ('backward participating' industries, bottom panel) to the responses of EA industries that, conversely, are particularly exposed to the US via exports but not imports ('forward participating' industries, middle panel). The responses are to a Fed information shock that is scaled to one standard deviation positive shock (throughout the paper), which in theory is the kind of shock that represents an upturn in the US business cycle. The 'overall effects' reported in Figure 2 comprises the sum of coefficients of the main effect of the shock and its interaction term with the given US trade exposure variable.

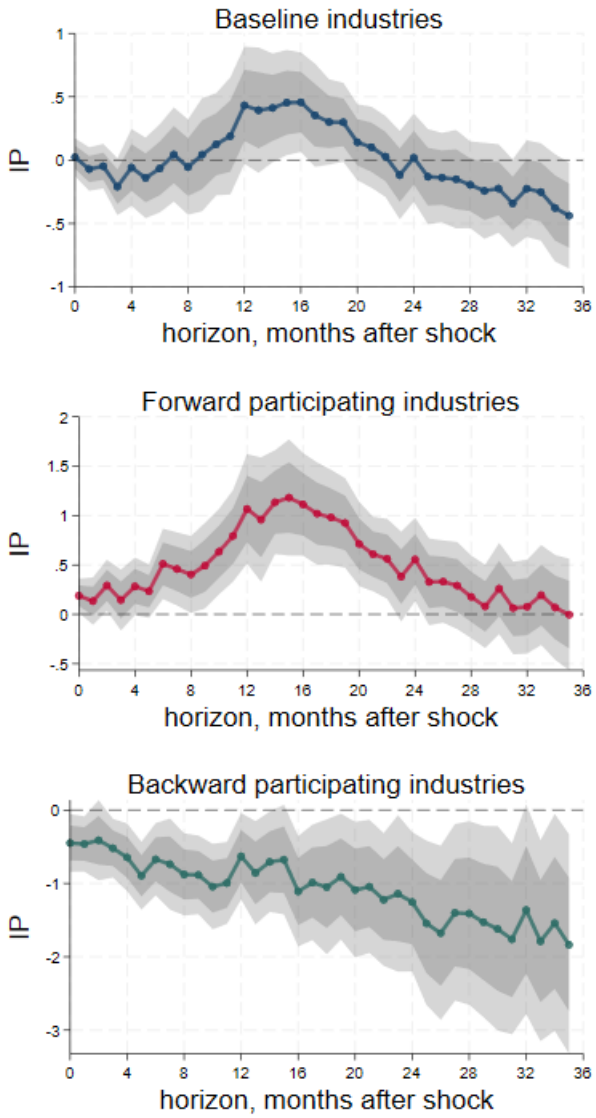


Figure 2: The overall response of EA IP-index to one standard deviation positive Fed information shock of 3 bps. The overall effects comprise the main effect and interaction terms, i.e. $\beta_h^c + \phi_h$ of a given variable in the LP model of Section 2.3. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

The top panel of Figure 2 ('baseline' industries) documents the effect of the shock on the EA industries

that are not particularly exposed to the US economy through trade; the baseline industries consist of industries that do not fall in the right tail of either the backward or forward participation distributions. These industries' response to the Fed information shock largely follows the pattern of the aggregate response (Figure 1). Comparison of the bottom and middle panels of Figure 2 reveals that overall the Fed information shock has opposite effects on forward and backward participating EA industries' real activity, as it expands the production of ultimate exporters and curtails the production of ultimate importers, contrary to the aggregate effects.

The bottom panel shows us that backward participating industries' production falls on impact from the shock's occurrence and continues to fall over the course of the following three years from the Fed announcement. At the trough backward participating EA industries' production falls on average around 2%. The adverse effect of the shock on this group of industries could be the outcome of having to compete (against the US firms or globally) with greater demand for inputs as the US economy booms, consistently with the price effects of the shock reported below in Section 3.1.2. The middle panel shows that the impact of the Fed information shock on the forward participating EA industries goes in the opposite direction; it takes about half a year for the effects to begin to materialise for these industries and they increase their production on average by 1% at the peak, likely as a result of higher exports. The boosting effect on the ultimate EA exporters dissipates after about 2.5 years from the shock's occurrence. The responses of both groups are mostly statistically significant at the 90% confidence level.

The differential effect of the Fed information shock becomes apparent also from the coefficients of the interaction terms alone, between the given trade-exposure variable and the Fed information shock (Figure 3). Following the Fed information shock, forward participating EA industries experience an additional boost of up to 0.75% on average by belonging to the group of most forward participating industries, while backward participating industries experience an offsetting production drop of up to 1.5% on average from the main effect.

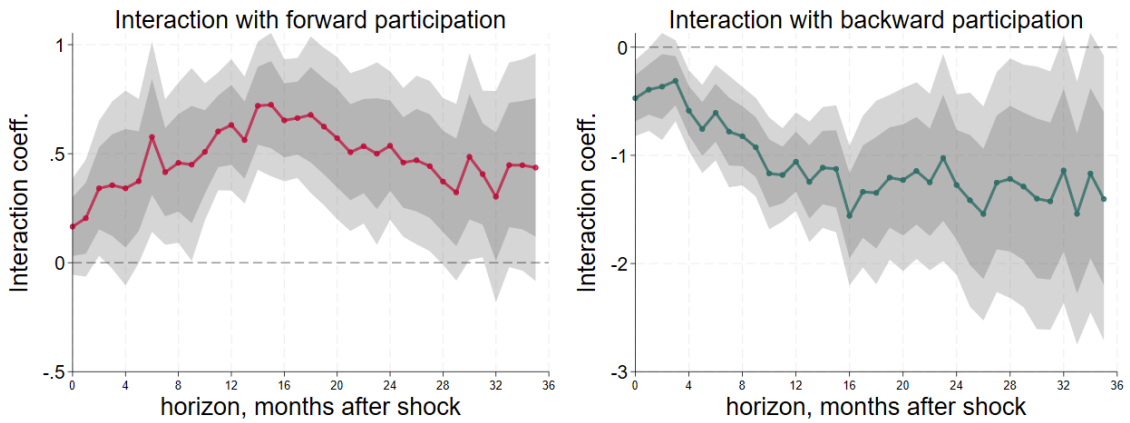


Figure 3: Interaction coefficients of the forward participation dummy (left) and backward participation dummy (right) with the Fed information shock, which is ϕ_h^i, $i \in \{fw, bw\}$ in the LP model of Section 2.3. The response of IP-index is scaled to one standard deviation positive Fed information shock. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

The main message of the results shown in Figures 2 and 3 is the substantial heterogeneity in the response among EA industries that have the opposite input-output linkages with the US economy; backward participating industries receive relatively much of their inputs (ultimately) from the US while forward participating industries' output is exposed to the US through their exports. At the same time, these industries do not have an offsetting exposure to the US, since they are characterised by a rather one-sided exposure (being predominantly either exporters or importers via-à-vis the US, but not both). These results demonstrate the advantage of studying the effects of the Fed information shocks through international data that allow studying the effects conditional on asymmetric input-output linkages. Utilising the distinct, one-sided, exposure to the US economy that a foreign industry may exhibit is likely to clear much of the ambiguity arising from input-output linkages, which lead aggregate effects to either understate the impact on some industries (ultimate exporters) or even predict effects that go in the opposite direction (as in the case of the ultimate importers).

The responses we observe among European industries are symptomatic to higher demand in the US economy for foreign goods, which Figure 4 below also confirms, as it shows that US net imports rise in response to the positive Fed information shock. However, these results do not allow us to infer whether the demand stems from changed relative prices internationally or a general rise in demand for goods, i.e. from an upturn in the US business cycle augmenting expenditure. Indeed, the findings presented above are consistent with a depreciation of the euro against the dollar, benefiting EA exporters and harming EA importers. That is to say, the observed effects could well be generated by expenditure-switching towards European goods that become relatively cheap in US dollar terms and away from dollar priced goods that become expensive in euro terms for EA importers. In the limit the observed real effects could be induced completely by expenditure-switching effects of exchange rate fluctuations, without an underlying benign US business cycle conditions that the Fed information shock is taken to represent. The next section reassesses the Fed information effects controlling for dollar value and the EUR/USD-exchange rate, showing that, while expenditure-switching effects are present, they by no means account for the full effect of the shock on European production.

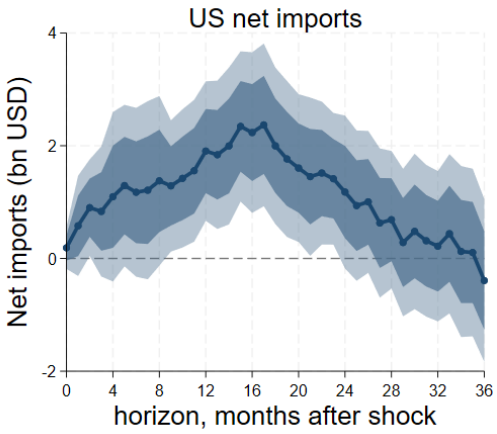


Figure 4: The response of real US net imports (in billions of USD) to one standard deviation positive Fed information shock of 3 bps. Vertical axis: change in net imports estimating $y_{t+h} - y_{t-1} = \alpha_h + \beta_h^e \epsilon_t + \mathbf{z}'_{t-j}\psi_h + \eta_{t+h}$ where $\boldsymbol{z} \equiv$ a vector of controls: lagged values of the dependent variable up to 6 months prior to shock; linear, quadratic and cubic trends; monthly dummies for seasonal effects. 68% and 90% confidence bands.

