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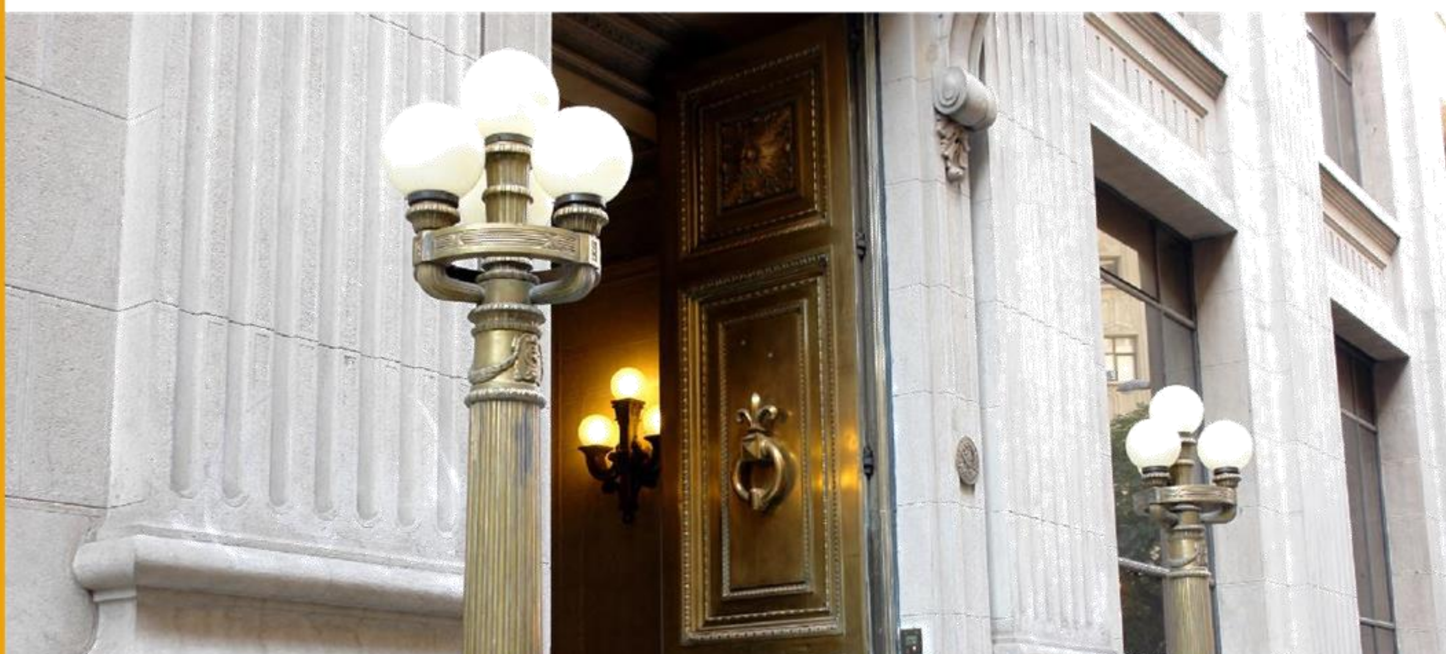

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Freight costs and domestic prices during the COVID-19 pandemic*

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Abstract

How much do changes in the cost of international freight spill over into domestic inflation? Using Chilean customs data, we document that imports from Asia primarily explain the sharp increase in average freight costs observed during 2019-2021. We exploit the heterogeneous exposure of importing firms to this region to implement a shift-share instrument for import prices to estimate the elasticity of substitution between intermediate inputs from Asia and the Rest of the world. Using this estimate in a general equilibrium model with nominal rigidities, we calculate that the observed increase in freight costs accounts for 14% of the inflation for the 2019Q4-2021Q4 period.

Resumen

¿En qué medida los cambios en los costos de transporte internacional se expresan en forma de cambios en la inflación doméstica? Usando datos de Aduanas de Chile, documentamos que las importaciones desde Asia son la principal explicación detrás del drástico aumento en los costos promedio de fletes internacionales observados durante el trienio 2019-2021. Explotamos, entonces, la heterogeneidad a través de las firmas en la exposición a importaciones desde Asia para implementar un instrumento del estilo shift-share que genere variación exógena en los precios de importaciones. El objetivo es estimar la elasticidad de sustitución entre insumos intermedios provenientes de Asia y el resto del mundo. Usando esta estimación en un modelo de equilibrio general con rigideces nominales, calculamos que el aumento observado en los costos de transporte internacional explica un 14% de la inflación en el período que va desde el cuarto trimestre de 2019 al cuatro trimestre de 2021.

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1 Introduction

One defining feature of the COVID-19 pandemic was the diversity of ways in which it affected the economy. As discussed in Baqaee and Farhi (2022), the pandemic was simultaneously a demand and supply shock. During 2021 most countries witnessed a revival of inflation, with year-on-year rates vastly surpassing the targets their monetary authorities had set for themselves. As identifying the separate contributions of supply and demand disruptions to inflation and aggregate fluctuations is complex, central bankers experienced difficulties designing monetary policy.

This paper evaluates the impact of a distinctive supply shock on domestic inflation, the pandemic-induced disruptions to global trade logistics. We use detailed transaction-level Chilean customs data to document two facts. First, higher freight costs had a non-trivial effect on the observed increase in *cost, insurance, and freight* (CIF) import prices. Second, imports from Asia experienced the most significant increases in freight costs relative to their *free on board* (FOB) prices. The capacity of firms to substitute imports away from Asia is critical in determining the effect of the sharp increase in freight costs in the domestic economy. The main novelty of our work is providing structural estimates of the elasticity of substitution to quantify in partial and general equilibrium frameworks the effect of the increase in freight costs on domestic inflation.

Motivated by the increase in freight costs in Asia relative to the Rest of the world, we estimate the elasticity of substitution between intermediate inputs sourced from these regions. If we were to estimate the elasticity of substitution by ordinary least squares (OLS), demand shocks that shift the relative demand for goods across origins while simultaneously affecting relative prices would contaminate the estimator. Health concerns and public health policy measures implemented during the period likely moved consumption preferences towards goods consumed at home. If any region is a primary provider of these goods, OLS estimates are biased.

To circumvent the problem of estimating the elasticity through OLS, we employ a research design that instruments CIF prices in the spirit of Bartik (1991). We build the instrument by interacting the pre-pandemic exposure of firms to importing from Asia or the Rest of the world with the aggregate changes in freight costs from their respective origin. We argue that the change in freight costs observed in the period was exogenous to Chilean firms' decisions. Using this, we obtain an elasticity of substitution of -1.43.[1]

[1] This number is in the lower range of similar estimates found in the literature. See Broda and Weinstein (2006), Feenstra et al. (2018) or Fajgelbaum et al. (2019)

To understand how freight cost changes affect domestic prices, we use a partial equilibrium framework in which we shut down the feedback loop from input cost changes to wages and aggregate income. Dealing with a shock in relative prices, the capacity of switching across supply sources determines how much the unit cost of imported materials is affected.[2] We characterize the pass-through of freight cost changes to total inflation as the sum of two effects: A direct effect that measures how much the prices of imported consumption goods increase. An indirect effect arises from firms' limited capacity to substitute across intermediate imported inputs. Using our estimate for the elasticity of substitution and a partial equilibrium framework, we calculate that the shock in freight costs accounts for around 17 percent of the observed inflation during the 2019Q4-2021Q4 period.

In this setting, we test that FOB prices are independent of the increases in freight costs, as the pass-through into CIF prices need not be zero. To do this, we construct a Bartik-like instrument that rests on the interaction between pre-pandemic exposure to importing from Asia at the firm level with the aggregate increase in freight costs from that origin. We find that freight cost changes do not affect FOB prices in this period, so the Chilean importer entirely bears the incidence of freight cost changes.

In order to measure the aggregate effect of freight costs on domestic prices and their importance relative to other relevant perturbations, we propose a parsimonious two-period general equilibrium model for a small open economy featuring nominal rigidities. The framework is inspired in Baqaee and Farhi (2022) and di Giovanni et al. (2022). Households consume domestic and imported goods, supply labor with a positive elasticity to real wages, and face sticky nominal wages. On the production side, intermediate firms combine labor together with domestic and foreign materials to produce their goods. Foreign intermediate inputs comprise various products that firms can source from Asia or the Rest of the world. The elasticity of substitution between foreign sources for a given category of imported materials is a free parameter. Retail firms produce varieties with intermediate goods and face sticky product prices.

We consider a set of shocks in addition to those over freight costs to validate the model's structure and consider the most important developments of the 2019-2021 period. These shocks include the impatience degree of households, foreign demand for do-

[2]See the discussion in Baqaee and Farhi (2022) regarding the importance of substitutability in inputs for the transmission of supply shocks. In brief, the effect of small perturbations to input costs on product prices is well approximated by the initial cost share of that input. In contrast, considerable perturbations may also have non-negligible effects on cost shares.

mestic goods, the economy's total factor productivity (TFP), the nominal exchange rate, and FOB prices of imported consumption and intermediate goods. We find that freight shocks account for around 14 percent of total inflation. We rationalize the higher figure to the partial equilibrium result due to the imperfect cost pass-through to prices derived from nominal rigidities and a decrease in overall aggregate demand induced by a lower real income.

We also find that shocks primarily affecting the economy's aggregate demand are less relevant in determining the period's inflation rate. The sum of the contributions of the shocks to the impatience degree of households and foreign demand account for roughly 13.1% of the total. In contrast, exchange rate movements explain around 46% of the total. This figure is comparable in magnitude to the added contribution of the supply shocks to TFP, FOB prices, and freight costs. Hence, under the lens of the model, exchange rate depreciation was the most important driver of inflation in the period under analysis. As for consumption, the relevance of the exchange rate shocks is the opposite; demand-side shocks explain almost all of the variation, and exchange rate and supply shocks offset each other.

Related literature. Our work contributes to the recent literature estimating the impact of the Covid-19 pandemic on macroeconomic outcomes. We build upon the work of Baqaee and Farhi (2022), who theoretically show the effect of supply and demand shocks on inflation in the context of a disaggregate economy, but with significant departures. We extend their setting to a small open economy framework that fits better with the size of Chile. We introduce wage and price rigidities, and a Walrasian labor market, to generate a steeper Phillips curve consistent with our empirical application. Rather than using a common cross-country global indicator of supply chain pressures, as in di Giovanni et al. (2022), our work relies on direct measures of supply-side bottlenecks. We measure the emergence of bottlenecks by the increase in transportation costs from different regions across the globe. The increase in transportation costs allows us to pin down the source of the shock and track down its propagation throughout the economy. In addition, we ground our quantitative analysis on estimating the relevant elasticity of substitution between goods affected and unaffected by the increase in transportation costs. In this setting, we quantify the contribution of demand and supply forces to account for the drivers of inflation over the pandemic. Ferrante et al. (2022) studies the effect on inflationary pressures from shifting services' consumption to goods triggered by the reallocation of demand caused by the Covid-19 pandemic; di Giovanni et al. (2023) quantifies the effect of demand shock without paying attention to the reallocation channel. Our quantitative exercise is similar to the latter and finds that forces that cannot be directly linked to supply-side shocks account for approximately half of the economy's inflation; supply-side shocks explain the other half.

Our work also pertains to the literature estimating the effects of trade shocks on inflation. We contribute to the scant literature estimating the elasticity of domestic inflation to freight costs. Herriford et al. (2016) and Carrière-Swallow et al. (2023) rely on panel data to estimate an elasticity to find values close to .0067. Following a quantitative general equilibrium approach, our estimate of the elasticity of inflation to freight costs is close to twice the magnitude mentioned (0.0131). This difference is likely explained by the reinforcing forces we capture such as the effect on the cost of domestic production.

An additional contribution is to provide estimates of the Armington elasticity of substitution. Broda and Weinstein (2006) and Feenstra et al. (2018) use structural econometric approaches to estimate elasticities of substitution for different types of goods. In particular, Feenstra et al. (2018) highlight the downward bias existent in simple OLS estimation via the application of both GMM and OLS on simulated data. Our approach intends to take these empirical challenges into account. However, instead of using a GMM-type of estimation, we rest on a shift-share design that imposes less structure on the data. In this sense, the paper that is closest to ours is Fajgelbaum et al. (2019), although we perform our estimation at a more granular level than they do and our focus is different.

The outline of the paper is as follows. In Section 2 we show the data and the evolution of freight costs during the Covid-19 pandemic. In Section 3.1 we lay out a simple model, which we then use in our empirical strategy in Section 3.2. In Section 3.3 we display our estimation results, and measure the partial equilibrium effects that freight costs had on inflation. In Section 4 we study the general equilibrium effects. Section 5 concludes.

2 Transportation costs during Covid-19

This section presents the data we use in the article and documents the rise of freight costs observed during 2021. We use data on imports at the product-firm level and report a severe increase in freight costs, which is almost entirely explained by imports from Asia. We exploit this finding to estimate key elasticities later in the paper.

2.1 Data

Data on Chile's international trade is from the Customs Import Declaration collected by the National Customs Service, and we use it for the period 2017-2021. The Customs data contains information about the category of the imported product at the HS8 level, country of origin, traded quantity, CIF value, the components of the CIF value (FOB value, freight cost, and insurance), and a firm identifier. We do not observe prices, so we approximate them by computing unit import values.[3]

We use data on imports to understand the dynamics of freight costs during the period. We focus on heterogeneity by sourcing regions. In particular, we collapse the data at two geographical levels, Asia (A) and the Rest of the world (W).[4] Given the administrative nature of the database, we drop all observations where the FOB value is larger than the CIF value and where either freight cost or insurance is above the FOB value.

