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The Micro and Macro of a Large and Sudden Devaluation*

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Abstract

This paper quantifies the micro- and macro-level consequences of the sudden appreciation of the Swiss franc in 2015, one of the sharpest and most persistent currency movements in recent decades. Using detailed firm-level data on French imports and exports, we show that the Swiss franc appreciation led to a rise in exports, driven mainly by the entry of new firms and new products, while imports increased only briefly due to a spike in prices among continuing firm–product pairs. These dynamics mirror a textbook J-curve adjustment and reveal the firm-level mechanisms underlying this aggregate response. On the macro side, we trace how the shock propagated through supply chains, capturing both direct and indirect exposures through input–output linkages. This network-based perspective uncovers a small but negative overall impact on French GDP, driven by the stronger hit to importers, more reliant on non-euro currencies and more central within domestic production networks, who acted as key conduits transmitting the negative side of the shock across the economy.

Keywords: Exchange rate shocks, international trade, production network.
JEL codes: F14, F31, F44.

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1 Introduction

Exchange rate movements are among the most closely monitored macroeconomic variables, as they shape international competitiveness, trade flows, and aggregate demand. Yet despite extensive research, our understanding of how economies adjust to large and sudden currency shocks remains limited for three main reasons. First, most exchange rate fluctuations are *endogenous*, making it difficult to identify their causal effects (e.g., Forbes, 2002; Burstein et al., 2005; Gopinath et al., 2010). Second, while the literature on *exchange rate pass-through* and *currency invoicing* is extensive (e.g., Devereux et al., 2017; Amiti et al., 2022), we still know relatively little about the firm-level mechanisms underlying aggregate adjustments (e.g., Berman et al., 2012; Bems and Johnson, 2013; Berthou and Fontagné, 2015; Gopinath and Neiman, 2014). Third, although recent research has shown that microeconomic shocks can propagate and generate aggregate effects through production networks (Acemoglu et al., 2012; Carvalho and Tahbaz-Salehi, 2019; Huneeus, 2020; Dhyne et al., 2021), the propagation of exchange rate shocks through input–output linkages has not yet been systematically evaluated.

This paper addresses these gaps by exploiting a rare natural experiment, namely the sudden, sharp and persistent appreciation of the Swiss franc in January 2015, to quantify both the micro- and macroeconomic consequences of an exchange rate shock. Using detailed firm-level data on French imports and exports, we trace how firms adjusted their trade patterns and how these adjustments propagated through the domestic production network to affect the French economy as a whole. In doing so, we bridge two strands of literature that have typically evolved in parallel: the firm-level analysis of trade responses to exchange rate movements and the macroeconomic evaluation of currency shocks.

We focus on the Swiss episode because it provides an almost ideal setting for identification. After years of maintaining a minimum exchange rate of CHF 1.20 per euro to counter appreciation pressures, the Swiss National Bank (SNB) unexpectedly abandoned this policy in January 2015. Within hours, the franc appreciated by nearly 20%, moving from 1.20 to 1.02 per euro, and it remained below 1.10 for more than two years. The event was largely unanticipated, sharp, and persistent, and, crucially, exogenous to French economic conditions. As such, it represents a quasi-experimental shock to currency conditions (Auer et al., 2019, 2021, e.g.,) that allows us to study both the micro and macro channels of adjustment.

Our analysis proceeds in two steps. In the first step, we characterize the French–Swiss trade corridor and examine how the Swiss franc appreciation affected trade flows between the two countries. The comparison is particularly meaningful because France and Switzerland are major trading partners that exchange largely similar high-value products, such as pharmaceuticals, vehicles, and luxury goods, yet differ substantially in market size. At the aggregate level, trade dynamics follow a textbook J-curve adjustment consistent with the Marshall–Lerner condition: exports rose gradually and persistently after the shock, while imports exhibited a short-lived surge in the year of the appreciation and then stabilized. As a result, the euro's depreciation translated into a sustained improvement in France's bilateral trade balance with Switzerland.

To understand the micro feature of these aggregate trends, we decompose the aggregate trade adjustment induced by the Swiss franc appreciation into its different components. Specifically, we distinguish three margins of adjustment. First, the *firm extensive margin* captures the entry and exit of firms trading with Switzerland. Second, among continuing firms, the *product extensive margin* captures product entry and exit within incumbent exporters and importers. Third, for *continuing* firm–product pairs, the *intensive margin* captures changes in trade values between two consecutive years. This decomposition reveals that the post-shock export growth was almost entirely driven by the entry of new firms and products into the Swiss market, whereas changes in the intensive margin were limited. Conversely, import dynamics were dominated by the intensive margin: existing firm–product relationships reacted with a sharp but temporary spike immediately after the appreciation, while the extensive margins remained largely unchanged. This asymmetry reflects structural differences between export and import flows: imports are more frequently invoiced in non-euro currencies and are more concentrated among continuing firm–product relationships than exports.

For continuing firm–product pairs, we further decompose the intensive margin into three components, namely *price*, *quantity*, and *interaction*, to disentangle pure price effects (holding quantities fixed), pure quantity responses (holding prices fixed), and the joint movement of both. For exports, this finer decomposition indicates that the erratic pattern of the intensive margin reflects only small and offsetting fluctuations in prices and quantities, implying that the devaluation had a limited effect on ongoing firm–product relationships. In contrast, for imports, the pronounced spike in the intensive margin is almost entirely explained by a sharp rise in the price component, while quantity and interaction terms remain negligible.

In the second step, we move from firms to the macroeconomy. We investigate how the shock to trading firms propagated through the French production network, affecting not only those directly exposed to Swiss trade but also firms indirectly connected via input–output linkages.

Our analysis builds on the framework of Acemoglu et al. (2012), which models how firm-level shocks can propagate across production networks to generate aggregate fluctuations. We extend this framework to explicitly incorporate exchange rate shocks that affect both imported intermediate inputs and exported outputs. In the model, heterogeneous firms produce with a Cobb–Douglas technology combining capital, labor, and intermediate inputs sourced from other firms. Exchange rate shocks enter as wedges on costs and revenues, raising the price of imported inputs and reducing the price of exported goods, which then diffuse through the network according to the structure of production linkages. The strength of propagation depends on each firm's position within the network, summarized by the *influence vector*, which measures how much a firm contributes to aggregate output fluctuations. This framework allows us to express the change in aggregate GDP as a weighted sum of firm-level distortions induced by the Swiss franc appreciation. While we adopt this parsimonious Cobb–Douglas benchmark for tractability, we also discuss extensions featuring CES production, imperfect competition, and endogenous link formation, which allow for input substitution, markup adjustments, and network reorganization in response to the shock.

To quantify the net effect of the Swiss franc appreciation within this framework, we require three key inputs: the firm-level input–output structure of the French economy, the shares of labor and capital in production, and the firm-specific price distortions induced by the shock. Because detailed firm-to-firm transaction data are unavailable for France, we infer the production network using the probabilistic method developed by Couttenier et al. (2022). This algorithm reconstructs buyer–supplier relationships based on observable characteristics. First, we identify the set of products that each French firm potentially sells or purchases by combining customs data, which report products traded by firm–sector, with information from Moody's DataHub, assuming that firms within the same NACE 5-digit industry produce and consume similar goods. Second, we estimate the likelihood that one firm supplies a given product to another according to two parameters: geographic proximity and supplier size. Larger firms located nearby are assigned higher probabilities of being linked, whereas smaller or more distant firms are less likely to form connections. Aggregating these probabilities across all possible pairs yields a large-scale approximation of the domestic production network, capturing indirect inter-firm linkages through intermediate inputs. The second component is the shares of labor and capital. We estimate it using firm-level balance-sheet data from Moody's DataHub and the econometric approach proposed by Wooldridge (2009). Finally, we structurally estimate the firm-level price distortions by exploiting the firm-level variation in prices before and after the shock.

Using these three elements, we quantify the aggregate impact of the Swiss franc appreciation on the French economy. The analysis shows that the appreciation generated a small but consistently negative effect on aggregate output. We find that the estimated input and output price distortions translate into a modest decline in French GDP, in the range of 0.01–0.05 percent depending on the specification. However, the direction of the effect remains robust across all parameters and alternative network structures. The asymmetry between importers and exporters explains this outcome. The appreciation increased import prices more sharply than it reduced export prices, raising input costs throughout the supply chain. Importing firms, which are both more exposed to non-euro currencies and occupy more central positions within the domestic production network, acted as the main transmitters of the shock. In contrast, the export-oriented network is smaller and less connected, limiting the diffusion of potential gains from improved competitiveness. As a result, the shock propagated primarily through the import side, magnified by the high connectivity of import-intensive firms, leading to a modest but persistent contraction in aggregate output.

This paper makes three complementary contributions. First, it exploits the sudden and exogenous appreciation of the Swiss franc in 2015 as a natural experiment to identify how firms adjust to large exchange rate shocks. This episode provides an unusually clean setting to study the effects of currency movements on trade, free from confounding policy or demand shocks, thereby contributing to the literature on exchange rate pass-through and currency invoicing (e.g., Devereux et al., 2017; Auer et al., 2019, 2021; Amiti et al., 2022).

Second, it contributes to opening the black box of these adjustments by documenting the mechanisms through which firms respond, in the spirit of Berman et al. (2012) and Corsetti et al. (2022). Using rich customs data linking firms, products, and currencies, we show that exports rose mainly through the entry of new firms and products, while imports increased only briefly due to price spikes among continuing firm–product pairs. These micro-level responses reveal the channels underlying the aggregate J-curve adjustment traditionally described in macroeconomic models.

Third, we connect these firm-level reactions to their macroeconomic consequences through the lens of production networks. By embedding the estimated firm-level distortions into a reconstructed input–output structure of the French economy, we provide the first empirical evidence on how an exchange rate shock propagates through domestic supply chains. In doing so, the paper bridges two strands of research that have so far evolved largely in parallel: the firm-level analysis of trade responses to exchange rate movements (e.g., Berman et al., 2012; Gopinath et al., 2010) and the macroeconomic evaluation of micro shocks (e.g., Huneeus, 2020; Dhyne et al., 2021).