3.1.2 The exchange rate and price effects

The Fed information shock affects EA industrial production presumably through a mix of channels, a key one being the exchange rate channel. The channel traditionally works through expenditure switching towards goods whose prices are denoted in a currency that depreciates. Let us first document the response of the bilateral EUR-USD exchange rate to the Fed information shock, by estimating a lag-augmented local projections model with the EUR/USD-rate as the dependent variable. Overall the US dollar tends to appreciate as a result of the Fed information shock (Figure 5), after a short-lived depreciation immediately after the Fed information event, although the appreciation of USD againt the euro starts to take hold only after about 20 months. The pattern of a brief depreciation followed by a longer term appreciation of USD against other advanced-economy currencies are also documented in Georgiadis and Jarocinski (2023) who rationalise the on-impact failure of the uncovered interest parity condition by a risk-on sentiment following positive Fed information shocks.

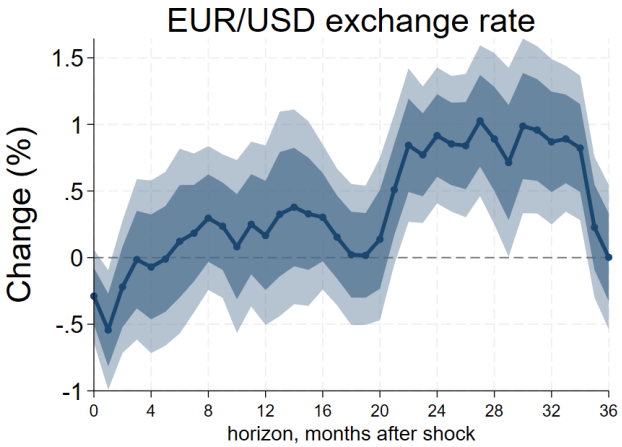


Figure 5: The EUR/USD rate response to one standard deviation positive Fed information shock of 3 bps. The FX rate is defined as euros per dollar, hence an increase in value means dollar appreciation. Vertical axis: change in the FX rate estimating: $y_{t+h} - y_{t-1} = \alpha_h + \beta_h^{\epsilon}\epsilon_t + \mathbf{z}'_{t-j}\psi_h + \eta_{t+h}$ where $\boldsymbol{z} \equiv$ a vector of controls: lagged values of the dependent variable up to 6 months prior to shock; linear, quadratic and cubic trends; monthly dummies for seasonal effects. 68% and 90% confidence bands.

This section re-simulates the effect of the positive Fed information shock in the same model specified in Section 2.3, but now controlling for the dollar value and the bilateral EUR/USD-exchange rate. Because of the presence of trade links, the movements in the EUR/USD rate should affect EA producers distinctly depending on their status as importers or exporters to the US economy, which calls for the inclusion of interaction terms between the exchange rate and the industry's US-trade exposure as additional controls. Hence, I include as controls: (i) the bilateral USD-EUR exchange rate; (ii) the dollar value against a currency basket of 27 main US trading partner currencies (both with the standard of six months of lagged values); as well as interaction terms for (iii) the EUR/USD-rate with the backward participation and (iv) the EUR/USD-rate with the forward participation, in order to account for a differential response to exchange rates among ultimate US exporters and importers.

The results in Figures 6 demonstrate that expenditure switching effects do play a role for the responses of EA industries to the Fed information shock; for both forward participating and baseline industries the magnitudes of the effect are muted from those of the main results (Figures 2 and 3), such that forward participating industries benefit less from the Fed information shock once the boosting effect of euro depreciation is addressed and the baseline group becomes virtually unaffected by the Fed information shock. Given that the baseline group appears to generally benefit from euro depreciation against the dollar (comparing the effect before and after controlling for euro value, i.e. Figure 2 vs. Figure 6), the baseline group of industries appears similar more to the forward participating industries that are characterised by net exports ultimately from the US. The effects on backward participating industries are much the same as without controlling for the exchange rate.

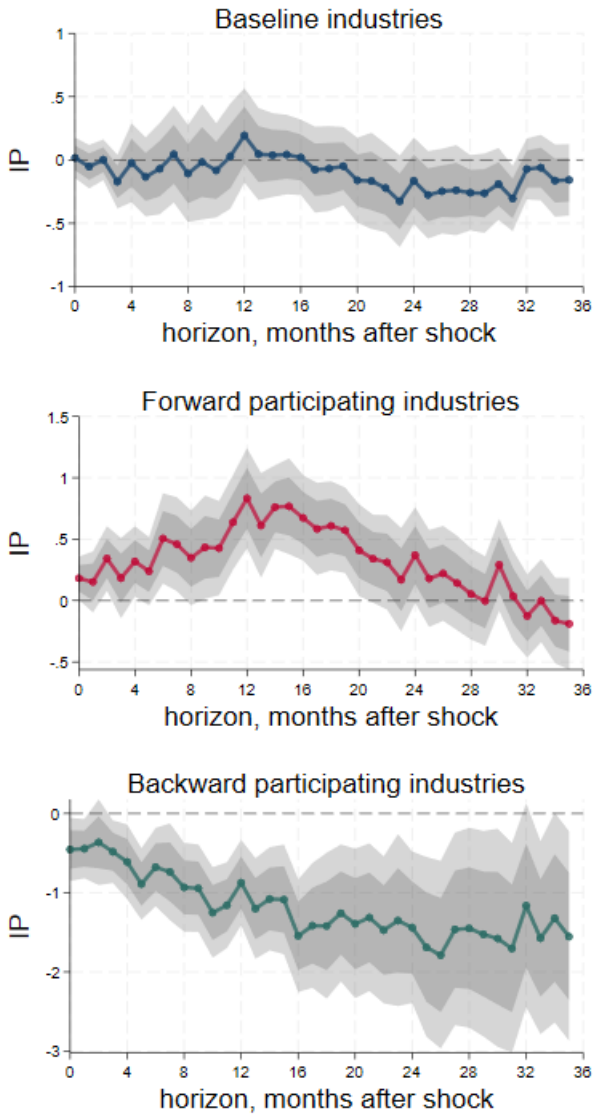


Figure 6: The overall response of EA IP-index to one standard deviation positive Fed information shock of 3 bps, controlling for dollar value. The overall effects comprise main effect and interaction terms, i.e. $\beta_h^e + \phi_h$ of a given variable in the LP model of Section 2.3. 68% and 90% confidence bands.

The main take-away of Figure 6 is that even after removing the exchange rate's influence, the bulk of the effects remain and the results stay statistically significant. This leaves a substantial proportion of the (positive) Fed information shock's influence on foreign trade partners attributable to the expenditure-augmenting effects of changed incomes, cash flows and expenditures in the US that reflect benign US business cycle conditions and resulting demand for foreign goods. This is noteworthy as it is informative about the nature of the Fed information shocks; it seems not to be the case that the US stock market response to the Fed announcement merely represents financial asset price movements, such as exchange rate fluctuations, which would drive real effects through expenditure switching alone without an underlying positive US economic outlook. Instead, the results above lend support to the presence of both income and expenditure switching effects of the Fed information shocks.

Turning to the price effects, in Figures 7 and 8 we see that the Fed information shock manifests itself in

international prices as measured by global commodity prices (7) as well as the prices of EA imports from outside the EA (8). The commodity price index is a comprehensive price index including all commodities in the IMF database and are traded in global markets. The EA import prices are reported for the categories of goods that are likely the most relevant for the EA manufacturing industries: capital goods, manufacturing goods as well as intermediate goods. Notably, these are extra-EA import prices i.e. prices that European firms pay for their imports globally. We observe that the Fed information shock tends to raise EA import prices across these categories of goods. The figures report greater magnitude increases in global commodity and oil prices but more certain increases in EA import prices.

A plausible explanation for the persistent adverse Fed information effects on the backward participating industries is higher costs of production which represent the 'bad news' of the Fed information effects; in concrete terms it means either paying more for imports or reducing the consumption of these factor inputs to the extent they are substitutable. In fact, Figure 15 in Appendix B.1.1 demonstrates that running the LP model again with controls for commodity prices and Brent crude oil clearly mitigates the adverse effects of the Fed information shocks, with particularly the backward participating group experiencing milder adverse effects on its production following the positive Fed shock. This is in keeping with the interpretation that the importing industries experience the Fed information effects mainly through input costs and are thus rather price sensitive. Controlling for oil and other commodity prices also results in the Fed information effects largely fading away by the end of the three-year horizon across the board, leaving much of the long-lasting international propagation of the shock observed in Figures 2 and 3 owing to the shock's effect on prices. Figure 16 in Appendix B.1.1 reports a similar effect when the price of intermediate goods is being controlled for, with also the forward participating industries' production being boosted slightly higher from the main results of Section 3.1.1. While the export boosting effects seem to clearly dominate in the forward participating industries' response to the positive Fed information shock, they are not immune to some adverse price effects reaching their input costs, albeit they import relatively little ultimately from the US.

In conclusion, the price responses reported here are indicative of higher US global demand that cannot be met with global supply. Figure 4 previously confirmed that the positive Fed information shock leads to greater demand in the US for foreign goods. These price signals point to a strong US economy whose foreign demand spills over to international shortage of goods in the first months and years after the positive Fed news, affecting ultimate trade partners along the value chain but also industries that compete with US demand for the goods.