2.2 Descriptive Evidence

The international prices that domestic importers face at the dock are composed of the Free-On-Board (FOB) price, the freight cost (Fre), and the insurance cost (Ins). The total corresponds to the Cost, Freight, and Insurance (CIF) value, which is the relevant price for the domestic economy, as most tariffs and other taxes are calculated on this value.

In order to measure the evolution of each CIF price component, we build indices that span the period from 2017 to 2021. We calculate the annual growth rates of the index as follows:

$$g_{X,t} = \sum_i \xi_{i,2017} d \log \left(\frac{X_{it}}{Q_{it}} \right), \quad X = \{CIF, FOB, Fre, Ins\},$$

where $\xi_{i,t} = \frac{FOB_{i,2017}}{\sum_i FOB_{i,2017}}$, $FOB_{i,2017}$ is the total FOB value of all imports of product i into

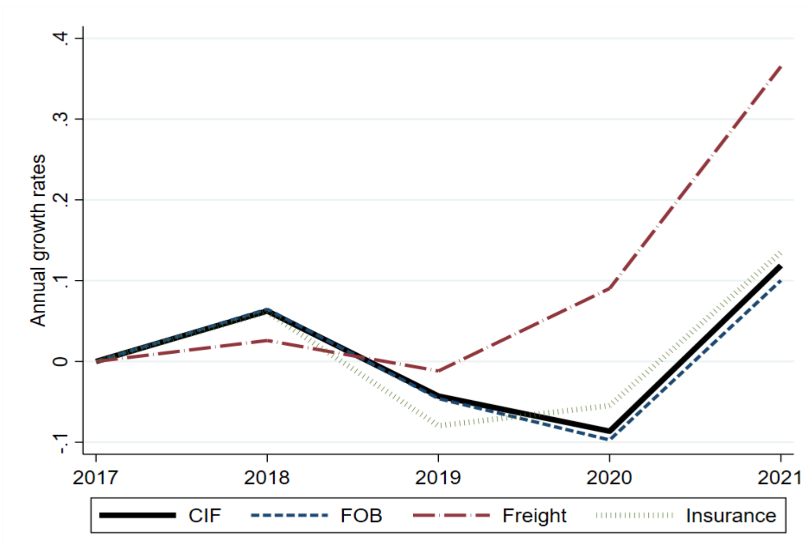
[3]This study was developed within the scope of the research agenda conducted by the CBC in economic and financial affairs of its competence. The CBC has access to anonymized information from various public and private entities, by virtue of collaboration agreements signed with these institutions. To secure the privacy of workers and firms, the CBC mandates that the development, extraction and publication of the results should not allow the identification, directly or indirectly, of natural or legal persons. Officials of the Central Bank of Chile processed the disaggregated data. All the analysis was implemented by the authors and did not involve nor compromise the SII, Aduanas and AFC. The information contained in the databases of the Chilean IRS is of a tax nature originating in self-declarations of taxpayers presented to the Service; therefore, the veracity of the data is not the responsibility of the Service

[4]Asia is defined following the Chilean customs definition. It considers Jordan, Saudi Arabia, Kuwait, Oman, Cyprus, Israel, Iraq, Afghanistan, Iran, Syria, Lebanon, Qatar, Bahrein, Sri Lanka, Cambodia, Laos, India, Bhutan, Thailand, Nepal, Bangladesh, Palestine, Pakistan, Vietnam, Myanmar, Maldives, Indonesia, Malaysia, Taiwan, Japan, Singapore, South Korea, North Korea, Philippines, China, Mongolia, EUA, Hong Kong, Macao, Brunei, and Yemen.

Chile during 2017 (i is defined at the HS8 level), and Q_{it} is total quantity.

Figure 1 shows the CIF value's growth rates and components. Freight costs appear stable before 2020, while insurance and FOB prices rise slightly in 2018 to fall in 2019. In the first year of the pandemic, FOB prices and insurance costs fall, which make CIF prices also go down even though freight costs increased by almost 10 log points. In 2021, all CIF components grow, but freight costs do so even more. It is reasonable to think that part of this sharp growth in freight cost is due to the global supply chain bottlenecks widely reported around the world (Celasun et al., 2022), especially in Asian ports and factories (Rees and Rungcharoenkitkul, 2021). Appendix Figure A.1 shows this at the quarterly level, where we can see how the rise gets more prominent as the year progresses, with annual growth in the fourth quarter of 53 log points.

Figure 1: Growth rates of CIF and its components



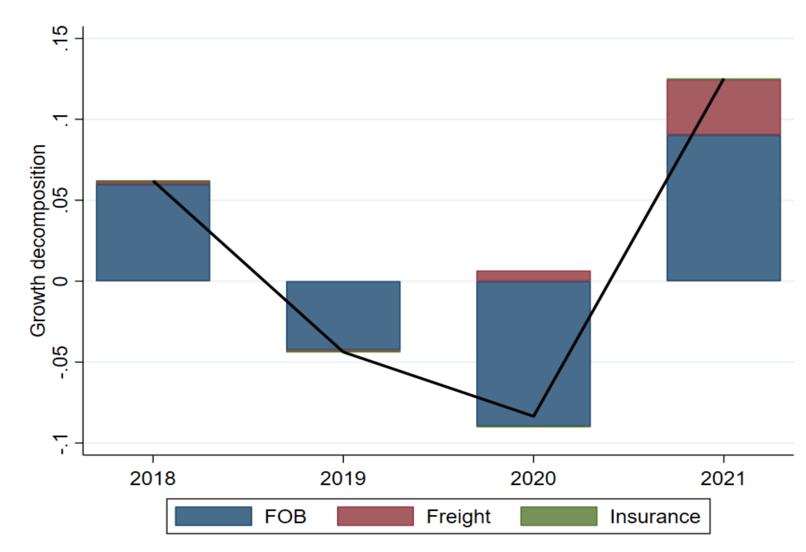
Notes: This figure plots the annual growth rates of the CIF price index of Chilean imports and its components (FOB, Freight, Insurance).

To understand the contribution that the rise in freight costs has on import prices, we decompose the variations in CIF prices into the growth of its components:

$$1 \approx \frac{\Psi^{\text{FOB}}_{t,t-1} d \log P^{\text{FOB}}_t}{d \log P^{\text{CIF}}_t} + \frac{\Psi^{\text{Fre}}_{t,t-1} d \log C^{\text{Fre}}_t}{d \log P^{\text{CIF}}_t} + \frac{\Psi^{\text{Ins}}_{t,t-1} d \log C^{\text{Ins}}_t}{d \log P^{\text{CIF}}_t},$$

where $\Psi^X_t = \frac{X_t}{\text{CIF}_t}$, $\Psi^X_{t,t-1}$ is the simple average of this last variable over periods t and $t-1$, and $X = \{FOB, Fre, Ins\}$. Figure 2 shows this decomposition for the universe of Chilean imports. Around one-third of the rise in import prices in 2021 comes from increases in freight costs, which is in stark contrast with the situation before 2021, where freight costs play little to no role in explaining the growth rates of CIF prices.

Figure 2: CIF prices decomposition



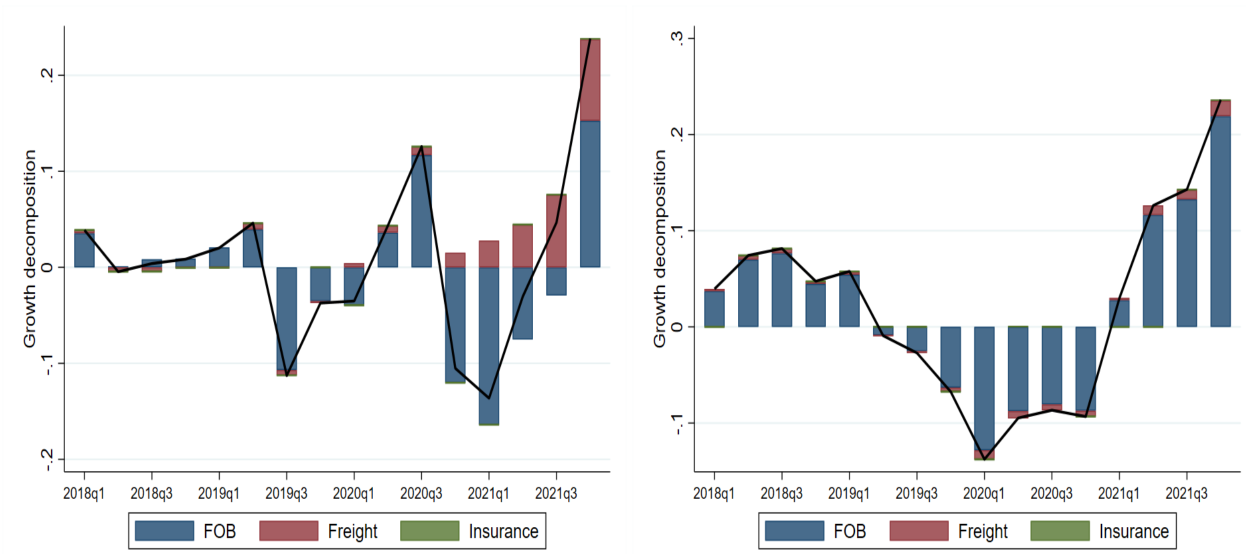
Notes: This figure plots the contribution each component of CIF has on its annual growth rate.

There are marked differences in the recent importance of freight costs when we apply the analysis to different sourcing regions. In Figure B.1, we replicate the decomposition above for imports coming from Asia (panel (a)) and those coming from the Rest of the world (panel (b)). Freight cost changes explain almost the entire increase in prices of Asian imports observed in 2021. In the case of imports from the Rest of the world, even though freight cost changes play a more significant role than in previous years, it is much less than that computed for Asian imports. One can interpret these findings as the Covid-19 pandemic having affected different regions of the globe in different ways. In Asia, product prices (i.e., FOB values) stay flat during 2021, so pandemic-induced disruptions in logistics seem to be the main driving force pushing CIF prices. On the other hand, logistics in the Rest of the world origins do not show much evidence of distress in this period, so pandemic-induced disruptions in production are likely what determine the significant observed jump in the levels of product prices in 2021.

Appendix Figure A.2 and Appendix Figure A.3 show the growth rates by component for Asia and Rest of the world, respectively. They show how in the last two quarters of

Figure 3: CIF prices decomposition by region

(a) Asia (b) Rest of the world



Notes: This figure plots the contribution each component of CIF has on its annual growth rate for different regions of origin: Asia and Rest of the world.

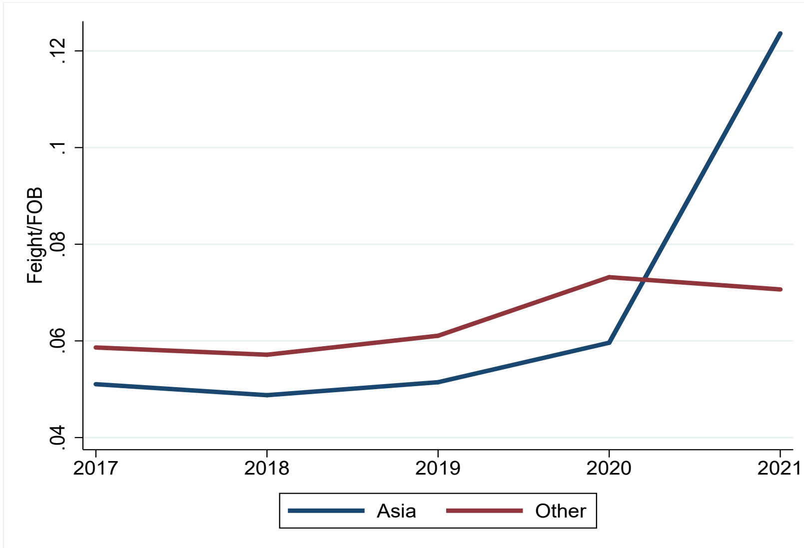
2021 freight costs in imports from Asia more than doubled annually.[5]

Another way of visualizing this is by looking at the ratio between freight costs and FOB values by region of origin. Figure 4 shows the total freight costs of imports from Asia and Rest of the world origins over total FOB from those same origins. Up until 2020, both regions display parallel trends for this ratio. However, in 2021 there is a marked change in trajectories. For Asian imports, the ratio more than doubles. The share falls on the margin for the Rest of the world origins..[6]

[5]The growth rates in log points in 2021Q3 and 2021Q4 were 87.6 and 81.1, respectively, which correspond to 240% and 225% rises with respect to their previous year.

[6]When we disaggregate into more regions, we observe a similar pattern. Appendix Figure A.5 shows that the rise is mostly driven by freight costs from China and the Rest of Asia, with a minor role played by European imports.

Figure 4: Freight/FOB by region



Notes: This figure plots the ratio of the total freight cost of imports to the total FOB value for each year, and for each importing region (Asia and Rest of the world).

We use these findings to design the empirical strategy to estimate the elasticity of substitution between imported intermediate inputs further below. The large rise in freight costs from Asian imports is widespread and unlikely to be determined by a particular Chilean firm importing a particular good, which contrasts with those from Rest of the world. In addition, past imports provide a distribution of the exposition firms have to each region. Put together, they may provide enough exogenous variation over the cross-section of importing firms.[7]

3 Partial equilibrium effects

We set up a simple model that expresses the effect of freight costs on consumer prices. The effect depends chiefly on the elasticity of substitution between inputs from different origins. We provide structural estimates of the elasticity of substitution, which we use to estimate the effect of the increase in freight costs on inflation.

[7] Appendix C provides sectoral and product evidence about the effect that rising freight costs had. In particular, we show that Footwear and Clothing together with Wooden and Glass/Ceramic products were among the most affected.