The remainder of the paper is organized as follows. Section 2 presents the micro features of the Swiss franc appreciation. Section 3 outlines the theoretical model used to aggregate firm-level shocks through the production network (3.1), the network and parameters estimation (3.3), the main results of the quantitative exercise (3.4), and the robustness checks (3.5). Section 4 concludes.

2 The Micro Side of the Euro Devaluation

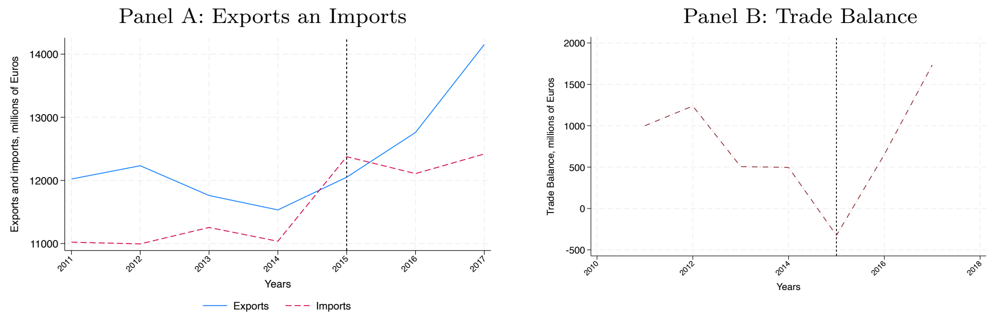
In this section, we analyze the aggregate trends of French exports to Switzerland and decompose them to uncover their underlying micro-level drivers.

The data comes from the French customs and is collected to compute official trade statistics from French firms engaged in international transactions through a mandatory reporting form. Our sample covers the period 2011-2017. This dataset offers many details about single transactions, such as the type (import or export), the identifier of the firm involved (SIREN), the country of origin or destination (iso 2-digit code), the value (in EUR), the currency of invoice, the quantity, the product code (at CN 8-digit level), the custom procedure, and transportation details. More detailed explanation of these data can be found in Bergounhon et al. (2018) and we apply their cleaning procedure, together with the algorithm of Behrens and Martin (2015) to have consistent product codes. The cleaned data are structured at the firm-product-country-currency-year level and consist of, on average, 5.38 million transactions per year, ranging from 4 859 379 in 2011 to 5 906 314 in 2017.

Before turning to the decomposition results, it is important to situate these data within the broader context of trade relations between France and Switzerland. Understanding the characteristics of this bilateral corridor helps interpret the aggregate patterns observed in the microdata. In 2014, Switzerland ranked as France's 9^{th} largest trading partner for both imports and exports, a position that has remained stable over time. With approximately 12.9 billion euros of exports and 12.7 billion euros of imports, Switzerland accounted for around 3% of total French exports and 2.5% of total French imports. From the Swiss perspective, France was its 5^{th} largest trading partner in both imports and exports, representing more than 6% of Switzerland's total trade in each direction. The two economies exchange largely similar high-technology and high-value products, such as medicaments, vehicles, and luxury goods (Table A1 in Appendix A). Hence, France and Switzerland are not only key trade partners but also competitors in similar product categories. The main differences lie in: (i) their scale, since France's trade values are more than twice as large as Switzerland's, and (ii) France's persistent and historically stable trade surplus vis-à-vis Switzerland.

We begin our empirical analysis by examining the impact of the Swiss franc deval-

Figure 1: Aggregate Dynamics of Exports, Imports and Trade Balance of French Trade with Switzerland



Panel A depicts the exports and imports of goods for French Trade with Switzerland. Panel B shows the trade balance (exports minus imports) for French trade with Switzerland. Data source: French Custom data.

uation on France's trade performance. As shown in Panel A of Figure 1, exports rose sharply beginning in 2015, following a flat trend that had persisted since 2011. Imports, which had also remained stagnant prior to the appreciation of the Swiss franc, reacted positively in the short term, largely reflecting price effects. However, Panel B shows that the increase in exports outpaced that in imports, resulting in an improvement in the trade balance, which had displayed a negative trend before 2015. This pattern is fully consistent with textbook predictions of the *Marshall–Lerner condition*: a partner-country's currency appreciation (or, equivalently, a home-country devaluation) tends to boost exports and, after short-term price adjustments, improve the trade balance when the combined price elasticities of export and import demand are sufficiently large. The Swiss Franc shock thus provides a clear empirical illustration of this classical mechanism.

To examine the micro-level sources of aggregate export adjustment, we decompose the change in total exports and imports of France with Switzerland between two consecutive years, ΔV, into three distinct components that capture (i) firm entry and exit, (ii) product turnover within continuing firms, and (iii) changes among continuing firm–product relationships. Analytically:

$$\begin{aligned}\Delta V = V_{t+1} - V_t = & \underbrace{\sum_{i \in E_i} \sum_{j} v_{ij,t+1} \; - \sum_{i \in X_i} \sum_{j} v_{ij,t}}_{\text{Firm extensive}} \\ & + \underbrace{\sum_{i \in C_i} \left(\sum_{j \in E_{ij}} v_{ij,t+1} \; - \sum_{j \in X_{ij}} v_{ij,t} \right)}_{\text{Product extensive}} \\ & + \underbrace{\sum_{(i,j) \in C} \left(v_{ij,t+1} - v_{ij,t} \right)}_{\text{Intensive}} . \qquad (1)\end{aligned}$$

where:

- $v_{ij,t}$ indicate the exports or imports of firm i of product j in year t;
- E_i and X_i denote the sets of *entering* and *exiting firms*, respectively;
- E_j and X_j denote the sets of *newly added* and *dropped products* among firms that are active in both years; and
- C is the set of *continuing firm–product pairs* that export in both years.

The first two terms represent the *extensive margins* of adjustment. The *firm extensive margin* measures the contribution of firms that enter or exit the bilateral trade relationship, while the *product extensive margin* captures the net effect of changes in product variety among continuing exporters or importers. The final term, the *intensive margin*, captures changes in export or import values among continuing firm–product relationships.

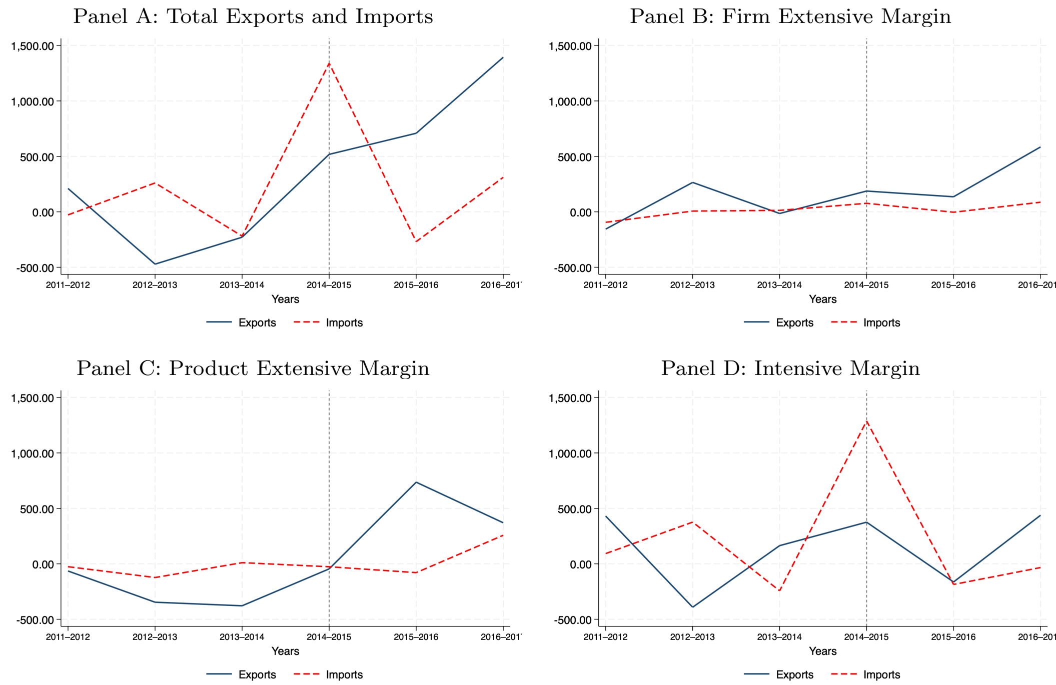
Results of this decomposition in Figure 2 show that the aggregate dynamics of French exports to Switzerland, depicted with a navy solid line in Panel A, are mainly driven by the firm extensive margin (Panel B) and by the product extensive margin (Panel C). In contrast, the intensive margin (Panel D) appear less sensitive to the devaluation shock with a more erratic dynamics that does not fully align with the timing of the Euro devaluation. In other words, the Swiss Franc appreciation created opportunities for new French firms and products to enter in the Swiss market, while the dynamics of continuing firm-products are harder to interpret.

Applying the same decomposition to imports, the dashed red line in Figure 2 shows a sharp spike in import values exactly at the time of the devaluation (i.e., in 2015). This increase was almost entirely driven by the intensive margin (Panel D), while both the firm extensive margin (Panel B) and the product extensive margin (Panel C) remained relatively flat. Hence, the adjustment patterns differ markedly between exports and imports: the former are mainly driven by extensive-margin dynamics and display greater resilience, whereas the latter react predominantly through the intensive margin, resulting in a sharper but short-lived adjustment.

These contrasting reactions can be traced to two structural differences between exports and imports. First, imports are more invoiced in currencies other than the Euro. On average, only about 66% of import values are denominated in Euros, compared with more than 77% for exports, implying that imports were more directly exposed to the currency shock. Second, the extensive margins represent a slightly larger share of total export values, typically above 10%, whereas for imports they account for less than 10%. Although this gap is modest (about 3–5 percentage points), it still helps explain the asymmetric adjustment. In particular, the stronger reliance on the euro and the relatively larger role of extensive margins made exports more responsive—and more resilient—to the positive demand shock induced by the euro's devaluation. Conversely, imports' greater exposure to non-euro currencies and their greater dependence on the intensive margin led to a sharper but more short-lived adjustment for imports.