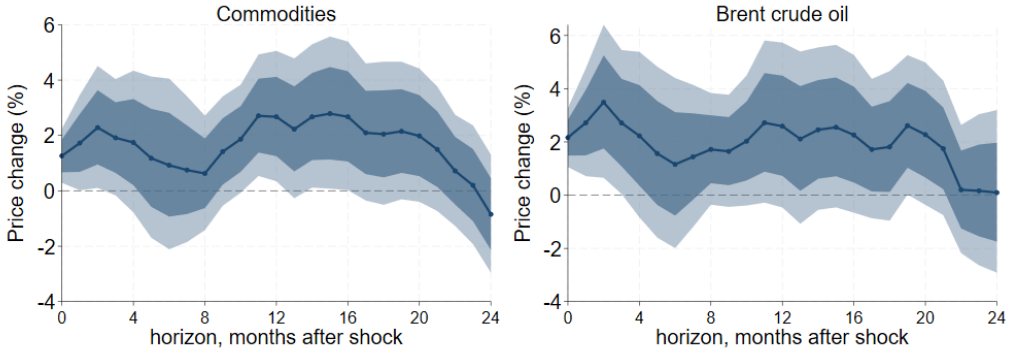


Figure 7: Global commodity price responses to one standard deviation positive Fed information shock of 3 bps. Vertical axis: %-change in the price index estimating $y_{t+h} - y_{t-1} = \alpha_h + \beta_h^{\epsilon}\epsilon_t + \mathbf{z}'_{t-j}\psi_h + \eta_{t+h}$ where $\boldsymbol{z} \equiv$ a vector of controls (6 lagged values of the dependent variable and the shock; linear, quadratic and cubic trends; monthly dummies for seasonal effects). 68% and 90% confidence bands.

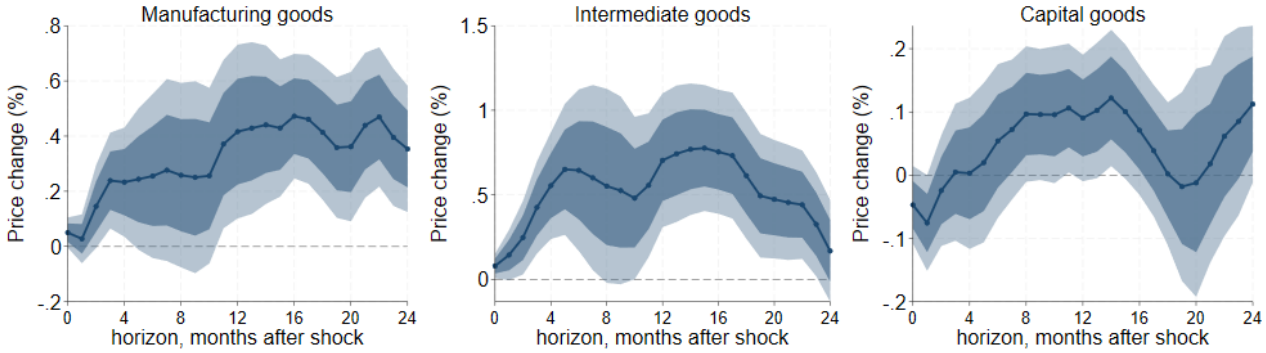


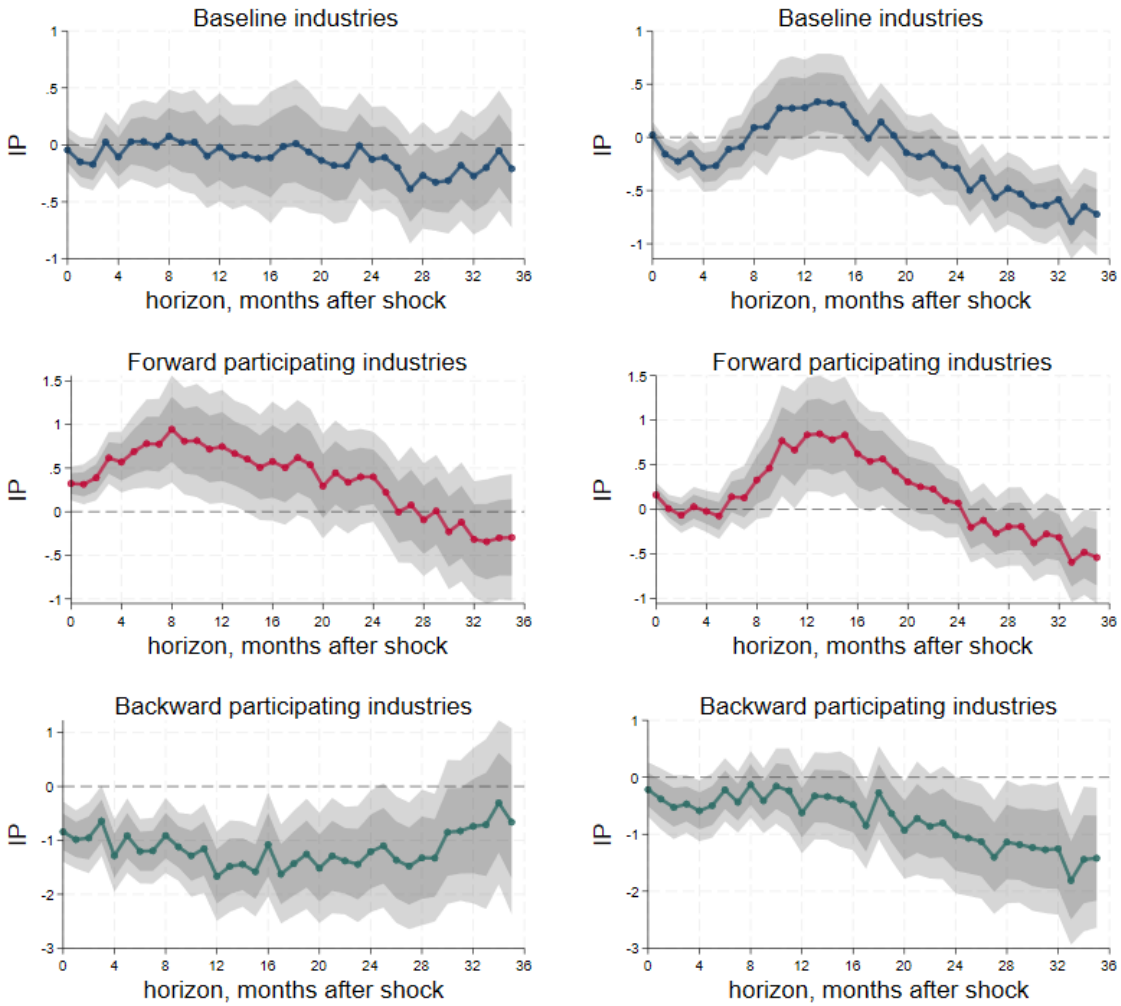
Figure 8: EA import price responses to one standard deviation positive Fed information shock of 3 bps. Vertical axis: %-change in the price index estimating $y_{t+h} - y_{t-1} = \alpha_h + \beta_h^{\epsilon}\epsilon_t + \mathbf{z}'_{t-j}\psi_h + \eta_{t+h}$ where $\boldsymbol{z} \equiv$ a vector of controls (6 lagged values of the dependent variable; linear, quadratic and cubic trends; monthly dummies for seasonal effects, and EA industrial confidence and EA real activity index of Scotti (2016) up to 6 months prior to shock). 68% and 90% confidence bands.

3.2 The effects of other US macroeconomic variables

To address the question of which US macroeconomic forces the Fed information shocks could resemble, Figure 9 contrasts the Fed information effects with the effects of other US macroeconomic variables on EA production. It does so applying the same LP specification of Section 2.3, but now switching the shock to monthly changes in US employment (left) or US consumer confidence series (right).[5] These results should be understood as a first pass at contrasting the Fed information effects with other US macroeconomic variables, noting that the new regressors are arguably not as well identified as the Fed information shock and could reflect anticipation among economic agents since their realisation is not necessarily "news" to the public, although the series are typically released with lags of their occurrence. As for the Fed information shocks, reverse causality is addressed by controlling for EA macroeconomic variables.

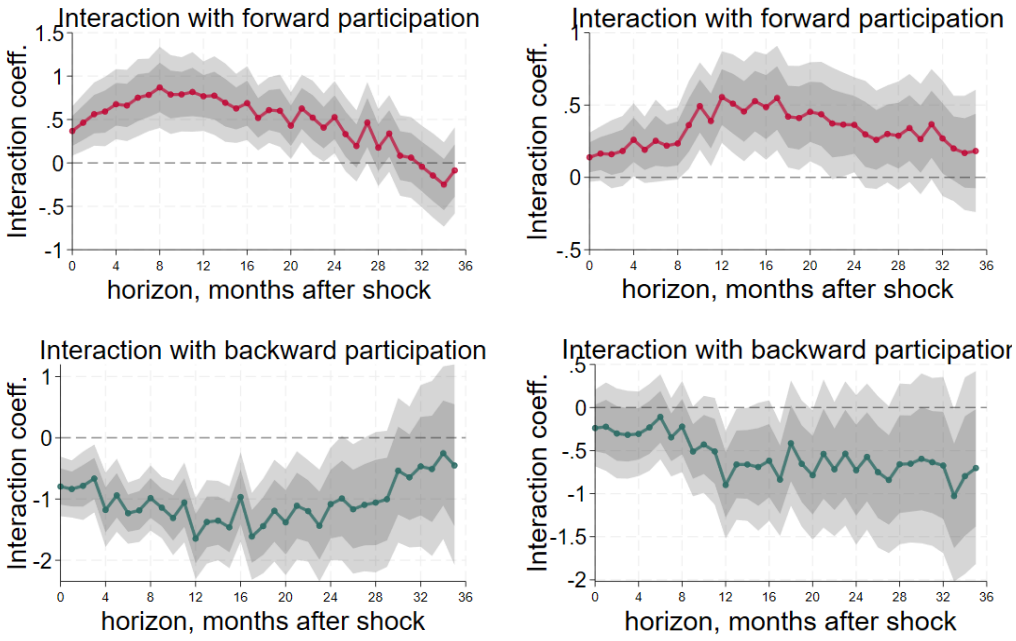
[5]For both US employment and consumer confidence series, I take the first differences of the data to study the effects of the monthly change in the macrovariable in question. Moreover, the US employment series is constructed as the inverse of the US unemployment series in order to interpret it as a positive change in US business cycle.