3.1 Analytical Framework

We propose an analytical framework that describes the fundamental forces behind the pass-through of shipping cost changes to total inflation. The distinctive element of the model we present below is the presence of two sourcing regions for intermediate goods, Asia and the Rest of the world. We assume that producers can substitute intermediate goods between the regions with a constant elasticity of substitution. The analysis takes place in a static framework. We render the analysis as partial equilibrium because we shut down any effect of the freight costs on the labor market. We characterize the pass-through of freight costs changes to total inflation as the sum of two effects: A direct effect that mechanically measures how much prices of imported consumption goods increase. An indirect effect arises from intermediate imported inputs used in the production process. The elasticity of substitution between imported materials and the share of imported inputs over total costs are crucial for the indirect effect.

Households. Households choose between consuming domestic or foreign goods, C_D and C_F, respectively, to optimize the following function:

$$\begin{aligned} &\max_{C_D,\, C_F} \quad C_D^{\eta} C_F^{1-\eta} \\ &\text{s.t.} \qquad C_D P_D + C_F P_F^c = w, \end{aligned} \tag{1}$$

where $\eta \in [0,1]$, P_D is the price of the domestic consumption good; P_F^c is the price of the foreign consumption good, which is the sum of a free-on-board price, $\tilde{p}_F^c$, and a freight cost, τ_F, expressed in domestic currency units $p_F^c = \mathcal{E}\left(\tilde{p}_F^c + \tau_F\right)$, $\mathcal{E}$ is the USD-CLP exchange rate to convert nominal imports in CLP; wages, w, are fixed throughout.[8]

Production. There is a competitive retailer firm that aggregates domestic manufacturing varieties, y_i, according to a constant returns technology to produce a domestic good, Y_D. The good produced domestically can be used for consumption or as an intermediate production input.

Manufacturing firms are heterogeneous and operate competitively in input markets. Firm i combines labor, l, domestic intermediates, m_D, and a foreign composite of intermediate inputs, m_F, according to a constant returns to scale production function to maximize

[8] Over 90% of Chilean imports are invoiced in USD. For a study of the invoice currency in Chile's international trade, see Giuliano and Luttini (2020). For the remainder of the analysis we abstract from insurance costs, which are negligible relative to FOB price and freight costs.

profits:

$$\begin{aligned} \max_{l_i, m_{iD}, m_{iF}} \quad & p_{iD} y_i - w l_i - p_D m_{iD} - p^m_{iF} m_{iF}, \\ \text{s.t.} \quad & y_i = l_i^{\alpha} \left(m_{iD}^{\gamma} m_{iF}^{1-\gamma} \right)^{1-\alpha}, \end{aligned} \tag{2}$$

where $\alpha, \gamma \in [0,1]$, p_{iD} is the price of firm i's production and p^m_{iF} is the unit price of the composite foreign good. The optimal share of imported materials from regions A and R results from the minimization problem

$$\begin{aligned} \min_{m_{iA}, m_{iR}} \quad & p^m_A m_{iA} + p^m_R m_{iR}, \\ \text{s.t.} \quad & m_{iF} = \left[\omega_i^{\frac{1}{\epsilon}} m_{iA}^{\frac{\epsilon-1}{\epsilon}} + (1-\omega_i)^{\frac{1}{\epsilon}} m_{iR}^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}}, \end{aligned} \tag{3}$$

where $\omega_i \in [0,1]$, m_{iA} and m_{iR} are intermediate imports from Asia and the Rest of the world, respectively, and ϵ is the elasticity of substitution between intermediate goods from both regions. Modeling the weight ω as firm-specific is something we exploit to estimate the elasticity of substitution. This brings the complication that the unit cost of imported materials is firm specific, whose expression is $p^m_{iF} = \left[\omega_i (p^m_A)^{1-\epsilon} + (1-\omega_i)(p^m_R)^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}}$; where p^m_A is the price of imported inputs from region A, defined as the sum of a free-on-board price, $\tilde{p}^m_A$, and a freight cost, τ_F, expressed in domestic currency units $p^m_A = \mathcal{E}\left(\tilde{p}^m_A + \tau_A\right)$, and similarly for p^m_R. Except for estimating the elasticity of substitution, in most of the article, we abstract from this source of heterogeneity.

Proposition 1. *In an economy defined by problems (1) to (3), under market-clearing of the final good, and shutting down any effect of the freight costs on the labor market, the partial equilibrium adjustments of aggregate prices summarize as follows:*

(i) Domestically produced goods inflation: $d \log P_D = \dfrac{(1-\alpha)(1-\gamma)}{1-(1-\alpha)\gamma} \mathbb{E}[d \log p^m_{iF}]$,

(ii) Consumer Price Index inflation: $d \log P = \dfrac{\eta(1-\alpha)(1-\gamma)}{1-(1-\alpha)\gamma} \mathbb{E}[d \log p^m_{iF}] + (1-\eta) d \log p^c_F$,

where $P = P_D^{\eta} P_F^{c\,\eta}$ *is the economy's consumer price level and* $\mathbb{E}[d \log p^m_{iF}] = \sum_i \dfrac{p_{iD} y_i}{p_D Y} d \log p^m_{iF}$.

The domestically produced goods inflation indicates that their changes come from the average variation in the cost of imported inputs, amplified by their use of domestic production as inputs, $(1-(1-\alpha)\gamma)^{-1}$. In addition to the effect of domestically produced goods, CPI inflation is affected by the change in the cost of imported consumption goods.

From this proposition, we derive a corollary about the effect of freight costs on CPI inflation:

$$\frac{d\log P}{d\log\tau} = \underbrace{\eta\frac{(1-\alpha)(1-\gamma)}{1-(1-\alpha)\gamma}\mathbb{E}\left[\frac{d\log p^m_{iF}}{d\log\tau}\right]}_{\text{Indirect Effect}} + \underbrace{(1-\eta)\frac{d\log p^c_F}{d\log\tau}}_{\text{Direct Effect}}. \tag{4}$$

This expression shows that increases in freight costs affect CPI inflation through an indirect effect that comes from the degree to which prices of domestic goods increase due to rising freight costs and a direct effect which mechanically measures by how much prices of imported consumption goods increase. A key element in equation (4) is how much the unit cost of imported materials increases due to the increase in freight costs. This object primarily depends on the elasticity ϵ that appears in the *exact* effect of freight costs fluctuations on p^m_{iF}:

$$\log\left(\frac{p^{m'}_{iF}}{p^m_{iF}}\right) = \frac{1}{1-\epsilon}\log\left(\xi_i\left(\frac{p^{m'}_A}{p^m_A}\right)^{1-\epsilon} + (1-\xi_i)\left(\frac{p^{m'}_R}{p^m_R}\right)^{1-\epsilon}\right), \tag{5}$$

where x' corresponds to the new value for any variable x, and ξ_i is the share of imported material corresponding to region A, $\frac{p^m_A m_{iA}}{p_{iF} m_{iF}}$. We can appreciate that the smaller ϵ is, the larger the impact of a change in the price of a good imported from any origin on the ideal price index associated with the imported intermediate bundle. To quantify the effects of the increase in freight costs on CPI inflation, we turn to compute the elasticity of substitution between imported materials and all the elements of equation (4).

3.2 Elasticity of substitution

We describe our approach for estimating the elasticity of substitution between intermediate goods from different sourcing regions. We begin by presenting the estimating equation and discussing the problems to estimate the parameters through OLS. We then present an instrumental variable strategy that uses a shift-share design. Finally, we present our results.

The first-order condition of the firm's problem lets us derive a structural specification from which we can estimate the elasticity of substitution between imported inputs. Any firm optimizing (3) satisfies the following condition:

$$\frac{m_{iA}}{m_{iR}} = \frac{\omega_i}{1-\omega_i}\left(\frac{p^m_A}{p^m_R}\right)^{-\epsilon}.$$

This condition applies to any product the firm sources from these two regions. Taking logarithms and the first difference of this expression, and considering the multi-product dimensions of the firm's decision problem, we arrive at the following structural equation:

$$d\log\left(\frac{m_{ijAt}}{m_{ijRt}}\right) = \lambda_i + \lambda_{jt} - \epsilon d\log\left(\frac{p^{CIF}_{ijAt}}{p^{CIF}_{ijRt}}\right) + \varepsilon_{ijt}, \tag{6}$$

where λ_i is a firm fixed effect, λ_{jt} is a product-time fixed effect, and j denotes product.

Estimating equation (6) by OLS is potentially contaminated by unobserved demand shocks (to ω_i in the context of the model) that shift the relative quantities purchased while simultaneously affecting in the same direction relative prices among origins. For instance, during the period, Covid-19-induced restrictions such as stay-at-home orders and quarantines were implemented by many governments. These policies likely move consumption preferences towards durable goods that could be used at home. If Asia or the Rest of the world disproportionately provide these goods to Chile, OLS estimates are biased. We propose an instrumental variable strategy that addresses these concerns.

3.2.1 Identification strategy: Shift-share design

We use an instrumental variable estimator to address the potential endogeneity problems of estimating (6); we construct instruments inspired in Bartik (1991). This class of instruments are also known as shift-share instruments, because they contain a shifter or shock, and a share or exposition. In our context, the shocks are region-specific and correspond to variation in freight costs when sourcing from a given region. The share is the initial exposition a firm i has when importing from different regions. We construct the instruments as follows:

$$\tilde{B}_{it} \equiv B_{iAt} - B_{iRt} = \xi_{iA,t-T}d\tau_{At} - \xi_{iR,t-T}d\tau_{Rt}, \tag{7}$$

where $\xi_{iA,t}$ measures the initial exposition to the Asian region, and it is defined as:

$$\xi_{iA,t} \equiv \frac{\text{Import FOB Value}_{iAt}}{\text{Import FOB Value}_{iAt} + \text{Import FOB Value}_{iRt}}, \tag{8}$$

and similarly for the initial exposure to the Rest of the world region, $\xi_{iR,t}$. T denotes the number of periods elapsed from the base period. The shocks are given by:

$$\begin{aligned} d\tau_{At} &= \frac{\sum_i \text{Freight Costs}_{iAt}}{\sum_i \text{Import FOB Value}_{iAt}} - \frac{\sum_i \text{Freight Costs}_{iA,t-T}}{\sum_i \text{Import FOB Value}_{iA,t-T}}, \\ d\tau_{Rt} &= \frac{\sum_i \text{Freight Costs}_{iRt}}{\sum_i \text{Import FOB Value}_{iRt}} - \frac{\sum_i \text{Freight Costs}_{iR,t-T}}{\sum_i \text{Import FOB Value}_{iR,t-T}}. \end{aligned} \tag{9}$$

Thus $d\tau_{At}$ and $d\tau_{Rt}$ represent the change in the share of freight cost expenses on FOB value across all Chilean firms that import from region A and R, respectively. The level of these shocks are shown Figure 4.[9]

The validity of the instruments comes from the exogeneity of the individual share expositions (Goldsmith-Pinkham et al., 2020), or the exogeneity of the aggregate shocks (Borusyak et al., 2021). A firm's exposition to a specific region depends on past decisions, likely to be correlated to *current* decisions about quantities and prices. Thus, the shares are not exogenous, and the validity of our approach must come from the shocks.

We want to make sure that these differences are not specific to Chile and do not reflect increased demand for transportation from domestic importers. Asia is one of the leading destinations of Chilean exports and the origin of its imports, with China playing an outsized role. It represents roughly a third of Chilean exports and a quarter of Chilean imports. However, Chile represents a tiny share of Chinese exports. Then, it is unlikely that what we observe in Figure 2 or Figure 4 is due to a rise in demand from Chilean importers. In line with this, UNCTAD (2021) describes how freight costs from China increased dramatically at the beginning of 2021. Indeed, the document shows that freight costs to South America increased by the most. Similarly, LaRocca (2021) documents freight costs of imports into the U.S. West coast and shows they have increased worldwide, but especially from East Asia.

How is this instrument relevant to the instrumented variable, $d\log\left(p^{CIF}_{ijAt}/p^{CIF}_{ijRt}\right)$? Our instrument is a weighted average of changes in the aggregate share of freight costs on FOB-valued imports across sourcing regions, with weights given by the initial participation of imports from each region on total intermediate imports for each firm. Given what

[9] Not all shocks for the specifications below use this, but the rationale for their validity is the same.

we observed in Section 2.2, changes in freight costs are much lower and explain a much lower fraction of changes in CIF prices in imports from the Rest of the world than in those from Asia. Therefore, changes in the aggregate share of freight costs on FOB-valued imports are minuscule for imports from the Rest of the world relative to those from Asia. In this way, most of the variation in the weighted average of the change in the share of freight costs on FOB imports come from Asian imports, where the initial exposure that the firm has to Asian imports modulates the exact impact. Hence, we generate variation in the relative CIF price of intermediate imports from Asia to that of imports from the Rest of the world that is orthogonal to local relative preference shocks.

3.2.2 Regression results

We are interested in the events that took place in 2021, and our baseline year would usually be the year 2020. However, this is when international trade came to an almost complete halt for many Chilean importing firms during certain quarters. Therefore, we use 2019 as the baseline year when taking differences. This means setting $T = 8$ as we consider data at a quarterly level. The same approach is considered in di Giovanni et al. (2022).

Table 1 shows the estimates of equation (6). Column 1 is the OLS estimation, which delivers a positive ϵ. This point estimate can have an upward bias if there are unobserved shocks generating, at the same time, a larger demand for varieties coming from Asia and pushing import prices up. Column 2 shows that the interaction of the initial exposure to a sourcing region with the aggregate growth in freight cost correlates positively and strongly with variations in the relative price of imports from Asia to the Rest of the world. In addition, the F-statistic is high enough to verify that the relevance condition of the instrument holds. Column 3 shows an elasticity of 1.43, confirming the upward bias of the OLS estimates.