The change in export values for continuing firm–products between two consecutive years can be further decomposed as:

Figure 2: Decomposition of French Trade Growth with Switzerland



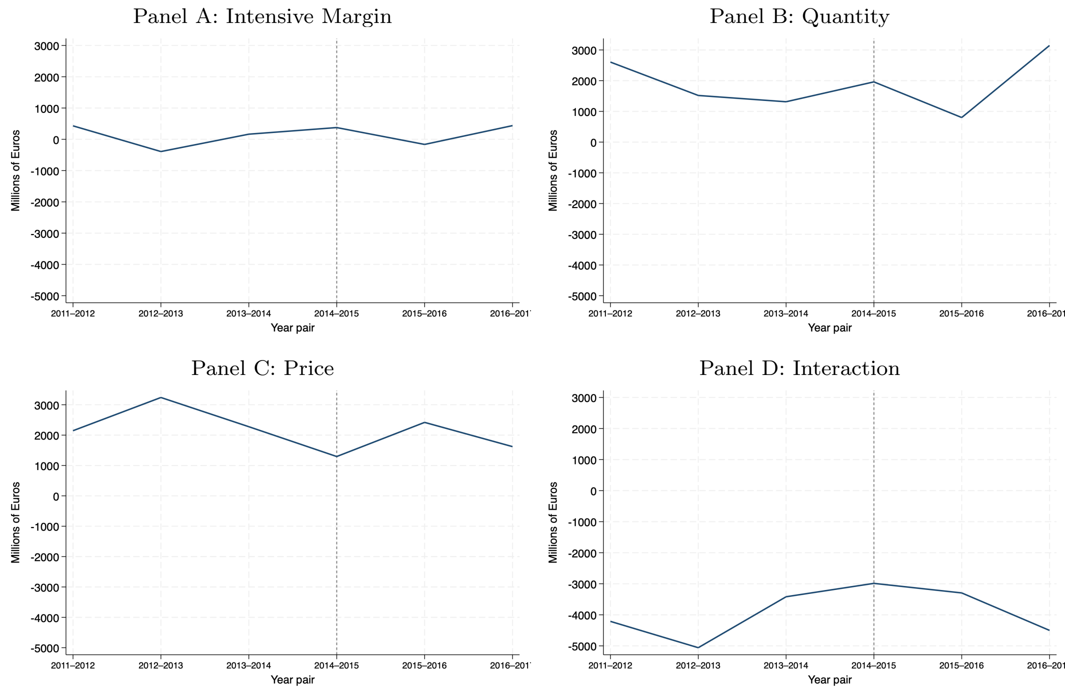
Panel A depicts the exports growth between two consecutive years for the period 2011-2017. Panel B represents the contibution of the firm extensive margin. Panel C represents the change in product extensive margin. Panel D represents the change in intensive margin. Data source: French Custom data.

$$\sum_{(i,j)\in C} (v_{ij,t+1} - v_{ij,t}) = \underbrace{\sum_{(i,j)\in C} q_{ij,t} \left(p_{ij,t+1} - p_{ij,t}\right)}_{\text{Price effect}} + \underbrace{\sum_{(i,j)\in C} p_{ij,t} \left(q_{ij,t+1} - q_{ij,t}\right)}_{\text{Quantity effect}} + \underbrace{\sum_{(i,j)\in C} \left(p_{ij,t+1} - p_{ij,t}\right)\left(q_{ij,t+1} - q_{ij,t}\right)}_{\text{Interaction term}}. \quad (2)$$

The first term represents the variation in export values due solely to changes in prices (holding quantities constant at their initial level), while the second term isolates the contribution of quantity changes (holding prices fixed). The third, typically smaller, interaction term captures the joint effect of simultaneous changes in both prices and quantities.

This decomposition can be applied only to continuing firm–product relationships, for which prices and quantities are observed in both years. It cannot be extended to the extensive margins—that is, to newly exported or discontinued firm–product pairs—because one of the two observations ($p_{ij,t}$, $q_{ij,t}$) is missing for either the base or comparison year. In such cases, the change in export value cannot be meaningfully

Figure 3: Decomposition of Continuing French Firm-product Export Growth with Switzerland

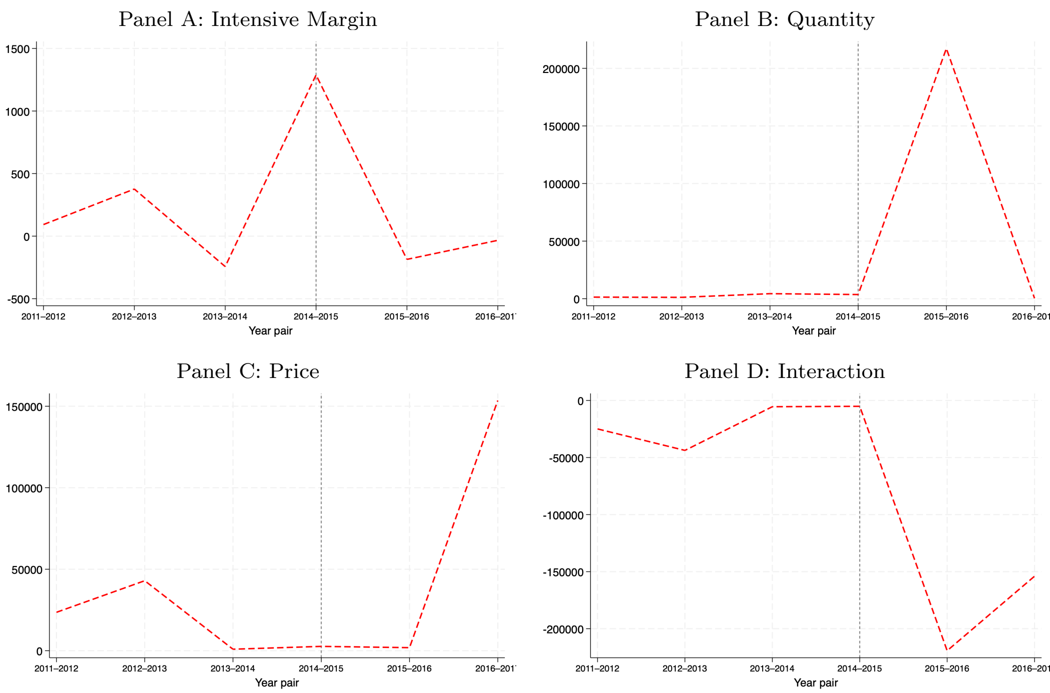


This figure depicts the decomposition of the intensive margin of exports growth between two consecutive years for the period 2011-2017. Panel A for the intensive margin, Panel B for quantities. Panel C for prices. Panel D for the interaction term. Data source: French Custom data.

attributed to a change in price or quantity without imposing an arbitrary reference value. For this reason, entry and exit are treated as distinct components of the overall export adjustment, collectively referred to as the *extensive margins*, while the decomposition into prices and quantities is confined to the *intensive margin* of continuing trade relationships.

The results of this decomposition are presented in Figure 3 for exports and in Figure 4 for imports. For exports, the graphs indicate that the erratic dynamics of the intensive margin stem from minor fluctuations in prices and quantities, suggesting that the devaluation had little impact on continuing firm–product relationships. In contrast, for imports, the sharp spike observed in the intensive margin is almost entirely driven by an increase in the price component. Although this movement is not visually apparent due to the scale of the graph, the price component nearly tripled and accounts for most of the surge reported in Panel A of Figure 4. While both price and quantity display pronounced fluctuations throughout the period, their combined effect on the overall intensive margin remains negligible. Hence, despite the dramatic underlying movements all along the period of analysis, the spike coinciding with the devaluation shock is almost entirely attributable to the surge in prices.

Figure 4: Decomposition of Continuing French Firm-product Import Growth with Switzerland



This figure depicts the decomposition of the intensive margin of exports growth between two consecutive years for the period 2011-2017. Panel A for the intensive margin, Panel B for quantities. Panel C for prices. Panel D for the interaction term. Data source: French Custom data.

3 The Macro Side of the Swiss Franc Appreciation

In this section, we present the theoretical model that allows us to understand how to connect micro and macro, we estimate the network structure and the main parameters, and we present the results of the quantification of the shock.

3.1 Theoretical Framework

In this subsection, we describe the theoretical model. In particular, we outline the microeconomic structure of the economy and show how we determine the macroeconomic effects of firm-specific shocks.

3.1.1 Micro Features and the Exchange Rate Shocks

We build on the baseline production network model of Acemoglu et al. (2012), extending it to account explicitly for exchange rate shocks that affect imported intermediate inputs and exported final goods. This model is considered the *baseline model* in the review of the literature on production networks and the macroeconomy by Carvalho and Tahbaz-Salehi (2019). It is a simple, yet convenient model since it relies on few parameters to estimate. We will discuss in subsection 3.2 how the results of the model change under different alternative modellization strategies.

The representative household supplies one unit of labor inelastically, owns one unit of capital, and has Cobb–Douglas preferences over N distinct goods:

$$u(c_1, c_2, \ldots, c_N) = \prod_{i=1}^{N} (c_i)^{1/N}, \tag{3}$$

where c_i denotes consumption of good i.

Goods are produced by N heterogenous firms and are used for household consumption or as intermediate inputs in the production processes of other firms, resulting in a production network. Each firm produces output using a Cobb-Douglas production function with constant returns to scale that has intermediate goods x_i, capital k_i and labor l_i as inputs:

$$y_i = \tilde{a}_i \, (k_i^{\gamma} l_i^{1-\gamma})^{\alpha} \, x_i^{1-\alpha}, \tag{4}$$

where $\tilde{a}_i = a_i \Gamma_d$ denotes firm productivity (firm-specific component a_i and common component Γ_d), k_i and l_i are capital and labor inputs, respectively, and x_i is the composite of intermediate inputs.