The results in Figure 9 show qualitatively similar responses in European production as we observe for the positive Fed information shocks. For the US consumer confidence (right panel) also the baseline group shows a similar ambiguous pattern of a slight increase in European production occurring with higher US consumer confidence, which turns into a decrease towards the three-year horizon. Quantitatively the results are of a similar magnitude as the Fed information effects on EA production, although less pronounced for the consumer confidence's impact on backward participating EA industries. Figure 10 confirms that the ultimate EA exporters to the US (top plots) benefit from the positive macroeconomic developments, while the ultimate EA importers from the US (bottom plots) are harmed by it. The similarity in responses to the positive Fed information shocks and the positive changes in macroeconomic data suggest that the Fed information effects reflect benign US business cycle conditions with some combination of positive developments in US employment and consumer confidence. The fact that the Fed information effects resemble changes in US employment is not surprising given that the Fed is mandated to target full employment besides its inflation target, which speaks for a tendency of its economic outlook to involve substantial employment news content. The US consumer confidence series is likely to also reflect US employment conditions in addition to other macroeconomic variables that contribute to consumers' confidence.



Panel A. Response to changes in US employment. Panel B.Response to changes in US consumer confidence.

Figure 9: The overall response of EA IP-index to one standard deviation positive change in the US employment series (left) and the US consumer confidence series (right). The overall effects comprise the main effect and interaction terms, i.e. $\beta_h^c + \phi_h$ of a given variable in the LP model of Section 2.3. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.



Panel A. Response to changes in US employment. Panel B.Response to changes in US consumer confidence.

Figure 10: The interaction coefficients of the trade exposure variable with: the change in the US employment series (Panel A) and the change in US consumer confidence series (Panel B). The interaction coefficient is ϕ_h^i, $i \in \{fw, bw\}$ in the LP model of Section 2.3. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

3.3 The Fed monetary shocks

This section turns lastly to the impact of the Fed monetary policy shocks on EA real activity, which in theory represent demand shocks of an opposite sign to the Fed information shocks. The 'pure' monetary policy shocks are taken to represent exogenous variation in the policy rate that is not linked to the state of the economy. The Fed monetary policy effects on euro area production are displayed in Figures 11, 12 and 13, which are produced by applying the same LP specification of Section 2.3, but replacing the Fed information shock this time with the exogenous Fed monetary shock series of Jarocinski and Karadi (2020). This gives us another key result of the paper, besides the heterogeneity in responses among European industries to the Fed information shocks (documented in Section 3.1.1): the Fed monetary effects mirror the Fed information effects on the aggregate (Figure 11), and very differently from the Fed information effects, the Fed monetary shocks effectively do not interact with the European industries' trade exposure to the US (Figure 13).

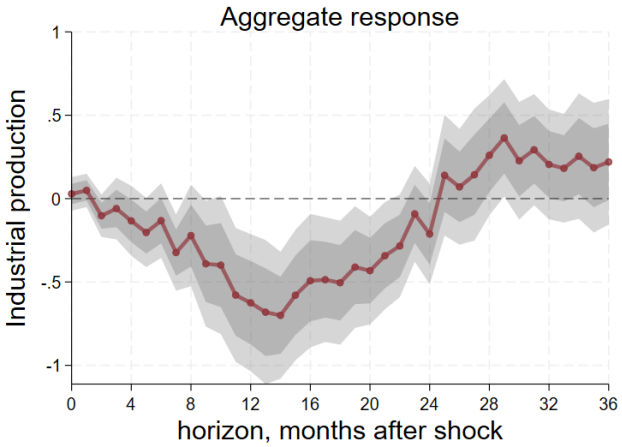


Figure 11: The response of EA IP-index to one standard deviation positive Fed monetary shock of 5 bps across all EA country-industry units. LP specification of Section 2.3 without variables *bw, fw, u* or related interaction terms. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

The adverse aggregate effect of the US monetary policy shock (Figure 11) is in line with what we would predict based on the demand dampening effects of monetary policy on the US economy, for foreign and domestic goods alike. With the real activity boosting effect of the Fed information shock on the one hand and the dampening effect of the monetary shock on the other (shown in Figures 1 and 11), these aggregate results largely cross-validate the results of Jarociński (2022) which document opposing effects of these two Fed shocks on the EA GDP. Observing the overall response of EA production to the Fed monetary shocks shown in Figure 12, it goes generally in the opposite direction than for the Fed information effects (Figure 2), with the baseline (top panel) and forward participating following closely the aggregate pattern. As for the magnitudes, the baseline effects are slightly stronger (statistically significant fall of 0.5% in the EA industrial production at trough) than the baseline Fed information effects (insignificant rise below 0.5%). Where the Fed monetary effects differ substantially from the Fed information effects is in the responses of the forward and backward participating industries. The forward participating industries (middle panel) follow closely the aggregate pattern, rendering them nearly indistinguishable from the baseline group. Only the backward participating industries (bottom panel) show some deviating pattern from the aggregate, with ambiguous and insignificant Fed monetary effects on this industry group. With effectively no resulting impact of the Fed monetary policy shock on the ultimate EA importers, the backward participating EA industries likely receive some noisy but offsetting benefits from lower input prices following the Fed monetary policy shock, contrary to the above documented Fed information effects on factor input prices.

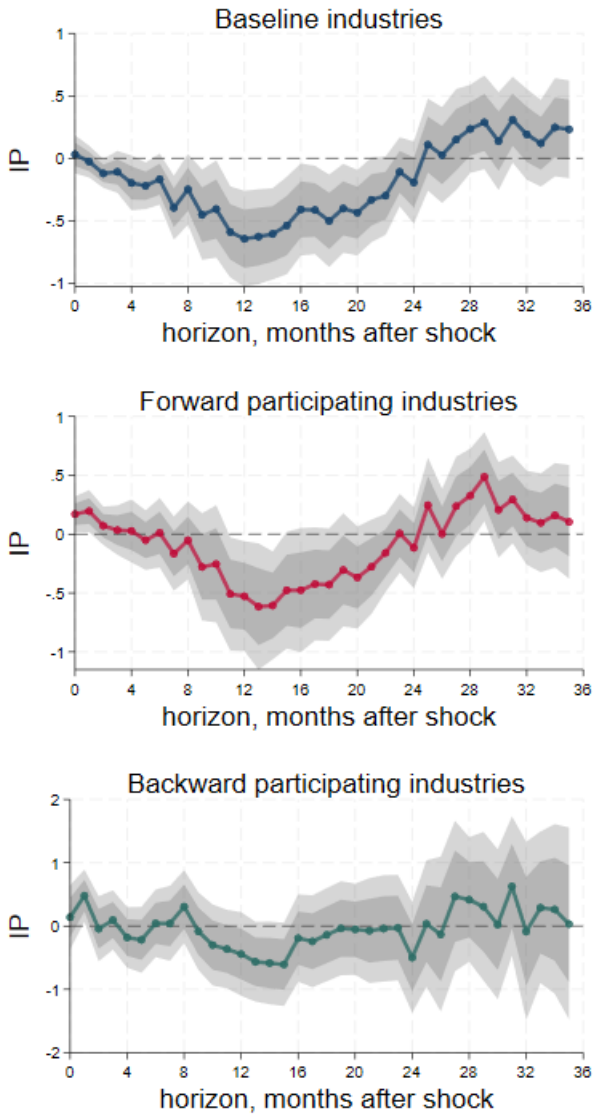


Figure 12: The overall response of EA IP-index to one standard deviation positive Fed monetary policy shock of 5 bps. The overall effects comprise the main effect and interaction terms, i.e. $\beta_h^c + \phi_h$ of a given variable in the LP model of Section 2.3. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

In stark contrast to the cross-Atlantic Fed information effects, the Fed's monetary effects appear not to be US exposure-specific, in the sense that trade links with the US do not drive the response among EA industries. The overall effects on forward participating industries follow largely the effects on the baseline group, which results from the lack of interaction of the monetary policy shock with trade links to the US economy, made apparent in Figure 13. The backward participating EA industries appear to receive some noisy effects from the interaction with the monetary shock on top of the adverse main effect, resulting in the overall effect close to zero. In sum, the lack of interaction generates broadly adverse Fed monetary effects across the board, with only the most US-imports-linked EA industries having no clear response to the Fed monetary shock. As such, the homogeneous responses to the Fed monetary policy stand in contrast with the Fed information effects and indicate that channels of transmission for the two shocks likely differ. The homogeneous effects hinge on monetary effects that come through prices affecting the manufacturing

EA industries more uniformly. While these baseline effects affecting EA industries more broadly are also present for the Fed information effects, they are clearly dominated by the distinct effects that the Fed information shock has through trade links (Figures 2 and 3). Indeed, Appendix B.2.1 shows that the adverse Fed monetary effects displayed above are sensitive to the inclusion of exchange rates and commodity prices in the model; adverse Fed monetary effects, if any, only occur after about 1.5 years of the Fed monetary shock's occurrence when these absolute and relative price movements are controlled for.