This value is on the lower end of similar estimates in the literature. However, most of such papers use countries instead of broad geographical regions as sources of imports. Fajgelbaum et al. (2019), for example, obtains an elasticity of 2.53 for US imports. In our case though, firms have *fewer* origins to choose from, which could limit their ability to react as an essential portion of the ability to substitute could be between countries within the same region. In the robustness section, we introduce more regions; as a result, we obtain a higher elasticity of substitution.

Table 1: Elasticity of substitution

	(1)	(2)	(3)
	$d\log m_A/m_R$	$d\log p_A^{CIF}/p_R^{CIF}$	$d\log m_A/m_R$
$d\log p_A^{CIF}/p_R^{CIF}$	1.0073***		1.4345***
	(0.0278)		(0.2578)
$\tilde{B}$		1.4986***	
		(0.2612)	
N	348,960	348,960	348,960
R^2	0.437	0.133	0.281
1st-stage F		32	

Notes: This table estimates (6) using Import Customs data from Chile. The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS8 level. All specifications include a product (HS8) and firm-time fixed effects. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

3.3 Effects of freight costs on inflation

Equipped with estimates for the elasticity of substitution, we turn to compute the effect of freight costs on inflation. In addition, we require to calculate parameters α and γ. Our model guides us to compute α as the ratio between two aggregates the wage bill to the sum of the wage bill and intermediate consumption. The coefficient γ results from the ratio of domestic intermediate to aggregate intermediate consumption. These aggregates are readily available from the National Accounts, and we retrieve them from the Central Bank of Chile, obtaining $\alpha = 0.33$ and $\gamma = 078$.

We proceed to compute the effect on the CPI from the observed increase in freight costs between 2019q4 and 2021q4. Plugging equation (5) into (4), we derive our accounting expression for the effect of the increase in freight costs on inflation:

$$d\log P_t = \frac{\eta(1-\alpha)(1-\gamma)}{1-(1-\alpha)\gamma}\frac{1}{1-\epsilon}\log\left[\xi_{t-8}\left(\exp\left(s^{\tau}_{A,t-8}d\log\tau_{A,t}\right)\right)^{1-\epsilon}\right.$$
$$\left. + (1-\xi_{t-8})\left(\exp\left(s^{\tau}_{R,t-8}d\log\tau_{R,t}\right)\right)^{1-\epsilon}\right] + (1-\eta)\left[s^{\tau}_{t-8}d\log\tau_t\right],$$

where $s^{\tau}_{o,t} = \frac{\text{Freight Costs}_{o,t}}{\text{Import FOB Value}_{o,t}}$ for $o = \{A, R\}$, $s^{\tau}_t = \frac{\sum_o \text{Freight Costs}_{o,t}}{\sum_o \text{Import FOB Value}_{o,t}}$, $\xi_t = \frac{\text{CIF}_{A,t}}{\text{CIF}_{A,t}+\text{CIF}_{R,t}}$ is the share of region A on the total value of materials imports, and $d\log x_t \equiv \log x_t - \log x_{t-8}$. All these statistics can be computed directly from Customs data, and parameter $1-\eta$ is computed as the share of imports to GDP in Chile, which averaged 0.3 between 2011 and 2020.

Using the estimated parameters and relevant values for 2021Q4, we compute an indirect effect of 0.57 log points and a direct effect of 1.01, which add to 1.58 log points.[10] CPI inflation between 2021Q4 and 2020Q4 was 6.42 log points, which means that the rise in freight costs explains 17.02 percent of the (log) Headline CPI inflation rate registered during this period.[11]

For this exercise, given the Cobb-Douglas nature of the production function at this input layer level, we have assumed that firms *do not* change their cost structure when they face these more expensive imported materials. One could expect that labor or domestic materials expenses would increase, alleviating the rise in costs. This constraint on this margin of adjustment implies that the effect we find is an upper bound.

3.4 Robustness checks

In this section, we address three potential threats to our results: Do freight costs affect FOB prices? Are freight cost exogenous to Chilean importers? Do our results change if we consider more regions in the empirical analysis?

Freight costs and FOB prices. One potential threat to our previous estimates is our assumption that freight costs do not pass-through to FOB prices does not hold in the data; we next show that freight costs have zero effect on FOB prices. To evaluate how much of the rise in freight costs pass-through on FOB prices, we estimate:

$$d\log p_{ijot}^{FOB} = \lambda_{jt} + \lambda_{ot} + \lambda_{io} + \beta d\log \tilde{\tau}_{ijot} + \varepsilon_{ijot}, \tag{10}$$

where λ_{jt} and λ_{ot} are product-time fixed effect and sourcing region-time fixed effects. The left-hand side variable is the change in the unit FOB import value of good j imported

[10] In particular, we use $d\log\tau_{A,t} = 1.0578$, $d\log\tau_{R,t} = .2467$, $d\log\tau_t = .5972$, $\xi_{t-8} = .3263$, $s^{\tau}_{A,t-8} = .0492$, $s^{\tau}_{t-8} = .0591$, $s^{\tau}_{t-8} = .0559$.

[11] The headline CPI inflation in 2021, computed between the months of December, was 7.2 percent or 6.95 log points. Here we are implicitly assuming that the pass-through from freight costs to CIF prices is complete. We confirm this to be the case in the robustness checks section 3.4.

from region o by firm i defined as:

$$d \log p_{ijot}^{FOB} = d \log \frac{\text{Import FOB Value}_{ijot}}{\text{Import Quantity}_{ijot}},$$

and the change in the unit cost of freight for firm i importing product j from region o is:

$$d \log \tilde{\tau}_{ijot} = d \log \frac{\text{Freight Costs}_{ijot}}{\text{Import Quantity}_{ijot}}.$$

In the face of a firm-specific demand shock for a particular product, it might be the case that FOB prices and freight costs move in the same direction, so estimating (10) by OLS might deliver biased estimates.

In order to obtain consistent estimates of β, we instrument the change in freight cost unit value with $B_{iot} = \xi_{io,t-T} d\tau_{ot}$, whose components are defined in (8) and (9). The first term measures the initial exposition to such shock. The second term in this instrument measures the aggregate increase in the ratio of freight costs to FOB prices that firms in a particular region o are subject to. Their interaction should be exogenous to demand shocks specific to a particular firm that imports a product from a certain region, as it fuses an earlier – potentially endogenous – sourcing decision with an unexpected and exogenous aggregate shock.

Table 2 shows the estimates of (10). Column 1 shows that higher freight costs are associated with higher FOB prices which, given the discussion in Section 3.2, we know may be biased. Demand shocks generate both upward pressure on the price of products (i.e., FOB price) and transportation costs, implying that an OLS estimator is likely biased upwards. Column 2 shows that our instrument strongly correlates with freight costs, with an F-statistic high enough to check that the relevance condition of the instrument holds. Column 3 shows that freight costs do not significantly affect FOB prices. This means there is a total pass-through from freight costs to CIF import prices, as we assume in our baseline exercise.

Table 2: Freight costs pass-through to FOB prices

	(1) $d\log p^{FOB}$	(2) $d\log\tilde{\tau}$	(3) $d\log p^{FOB}$
$d\log\tilde{\tau}$	0.4769***		0.0619
	(0.0169)		(0.1184)
B		3.5357***	
		(0.6696)	
N	347,153	347,153	347,153
R^2	0.474	0.251	0.094
1st-stage F		27	

Notes: This table estimates (10) using Import Customs data from Chile. The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS8 level. All specifications include a product-origin, firm-time and origin-time fixed effects. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Exogeneity of the freight costs and product aggregation. A second source of concern is that the shocks to freight costs might not be exogenous to the Chilean importers. For instance, the higher demand faced domestically by goods produced in Asia could have increased both the price of the actual goods and the freight cost. A way to test whether freight costs from Asia and other regions are exogenous to Chilean firms is to use similar data from a different country.[12] We use Customs data from Colombia which is also in South America and has an important port in the Pacific Ocean. Appendix Section D provides more details of this approach. Appendix Figure C.1 replicates Figure 4 for the case of Colombia, where we again observe the parallel trends that only slightly vary in 2020, to then fully change in 2021, just as in the case of Chile. Appendix Table C.1 replicates Table 1, where we observe an elasticity very similar to the one computed with shocks from Chilean imports.

Finally, we perform other robustness checks to confirm that the initial specification does not drive our results. Appendix Table A.4 and A.5 show the results if we use an HS4 aggregation instead of HS8 as in the baseline.

[12]This is similar to the approach carried out by Autor et al. (2013) where they estimate the effect of increased competition by Chinese imports on U.S. labor markets by using the growth of imports from China of other eight developed economies.

More regions. In the baseline exercise, we consider two regions: Asia and the Rest of the world. This might be an issue because of the level of aggregation, as for a given product, goods are more likely to be different the more countries we include in a specific region. Doing so makes unit values more distant from an actual price and varieties more heterogenous within the same good's category. Furthermore, Borusyak et al. (2021) show that the consistency properties of the shift-share IV estimator improve when we consider more shocks, which happens as we increase the number of regions. We replicate our baseline results using five origin regions: China, Asia excluding China, South and Central America, North America, and Europe. We drop Africa and Oceania as they represent tiny shares of Chilean imports, and it is more likely that firms are not consistently buying from them. For this, we generalize the CES aggregator of problem (3) and assume that imports aggregate as follows:

$$m_{iF} = \left[\sum_{O} \omega_i^{\frac{1}{\epsilon}} m_{iO}^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}}, \quad \omega_i \in [0,1]. \tag{11}$$

Then, using these five regions, we perform two exercises. We run a regression as in (6) for four regions except 'Asia excluding China' that we use as the normalizing region.[13] Appendix Table A.1 shows the results for ϵ using this approach, where we observe that the elasticity, in this case, rises considerably to 3.23, which is still within the range of values we expect these elasticities to be in. The higher elasticity is expected as coarser regions might conceal changes that otherwise occur. In this case, the partial equilibrium effect of freight costs on inflation is only 0.04 percentage points lower.

We also run a regression of the log differentiated demand function for m_{iO}.[14] Appendix Table A.2 and A.3 show the results for different combinations of fixed effects, where in both cases, the elasticity is higher as we would expect with more observed variations with the new specification. In this case, the share of inflation explained by freight cost fluctuations in 2021 is virtually identical to the baseline.

[13] When we run (6) we are normalizing Asia with Other regions, and now we do something similar. In particular, we estimate $d\log\left(\frac{m_{ijOt}}{m_{ijAt}}\right) = \lambda_i + \lambda_{jt} - \epsilon d\log\left(\frac{p^{CIF}_{ijOt}}{p^{CIF}_{ijAt}}\right) + \varepsilon_{ijt}$ for O = {China, South-Central America, North America, Europe}.

[14] The associated demand functions for each origin in (11) correspond to $m_{iO} = \omega_{iO}\left(\frac{p_{iO}}{p_{iF}}\right)^{-\epsilon} m_{iF}$.

4 General equilibrium analysis

4.1 Model

We present a small open economy general equilibrium model that embeds the elements of the framework presented in section 3.1. The model lasts two periods, present and future. Agents take as given the price level in the future.[15] There is no investment. There is a representative firm that produces a homogeneous domestic intermediate. A continuum of mass 1 of retailers sell differentiated varieties to a competitive final good producer that aggregates the varieties through a CES aggregator. Finally, there is a continuum of mass 1 of households that consume domestic and imported products.

4.1.1 Households

Households, indexed by τ, live for two periods and supply a household-specific variety of labor to the market. They maximize a lifetime utility function given by:

$$U^\tau = \sum_{t=0,1} \beta^t \left(\log(C_t^\tau) - \chi \frac{(L_t^\tau)^{1+\psi}}{1+\psi} \right)$$

where β is the time preference parameter, C_t^τ is consumption, L_t^τ is labor, χ is a disutility of labor parameter, and ψ is the labor Frisch elasticity.

The household has access to an internationally traded risk-free bond, denominated in foreign-currency, that pays a nominal interest rate i_t, to smooth consumption.

Households have also access to a full set of state-contingent domestically-traded securities to insure themselves against variations in household-specific labor income. As a result, labor income plus the net income received from the trading of the state-contingent securities, $w_t^\tau L_t^\tau + A_t^\tau$, will be equal across households and equal to aggregate labor income.

All households start out with zero wealth, an assumption which, jointly with the trading of state-contingent securities, will imply that the marginal utility of consumption (and thus consumption) will be identical across all households.

[15] This is isomorphic to an infinite-horizon model where after an initial unexpected shock in period 1, the economy returns to a flexible price long-run equilibrium featuring market clearing and full employment.

The budget constraints of household τ are thus given by:

$$\begin{aligned} \text{Period 0}: \quad & P_0 C_0^\tau + \mathcal{E}_0 B_1^\tau = w_0^\tau L_0^\tau + A_0^\tau + \Pi_0 \\ \text{Period 1}: \quad & P_1 C_1^\tau = w_1^\tau L_1^\tau + A_1^\tau + \Pi_1 + (1+i_1)\mathcal{E}_1 B_1^\tau \end{aligned}$$

where P_t is the price of consumption, $\mathcal{E}_t$ is the nominal exchange rate between the domestic and the foreign currencies, w_t^τ is the household-specific wage rate per hour of labor, A_t^τ is the net cash received from state-contingent securities, and Π_t is firms' profits, which are rebated lump-sum to all households.

From the solution to the dynamic problem we obtain the following Euler equation:

$$C_0^\tau = \frac{1}{\beta}\frac{1}{1+i_1}\frac{\mathcal{E}_0}{\mathcal{E}_1}\frac{P_1}{P_0}C_1^\tau \tag{12}$$

Given that the marginal utility of consumption is the same for every household, we have $C_t^\tau = C_t$. We drop the τ index from now on.