Intermediate inputs are combined via another Cobb–Douglas aggregator:

$$x_i = \prod_{j=1}^{N} x_{ji}^{\omega_{ji}}, \tag{5}$$

where x_{ji} denotes the amount of good j used by firm i, and $\omega_{ji} \geq 0$ is the input share such that $\sum_{j=1}^{N} \omega_{ji} = 1$ for each i. The $N \times N$ matrix $\Omega = [\omega_{ji}]$ captures the production network structure.

Let ε denote an exogenous log shock to the exchange rate. This shock affects:

1. the cost of imported intermediate inputs: define $\delta_{ji} \in [0, 1]$ as the share of input j used by firm i that is imported, and ϕ_j as the pass-through elasticity of the price of input j with respect to ε; the wedge on the cost of input j for firm i is:

$$\log(1 + \tau_{ji}^{x}) = \delta_{ji} \, \phi_j \, \varepsilon.$$

2. the revenue from exports: define ψ_i as the share of sales of firm i exported (or its revenue pass-through parameter); the wedge on revenue is:

$$\log(1 + \tau_i^{y}) = \psi_i \, \varepsilon.$$

Firms operate under perfect competition and choose inputs to maximize profits:

$$\max_{\{x_{ji}\}_j, \, k_i, \, l_i} \quad \pi_i = (1 + \tau_i^{y}) \, p_i y_i - R k_i - h l_i - \sum_{j=1}^{N} (1 + \tau_{ji}^{x}) \, p_j x_{ji}, \tag{6}$$

where p_i and p_j are the output and input prices, respectively, R is the rental rate of capital, and h is the wage. The terms $(1 + \tau_i^{y})$ and $(1 + \tau_{ji}^{x})$ capture the exchange rate shock wedges defined above. Firms that neither import nor export have $\tau_i^{y} = \tau_{ji}^{x} = 0$.

Cost minimization with a Cobb–Douglas technology implies that the optimal price equals marginal cost. Taking logs and linearizing, the optimal price satisfies:

$$\log p_i = \alpha\gamma \log R + \alpha(1-\gamma)\log h + (1-\alpha)\sum_j \omega_{ji} \log\left(\frac{p_j}{\omega_{ji}}\right) - \log \tilde{a}_i + T_i. \tag{7}$$

The term T_i represents the distortions caused by the exchange rate shock for each firm, and it is defined as follows:

$$T_i = (1-\alpha)\sum_j \omega_{ji} \log(1+\tau_{ji}^x) - \log(1+\tau_i^y) \tag{8}$$

Therefore, the final effect on firms' optimal price differs between importers and exporters. Firms exporting to Switzerland observe a price reduction, while firms importing from Switzerland experience an increase in their price. However, for firms involved in both importing from and exporting to Switzerland, the overall effect is ambiguous, as it critically depends on the relative magnitude of the distortions.

3.1.2 The Network and Aggregate Output

The input-output relationships between firms are summarized by the matrix $\Omega = [\omega_{ji}]$, whose columns represent the share of firm i's output used as input by other firms, i.e. the firm-level *weighted outdegree*. This matrix allows us to establish the overall effect of microeconomic shocks on aggregate GDP.

Following Acemoglu et al. (2012), the (log) GDP can be expressed as a linear function of firm-level shocks that propagate through the production network:

$$\log Y = \mu + v'\mathcal{T} \tag{9}$$

Here, μ is a constant unrelated to macroeconomic fluctuations, v is the *influence vector*, and $\mathcal{T}$ captures the distortions due to exchange rate shocks.

The influence vector v is given by:

$$v = \frac{1}{N}\left[I - (1-\alpha)\Omega'\right]^{-1}\mathbf{1}, \tag{10}$$

where $\mathbf{1}$ is an $N \times 1$ vector of ones.

Equation 9 highlights the key economic mechanism of our framework: aggregate output fluctuations arise both from idiosyncratic productivity shocks and from wedges in marginal costs induced by exchange rate shocks.

Since the empirical analysis is concerned with the aggregate impact of exchange rate shocks, we focus on their effect on the percentage change in GDP:

$$\Delta Y = v'\mathcal{T} \tag{11}$$

The vector $\mathcal{T}$ is defined using the wedges derived in equation 8:

$$T_i = (1-\alpha)\sum_j \omega_{ji}\delta_{ji}\phi_j\varepsilon - \psi_i\varepsilon, \tag{12}$$

for firms directly engaged in trade with Switzerland and $T_i = 0$ otherwise.

In the next subsection, we discuss how this network structure and the propagation of the shock change under different modellization strategies.

3.2 Model Discussion

Our benchmark model has a Cobb–Douglas–Cobb–Douglas (CD–CD) structure and perfect competition environment, in which each firm combines value added and a Cobb–Douglas bundle of intermediates, and prices equal unit costs. Thanks to log linearity, the pass-through of exchange-rate wedges to prices is tractable, and the aggregate effects of the exchange rate shock depend on the input-output matrix Ω, the value-added share α, and the influence vector v.

While analytically convenient, the benchmark imposes strong restrictions that limit its ability to capture richer propagation mechanisms. We discuss three extensions that relax (i) unit elasticity across inputs, (ii) perfect competition and (iii) exogenous network formation. Appendix B offers a summary of the information outlined in this section and adds some notes on the empirical implementation.

Let us start by defining a unifying notation for wedges and shares to allow the extension of the benchmark model to more complex settings.

Let $\hat{\tau}^y$ be the $N \times 1$ vector with i-th component $\hat{\tau}_i^y \equiv \Delta \log(1 + \tau_i^y) = \psi_i \, \varepsilon$. On the import side, define the $N \times N$ matrix of import shares $D = [\delta_{ji}]$ and the $N \times 1$ vector $\hat{\tau}^x$ with j-th component $\hat{\tau}_j^x \equiv \Delta \log(1 + \tau_j^x) = \phi_j \, \varepsilon$.

Let M denote the $N \times N$ matrix of *cost shares* of inputs across firms evaluated at the baseline: $M = \Omega$ under Cobb–Douglas (shares fixed), and $M = S$ under CES (shares endogenous, see below). For import wedges that load on links ($j \to i$) through δ_{ji}, define the Hadamard-weighted matrix $W \equiv M \circ D$ and note that the firm-i average import wedge entering its unit cost is $(W'\hat{\tau}^x)_i = \sum_j m_{ji} \, \delta_{ji} \, \hat{\tau}_j^x$. [1]

Unless otherwise stated, we consider *price shocks only* (factor prices and productivities fixed) and work with log deviations $\hat{p}$.

CD–CES under perfect competition. The CD–CD benchmark restricts the elasticity of substitution across intermediates to one. As a result, the expenditure shares on different inputs are fixed and independent of relative prices. Consequently, an exchange rate shock affects firms' costs only through the weights ω_{ji}. A shock hitting firm i thus propagates downstream by influencing the buyers of its output, but it does not alter their input shares, so, there is no upstream reallocation; the only upstream force is a scale effect if firm outputs change. This assumption is especially appropriate for short-term analyses, as firms typically face frictions that prevent them from quickly switching products or suppliers. However, it falls short of capturing more medium-term dynamics in which firms reallocate inputs sourcing. Firms may substitute away from expensive inputs or treat inputs as complements. To allow for this flexibility, we can replace the Cobb–Douglas aggregator with a constant elasticity of substitution (CES) aggregator with elasticity σ. In this setting, input expenditure shares become price-dependent. Let $S = [s_{ji}]$ denote the baseline cost shares. The unit-expenditure function

[1]The elements of the matrix W are are $\omega_{ji} = m_{ji}\delta_{ji}$ and represents the shares of imported cost for each firm i and input j.

for the intermediate bundle implies that, after log-linearizing around the baseline, the pass-through from input prices to firm prices is[2]:

$$\big[I-(1-\alpha)S'\big]\hat{p} \;=\; (1-\alpha)\,W'\hat{\tau}^{x} \;-\; \hat{\tau}^{y}$$

Accordingly, the associated influence vector is:

$$v_{\mathrm{CES}} \;=\; \tfrac{1}{N}\big[I-(1-\alpha)S'\big]^{-1}\mathbf{1}$$

Relative price changes also induce *upstream* reallocation across suppliers. When $\sigma > 1$ (substitutes), import-price wedges are partially offset by shifting expenditure toward cheaper inputs; when $\sigma < 1$ (complements), wedges are amplified.

Monopolistic competition with constant markups. A second limitation of the benchmark model is the assumption of perfect competition. If instead firms compete in monopolistic competition with constant elasticity of demand ϵ, prices are set as a constant markup over marginal cost:

$$p_i = \mu\, MC_i, \qquad \mu = \frac{\epsilon}{\epsilon - 1}.$$

Hence $\log p_i = \log\mu + \log MC_i$ and, in log differences, $\hat{p}_i = \hat{MC}_i$ since $\hat{\mu} = 0$. Therefore, the network structure is identical to the perfect-competition case (CD–CD or CD–CES depending on the input aggregator). This preserves tractability but it does not generate additional channels of shock amplification or attenuation.

Monopolistic competition with variable markups. With non-constant demand elasticity, markups become endogenous. Let $\Theta = \mathrm{diag}(\theta_i)$ capture the (local) sensitivity of firm i's markup to its own price,[3] and let Ξ_x, Ξ_y be vectors encoding any direct response of markups to import/export wedges (e.g. via residual demand shifters). Log-linearizing yields the price system:

$$\big[I-(1-\alpha)M'-\Theta\big]\hat{p} = (1-\alpha)\,W'\hat{\tau}^{x} - \hat{\tau}^{y} + \Xi_x - \Xi_y.$$

The corresponding influence vector is:

$$v_{\mathrm{MC}} = \tfrac{1}{N}[I-(1-\alpha)M'-\Theta]^{-1}\mathbf{1}$$

Aggregate output responds as:

$$\Delta\log Y = v_{\mathrm{MC}}'\big[(1-\alpha)\,W'\hat{\tau}^{x} - \hat{\tau}^{y}\big] + v_{\mathrm{MC}}'(\Xi_x - \Xi_y).$$

[2]With a CES aggregator, each firm's price is (to first order) a weighted average of its suppliers' prices, with weights given by the baseline cost shares S and overall intensity equal to the intermediate-input share $1-\alpha$. Import wedges affect costs only through the imported fraction of each link (term $(1-\alpha)W'\hat{\tau}^{x}$), while export wedges reduce the desired price (term $-\hat{\tau}^{y}$). Iterating this rule along the network (i.e., via the price Leontief inverse) delivers the full pass-through from input and export shocks to equilibrium prices.