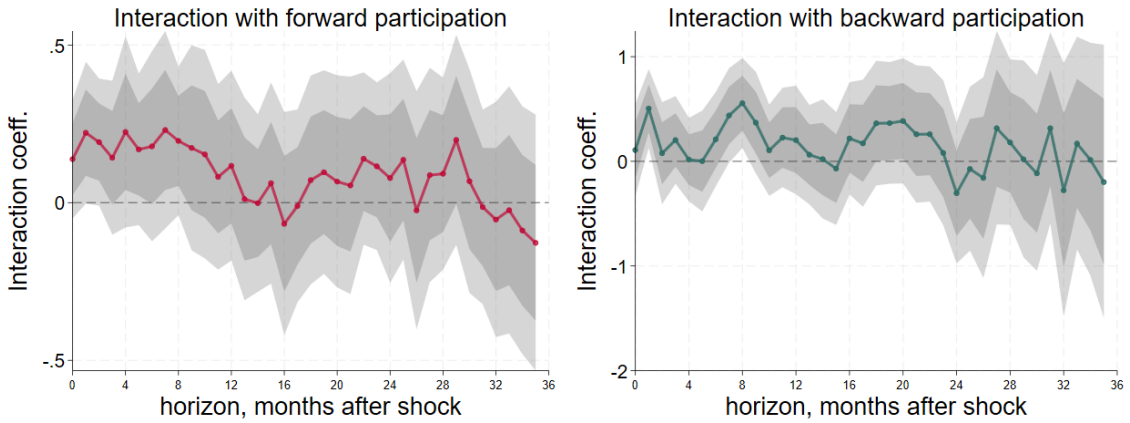


Figure 13: Interaction coefficients of the forward participation dummy (left) and backward participation dummy (right) with the Fed monetary policy shock, which is ϕ_h in the LP model of Section 2.3. The response of IP-index is scaled to one standard deviation positive Fed monetary policy shock. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

There are several plausible explanations for the observed lack of real monetary effects through trade links, which this paper does not investigate further. Economically, it is possible that the pure monetary policy shock that is considered originating at the Fed and having an impact to the extent monetary policy is non-neutral, produces a more muted global demand effect on international trade, compared to a proxy for the underlying US economic state which the Fed information shock could be considered as. Indeed, the part of monetary policy surprises that is purged and considered as exogenous is reduced to shocks with a standard deviation of about 5 basis points. Although the units of the sign identified monetary policy shocks extracted from the principal component are no longer interpretable in the units of interest rate futures changes, a one-standard deviation change in the monetary policy shock component of the policy rate falls substantially below the typical size of a policy rate change of 25-50 basis points deemed macroeconomically effective. In contrast, the Fed information shocks which are equally scaled to one standard deviation change (equal to about 3 bps) appear to capture the US demand effects even when measured by small variations in financial prices. This could be rationalised by the function of the (positive) Fed information shocks as a proxy for very good macroeconomic news previously not priced in asset prices, while the pure monetary shocks, being exogenous and not proxying for the real economic developments under way, should be impactful on the US economy only on their own through e.g. nominal rigidities and financial frictions, and require sufficient magnitude to be macroeconomically potent. The global financial effects of the Fed mon-

etary policy are well documented by now. The results presented here control for risk, investor sentiments and financial channels, which are the subject of study in numerous previous works and could plausibly give the Fed monetary effects the impetus lacking in this context.

4 Discussion

The empirical evidence brought forward in the previous section come with certain caveats. As I do not control for EA industries' trade with other countries than the US, those industries that are particularly backward- or forward participating with respect to the US, may be so also with respect to other economies. Hence, the forward- and backward participation measures vis-à-vis the US can proxy for trade links of the EA industries also with economies other than the US. When the Fed takes policy action (including communication) responding to the global developments that affect the US domestic economy, it can generate a Fed information shock. Hence, I might occasionally be capturing EA response to economic developments in some third country to which Fed responds, and I would capture it distinctly depending on the industry's trade exposure to the US insofar as the EA industries that are ultimate exporters to the US are also ultimate exporters to the third country. The theoretical possibility of this type of omitted variable bias cannot be excluded, although empirically it could prove difficult to capture this effect with statistical significance. This would require the Fed to frequently and consistently respond to the third country business cycle, as well as EA industries' US trade exposure to have a clear correlation with their trade exposure to the third country, as otherwise US would prove an irrelevant proxy for it. Econometrically there is no obvious bias, since the third country business cycle could push the Fed's response towards either monetary tightening or loosening, such that these kind of occurrences would likely represent noise in the estimates documented in this paper.

Another caveat worth considering is the role of supply-side US shocks. Throughout the paper the Fed information shocks are referred to as demand shocks, which is from the perspective of the EA industry. Naturally it is possible for the Fed to take policy action and make communications also when the US economy faces supply shocks. As discussed in Jarocinski and Karadi (2020), there is a possibility of misclassification of Fed information shocks as pure monetary policy shocks when the shock is a supply-side shock. Take for instance a disinflationary technological advancement which could lead the Fed to enact monetary easing to uphold target inflation. For stock valuation, the joint effect of technological improvement and monetary policy would unambiguously appreciate stock prices, leading to a positive co-movement of policy rates and stock prices, which is falsely classified as a pure monetary shock. From the perspective of the EA industry, however, the positive supply shock could be experienced as a positive demand shock from the US.[6] What is of interest for this paper's empirical analysis, are the potentially missing Fed information shocks

[6]The positive supply shock in the US could manifest itself as a positive demand shock for the EA as long as US economic growth increases demand for foreign goods; e.g. as the sectors that become more productive grow in size or the wealth effect of the productivity gain spills over more widely in the US economy adding to demand.

that represent supply shock-driven demand in the US for EA goods. As for the Fed monetary effects analysis of Section 3.3, the supply-side Fed information shocks misclassified as pure monetary policy shocks could create an attenuation bias in the results if they add to foreign demand in the US, since a monetary shock has the opposite sign and the sample of monetary policy shocks would become contaminated with misclassified information shocks counteracting the estimated impact of Fed monetary policy on the EA activity.[7] Quantitatively the issue of misclassified supply-driven Fed information shocks is likely to be less pressing, since Jarocinski and Karadi (2020) find supply shocks (which they define as those information shocks driving output and inflation in opposite directions) not to account for much of the variation in their dependent variables.

Lastly, this paper treats the Fed information shocks as proxies for the underlying US demand for foreign goods and is agnostic about the source of information asymmetries between the central bank and the general public. Bauer and Swanson (2023) find that economic news released in the days leading up to an FOMC announcement is an important omitted variable in the regressions of professional forecast revisions on monetary policy surprises (originally used in Campbell et al. (2012)), and controlling for the very newest economic data releases reproduces monetary policy coefficients in line with standard macroeconomic models. The the surprise element during the FOMC announcements should then lie in the information asymmetry between the public and the central bank about the monetary policy function. The findings of this paper do not allow us to take a stance on whether the Fed has private information about the state of the economy superior to the public, which is the assumption originally behind the central bank information channel, or whether the Fed and the markets learn and process equally the same newly arrived macroeconomic information. The message of these results is rather that the Fed information shocks identified from stock market reactions can be taken as a proxy for the underlying state of the US economy that bears distinct economic significance for trade partners' activity. If this feature exists, it would hold under either type of information asymmetry between the Fed and the public, with the EA response not allowing to distinguish where the information asymmetry lies between the Fed and the financial markets.

Indeed, it is conceivable that foreign trade partners' response documented in the results is less so to the Fed announcement itself about how the Fed views the US economy but, rather, that the Fed information shock is a strong proxy for the demand that develops regardless of the announcement. Otherwise, for there to be a systematic, statistically significant response from the EA trade partners, it would require EA business managers to maintain a constant surveillance of the FOMC announcements as well as to have an understanding of how their value added may ultimately end up in the US through all the (theoretically infinite) global value chain paths. For the purpose of using the Fed information shocks as reliable proxies of US demand for foreign goods, it suffices that stock market investors conduct constant Fed announcement

[7] Given the Fed's dual mandate of maximum employment and price stability, a supply-side information shock would not be misclassified as a pure monetary policy shock in the event that the technology shock used as an example would raise employment exceedingly such that the Fed chooses to *raise* its policy rate in the face of the positive US supply shock.

surveillance and, crucially, have the ability to translate it into *domestic* US equity valuation that strikes the right balance between the impacts of macroeconomic developments and of monetary policy on the stock price.

5 Conclusions

The paper estimated the effect of Fed information shocks on euro area industrial production empirically through a panel local projection model. The identification strategy of these shocks relies on high-frequency stock market reactions and calls into question how the shocks materialise from a real economic point of view. These shocks are, by now, well-familiar to the literature, as it has become the standard to control for the channel which they are taken to represent, when an exogenous representation of monetary policy is needed for empirical analysis. Yet, relatively little space in the literature is dedicated to what these residual "catch-all" shocks are, and what are the real economic outcomes that they stir. The results of this paper revealed that the Fed information effects extend to real economic activity across the Atlantic, yet the impact depends crucially on the Ultimate trade partner's exposure to the US economy.