Consumption, C_t, is a Cobb-Douglas composite of a domestic (D) and an imported consumption good (F). Households solve the same intratemporal allocation problem displayed in (1).

Households supply their specific variety of labor to a competitive intermediary firm that then sells a CES labor bundle to intermediate goods firms. The CES aggregator is given by:

$$L_t = \left[\int_0^1 (L_t^\tau)^{\frac{\sigma_L - 1}{\sigma_L}} d\tau\right]^{\frac{\sigma_L}{\sigma_L - 1}}, \quad \sigma_L > 1$$

where σ_L is the elasticity of substitution between different labor varieties.

In period 0, a fraction $1-\varrho_L$ of households can adjust the wage that they demand from the intermediary in order to supply a unit of labor. In period 1, every household can adjust. This implies that the aggregate wage rate in period 0 is given by:

$$W_0 = \left[(1-\varrho_L)(W_0^*)^{1-\sigma_L} + \varrho_L (W_{-1})^{1-\sigma_L}\right]^{\frac{1}{1-\sigma_L}}$$

where W_0^* is the wage rate associated to those households that can adjust their wages in period 0, and W_{-1} is the value of the wage index in the period previous to period 0, which would correspond to the no-shocks flexible price equilibrium. Households that can adjust conform to the following wage setting rule:

$$W_0^* = \frac{\sigma_L}{\sigma_L - 1}\chi(L_t^*)^{\psi} P_t C_t$$

4.1.2 Intermediate Good Firms

There is a competitive representative firm that produces a homogeneous intermediate good by combining labor, l, domestic materials, m_D, and a composite of foreign materials, m_F, according to a constant returns to scale Cobb-Douglas production function. The representative firm thus solves the following profit maximization problem:

$$\begin{aligned} \max_{l_t, m_{Dt}, m_{Ft}} \quad & p_{Dt}^{int} y_t - w_t l_t - p_{D_t} m_{D_t} - p_{F_t}^m m_{F_t}, \\ \text{s.t.} \quad & y_t = z_t {l_t}^{\alpha} \left(m_{Dt}^{\gamma} m_{F_t}^{1-\gamma} \right)^{1-\alpha} \quad \text{where} \quad \alpha, \gamma \in [0,1], \end{aligned}$$

where z_t is the firm's TFP. All the other variables and parameters follow the same definitions laid out for them in section 3.1. The firm sources imported materials from regions A and R and it chooses how much to demand from each source by solving the following cost minimization problem, which is analog to the one displayed in section 3.1:

$$\begin{aligned} \min_{m_{At}, m_{Rt}} \quad & p_{At}^m m_{At} + p_{Rt}^m m_{Rt}, \\ \text{s.t.} \quad & m_{Ft} = \left[\omega^{\frac{1}{\epsilon}} m_{At}^{\frac{\epsilon-1}{\epsilon}} + (1-\omega)^{\frac{1}{\epsilon}} m_{Rt}^{\frac{\epsilon-1}{\epsilon}} \right]^{\frac{\epsilon}{\epsilon-1}}, \ \omega \in [0,1]. \end{aligned}$$

The unit cost of the imported materials composite is thus given by:

$$p_{Ft}^m = \left[\omega (p_{At}^m)^{1-\epsilon} + (1-\omega)(p_{Rt}^m)^{1-\epsilon} \right]^{\frac{1}{1-\epsilon}}.$$

The CIF prices of materials from A and R regions are defined as follows,

$$\begin{aligned} p_{At}^m &= \mathcal{E}_t (\tilde{p}_{At}^m + \tau_{At}^m) \\ p_{Rt}^m &= \mathcal{E}_t (\tilde{p}_{Rt}^m + \tau_{Rt}^m) \end{aligned}$$

where again all the variables follow the same definitions as in section 3.1.

4.1.3 Retailers

Domestic production, Y, is performed by competitive retailers, who aggregate a continuum of varieties of mass 1, indexed by f, according to a CES function:

$$Y = \left(\int_0^1 y_{ft}^{\frac{\sigma_C - 1}{\sigma_C}} df \right)^{\frac{\sigma_C}{\sigma_C - 1}}, \quad \sigma_C > 1$$

where σ_C is the elasticity of substitution across domestic varieties.

Each variety is produced according to a linear function that only uses the homogeneous intermediate good as input. Hence, marginal cost is the same for all variety producers and is equal to p_{Dt}^{int}.

A variety producer is able to freely adjust its price with probability $1 - \varrho_C$. In period 1 all prices are flexible, so the pricing decision in period 0 is totally static.

We can thus write the price level of domestic production at $t = 0$ in the following way:

$$p_{D0} = \left[(1 - \varrho_C)(p_{D0}^*)^{1-\sigma_C} + \varrho_C (p_{D,-1})^{1-\sigma_C} \right]^{\frac{1}{1-\sigma_C}}$$

where $p_{D,-1}$ is the ideal price index of the domestic good in the flexible price equilibrium, and p_{D0}^* is the optimal price set by those variety producers that can adjust prices at $t = 0$, which is given by:

$$p_{D0}^* = \frac{\sigma_C}{\sigma_C - 1} p_{D0}^{int}$$

4.1.4 Market Clearing Conditions

The market for the domestic good is in equilibrium if:

$$C_{Dt} + m_{Dt} + X_t = Y_t$$

where X_t is exports of the domestic good. We specify the following demand function for domestic exports:

$$X_t = b \left(\frac{\mathcal{E}_t}{p_{Dt}} \right)^{\epsilon}$$

where we have abstracted from freight rates associated to move goods from the domestic market to the exterior.[16] Additionally, we have imposed our estimated elasticity of

[16] We found evidence that global changes in freight rates did not affect exporting behavior in Chile. Results can be provided upon request

substitution as the foreign demand elasticity for domestic goods. This implicitly assumes that Chilean exports are mostly intermediates, which seems like a plausible assumption, given that more than 50% of the value of Chilean exports is composed of raw materials (especially copper).

Market equilibrium for labor has to satisfy that the total supply of the labor bundle offered by the labor intermediary has to be equal to the total labor demanded by the intermediate good firm:

$$\left[\int_0^1 (L_t^\tau)^{\frac{\sigma_L-1}{\sigma_L}} d\tau\right]^{\frac{\sigma_L}{\sigma_L-1}} = l_t$$

The balance of payments conditions in nominal terms for the two periods are given by:

$$\begin{aligned} \text{Period 0}: \quad & \mathcal{E}_0 B_1^* = p_{D0}X_0 - p_{F0}^m m_{F0} - p_{F0}^c C_{F0} \\ \text{Period 1}: \quad & 0 = p_{D1}X_1 + (1+i_1)\mathcal{E}_1 B_1^* - p_{F1}^m m_{F1} - p_{F1}^c C_{F1} \end{aligned}$$

So, in period 0, all savings are generated by the country's trade balance or, conversely, all debts fund the trade deficit. In period 1, all debts are repaid with the period's trade balance.

Equilibrium. Given a foreign nominal interest rate $(1+i_1)$, present and future nominal exchange rates, $\{\mathcal{E}_t\}_{t=0,1}$, future nominal consumption, P_1C_1, a foreign demand preference parameter for domestic goods, b, a productivity parameter z, FOB prices in foreign currency for foreign materials from each origin $o \in \{A,R\}$, $\tilde{p}_{o0}^m$, freight costs in foreign currency for foreign materials from each origin $o \in \{A,R\}$, τ_{o0}^m, FOB prices in foreign currency for the foreign consumption good, $\tilde{p}_{F0}^c$, and freight costs in foreign currency for the foreign consumption good , τ_0^c, an equilibrium is a set of:

- prices, $\left\{p_{D0}, p_{D0}^{int}, p_{f0}, P_0\right\}$
- wages, $\left\{\left\{w_0^\tau\right\}_{\tau\in[0,1]}, W_0\right\}$
- quantities consumed, $\left\{\left\{C_0^\tau\right\}_{\tau\in[0,1]}, C_{D0}, C_{F0}, C_0\right\}$
- assets accumulated, B_1
- units of labor, $\left\{\left\{L_0^\tau\right\}_{\tau\in[0,1]}, l_0, L_0\right\}$

- quantities of materials, $\{m_{D0}, m_{F0}, m_{A0}, m_{R0}\}$
- outputs, $\left\{y_0, \{y_{f0}\}_{f\in[0,1]}, Y_0\right\}$
- exports, X_0

such that each producer maximizes its profits subject to its technological constraint, consumers maximize their utility and markets for all goods and factors clear.

4.1.5 Shocks

We consider one-time shocks that only take place in period 0. Shocks and the responses of the endogenous variables of the model are defined relative to the flexible price equilibrium benchmark. The group of perturbations in our analysis are to the households' impatience degree, $d\log\zeta$, to the shifter of foreign demand for domestic goods, $d\log b$, to the productivity parameter of intermediate good firms, $d\log z$, to the nominal exchange rate, $d\log\mathcal{E}$, to the CIF price in foreign currency of the imported consumption good, $d\log p_{Ft}^{USD,c}$, and to the CIF price in foreign currency of imported materials of each origin considered, $d\log p_{ot}^{USD,m}$, $o \in \{A, R\}$. Both CIF price shocks consist in turn of shocks to FOB prices, $d\log\tilde{p}_{Ft}^{c}$ and $d\log\tilde{p}_{ot}^{USD,m}$, and freight rates, $d\log\tau_t^c$ and $d\log\tau_{ot}^m$.

We focus on the bi-annual period Q42019 to Q42021. There are two reasons for this choice. The first one is that Q42019 provides a better normal times benchmark than Q42020 or Q42021. The second one is that the model's first period is quasi-static, so it is a more accurate representation of medium-run dynamics than short-run ones. Medium-run dynamics are more likely to take place in a two-year span than within a year or a quarter.

The shock to the household's impatience degree is defined after log-linearizing the Euler equation (12):

$$d\log P_0C_0^{\tau} = d\log\mathcal{E}_0 + \underbrace{d\log P_1C_1^{\tau} - d\log\beta - d\log(1+i_1) - d\log\mathcal{E}_1}_{\equiv d\log\zeta}$$

We call this perturbation an impatience degree shock even though it comprises more than the change in the discount factor, as any changes in future nominal consumption, $P_1C_1^{\tau}$, international interest rates, $1+i_1$, or exchange rates, $\mathcal{E}_1$, are isomorphic to a unique change in β equal to the sum of the changes in all the constituent parts of ζ.

The shock to the foreign demand shifter, b, is aimed to capture any world developments that might have altered the demand curve for the domestic good, such as changes in preferences, production needs, or market size.

Changes in the nominal exchange rate, $\mathcal{E}$, will be considered structural shocks. There are three implications of this assumption. First, we implicitly assume uncovered interest parity. Changes in exchange rates affect the interest rate that is paid on risk-free assets in terms of domestic currency. Second, exchange rate changes do not respond to any other model variable, so monetary policy will be totally implicit and passive. This situation can be understood as one in which both domestic and foreign monetary policy rates are fixed, such as at the zero lower bound[17]. Finally, also because of their exogeneity, we are not able to assess the extent to which observed changes in exchange rates are due to endogenous responses to supply and demand shocks of a different origin. In this sense, the model can only speak about supply and demand shocks net of exchange rate movements.

The change in the CIF price in foreign currency of the imported consumption good does not delve in the actual determinants of the variation of this price beyond the changes in FOB prices and freight costs. This is different from the change in the CIF price of imported materials. In this case we distinguish between origins and we establish separate shocks for imports coming from Asia and the Rest of the world.

4.2 Calibration

We have 15 parameters and/or shares and 10 shocks to calibrate. We assign values either from previous literature or from data counterparts as much as we can, leaving the rest for internal calibration. Appendix A discusses in detail how we calibrate each of the model's parameters. Our focus here is on explaining the calibration of the model's shocks.

We impose a change in the productivity parameter z that is equal to the measured change in Chilean TFP during the period 2019-2021 by the National Commission of Productivity (CNP, in Spanish), which is 3.4%. We also calculate the depreciation rate of the Chilean peso against the American dollar during the Q42019-Q42021 period from the CBC webpage, and assign that number to the exchange rate depreciation shock of the model, $d\log\mathcal{E}$, which we fix to 8.93%. From Customs data we calculate the following average changes in FOB prices and freight rates and impose them on their model counterparts.

[17]The Central Bank of Chile's (CBC) monetary policy rate actually did change during the Q42019-Q42021 period, from 1.81% to 2.82%. However it remained at its technical lower bound or close to it from Q22020 to Q32021, which is the period in which most of the shocks under analysis took place.

The average change in the CIF price of intermediate imports from Asia, $\Delta p^m_A / p^m_A$, is set to 30% ; the average change in the CIF price of intermediate imports from the Rest of the world, $\Delta p^m_R / p^m_R$, to 27.5%; the average change in the unit freight cost of intermediate imports from Asia, $\Delta \tau^m_A / \tau^m_A$, to 105.8%; the average change in the unit freight cost of intermediate imports from the Rest of the world, $\Delta \tau^m_R / \tau^m_R$, to 24.7%; the average change in the CIF price of consumption goods imports, $\Delta \log p^c_F$, to 11.7%; and the average change in the unit freight cost of consumption goods imports, $\Delta \tau^c / \tau^c$, to 59.7%.

We are still left with two shocks to be assigned values: the impatience shock, $d \log \zeta$, and the foreign demand shock, $d \log b$. We internally calibrate both perturbations. In the case of the impatience shock, we target the log change in the nominal value of internal absorption, which was equal to 28.8% in the Q42019-Q42021 period. The foreign demand shock is calibrated to match the log change in the nominal value of exports, expressed in terms of US dollars, in the same period, which was 17.7%.