[3]Formally, $\theta_i \equiv \partial\log\mu_i/\partial\log p_i$ evaluated at the baseline.

Relative to the benchmark, shocks now affect both marginal costs and markups. Endogenous markups introduce a demand-side channel that changes quantities (a scale effect), while under CES relative-price changes also induce upstream reallocation across suppliers. Combining CES intermediates with variable markups therefore delivers both reallocation and scale effects, offering the richest (though least tractable) propagation environment.

Endogenous network formation with link-activation costs. A further extension allows the input-output network itself to reorganize in response to exchange-rate shocks through endogenous link formation. Following Korovkin et al. (2025), firms face a cost $\kappa_{ji} > 0$ to establish or maintain a supplier link ($j \to i$). Each firm i chooses input quantities $\{x_{ji}\}$ and link activations $I_{ji} \in \{0, 1\}$ to maximize profits:

$$\max_{\{x_{ji}, M_{ji}\}} \Pi_i = (1 + \tau_i^y) p_i y_i - \sum_j \left[(1 + \tau_{ji}^x) p_j x_{ji} + \kappa_{ji} I_{ji} \right] - Rk_i - hl_i,$$

subject to a CES input aggregator with elasticity of substitution $\sigma > 1$:

$$x_i = \left(\sum_j (\omega_{ji} x_{ji})^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \qquad x_{ji} > 0 \Rightarrow I_{ji} = 1.$$

The delivered input price $\tilde{p}_{ji} = (1 + \tau_{ji}^x) p_j$ incorporates the exchange-rate wedge on imported intermediates. For a given set of active suppliers, the optimal expenditure share on input j is:

$$s_{ji}^\star = \frac{(\omega_{ji} \tilde{p}_{ji})^{1-\sigma}}{\sum_{\iota \in J_i} (\omega_{\iota i} \tilde{p}_{\iota i})^{1-\sigma}},$$

where J_i denotes the set of active links. A supplier link is activated only if its expected spending exceeds the fixed cost:

$$(1 - \alpha)\, s_{ji}^\star\, p_i y_i \geq \kappa_{ji}.$$

Exchange-rate shocks thus alter both delivered input prices $\tilde{p}_{ji}$ and firm scale $p_i y_i$, inducing entry and exit of supplier links. The resulting input-output matrix $\Omega(\varepsilon)$ becomes sparse and shock-dependent, capturing the endogenous reorganization of production networks that mitigates (for $\sigma > 1$) or amplifies (for $\sigma < 1$) the aggregate impact of exchange-rate fluctuations.

In more general formulations, the responsiveness of the production network can also depend on link-formation elasticities (λ_B, λ_S) and on the cost structure of creating and maintaining supplier links, summarized by firm-level costs e_i or bilateral activation costs κ_{ji}. These parameters govern how quickly firms reorganize their connections in response to shocks and determine the overall density of the production network. We discuss their role and the empirical requirements for estimating them in Appendix B.

3.3 Influence Vector Construction and Parameter Estimation

The key element to evaluate the impact of the Swiss franc appreciation on the aggregate economy is the influence vector v, defined in equation 10. This vector is a non-linear function of the matrix Ω and the parameter α. The matrix Ω represents the input-output structure of the French economy. The parameter α reflects the capital and labor share in the Cobb-Douglas production function, as defined in equation 4, and the terms $(1 + \tau_i^y)$ and $(1 + \tau_{ji}^x)$ represent the input and output price distortions. In this section, we outline the methodology used to compute the input-output network from product and location data and explain how we estimate the share of capital and labor using data from French firms.

3.3.1 The Production Network

To construct the network, we would ideally rely on firm-to-firm transaction data, which, however, are not available for France. As a result, we approximate the input–output network using information from multiple sources.

To begin with, we identify the products produced by all firms in the economy. We obtain this information by merging data from French Customs with firm-level data from Moody's DataHub. The latter provides extensive information on French firms, including their unique SIREN identifier, industry classification, geographical location, sales, and costs, allowing for a perfect match with the customs data. Through this merge, we assign a NACE sector to each company engaged in international trade.

Next, we identify the most traded products within each sector by retaining only those whose import or export share, relative to the sector total, exceeds a 10% threshold. The resulting dataset covers 577 NACE sectors, with the number of associated products per sector ranging from zero to nine.[4]

We then merge the industry-level information on produced and purchased products with firm-level data, allowing us to assign product information to more than 18.4 million producing firms and 19.8 million purchasing firms. Starting from these data, we retain only observations that contain location information and either input or output values, and we then split the dataset accordingly. Input data (representing costs) and output data (representing revenues) are drawn from firms' balance sheets. Specifically, costs are proxied by the cost of goods sold variable or by material costs when the former is missing, while revenues are proxied by operating revenue turnover or, when unavailable, sales. Tables A2 and A3 in the Appendix present the number of selling and purchasing firms using respectively the 10% and 5% thresholds.

To link producers to purchasers, we follow the approach of Couttenier et al. (2022). For each firm, we compute an index capturing the likelihood of being a supplier of the purchased products for a given buyer. This index increases with the supplier's market size and decreases with geographical distance, thus approximating the buyer–supplier link, i.e. the element of the matrix Ω.

[4] We perform a robustness exercise using a 5% threshold, yielding 607 sectors and up to eleven associated products per sector. The number of sectors for which product information is missing is very small (four for purchased products and seven for sold products in the 10% dataset, and three and five, respectively, in the 5% dataset) accounting for less than 1% of all observations.

Formally, for each buyer i, we observe the input bundle and for each product k we observe its producers j. The probability that a producer j is the actual supplier of good k is given by:

$$\rho_{ji,t}(k) = \lambda \frac{D_{ji}(k)}{\sum_{j \in J} D_{ji}(k)} + (1-\lambda) \frac{Q_{jt}(k)}{\sum_{j \in J} Q_{jt}(k)} \tag{13}$$

Where, $D_{ji}(k)$ is the inverse distance between supplier j and buyer i, rescaled by the total inverse distance between the buyer and all potential sellers of product k, while $Q_{jt}(k)$ is the value of the product sold by firm j, relative to the total value of good k produced. By construction, these probabilities sum to one for every buyer-product pair.

We also experiment a non-linear combination of relative distance and size to compute the importance indexes. This allows us to assign more (less) weight to the larger (smaller) and closer (farther) suppliers. The formula is as follows:

$$\rho_{ji,t}(k) = \frac{\frac{D_{ji}(k)}{\sum_{j \in J} D_{ji}(k)} \times \frac{Q_{jt}(k)}{\sum_{j \in J} Q_{jt}(k)}}{\sum_{j \in J} \left(\frac{D_{ji}(k)}{\sum_{j \in J} D_{ji}(k)} \times \frac{Q_{jt}(k)}{\sum_{j \in J} Q_{jt}(k)} \right)} \tag{14}$$

which captures the potential trade relationships among French firms and plays a central role in calculating the influence vector.[5]

Once all the importance indexes $\rho_{ji,t}(k)$ are computed, we obtain an estimate of the matrix Ω, which captures all potential trade relationships between French firms and plays a central role in calculating the influence vector.[6] We call Ω_L the network matrix built with the linear probabilities, Ω_{NL} the one with the non-linear probabilities. We construct four network matrices per year: $\Omega_{L(5)}$, $\Omega_{L(10)}$, $\Omega_{NL(5)}$, $\Omega_{NL(10)}$, corresponding to the linear and non-linear probability specifications and to the two product thresholds (5% and 10%).

3.3.2 The Share of Capital and Labor

The theoretical framework outlined in Section 3.1 is based on a Cobb-Douglas production technology that combines capital, labor, and intermediate inputs. The output elasticities of labor and capital are captured by the parameter α. This parameter is estimated using the firm-level data from Moody's DataHub. Specifically, we estimate the following log-linearized production function for the period 2011–2017:

$$\ln y_{it} = \delta + \alpha \left[\gamma \ln l_{it} + (1-\gamma) \ln k_{it} \right] + (1-\alpha) \ln \tilde{a}_i + \varepsilon_{it} \tag{15}$$

Here, y_{it} denotes firm i's output in year t, l_{it} represents labor input, k_{it} is the capital

[5] Given the large number of firms, computing the importance indexes is computationally demanding. We therefore run the procedure iteratively by firm and year, discarding links with probabilities below 1%. The computation is performed in parallel in Matlab on a 32-core server with 512 GB RAM, taking between 8 and 48 hours per year depending on dataset size.

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stock and a_{it} captures the total factor productivity (TFP). These variables are proxied by the value of sales, the number of employees, capital and material costs, respectively.

We estimate this equation using three widely adopted methodologies: Levinsohn and Petrin (2003) (LP), Olley and Pakes (1996) (OP), and Wooldridge (2009) (Wrdg). The results are reported in Table 1 and the estimate of *alpha* is derived by summing the coefficients of labor and capital.