The empirical model of this paper borrows from the production network literature to form a comprehensive view of European industries' trade exposure vis-à-vis the US. It utilises cross-industry heterogeneity in European industries' trade exposure that allows estimating the Fed effects conditional on the asymmetry in input-output linkages among the ultimate European trade partners. The empirical approach unmasked sector-specific trade-related patterns in the transmission of Fed information shocks to euro area activity which become undetectable from aggregated data and informed us about which type of demand shock the EA industries experience the Fed information effects as.

The effects of the Fed information shocks on EA production were contrasted with the equivalent effects of changes in US employment and US consumer confidence, with qualitatively and quantitatively similar outcomes to the Fed information effects. The resemblance among the outcomes suggests that the Fed information shocks represent economic forces that are a combination of these variables. The Fed information effects were subsequently contrasted with the effects of Fed monetary policy shocks that are classified as exogenous. Interestingly the EA industries' trade links with the US appear to be inconsequential for the impact of the Fed monetary policy on EA production. This stands in stark contrast with the evidence that US trade links are decisive for the Fed information effects on Europe. European industries respond rather homogeneously to the Fed monetary shocks, which points to monetary effects arising through changes in absolute and relative prices affecting EA economic activity more broadly, as opposed to trade links that appear to be the driver of heterogeneity among European industry-level responses.

This paper brings forth an economically meaningful finding: the Fed information effects on EA trade partners appear as a potent global demand shock. The positive Fed information effects resemble the effects of other US macroeconomic forces which speaks for benign business cycle conditions in the US. The

US economic upturn, communicated through the central bank, has a global reach visible in a wide range of international prices, which ought to affect firms competing for inputs with the US economy. The positive Fed information shock foretells a positive outlook for the European suppliers of the US economy who will reap the benefits of the US economic upswing, while it penalises those European trade partners that rely ultimately on the US economy as a source of inputs. The empirical findings of this study serve to establish the connection between the stock price reactions during the Fed announcements and the ensuing macroeconomic outcomes. This supports the identification assumption that stock markets have the ability to process central bank announcements efficiently, such that researchers may treat the central bank information shocks as something with (real) economic meaning.

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APPENDICES

A Trade related variables' construction

A simplified structure of a world input-output table is shown in Figure 14.

			Input use & value added							Final use			Total use
			Country 1			⋯	Country J			Country 1	⋯	Country J	
			Industry 1	⋯	Industry S	⋯	Industry 1	⋯	Industry S				
Output supplied	Country 1	Industry 1	Z_{11}^{11}	⋯	Z_{11}^{1S}	⋯	Z_{1J}^{11}	⋯	Z_{1J}^{1S}	F_{11}^{1}	⋯	F_{1J}^{1}	Y_1^1
		⋯	⋯	Z_{11}^{rs}	⋯	⋯	⋯	Z_{1J}^{rs}	⋯	⋯	⋯	⋯	⋯
		Industry S	Z_{11}^{S1}	⋯	Z_{11}^{SS}	⋯	Z_{1J}^{S1}	⋯	Z_{1J}^{SS}	F_{11}^{S}	⋯	F_{1J}^{S}	Y_1^S
	⋯	⋯	⋯	⋯	⋯	Z_{ij}^{rs}	⋯	⋯	⋯	⋯	F_{ij}^{r}	⋯	Y_i^r
	Country J	Industry 1	Z_{J1}^{11}	⋯	Z_{J1}^{1S}	⋯	Z_{JJ}^{11}	⋯	Z_{JJ}^{1S}	F_{J1}^{1}	⋯	F_{JJ}^{1}	Y_J^1
		⋯	⋯	Z_{J1}^{rs}	⋯	⋯	⋯	Z_{JJ}^{rs}	⋯	⋯	⋯	⋯	⋯
		Industry S	Z_{J1}^{S1}	⋯	Z_{J1}^{SS}	⋯	Z_{JJ}^{S1}	⋯	Z_{JJ}^{SS}	F_{J1}^{S}	⋯	F_{JJ}^{S}	Y_J^S
Value added			VA_1^1	⋯	VA_1^S	VA_j^s	VA_J^1	⋯	VA_J^S				
Gross output			Y_1^1	⋯	Y_1^S	Y_j^s	Y_J^1	⋯	Y_J^S	⋯			

Figure 14: The structure of a world input-output table. Source: Antras and Chor (2022)

The world input-output data is aggregated from the national statistical agencies' input-output tables and is being produced with substantial lags; the latest version of WIOD covers data from 2014 on 43 countries (J=43) (with the rest of the world aggregated into one region) and 56 industries (S=56) classified under the UN's ISIC Rev. 4.

A.1 Backward and forward participation

The forward participation measure of the country-industry *ir* with respect to country *j* (through any country m,k and industry l,t) are computed as:

$$FW_{ij}^{r} = \frac{\sum_{s=1}^{S} F_{ij}^{rs}}{VA_i^r} + \frac{\sum_{k=1}^{K}\sum_{l=1}^{L}\sum_{s=1}^{S} a_{ik}^{rl} F_{kj}^{ls}}{VA_i^r} + \frac{\sum_{m=1}^{M}\sum_{k=1}^{K}\sum_{l=1}^{L}\sum_{t=1}^{T}\sum_{s=1}^{S} a_{ik}^{rl} a_{km}^{lt} F_{mj}^{ts}}{VA_i^r} + \ldots \tag{4}$$

The value added from EA ultimately exported to the US is weighed by the EA industry's total value added, VA_i^r in order to normalise by the industry size in a way that reflects the proportional significance of the value added that ends up in the US, out of the entire value added generated by the country-industry.

The below states that gross output produced, Y (left-hand side), can be split into the uses (right-hand side) of final absorption, F, and value added use, AY, – all of which will ultimately be used for final absorption, in matrix notation:

$$Y = F + AY = F + AF + A^2F \ldots \tag{5}$$

$$\Rightarrow Y = [\mathbf{I} - \mathbf{A}]^{-1} F \tag{6}$$

where the second lines results from an infinite geometric sum sequence, as $[\mathbf{I} - \mathbf{A}]^{-1} = \sum_{k=0}^{\infty} A^k$ (see also

Antras and Chor (2022), Johnson (2018)), Carvalho and Tahbaz-Salehi (2019). The above expression can be normalised to express value added required to create the amount of final absorption F:

$$VA = \mathbf{VA}^{-1}[\mathbf{I}-\mathbf{A}]^{-1}F \tag{7}$$

where ***VA*** is a diagonal matrix with the value added-to-output ratios of all importing country-industries *js* along the diagonal, vector F consists of all final absorptions and vector VA consists of all value added.

The term $[\mathbf{I}-\mathbf{A}]^{-1}$ is the Leontief inverse of the global input-output matrix. A given element (*ir,jl*) of the Leontief inverse measures the importance of country-industry *ir* as a direct and indirect input supplier to country-industry *jl* in the global economy (see also Carvalho and Tahbaz-Salehi (2019)). To fix a country-industry *ir*'s forward-participation against a specific country *j*, one restricts the final absorption F to the segment of the vector corresponding country *j* only (denoted by f_j) and restricts the value added to the segment of the vector corresponding to *ir* (denoted va^r_{ij}):

$$va^r_{ij} = \mathbf{VA}^{-1}[\mathbf{I}-\mathbf{A}]^{-1}f_j \tag{8}$$

$$\tag{9}$$

where va^r_{ij} is a vector of length J of the value added of a country-industry *ir* absorbed ultimately by an industry in country *j*, and f_j is a vector of length JxS of the final goods produced by all JxS country-industries *ir* and ultimately absorbed by country *j*. The resulting vector va^r_{ij} measures the value added needed to be generated by country-industry *ir* in order to meet the final demand in country *j*.

To compute a forward participation measure that describes the country-industry *ir*'s exposure to country *j*, we can normalise va^r_{ij} by dividing it either by the total value added produced by *ir*, VA^r_i, or the total industry output of *ir*, Y^r_i, of which a fraction is the industry's own value added and remaining fraction purchases of intermediate inputs, which are the the value added of industries other than *ir*. In the empirical analysis of this paper, the measure is normalised by the total value added produced by *ir*, i.e.:

$$fw^r_{ij} = va^r_{ij}[VA^r_i]^{-1} \tag{10}$$

fw^r_{ij} is a vector of length S (number of sectors) of the forward participation rates of country-industry *ir* vis-à-vis country *j*.

The forward participation measure indicates how much an industry exports its value added to other industries, i.e. to what extent an industry is a supplier of goods to other industries. The measure indicates a given EA industry's exposure to country *j* through direct and indirect trade in value added trough its exports. The final destination is fixed to *j=US* and ultimate source is fixed as *i* = {Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal} for the forward participation

measure.