A summary of the parameters, shares, and shocks that have been calibrated, jointly with their values, targets, and sources can be found in Table 3.

4.2.1 Model Fit

The model has a good fit in terms of the targeted moments. Panel a) of Table 4 summarizes the results of the targeted moments. The model correctly predicts the observed change in nominal absorption and the observed increase in the USD value of nominal exports.

We choose three moments to assess the out-of-sample fit of our theoretical framework: the log change in the absorption deflator, the log change in real absorption, and the log change in nominal wages per hour. In this sense, we evaluate the performance of the model in terms of its predictions regarding the split between the nominal and the real component of consumption, for which the data analog is absorption, and in terms of its implications for wage inflation. We take the information for the nominal and the real components of absorption from National Accounts, while the change in the nominal hourly wage is taken from the hourly wage index (*Índice de Remuneraciones*, in Spanish) elaborated by the National Institute of Statistics (*Instituto Nacional de Estadísticas*, in Spanish). The model does reasonably well in matching these two targets. It underpredicts the rate of inflation by about 1 percentage point at 8.46% versus 9.51% in the data, while it slightly overpredicts the real growth in absorption at 20.4% versus 19.3% in the data. Nominal wage changes in the model and the data are quite close to one another, with 10.8% and 10.2%, respectively. The results are summarized in Panel B. of Table 4.

Table 3: Calibration

Parameter	Source/Target	Value
A. Externally Calibrated		
ϱ_C	Literature	0.51
ϱ_L	Literature	0.17
σ_L	Literature	12
ψ	Literature	3
σ_C	Markup = 1.2	6
η	National Accounts	0.70
α	National Accounts	0.33
γ	National Accounts	0.78
C_D/Y	National Accounts	0.4
X/Y	National Accounts	0.1
ϵ	Estimation	1.43
ω	Customs	0.33
θ^m_A	Customs	0.05
θ^m_R	Customs	0.06
θ^c	Customs	0.06
$d\log z$	CNP (2022)	0.03
$d\log \mathcal{E}$	CBC	0.09
$\Delta p^m_A/p^m_A$	Customs	0.30
$\Delta p^m_R/p^m_R$	Customs	0.28
$\Delta \tau^m_A/\tau^m_A$	Customs	1.06
$\Delta \tau^m_R/\tau^m_R$	Customs	0.25
$\Delta \log p^c_F$	Customs	0.11
$\Delta \tau_c/\tau_c$	Customs	0.60
B. Internally Calibrated		
$d\log \zeta$	Δ% in nominal absorption	0.20
$d\log b$	Δ% in USD value of nominal exports	0.15

Table 4: Moments

	Model	Data
A. Targeted		
Δ% in nominal absorption	28.8	28.8
Δ% in USD value of nominal exports	17.7	17.7
B. Untargeted		
Δ log in absorption deflator	8.5	9.5
Δ log in real absorption	20.4	19.3
Δ log in hourly nominal wage	10.8	10.2

4.3 Counterfactuals

We evaluate the importance of shocks for inflation and real consumption by grouping them into three broad categories. To measure the contribution of a certain category, we keep activating all the shocks belonging to that category and shut down all the shocks belonging to other categories. The three categories we consider are: Supply, demand, and exchange rate shocks.

We include the productivity shock, FOB price shocks, and freight cost shocks in the supply shocks category. In the demand category, we include impatience and foreign demand shocks. We leave the exchange rate shock as a stand-alone category, given that its effects on the economy affect both the supply and the demand side of the market. The supply side is affected by the change in the domestic currency cost of imported inputs, which affects the marginal costs that intermediate good firms face. The demand side of the economy is affected by the change in the real interest rate that households face and through the change in the relative price of domestic and foreign goods.

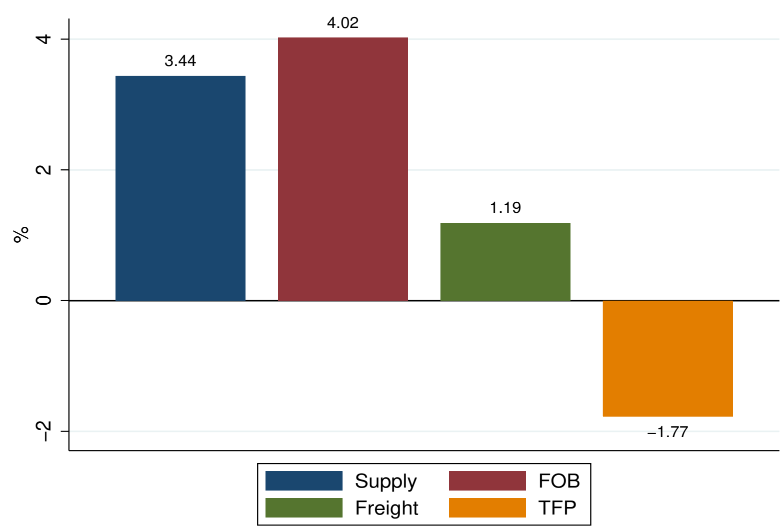
Relevance of freight cost shocks. In order to measure the contribution of freight cost shocks to inflation, we will flesh out the importance of each supply shock to the total contribution of supply shocks to inflation. To do this, we directly measure the contribution of TFP and freight costs. For FOB price shocks, we directly measure CIF price shocks and subtract the effect of freight cost changes from the change in CIF prices.

In Figure 5, we display the results of this analysis. We can observe that FOB price shocks constitute the critical contributor to supply shocks. This is not surprising, given that CIF prices changed dramatically during this period and freight costs constitute, on average, at best 6% of total CIF import value. What is remarkable is the contribution of freight costs which, even though they are a lesser part of total CIF costs, explain around

35% of total supply shocks. This highlights the magnitude of the disruption to international trade logistics in this period and how this disruption spilled over to domestic prices. Regarding its contribution to total inflation, the freight cost shocks represent 14% of the figure observed in this period, equivalent to 1.19 log points of inflation.

The contribution of freight costs is lower than the one found in Section 3.3. There are two reasons for this lower figure. One is that in the general equilibrium model, we have imposed nominal rigidities in product prices and wages. Sticky product prices prevent cost increases from being fully passed through to the final consumer, attenuating the direct impact of freight cost increases. In addition, when firms try to substitute away from imported materials for domestic goods and labor, rigidities avoid the demand pressures to express themselves in prices as much as they would in a flexible price environment. The other reason is that higher product prices reduce households' real income, and they respond by reducing consumption today, which reduces the pressure on product and input prices.

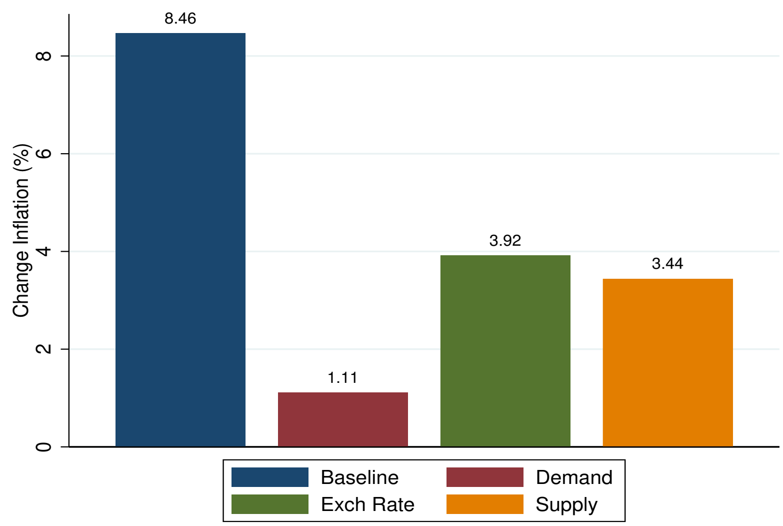
Figure 5: Supply Shocks and its Constituent Parts



Notes: The "Supply" bar includes the shocks to FOB prices, freight costs and TFP. The "FOB" bar only includes shocks to FOB prices. The "Freight" bar only includes shocks to freight costs. The "TFP" bar only includes the shock to firms' TFP parameter.
Source: Authors' calculations.

Supply vs. Demand Shocks. To put the results on the contribution of freight costs to inflation in perspective, we decompose the total inflation figure of the period in the contribution of demand, supply, and exchange rate shocks. In Figure 6, we can observe that demand shocks play a minor role in determining inflation, explaining 1.11 log points of the total 8.46 that we observe for the period. On the other hand, exchange rate shocks explain around 46% of observed inflation, generating 3.92 log points. Supply shocks are almost equally relevant, representing 3.44 log points of total inflation. This means that exchange rate depreciation and supply shocks explain about 87% of observed inflation, with supply shocks representing 40% of it[18]. The intuition is that conditional on the exchange rate shock, the residual variation in nominal consumption accounted for by the impatience, and the foreign demand shock only generates a minor increase in product prices. An exchange rate depreciation, such as the one present in the period under analysis, increases the value of present consumption and induces households to substitute away from foreign consumption goods for domestic ones. This movement pushes up the demand for domestic production above and beyond the general expenditure increase induced by the change in relative prices over time. Supply shocks explain a significant portion of inflation due to their large size. Even after considering imperfect pass-through

Figure 6: Decomposition of Inflation



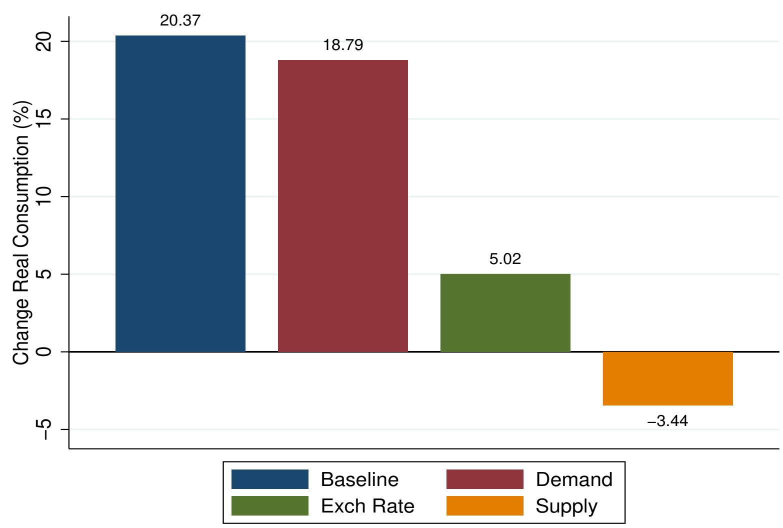
Notes: The "Baseline" bar includes demand, exchange rate, and supply shocks. The "Demand" bar only includes demand shocks. The "Exchange Rate" bar only includes the shock to the nominal exchange rate. The "Supply" bar only includes supply shocks.
Source: Authors' calculations.

[18]As it was explained in Section 4.1.5, the analysis performed in this article only discusses responses to supply and demand shocks net of exchange rate movements. It might well be the case that a very large share of the responses to exchange rate movements are due to changes in exchange rates induced by demand shocks. This is actually the narrative put forward by the Central Bank of Chile, as it can be noted in its June 2022 Monetary Policy Report https://www.bcentral.cl/en/content/-/details/monetary-policy-report-june-2022

due to wage and price rigidities, product prices are still affected to a significant extent.

In real consumption, the situation is quite different. In Figure 7, we can appreciate that demand shocks explain almost all of the observed inflation, with the exchange rate and supply shocks almost offsetting perfectly. The intuition behind this result is as follows.

Figure 7: Decomposition of Real Consumption



Notes: The "Baseline" bar includes demand, exchange rate, and supply shocks. The "Demand" bar only includes demand shocks. The "Exchange Rate" bar only includes the shock to the nominal exchange rate. The "Supply" bar only includes supply shocks.
Source: Authors' calculations.

On the one hand, exchange rate depreciation reduces the real interest rate, which should partly increase real consumption, but it also makes goods more expensive. Foreign consumption goods prices are affected one-to-one due to the law of one price assumption, while domestic consumption goods face higher costs due to imported intermediates. As the direct effect on foreign consumption goods gets passed through to households more entirely than the intermediates cost channel of domestic goods, there is a reallocation of consumption towards domestic goods, which also helps to sustain real production and income. Overall, the net positive effect is more muted than in the case of inflation. Demand shocks, on the other hand, do not face any countervailing force and, due to nominal rigidities, express themselves mostly on output. Most supply shocks work opposite to demand shocks and, again, due to nominal rigidities, have a negative effect on output. Because of domestically provided inputs, they are less important than demand shocks.

5 Conclusions

We contribute to the understanding of the impact that pandemic-induced disruptions to global trade logistics had on domestic inflation. We document that importers faced a steep rise in freight costs from 2019-2021, and we show that imports from Asia primarily drove this rise. The extent to which the negative shock affects firms depends on their ability to substitute imports away from Asia. Leveraging the idiosyncratic exposure of firms to changes in freight costs among different origins, we implement an instrumental variable research design to estimate the elasticity of substitution across materials imported from different regions. Our estimates for the elasticity of substitution suggest that the relative use of Asian materials to those sourced from the Rest of the world decreases by 1.43 times the increase in relative prices.

We use a small open economy general equilibrium model featuring nominal rigidities to quantify the role that freight costs have over inflation during the period. We introduce the presence of Asia and the Rest of the world as foreign sources of intermediate goods and a flexible degree of substitutability between goods of these regions. After using our elasticity estimate, we run a counterfactual exercise through which we estimate that freight costs can explain up to 14% of CPI inflation. The significant size of the change in freight costs that occurred during 2019-2021 causes these shocks to play a crucial role in the revival of inflation. The joint occurrence of these perturbations with those of FOB price shocks accounts for around half of the period's inflation, highlighting the disruptiveness of the pandemic-induced perturbations to global trade over macroeconomic conditions.