Table 1: Estimates of the Share of Labor and Capital

	Methodology			
Regressors	**LP**	**LP(ACF)**	**OP**	**Wrdg**
$\ln(l_{it})$	0.270^{a}	0.296^{a}	0.273^{a}	0.284^{a}
	(0.0012)	(0.0196)	(0.0014)	(0.0004)
$\ln(k_{it})$	0.0980^{a}	0.0844^{a}	0.239^{a}	0.0658^{a}
	(0.002)	(0.0127)	(0.0091)	(0.0014)
$\ln(\tilde{a}_i)$	0.721^{a}	0.858^{a}		0.669^{a}
	(0.0029)	(0.0689)		(0.0009)
Observations	1,544,359	1,544,359	1,544,359	760,053
Number of groups	631,320	631,320	631,320	631,320

Standard errors in parentheses.
^{a} p<0.01, ^{b} p<0.05, ^{c} p<0.1

The two estimates using the LP method differ in that the column labeled LP(ACF) incorporates the correction proposed by Ackerberg et al. (2015) to address the potential endogeneity of the labor input. Despite this adjustment, both approaches yield similar results for α, with estimated values of 0.37 and 0.38. In contrast, the OP method produces a higher estimate of $\hat{\alpha} = 0.51$, while the Wooldridge method results in a lower estimate of $\hat{\alpha} = 0.35$. We use the estimates coming from the Woolridge method as the benchmark and the remaining as robustness.

3.3.3 Price Distortions

To quantify the distortions induced by the Swiss franc appreciation, we estimate firm-level price changes for importers and exporters that trade with Switzerland. Specifically, we rely on observed changes in unit values for each firm–product pair between 2014 and 2015, isolating price variations attributable to the exchange rate shock from firm-product average price level changes.

We first estimate the following specification separately for imports and exports:

$$\log \mathrm{uv}_{ipt=2014|2015} = \delta_0 + \gamma_{ip} + \varepsilon_{ipt=2014|2015}, \tag{16}$$

where $\log \mathrm{uv}_{ipt=2014|2015}$ denotes the logarithm of import or export prices for firm i, product p, in years 2014 and 2015. The term γ_{ip} captures firm–product fixed effects, while ε_{ipt} represents the residual component of prices after controlling for firm–product means. By comparing the residuals for 2014 and 2015, we identify within–firm–product price deviations that can be interpreted as the impact of the Swiss franc appreciation. The underlying assumption is that, conditional on firm–product fixed effects, residual price changes reflect only the exchange rate shock.

We then construct measures of price distortions for imports and exports, denoted $\tau_{x,i}$ and $\tau_{y,i}$, using two complementary aggregation procedures.

The first one is based on firm-level aggregation ($\tau_{x,i}^{14-15}$, $\tau_{y,i}^{14-15}$). We compute the average difference in firm–product residuals between 2014 and 2015 across all products traded by a given firm. This provides a direct firm-level measure of the price distortion. However, this measure is available only for firms trading more than one product because the estimation procedure requires at least two products for each firm.

The second one is based on product-level aggregation ($\tau_{x,i}^{P14-15}$, $\tau_{y,i}^{P14-15}$). To include single-product firms, we first aggregate the change in residuals at the product level, then assign the corresponding product-level distortion to each firm–product observation and average across products. This approach captures broader product-specific price shifts and allows coverage of the entire sample. Finally, to account for potential price adjustments over time, we repeat both procedures by comparing the average residuals between the pre-shock period (2011–2014) and the post-shock period (2015–2017). These long-difference measures are denoted $\tau_{x,i}^{11-17}$, $\tau_{y,i}^{11-17}$ and $\tau_{x,i}^{P11-17}$, $\tau_{y,i}^{P11-17}$.

Table 2: Estimated Distortions

Variable	**EXPORTS**	**Variable**	**IMPORTS**
	2014-2015		
$\tau_{y,i}^{14-15}$	0.0208	$\tau_{x,i}^{14-15}$	0.0418
$\tau_{y,i}^{P14-15}$	0.0256	$\tau_{x,i}^{P14-15}$	0.0405
	2011-2014 vs. 2015-2017		
$\tau_{y,i}^{11-17}$	0.0049	$\tau_{x,i}^{11-17}$	0.0112
$\tau_{y,i}^{P11-17}$	0.0066	$\tau_{x,i}^{P11-17}$	0.0096

Table 2 summarizes the average distortions obtained from these calculations. The estimated distortions are consistently larger for imports than for exports. In the immediate aftermath of the shock (2014–2015), import price distortions average around 4%, while export distortions are roughly half as large. Over the medium term (2011–2014 vs. 2015–2017), the magnitudes decrease substantially, consistent with partial price adjustment or firm-level adaptation, but the import–export asymmetry persists.

Consistent with the descriptive findings of Section 2, these findings indicate that the appreciation of the Swiss franc led to a stronger increase in import prices relative to any reduction in export prices, resulting in a net adverse effect on French firms' cost structures. The next subsection quantifies how these distortions propagate through the production network and affect aggregate output.

3.4 The Impact of the Shock on the French Economy

Our primary objective is to assess the impact of the Swiss franc appreciation on the aggregate economy. In this section, we bring the theoretical model to the data and present the corresponding empirical results. The evaluation is based on equation 11, which combines two key components: the influence vector v, defined in equation 10 and computed as described in section 3.3, and the distortion induced by the shock, $\mathcal{T}$. The influence vector is derived from the 2014 network structure, which represents the state of the economy before the appreciation and can therefore be treated as exogenous to the shock. The distortion term $\mathcal{T}$ is obtained from the estimates in the previous subsection, assigning a value of zero to firms not engaged in trade with Switzerland and non-zero values to those that are. We conduct three quantitative exercises. First, we assume that the shock affects all firms trading with Switzerland uniformly and symmetrically across importers and exporters. Second, we employ firm-level estimated price wedges. Third, we use product-level estimated price wedges. Finally, we explore the mechanisms underlying these results to better understand how the appreciation propagated through the production network.

Our main results are obtained using the 2014 production network based on linear probabilities, the 10% product share threshold, the estimate of $\hat{\alpha} = 0.35$ obtained via the Wooldridge (2009) method, and the price distortions estimated in subsection 3.3.3.

Table 3 reports the estimated effects of the exchange rate shock on aggregate production, disaggregated into import and export channels, and the net impact on the economy when using the estimated distortions.

Table 3: Effects on the Economy with Estimated Price Distortions, $\hat{\alpha} = 0.35$ and $\Omega_{L(10)}$

	IMPORT	**EXPORT**	**OVERALL**
By Firm			
value(2015) - value(2014)	-0,95%	0,49%	-0,47%
mean(2015-2017) - mean(2011-2014)	-0,07%	-0,04%	-0,11%
By Product			
value(2015) - value(2014)	-1,02%	0,25%	-0,76%
mean(2015-2017) - mean(2011-2014)	-0,21%	0,03%	-0,17%

The exchange rate shock had a contractionary effect on the economy, primarily through the import channel. When using firm-level distortions based on the year-on-year change (2015 vs. 2014), the economy experiences a 0.95% decline in output through imports, only partially offset by a 0.49% gain via exports, resulting in a net loss of 0.47%. The effects are smaller when averaging over multi-year periods, suggesting a partial reversion or adjustment over time.

Product-level distortions indicate a slightly stronger import-side contraction, particularly in the immediate aftermath of the shock (-1.02%), and a more modest export response (0.25%), producing a net output loss of 0.76%. Again, the longer-run average effects are smaller in magnitude.

These results confirm that the appreciation of the Swiss franc had an asymmetric impact across trade channels, with import prices rising more significantly than export prices fell, leading to an overall negative shock to the French economy.

It is informative to explore whether the effects of the Swiss franc appreciation exhibited any geographical patterns. Since our data include firm locations, we can exploit this information to examine how the shock propagated across French departments. For this exercise, we use price distortions based on firm-level aggregation and comparison between 2014 and 2015.

Figure 5: Geographical Effects of the Exchange Rate Shock on Exports and Imports

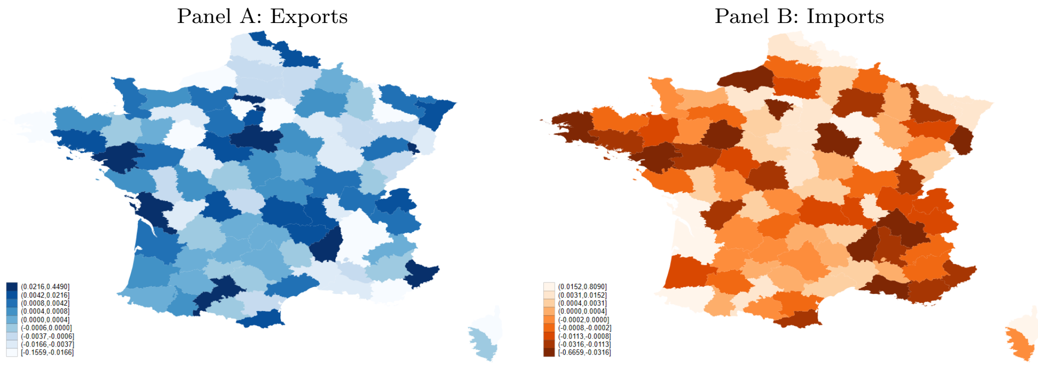
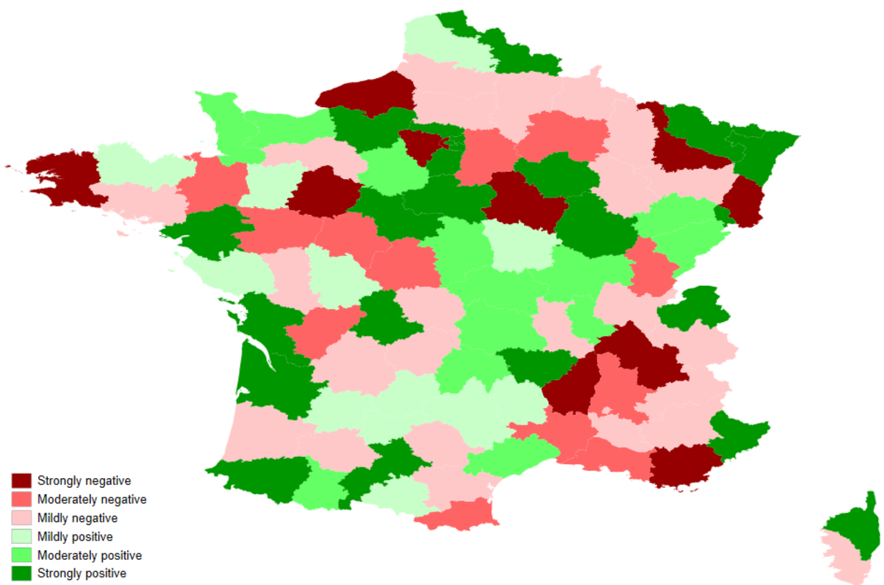


Figure 6: Geographical Net Effects of the Exchange Rate Shock



The geographical distribution of the effects reported in Figures 5 and 6 reveals a marked spatial heterogeneity. Panel A of Figure 5 shows that the positive export response was concentrated in a few departments, mostly in eastern and few central and western areas, while much of the country experienced negligible or even slightly negative export effects. Panel B indicates that the contraction in imports was more widespread and generally stronger in magnitude, with particularly pronounced declines in western and southern regions.