Similarly, the backward participation measure of the country-industry *js* with respect to country *i* is defined as:

$$BW_{ij}^{s} = \frac{\sum_{s=1}^{S} F_{ji}^{sr}}{VA_{j}^{s}} + \frac{\sum_{k=1}^{K}\sum_{l=1}^{L}\sum_{s=1}^{S} a_{jk}^{sl} F_{ki}^{lr}}{VA_{j}^{s}} + \frac{\sum_{m=1}^{M}\sum_{k=1}^{K}\sum_{l=1}^{L}\sum_{t=1}^{T}\sum_{s=1}^{S} a_{jk}^{sl} a_{km}^{lt} F_{mi}^{tr}}{VA_{j}^{s}} + \dots \tag{11}$$

The backward participation measure indicates to what extent an industry imports value added from other industries. The final destination is fixed to j = {Austria, Belgium, Germany, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal} and ultimate source is fixed as *i=US* for the backward participation measure. The measure is normalised with the *importing* (EA) country-industry's total value added, VA_{j}^{s}, to reflect the proportional significance of ultimate US imports from the perspective of the EA industry.

As a measure of an industry's total trade integration through global value chains, one can compute the global value chain participation rate as a sum of the forward- and backward participation measures (see e.g. Georgiadis).

B Robustness

B.1 Robustness of the main results of Section 3.1.1

The tests here check for the robustness of the main results displayed in Figures 2 and 3.

B.1.1 Controlling for price effects on commodities and oil

This robustness test re-runs the LP model of of Section 3.1.1, controlling for commodity prices and Brent crude oil prices (see Data appendix for data details.).

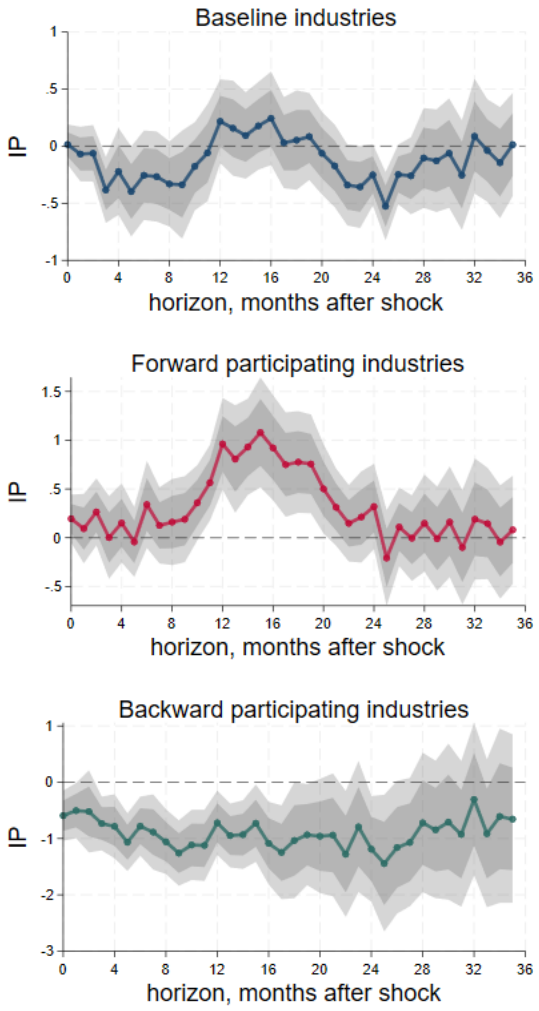

Figure 15: The overall response of EA IP-index to one standard deviation positive Fed information shock of 3 bps, once commodity and Brent crude oil prices are controlled for. The overall effects comprise the main effect and interaction terms, i.e. $\beta_h^c + \phi_h$ of a given variable in the LP model of Section 2.3. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

B.1.2 Controlling for price effects on intermediate goods

This robustness test re-runs the LP model of of Section 3.1.1, controlling for intermediate goods' import prices (see Data appendix for data details.).

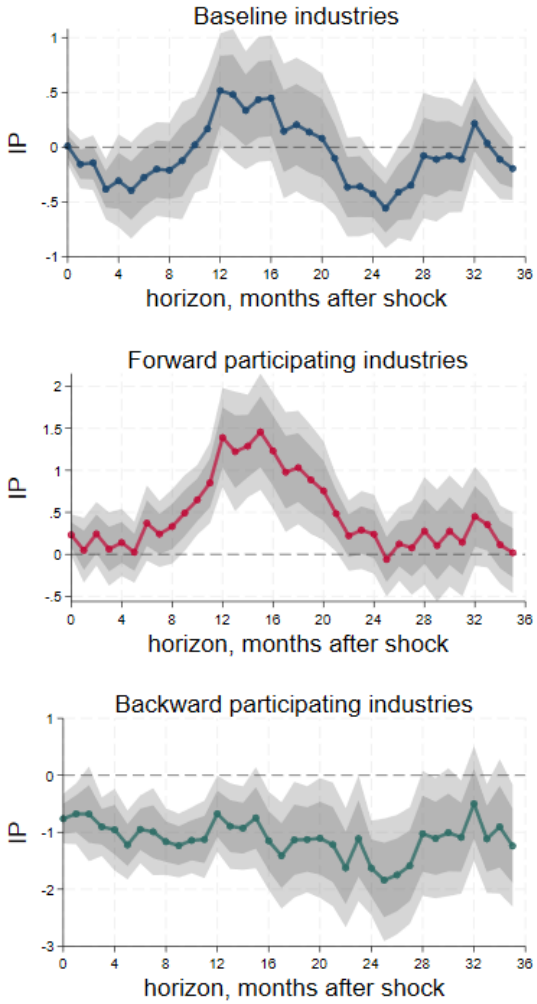

Figure 16: The overall response of EA IP-index to one standard deviation positive Fed information shock of 3 bps, once intermediate goods' import prices are controlled for. The overall effects comprise the main effect and interaction terms, i.e. $\beta_h^c + \phi_h$ of a given variable in the LP model of Section 2.3. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

B.1.3 Extending time period to 2000m1-2019m12

This robustness test re-runs the LP model of Section 3.1.1 with data for the time period 2000m1-2019m12 (last date of the Fed information shock is June 2019). The euro area industrial production index used in this simulation uses the Eurostat's industrial production index with basis year 2015 [8]). The IP-index used in all other empirical exercises of the paper has a basis year 2010 and was discontinued from 2018. Note: Eurostat has slightly modified the industry composition for the EA IP-index with basis year 2015 from the series with basis year 2010.

[8] 'Price-adjusted output of industry'; 2015=100. Seasonally and calendar adjusted. Eurostat series code: sts_inpr_m.

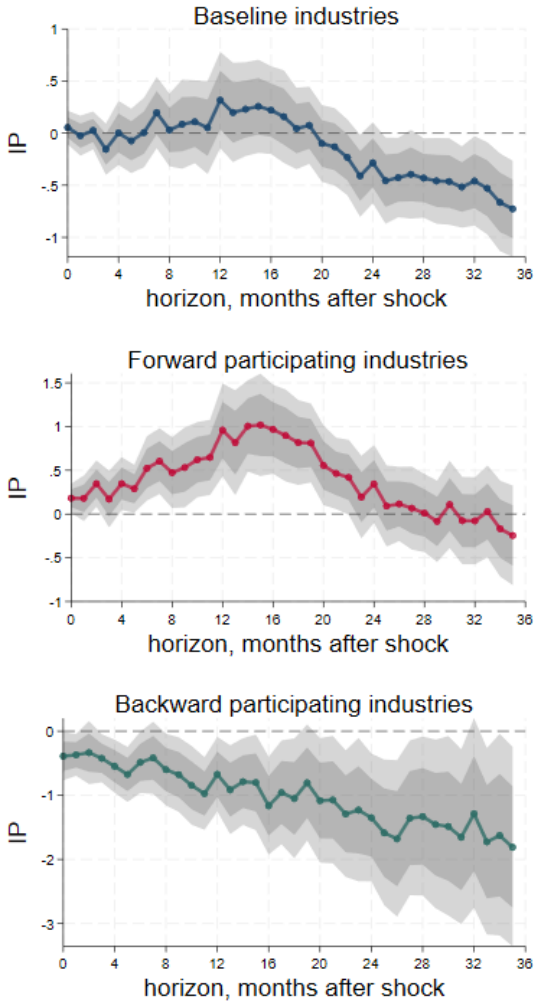

Figure 17: The overall response of EA IP-index to one standard deviation positive Fed information shock of 3 bps, with the inclusion of data until 2019m12. The overall effects comprise the main effect and interaction terms, i.e. $\beta_h^{\epsilon} + \phi_h$ of a given variable in the LP model of Section 2.3. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

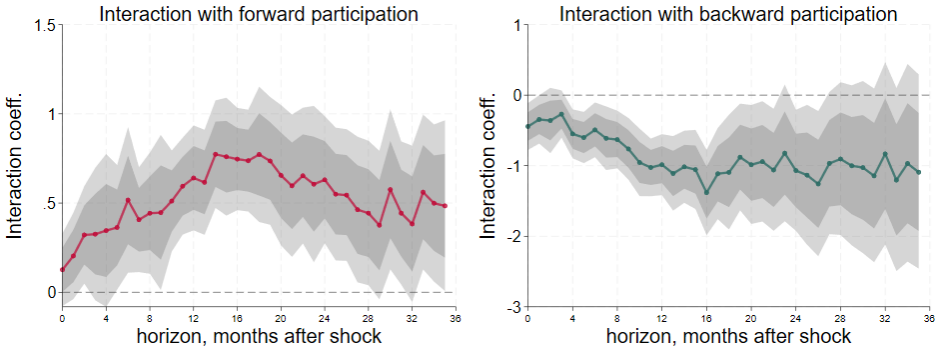

Figure 18: Interaction coefficients of the forward participation dummy (left) and backward participation dummy (right) with the Fed information shock, with the inclusion of data until 2019m12. The response of IP-index is scaled to one standard deviation positive Fed information shock. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

B.1.4 No outliers excluded

This robustness test re-runs the LP model of Section 3.1.1 without excluding any outlier industries.