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"Freight Costs and Domestic Prices During the Covid-19 Pandemic"

by Gustavo González, Emiliano Luttini, and Marco Rojas

Online Appendix

A Calibration

We set the nominal rigidity parameters to bi-annual analogs of quarterly values found in estimated models in the DSGE literature, such as those in Smets and Wouters (2003) and Christiano et al. (2005). Specifically, we choose a value of 0.51 for ϱ_C and of 0.17 for ϱ_L, which are, respectively, equivalent to 0.92 and 0.80 at quarterly frequency. The price rigidity number corresponds to that estimated with the model without variable capital utilization in Christiano et al. (2005), while the wage rigidity figure corresponds to that estimated with the model with no habit formation in the same paper[19].

We choose the value of 12 for the elasticity of substitution between labor varieties, σ_L. This is the average between the number used in Christiano et al. (2005) (21) and the one used in Smets and Wouters (2003) (3). Sensitivity analysis to this value did not affect the results much. The Frisch elasticity of labor, ψ, is fixed to 3, as in Galí and Monacelli (2005). We assign the value of 6 to the elasticity of substitution between good varieties, σ_C, in order to rationalize a markup of 1.2.

We calibrate the preference parameter for consuming domestic goods to 0.70, to reproduce the share that spending on domestic goods represents of total consumption expenditure. The production function parameter associated to labor, α, is set to to 0.33 in order to match the share that labor payments represent of total intermediate purchases in the 2019 Chilean national accounts. We set the value of γ to 0.78 to target the share of purchases of intermediates from domestic providers over total intermediate purchases in the same version of the national accounts. The last two statistics we take from Chilean national accounts to calibrate the model are the share that domestic consumption represents of gross production, C_D/Y, which is set to 0.4, and the share that exports represent of gross production, X/Y, which is fixed to 0.1.

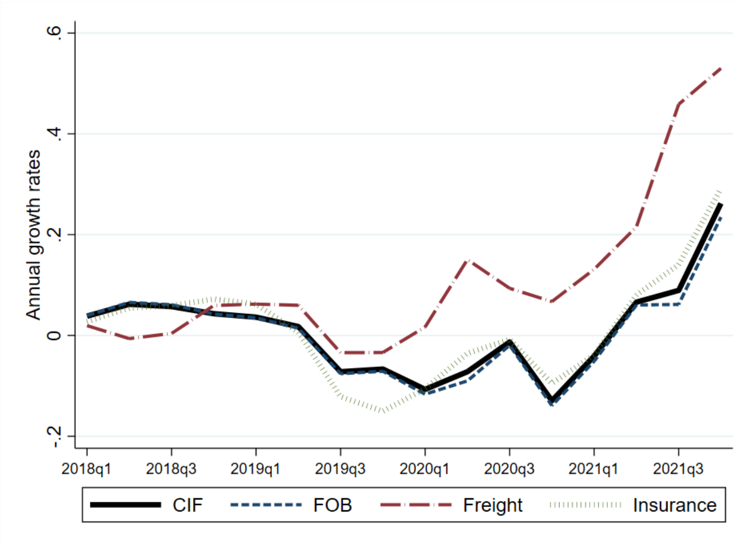
We take similar values as the ones used in Section **??** for the preference parameter for intermediate imports from Asia, ω, the share that freight costs represent of total CIF value for intermediate imports of each origin, θ_o^m, and the share that freight costs represent of total CIF value for consumption goods, θ^c. Hence, we will set $\omega = 0.33$, $\theta_A^m = 0.05$, $\theta_R^m = 0.06$, and $\theta^c = 0.06$.

Finally, we set the elasticity of substitution between origins for intermediate product imports, ϵ, to the value we estimate in Section 3.2, which is 1.43.

[19] Numbers are displayed in Table 2 of Christiano et al. (2005)

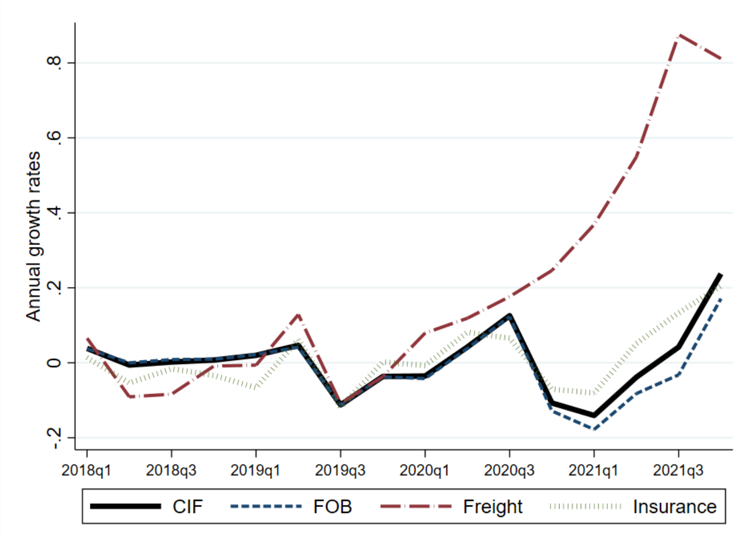
B Additional tables and figures

Figure A.1: Growth rates of CIF and its components – Quarterly, Aggregate



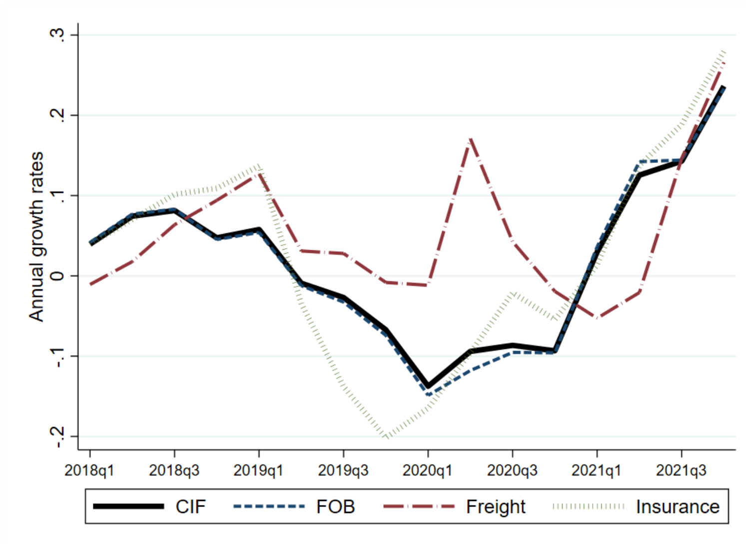
Notes: This figure plots the absolute contribution each component of CIF has on its annual growth rate.

Figure A.2: Growth rates of CIF and its components – Quarterly, Asia



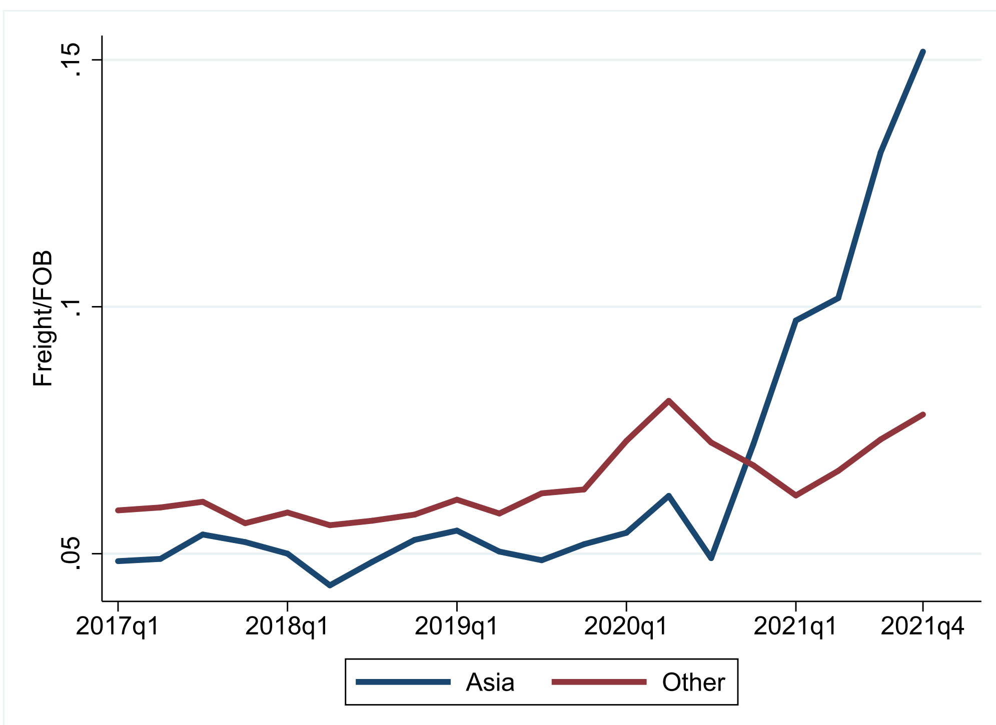
Notes: This figure plots the absolute contribution each component of CIF has on its annual growth rate.

Figure A.3: Growth rates of CIF and its components – Quarterly, Rest of the world



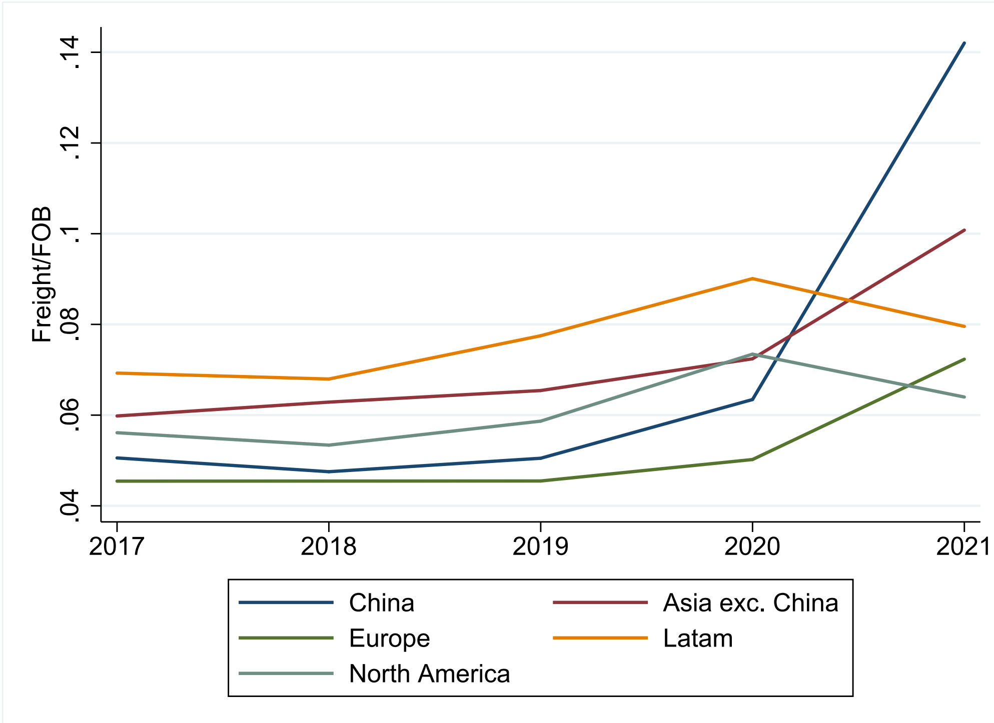
Notes: This figure plots the absolute contribution each component of CIF has on its annual growth rate.

Figure A.4: Freight/FOB by region by quarter



Notes: This figure plots the ratio of the total freight cost of imports to the total FOB value quarterly, and for each importing region (Asia and Rest of the world).

Figure A.5: Freight/FOB by region by quarter



Notes: This figure plots the ratio of the total freight cost of imports to the total FOB value for each year, and for five importing regions (China, Asia excluding China, Europe, and Latin America).

20

[20]Finally, we can replicate a similar exercise but focusing on the sector the firm is in. The sectors come from the Chilean Economic Activity Classification.[21] Figure **??** shows the difference between 2021 and 2019 in the exposition of importing from Asia. Around one-third of the sectors become less intensive in their imports from Asia. The following third has sectors with negligible to small positive changes, which include the retail sector. The remaining third has considerable changes. Wholesalers have 4.0pp increase, Vehicle sellers a 5.6pp, Health a 10pp and Construction over 15pp.