The resulting net effects, shown in Figure 6, confirm the presence of marked geographical heterogeneity. A few departments scattered across the country experienced negative effects, while moderate to negative impacts are more concentrated in the northeastern and southeastern regions. Positive effects, in contrast, are more widespread across the rest of the territory. Overall, the aggregate negative impact appears to be driven by the combination of a few severely affected areas and a broader set of regions facing moderate downturns. This pattern suggests that local economic structures and supply-chain integration played a key role in shaping the aggregate response to the appreciation shock: regions with higher import exposure or stronger backward linkages to importing firms were hit hardest, amplifying the contractionary effects at the national level.

3.5 Mechanisms and Robustness Checks

In this subsection we analyze the possible mechanisms behind the negative aggregate effect of the Swiss franc appreciation and we perform some robustness checks.

3.5.1 Symmetric Shocks

To understand whether the greater magnitude of the negative effect on imports is driven by the size of the distortion, set them to 0.01 for exporters and -0.01 for importers. In this case, we find that a one percentage point change distortion translates into an annual change in aggregate GDP of -1.361% through imports and +0.126% through exports. The net effect corresponds to a total decrease in aggregate output of 0.023%.

To assess the robustness of these findings, we repeat the same exercise using alternative estimates of α obtained through different methodologies, as reported in Table 1. The corresponding results are presented in Table A4 in the appendix. As shown, the aggregate effect remains negative across all specifications, although its magnitude varies with the assumed capital-labor share. In particular, the estimate using the Olley and Pakes method ($\hat{\alpha} = 0.51$) leads to a smaller overall decline in production. This means that our results do not depend on the size of α.

These results indicate that the negative net effect on aggregate output is not due to the asymmetry in the size of the shock itself. When applying a symmetric shock the negative effect on imports is still higher than the positive one on exports. Therefore, this result must be due to network characteristics.

Therefore, in the next subsection we study the network structure computing some network statistics.

3.5.2 Network Structure and Shock Transmission

In this subsection we examine the network structure to better understand why the effects of the Swiss franc appreciation are stronger on imports than on exports.

We compute the following network statistics for the 2014 input–output matrix: (i) *Influence*, which captures a firm's overall importance in the network based on its position and connectivity; (ii) *Eigenvector centrality*, which reflects not only the number of connections but also their quality, weighting more links to other central nodes; (iii) *Degree centrality*, defined as the total number of connections (both incoming and outgoing) and capturing a firm's overall embeddedness in the network; (iv) *In-strength* and (v) *Out-strength*, which measure the weighted intensity of incoming and outgoing connections, respectively; and finally (vi) *In-degree* and (vii) *Out-degree*, which count the number of incoming and outgoing connections each firm maintains.

These statistics are computed at the firm level and then aggregated taking the mean across different groups. In particular, we distinguish between firms that import from Switzerland (*importers*), export to Switzerland (*exporters*), perform both activities (*both*), and other firms indirectly connected to Swiss trade (*other*). Firms classified as *traders* include all entities that either import or export. Table 4 displays the results.

Table 4: Network Statistics by Trade Orientation, 2014

Group	Influence	Eig. Cent.	Deg. Cent.	In Str.	Out Str.	In Deg.	Out Deg.
trader	7.22E-06	2.45E-05	9.26E-05	6.06	0.48	160.74	12.79
importer	1.27E-05	2.66E-05	1.68E-04	11.58	0.49	301.38	13.57
exporter	6.32E-06	2.41E-05	8.21E-05	5.16	0.48	141.08	12.71
both	1.54E-05	2.73E-05	2.12E-04	14.32	0.50	382.09	14.12
other	1.27E-06	4.70E-07	7.68E-06	0.20	0.34	5.31	9.08

The network indicators reveal substantial heterogeneity in firms' connectivity and centrality across trade orientations. Firms engaged in both importing and exporting exhibit the highest values of *in-degree*, *in-strength*, and *degree centrality*, indicating that they act as key hubs within the production network and maintain dense linkages with a large number of domestic partners. Pure importers are also relatively well connected, with a high number of incoming links and strong in-strength values, suggesting that imported inputs play a central role in domestic production chains. Exporters, by contrast, appear less connected and occupy more peripheral positions, while firms not directly trading with Switzerland remain largely isolated within the network.

This configuration provides a microeconomic explanation for the asymmetric macroeconomic effects reported in Table 3. The appreciation of the Swiss franc primarily increased the cost of imported intermediate goods for French firm. Because importers are highly connected nodes within the network, these cost shocks were transmitted downstream to many other firms. In contrast, the export-oriented subnetwork is smaller and less densely connected, which limits the diffusion of potential gains from improved export competitiveness.

Taken together, the distortion estimates and network analysis indicate that the exchange rate shock was transmitted primarily through the import network. The higher connectivity and centrality of import-oriented firms magnified the impact of price distortions, which were themselves larger for importers, thereby reinforcing the contractionary effect of the Swiss franc appreciation on aggregate output.

3.5.3 Robustness checks

To assess the robustness of our baseline results, we perform a series of sensitivity analyses with respect to the key parameters and alternative network structures. Specifically, we re-estimate the aggregate effects of the Swiss franc appreciation using different values of the parameter α obtained in Section 3.3.2, and the three additional input–output matrices for 2014: $\Omega_{L(5)}$, $\Omega_{NL(5)}$, and $\Omega_{NL(10)}$. These matrices differ from the baseline because they consider a 5% threshold for products and/or non-linear probabilities, as outlined in Section 3.3.1.

The results reported in Tables A5–A7 in Appendix A confirm the robustness of our findings with respect to alternative values of the parameter α. Across all specifications, the qualitative pattern of the results remains unchanged: the appreciation of the Swiss franc generates a contractionary effect on aggregate output, primarily transmitted through the import channel. The import-related losses are consistently larger in magnitude than the export gains, leading to a net negative effect on production.

When α increases from 0.35 to 0.51, the overall contraction becomes slightly smaller in absolute terms, reflecting the reduced sensitivity of production to imported inputs under higher substitution elasticities. However, the asymmetry between import and export responses persists, with import effects remaining roughly twice as large as export effects across all parameterizations. These results indicate that the main conclusions are not driven by the specific calibration of α, but rather by the structural features of the production network, i.e. the greater centrality and interconnectedness of import-oriented firms and the larger distortions they experienced following the shock.

Tables A8–A10 in Appendix A reports the results of the robustness check when considering alternative network structures. Overall, the qualitative conclusions remain unchanged across all specifications: in every configuration, import-related losses are larger than export gains, resulting in a persistent negative net effect on production.

Quantitatively, the magnitude of the effects varies moderately with the structure of the network. In the linear matrices ($\Omega_{L(5)}$ and $\Omega_{L(10)}$), the overall contraction is somewhat smaller, reflecting lower connectivity and weaker propagation. In contrast, the non-linear matrices ($\Omega_{NL(5)}$ and $\Omega_{NL(10)}$) yield slightly larger effects in absolute value, suggesting that non-linear linkages reinforce the transmission of shocks. Nevertheless, the asymmetry between import and export responses remains robust across all cases, confirming that the contractionary impact of the Swiss franc appreciation is structurally linked to the network structure and particularly to the high centrality of import-oriented nodes and the stronger import-side distortions identified in the baseline analysis.

4 Conclusions

This paper provides new evidence on how large and sudden exchange rate shocks propagate from firms to the aggregate economy.

Exploiting the 2015 appreciation of the Swiss franc as an exogenous natural experiment, we show that the adjustment operates through markedly asymmetric channels: exports expand primarily along the extensive margin through firm and product entry, while imports react mainly through short-lived price adjustments among continuing relationships.

Embedding these micro responses within a reconstructed production network reveals that the aggregate effect is small but negative, as import-intensive firms, being more central within domestic supply chains, amplify the transmission of higher input costs throughout the economy.

Taken together, our findings underscore the importance of production-network linkages in shaping the macroeconomic consequences of exchange rate movements. The aggregate impact of currency shocks thus depends not only on price pass-through or invoicing patterns, but also on the network position and exposure structure of trading firms.