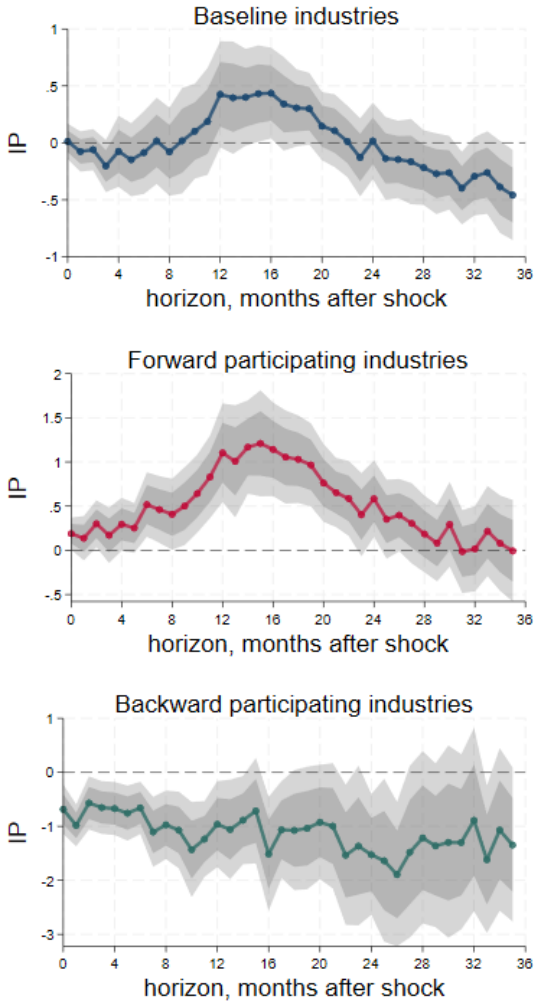

Figure 19: The overall response of EA IP-index to one standard deviation positive Fed information shock of 3 bps, with the inclusion of all industries in the sample. The overall effects comprise the main effect and interaction terms, i.e. $\beta_h^c + \phi_h$ of a given variable in the LP model of Section 2.3. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

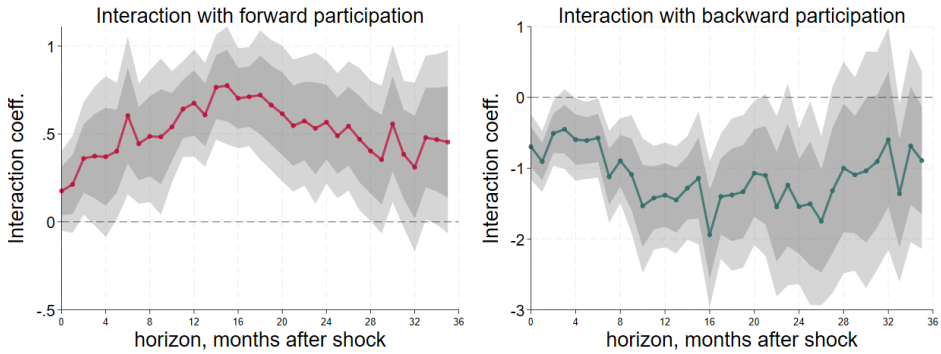

Figure 20: Interaction coefficients of the forward participation dummy (left) and backward participation dummy (right) with the inclusion of all industries in the sample. The response of IP-index is scaled to one standard deviation positive Fed information shock. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

B.2 Robustness of exogenous monetary policy

B.2.1 Fed monetary policy effects controlling for exchange rates and commodity prices

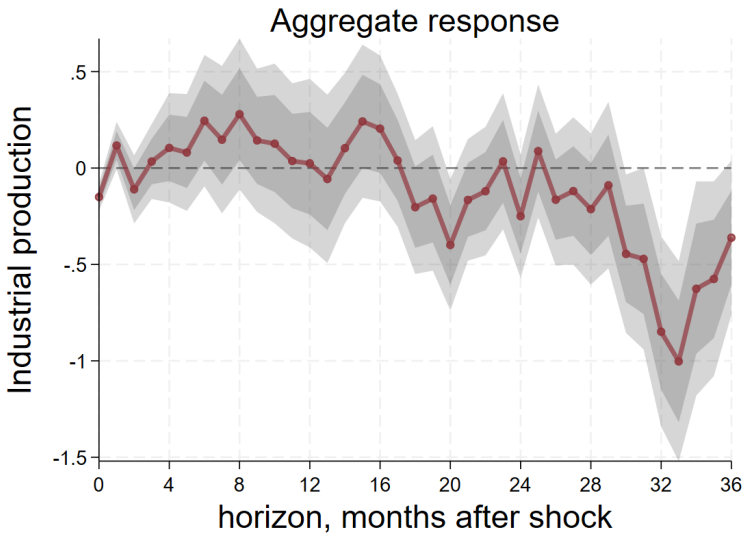

Figure 21: The response of EA IP-index to one standard deviation positive Fed monetary shock of 5 bps across all EA country-industry units and controlling for commodity prices and dollar value against the euro and a broader currency basket. LP specification of Section 2.3 without variables *bw, fw* or related interaction terms. Impulse responses are reported as percent changes in the IP-index. 68% and 90% confidence bands.

C Data appendix

Table 1: Summary of data for control variables

Variable	Source	Periods	Details
Euro stoxx 50 volatility index (VSTOXX)	STOXX Ltd www.stoxx.com	2000m1-2019m12	Monthly values averaged from daily closing value of the index. Series key: V2TX.
VIX index	Chicago Board Options Exchange, retrieved from FRED	2000m1-2019m6	Monthly, average. Series key: VIXCLS.
USD broad value index	BIS	2000m1-2019m12	USD value against a basket of 27 main trading partner currencies. Real value, Index, 2020 = 100. Series key: M.R.N.US
Oil price	IMF, retrieved from FRED	2000m1-2019m12	Global price of Brent Crude. Series key: POILBREUSDM. Real values obtained dividing by US CPI; series key CPIAUCSL (also via FRED).
2-year US Treasury yields	Board of Governors of the Federal Reserve System, retrieved from FRED	2000m1-2019m12	Market Yield on U.S. Treasury Securities at 2-Year Constant Maturity, Quoted on an Investment Basis [GS2].
Eonia	ECB	2000m1-2019m12	Series key: FM.M.U2.EUR.4F.MM.EONIA.HSTA
Excess bond premia	Gilchrist and Zakrajsek (2012)	2000m1-2019m12	
EA real activity index	Scotti (2016)	2000m1-2019m12	

Notes: All data are with monthly frequency unless stated otherwise.

Table 2: Summary of data for main variables

Variable	Source	Periods	Details
EA industrial production	Eurostat	2000m1-2017m12	Price-adjusted output of industry; index, 2010=100. Seasonally and calendar adjusted. Series code: sts_inpr_m.
Fed information shocks	marekjarocinski.github.io	2000m1-2019m6	shocks obtained with the median rotation that implements the sign restrictions
Fed monetary shocks	marekjarocinski.github.io	2000m1-2019m6	shocks obtained with the median rotation that implements the sign restrictions
EUR/USD rate	BIS	2000m1-2019m12	Nominal values; euros per one US dollar.
EA NFC credit spread	Gilchrist and Mojon (2017)	2000m1-2019m12	Credit spread of EA non-financial corporates over the German Bund.
Backward participation	World Input-Output Database (WIOD), Timmer et al.)	2000-2014	Annual data.
Forward participation	World Input-Output Database (WIOD), Timmer et al.)	2000-2014	Annual data.
Upstreamness	World Input-Output Database (WIOD), Timmer et al.)	2000-2014	Annual data.
EA capital good import price	Eurostat	2005m1-2019m12	Import price index (from outside EA) for 20 EA member states. MIG Capital Goods Industry - NACE Rev.2. Accessed via ECB. Series key: STS.M.I9.N.IMPX.NS0050.4.000
EA manufacturing good import price	Eurostat	2005m1-2019m12	Import price index (from outside EA) for 20 EA member states. MIG Manufacturing Goods Industry - NACE Rev.2. Accessed via ECB. Series key: STS.M.I9.N.IMPX.2C0000.4.000
EA intermediate good import price	Eurostat	2005m1-2019m12	Import price index (from outside EA) for 20 EA member states. MIG Intermediate Goods Industry - NACE Rev.2. Accessed via ECB. Series key: STS.M.I9.N.IMPX.NS0040.4.000
Global Price Index of All Commodities	IMF	2003m1-2019m12	Index with prices for all commodities in IMF database. Basis year 2016=100. Code PALLFNFINDEXM.
US net imports (deflated gross imports minus deflated gross exports)	U.S. Census Bureau and U.S. Bureau of Economic Analysis (retrieved from FRED)	2005m1-2019m12	Exports of Goods and Services, Balance of Payments Basis [BOPTEXP]; Imports of Goods: Balance of Payments Basis [BOPGIMP]. Deflator: Personal consumption expenditures: Market-based (chain-type price index) [DPCMRG3M086SBEA]. Index 2017=100. All seasonally adjusted.
US real activity index	Scotti (2016)	2000m1-2019m12	Built from a dynamic factor model with US GDP, industrial production, non-agricultural payrolls, retail sales, the ISM manufacturing index and personal income)