Table A.1: Estimates of ϵ using five regions normalizing with Asia excluding China

	(1) $d\log m_O/m_A$	(2) $d\log p_O^{CIF}/p_A^{CIF}$	(3) $d\log m_O/m_A$
$d\log p_O^{CIF}/p_A^{CIF}$	-1.0063***		-3.2319**
	(0.0491)		(1.4097)
$\tilde{B}$		0.6166**	
		(0.2407)	
N	50,489	50,489	50,489
R^2	0.469	0.180	-1.282
1st-stage F		6	

Notes: This Table estimates $d\log\left(\frac{m_{ijOt}}{m_{ijAt}}\right) = \lambda_i + \lambda_{jt} - \epsilon d\log\left(\frac{p_{ijOt}^{CIF}}{p_{ijAt}^{CIF}}\right) + \varepsilon_{ijt}$. The IV first-stage uses $B_{iOt} = \omega_{iOt-T} d\tau_{Ot}$ defined in (9). The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS8 level. All specifications include a product and firm-time fixed effects. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.2: Estimates of ϵ using five regions

	(1) $d\log m_O$	(2) $d\log p_O^{CIF}$	(3) $d\log m_O$
$d\log p_O^{CIF}$	-1.0031***		-1.9019***
	(0.0346)		(0.6241)
B		1.0939***	
		(0.3021)	
N	73,975	73,975	73,975
R^2	0.442	0.102	0.071
1st-stage F		13	

Notes: This Table estimates $d\log m_{ijOt} = \lambda_{jt} + \lambda_o + \lambda_i - \epsilon d\log p_{ijOt} + \varepsilon_{ijOt}$. The IV first-stage uses $B_{iOt} = \xi_{iOt-T} d\tau_{Ot}$ defined in (9). The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS8 level. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.3: Estimates of ϵ using five regions

	(1)	(2)	(3)
	$d\log m_O$	$d\log p_O^{CIF}$	$d\log m_O$
$d\log p_O^{CIF}$	-1.0219***		-1.1221*
	(0.0415)		(0.5868)
B		1.1207***	
		(0.4188)	
N	65,827	65,827	65,827
R^2	0.608	0.373	0.359
1st-stage F		7	

Notes: This Table estimates $d\log m_{ijOt} = \lambda_{ijt} + \lambda_o - \epsilon d\log p_{ijOt} + \varepsilon_{ijOt}$. The IV first-stage uses $B_{iOt} = \xi_{iOt-T} d\tau_{Ot}$ defined in (9). The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS8 level. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.4: Estimates of (6) using HS4

	(1)	(2)	(3)
	$d\log m_A/m_R$	$d\log p_A^{CIF}/p_R^{CIF}$	$d\log m_A/m_R$
$d\log p_A^{CIF}/p_R^{CIF}$	-0.9775***		-2.0734***
	(0.0226)		(0.4679)
$\tilde{B}$		1.5559***	
		(0.3092)	
N	289,977	2899,77	289,977
R^2	0.458	0.123	-0.096
1st-stage F		25	

Notes: This table estimates (6) using Import Customs data from Chile. The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS4 level. All specifications include a product and firm-time fixed effects. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table A.5: Estimates of (10) using HS4

	(1) $d\log p^{FOB}$	(2) $d\log\tilde{\tau}$	(3) $d\log p^{FOB}$
$d\log\tilde{\tau}$	0.5347***		0.0228
	(0.0138)		(0.0742)
B		4.5908***	
		(0.5687)	
N	287,625	287,625	287,625
R^2	0.514	0.244	0.036
1st-stage F		65	

Notes: This table estimates (10) using Import Customs data from Chile. The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS4 level. All specifications include a product-origin, firm-time and origin-time fixed effects. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

C Sectoral and product evidence

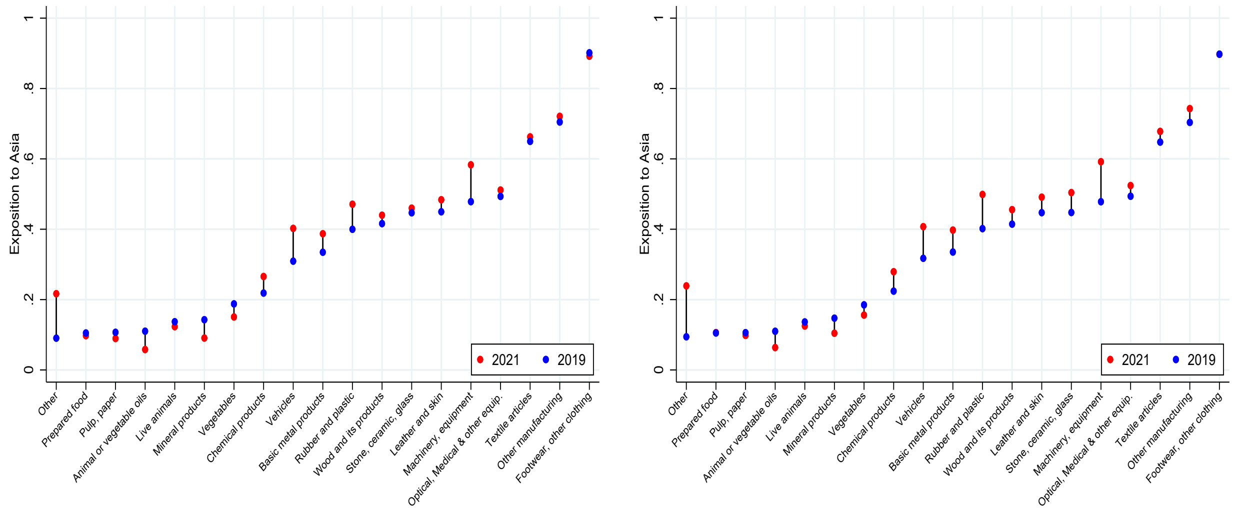
In this Appendix section we show what products are more exposed to Asia, and potentially more affected by this. The level of aggregation we consider for products is at the Section level of the HS classification.[22] For each Section, we compute the share of imports – measured by the FOB value – that come from Asia among all imports. Figure B.1a shows this measure of exposition in 2019 and 2021. Clothing products are the most exposed but do not change their exposition to Asia. Something similar happens to less-exposed products, such as Prepared food, and Pulp and paper. The exposition increase occurs in more Sections in the middle of the distribution, such as Vehicles, or Machinery and equipment. Figure B.1b repeats the exercise using CIF values instead.

[22]Sections for Chilean HS version are the same as the ones for the US, which are available at https://hts.usitc.gov/current.

Figure B.1: Exposition to Asia

(a) FOB exposition to Asia by HS Section

(b) CIF exposition to Asia by HS Section



Notes: This figure plots the exposition to Asia in 2019 and 2021 for each HS Section. The measure corresponds to the imports from Asia as a share of total imports in that section.

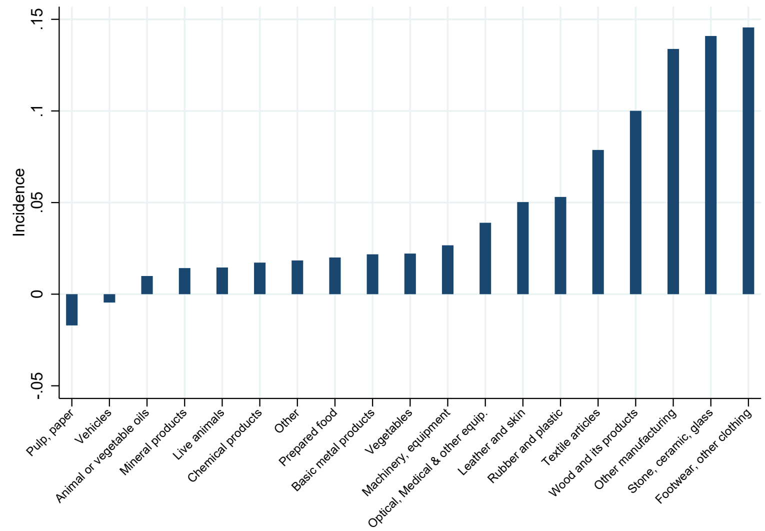
Given the small variation in their expenditure shares, this could be an indication that importing firms have a unitary elasticity of substitution within their import bundle, i.e., Cobb-Douglas. However, during this period strong preference shocks and others take place as well, thus making it difficult to obtain such conclusion just by looking at expenditures. In addition, when looking at actual expenditure shares using CIF, we observe a rise for most HS Sections.

To see the direct incidence of increased freight costs in products, we combine the exposition with the shock in the freight cost. We compute this using the difference between the ratio of Freight-to-FOB in 2021 and 2019, multiplied by the exposition levels above in 2019.[23] Figure B.2 displays this incidence measure, where only two product sections have negligible or small negative effects. All the other products present positive small-to-large effects, which speaks to the universality of the shock that took place regardless of their exposition.

[23]In practice, for each section j we combine the share and the shift or shock:

$$\frac{\text{FOB}_{2019,j,\text{Asia}}}{\text{FOB}_{2019,j,Asia} + \text{FOB}_{2019,j,\text{Rest of the world}}} \times \left(\frac{\text{Fre}_{2021,j,\text{Asia}}}{\text{FOB}_{2021,j,\text{Asia}}} - \frac{\text{Fre}_{2019,j,\text{Asia}}}{\text{FOB}_{2019,j,\text{Asia}}} \right).$$

Figure B.2: Incidence of freight costs in Asia by HS Section



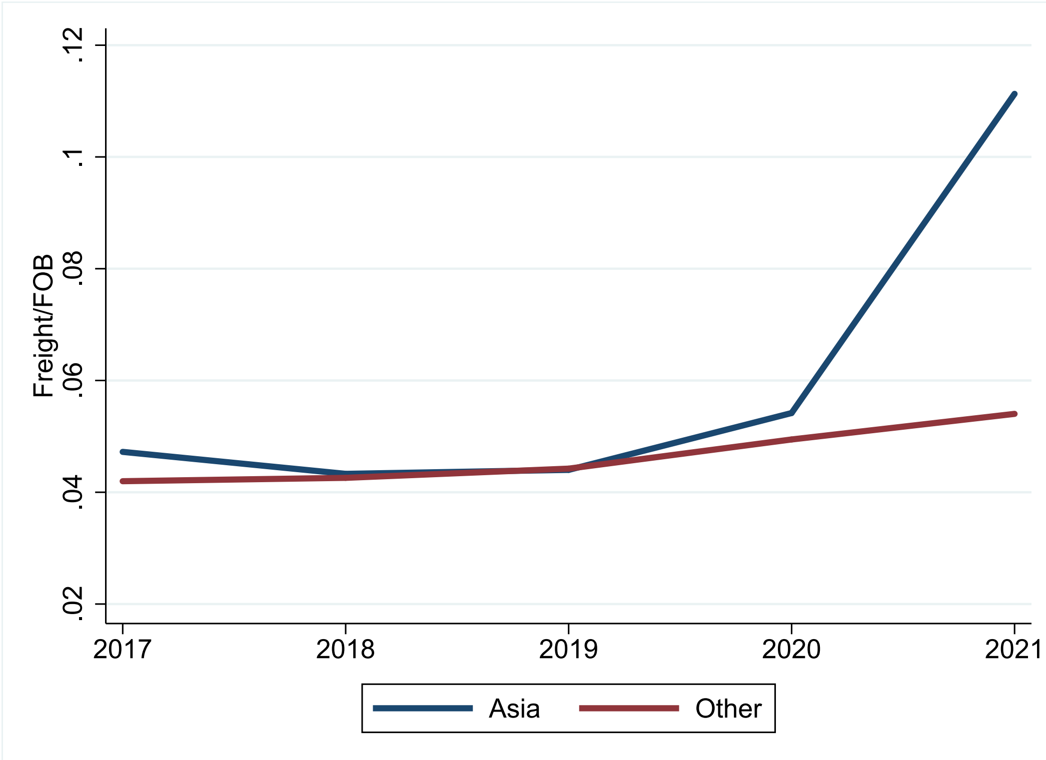
Notes: This figure plots the incidence to Asia between 2019 and 2021 for each HS Section. The measure is computed as $\frac{\text{FOB}_{2019,j,\text{Asia}}}{\text{FOB}_{2019,j,Asia}+\text{FOB}_{2019,j,\text{Rest of the world}}} \times \left(\frac{\text{Fre}_{2021,j,\text{Asia}}}{\text{FOB}_{2021,j,\text{Asia}}} - \frac{\text{Fre}_{2019,j,\text{Asia}}}{\text{FOB}_{2019,j,\text{Asia}}} \right)$, where j is an HS Section.

D Results using Colombian freight costs

In this Appendix section we replicate certain results using Colombian customs data, which is publicly available at https://www.dian.gov.co/dian/cifras/Paginas/Bases-Estadisticas-de-Comercio-Exterior-Importaciones-y-Exportaciones.aspx.

Figure C.1 replicates Figure 4 using Colombian data. The divergence between Asia and the other regions can also be appreciated here.

Figure C.1: Freight/FOB by region, Colombia



Notes: This figure plots the ratio of the total freight cost of imports to the total FOB value for each year, and for each importing region (Asia and Rest of the world). It uses Colombian customs data.

Table C.1 replicates Table 1, but using freight cost variations into Colombia when constructing the instrument. This means replacing $d\tau_{At}$ and $d\tau_{Rt}$ in (7) with their corresponding variations for Colombia. The results below confirm our baseline estimates for the elasticity of substitution. Similarly, Table C.2 replicates Table 2. Again, the results are unaffected by using different shocks.

Table C.1: Baseline estimates of (6) using Colombian shocks

	(1) $d\log m_A/m_R$	(2) $d\log p_A^{CIF}/p_R^{CIF}$	(3) $d\log m_A/m_R$
$d\log p_A/p_R$	-1.0073***		-1.3160***
	(0.0278)		(0.2805)
$\tilde{B}^{Col}$		1.4937***	
		(0.2746)	
N	348,960	348,960	348,960
R^2	0.437	0.133	0.311
1st-stage F		29	

Notes: This table estimates (6) using Import Customs data from Chile for prices, quantities and firm-exposition. The freight cost shocks use Imports Customs data from Colombia. The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS8 level. All specifications include a product (HS8) and firm-time fixed effects. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table C.2: Baseline estimates of (10) using Colombian shocks

	(1) $d\log p^{FOB}$	(2) $d\log\tilde{\tau}$	(3) $d\log p^{FOB}$
$d\log\tilde{\tau}$	0.4769***		0.0492
	(0.0169)		(0.1323)
B^{Col}		3.5310***	
		(0.7188)	
N	347,153	347,153	347,153
R^2	0.474	0.251	0.076
1st-stage F		24	

Notes: This table estimates (10) using Import Customs data from Chile for prices, quantities and firm-exposition. The freight cost shocks use Imports Customs data from Colombia. The log-difference is computed using an 8-quarter lag between 2021Q1-2021Q4 and product is defined at HS8 level. All specifications include a product-origin, firm-time and origin-time fixed effects. Standard errors clustered at the sector level in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

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