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Appendix

A Additional Tables

Table A1: Most Traded Product with Switzerland and EU

SWITZERLAND		EU	
Most Exported	**Most Imported**	**Most Exported**	**Most Imported**
Medicaments	Medicaments	Diesel cars 1500-2500cc	Natural gas
Jewellery	Jewellery	Medicaments	Diesel cars 1500-2500cc
Watches	Watches	Motor vehicle parts	Refined petroleum oils
Aircraft parts	Aircraft parts	Aircraft >15000kg	Aircraft >15000kg
Engine parts	Precious stones	Gear boxes	Medicaments

Table A2: Number of Firms per Year (10% product threshold)

Year	N°of buyers	N° of sellers
2011	859 594	1 288 854
2012	926 949	1 340 273
2013	816 615	1 975 019
2014	664 468	1 977 705
2015	574 022	615 264
2016	504 976	1 945 705
2017	483 192	587 412
Total	4 829 816	9 730 232

Table A3: Number of Firms per Year (5% product threshold)

Year	N°of buyers	N° of sellers
2011	973 496	1 458 896
2012	1 046 830	1 525 378
2013	922 487	2 199 555
2014	750 978	2 193 556
2015	647 985	699 137
2016	568 232	2 145 419
2017	542 204	664 127
Total	5 452 212	10 886 068

Table A4: Effects on the Economy with $T_i = \pm 1\%$

$\hat{\alpha}$	**IMPORT**	**EXPORT**	**OVERALL**
0.35	-1.361%	1.126%	-0.023%
0.37	-1.305%	1.084%	-0.022%
0.38	-1.128%	1.063%	-0.021%
0.51	-0.096%	0.082%	-0.014%

Table A5: Effects on the Economy with Estimated Price Distortions, $\hat{\alpha} = 0.37$ and $\Omega_{L(10)}$

	IMPORT	**EXPORT**	**OVERALL**
By Firm			
value(2015) - value(2014)	-0,92%	0,46%	-0,46%
mean(2015-2017) - mean(2011-2014)	-0,07%	-0,04%	-0,11%
By Product			
value(2015) - value(2014)	-0,98%	0,25%	-0,73%
mean(2015-2017) - mean(2011-2014)	-0,20%	0,03%	-0,16%

Table A6: Effects on the Economy with Estimated Price Distortions, $\hat{\alpha} = 0.38$ and $\Omega_{L(10)}$

	IMPORT	**EXPORT**	**OVERALL**
By Firm			
value(2015) - value(2014)	-0,91%	0,45%	-0,45%
mean(2015-2017) - mean(2011-2014)	-0,04%	-0,04%	-0,11%
By Product			
value(2015) - value(2014)	-0,94%	0,24%	-0,71%
mean(2015-2017) - mean(2011-2014)	-0,19%	0,03%	-0,16%

Table A7: Effects on the Economy with Estimated Price Distortions, $\hat{\alpha} = 0.51$ and $\Omega_{L(10)}$

	IMPORT	**EXPORT**	**OVERALL**
By Firm			
value(2015) - value(2014)	-0,70%	0,32%	-0,38%
mean(2015-2017) - mean(2011-2014)	-0,06%	-0,03%	-0,09%
By Product			
value(2015) - value(2014)	-0,72%	0,20%	-0,52%
mean(2015-2017) - mean(2011-2014)	-0,15%	0,03%	-0,12%

Table A8: Effects on the Economy with Estimated Price Distortions, $\hat{\alpha} = 0.35$ and $\Omega_{L(5)}$

	IMPORT	EXPORT	OVERALL
By Firm			
value(2015) - value(2014)	-0,45%	-0,16%	-0,61%
mean(2015-2017) - mean(2011-2014)	-0,35%	0,02%	-0,33%
By Product			
value(2015) - value(2014)	-1,17%	-0,03%	-1,20%
mean(2015-2017) - mean(2011-2014)	-0,25%	0,00%	-0,25%

Table A9: Effects on the Economy with Estimated Price Distortions, $\hat{\alpha} = 0.35$ and $\Omega_{NL(10)}$

	IMPORT	EXPORT	OVERALL
By Firm			
value(2015) - value(2014)	-1,27%	0,43%	-0,84%
mean(2015-2017) - mean(2011-2014)	-0,12%	-0,06%	-0,18%
By Product			
value(2015) - value(2014)	-1,24%	0,30%	-0,94%
mean(2015-2017) - mean(2011-2014)	-0,25%	0,04%	-0,21%

Table A10: Effects on the Economy with Estimated Price Distortions, $\hat{\alpha} = 0.35$ and $\Omega_{NL(5)}$

	IMPORT	EXPORT	OVERALL
By Firm			
value(2015) - value(2014)	-0,66%	-0,27%	-0,93%
mean(2015-2017) - mean(2011-2014)	-0,50%	0,04%	-0,46%
By Product			
value(2015) - value(2014)	-1,50%	-0,03%	-1,52%
mean(2015-2017) - mean(2011-2014)	-0,32%	0,01%	-0,31%

B Model Variants and Empirical Implementation

Extensions with CES and monopolistic competition In section 3.2 we described three extensions to the baseline empirical model to unveil their implications for the analysis of the economic network. In summary, the CD–CD perfect-competition benchmark delivers clean, closed-form propagation but rules out input substitution and markup variation. The CD–CES setup introduces substitution through the CES cost shares S and elasticity σ. Monopolistic competition with variable markups adds a demand-side channel via Θ and (Ξ_x, Ξ_y); combining CES with variable markups yields both reallocation and scale effects at the cost of tractability.

Table A11 summarizes the key features of the variants reviewed in Section 3.2; Table A12 details the empirical inputs needed to evaluate the models.

Endogenous network formation and empirical implementation. A further extension allows the production network itself to adjust endogenously in response to exchange-rate shocks. In this setting, the intensity of linkages across firms, summarized by the matrix $I = [I_{ji}]$ is no longer fixed, but reacts to shocks through two main channels: (i) continuous input substitution governed by the elasticity of substitution σ, and (ii) discrete creation or dissolution of supplier links governed by link-formation frictions.

Following Korovkin et al. (2025), the measure or intensity of links between supplier j and buyer i can be expressed as:

$$I_{ji} \;\propto\; X_{ji}^{\lambda_B+\lambda_S}\, e_j^{\lambda_B}\, e_i^{\lambda_S},$$

where X_{ji} denotes the expected value of intermediate-input flows, and the parameters (λ_B, λ_S) capture how responsive the network is to changes in trade volumes and link costs from the buyer and supplier sides, respectively. The terms e_i and e_j represent the firm-level costs of maintaining connections, and are typically modeled as a function of local input prices and wages:

$$e_i = w_i^{\mu}\, C_i^{1-\mu},$$

with $\mu \in [0, 1]$ denoting the labor share in link-formation costs and C_i the marginal cost of intermediate inputs.

The bilateral link-activation costs $\kappa_{ji} > 0$, which determine whether a specific supplier link $(j \to i)$ is formed, allow to microfound these firm-level costs.

Exchange-rate shocks affect both the delivered input prices $\tilde{p}_{ji} = (1 + \tau_{ji}^{x})p_j$ and firm scale $p_i y_i$, thereby altering the set of active links. The firm-level cost parameter e_i can then be interpreted as an aggregation of the bilateral costs κ_{ji} across all active suppliers:

$$e_i \;\approx\; \left(\frac{1}{|J_i|} \sum_{j \in J_i} \kappa_{ji} \right)^{1-\mu} w_i^{\mu},$$

where J_i denotes the set of suppliers linked to firm i.

Estimating the parameters $(\lambda_B, \lambda_S, \mu)$ as well as the cost structure κ_{ji} requires observing how the firm-to-firm network reorganizes after a shock. This, in turn, demands

Table A11: Comparison of Model Variants: Price System, Influence Vector, and GDP Response (price shocks only)

	CD–CD, PC	**CD–CES, PC**	**CD–CD, MC**	**CD–CES, MC**
Input bundle	CD over x_{ji} ($\sigma = 1$)	CES over x_{ji} ($\sigma \neq 1$)	Same as CD–CD, PC	Same as CD–CES, PC
Price system (log-lin)	$[I - (1-\alpha)\Omega']\,\hat{p} =$ (1-α)$W'\hat{\tau}^x - \hat{\tau}^y$	$[I - (1-\alpha)S']\,\hat{p} =$ (1-α)$W'\hat{\tau}^x - \hat{\tau}^y$	$[I - (1-\alpha)\Omega' - \Theta]\,\hat{p} =$ (1-α)$W'\hat{\tau}^x - \hat{\tau}^y + \Xi_x - \Xi_y$	$[I - (1-\alpha)S' - \Theta]\,\hat{p} =$ (1-α)$W'\hat{\tau}^x - \hat{\tau}^y + \Xi_x - \Xi_y$
Influence vector	$v = \frac{1}{N}[I - (1-\alpha)\Omega']^{-1}\mathbf{1}$	$v_{CES} = \frac{1}{N}[I-$ (1-α)$S']^{-1}\mathbf{1}$	$v_{MC-CD} = \frac{1}{N}[I-$ (1-α)$\Omega' - \Theta]^{-1}\mathbf{1}$	$v_{MC-CES} = \frac{1}{N}[I-$ (1-α)$S' - \Theta]^{-1}\mathbf{1}$
GDP effect	$\Delta \log Y = v'[(1-\alpha)$ ’$^x - \hat{\tau}^y]$	$\Delta \log Y = v'_{CES}[(1-\alpha)$ W’$^x - \hat{\tau}^y]$	$\Delta \log Y = v'_{MC-CD}[(1-\alpha)$ W’$^x - \hat{\tau}^y] + v'_{MC-CD}$ $(\Xi_x - \Xi_y)$	$\Delta \log Y = v'_{MC-CES}[(1-\alpha)$ W’$^x - \hat{\tau}^y] + v'_{MC-CES}$ $(\Xi_x - \Xi_y)$

Notes. $\hat{p}$ denotes log-deviation of prices; $\hat{\tau}^x, \hat{\tau}^y$ are log wedges from import and export shocks; α is the labor share; Ω: are fixed input shares (Cobb–Douglas); S are expenditure shares in CES (depend on prices and elasticity σ); $W \equiv M \circ D$ aggregates import wedges into unit costs; $\Theta = \text{diag}(\theta_i)$ captures sensitivity of markups to own prices; Ξ_x, Ξ_y are direct markup responses. In MC with constant elasticity (constant markup), $\Theta = \Xi_x = \Xi_y = 0$ and results collapse to the PC case.

Table A12: Empirical Requirements by Model Variant

Model	**To estimate**	**Key mechanism**
CD–CD, PC	α, Ω, D, wedges ($\hat{\tau}^x$, $\hat{\tau}^y$)	Linear propagation; no substitution; no markups
CD–CES, PC	α, S, σ, D, wedges	Input substitution (attenuation or amplification)
CD–CD, MC (var. markups)	α, Ω, D, wedges, Θ, Ξ	Endogenous markups (demand-side channel)
CD–CES, MC (var. markups)	α, S, σ, D, wedges, Θ, Ξ	Substitution + endogenous markups

detailed data on transaction-level linkages between firms, which are not available in our empirical setting.

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