Foreign supply shocks and the structure of trade in a small open economy

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Abstract

This paper uses high-frequency product-level trade data to evaluate how imports of a highly developed, diversified and small open economy adjusted to economic disruptions in source countries during the first year of the COVID-19 pandemic. We use information on the differential timing, stringency, and persistence of coronavirus containment measures in source countries to estimate their impact on the value and trade-partner composition of imports. Our findings suggest that more than half of the observed contraction in imports can be attributed to supply-sided disruptions in source countries. Moreover, we document that contractions were more pronounced in more concentrated import markets and that more severe contractions could be prevented through trade partner substitution in an economically significant order of magnitude. Finally, we observe a systematic reallocation of market shares towards countries with large supply capacity and low incidence rates in the second half of 2020. Most of this reallocation seems to be demand-driven, however, so that a return to the pre-pandemic pattern of the aggregate trade partner composition can be expected.

JEL-Classification: F14

Keywords: International trade, COVID-19 pandemic, Supply-side disruptions, Trade partner substitution

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1 Introduction

Amid an enduring episode of recurring political, natural, and economic crises, the resilience of modern international trade networks to external shocks has become a salient issue in public debates. The COVID-19 pandemic is arguably one of the economically most complex recent events that put countries around the world to a serious test. Understanding its impact on the volume and structure of international trade activity is an important element in the assessment of a country's economic vulnerability.

As trade in intermediate inputs accounts for a significant portion of trade activity in many countries (Antràs, 2019; Johnson, 2014), adverse effects of disrupted international supply chains materialize through various channels. Next to the direct impact on the performance of the importing firms, their evident centrality in domestic economic and business networks implies potential spillovers and contagion effects that may affect the economy more broadly (e.g. Dhyne et al., 2020).[1] The ability of countries to absorb or cushion import supply shocks is therefore a critical determinant of their economic stability.

The present paper uses high-frequency product-level trade data to evaluate how imports of a highly developed, diversified and small open economy (aka the Netherlands) adjusted to economic disruptions in source countries during the first year of the COVID-19 pandemic. We use information on the differential timing, stringency, and persistence of coronavirus containment measures (i.e. CCMs or "lockdowns") in source countries to estimate their impact on the value and trade-partner composition of imports. The latter is particularly relevant, as it informs about the flexibility of a country's international sourcing network. We shed light on the evolution of these networks during the pandemic and address the question whether the differential severity of disruptions experienced across countries has entailed a significant redistribution of market shares.

Investigating empirically the effects of the pandemic-related economic disruptions on trade flows is difficult. It requires both making assumptions as well as carefully executed specification tests. While the distinction of demand and supply-side effects of the pandemic already constitute a meaningful challenge for identification, the global nature of pandemics requires an explicit consideration of changes in the so-called "multilateral resistance term" of the gravity equation of international trade (Head and Mayer, 2014). Indeed, the differential experiences of countries during the pandemic, and their respective position in global sourcing networks, might contribute to the overall severity of supply-side disruptions faced by importers and co-determine the scope and materialization of trade partner substitution.

[1] Even without such linkages and downstream transmission, their sheer size might induce significant aggregate fluctuations (Gabaix, 2011; di Giovanni et al., 2017, 2018, 2020).

Using a panel data set of monthly product-level observations for the period 2017-2020, we obtain our baseline results from estimating the net effect of CCMs in source countries on import values. To control for potentially confounding demand shocks, we make use of panel estimation techniques and control variables that capture potential (product-specific) pre-trends and a persistent (product-specific) demand shock in 2020. According to our preferred specification, lockdowns imposed by governments in source countries entailed a reduction in imports by about 8.4-8.8 percent of the counterfactual amount where any COVID-19 related disruptions are absent. This implies that between one-half and two-thirds of the overall observed reduction in aggregate imports of the Netherlands in 2020 (about 12.7-14.9 percent) can be attributed to supply-sided disruptions. Our findings are statistically robust to the use of alternative specifications and measures.

We also report evidence of heterogeneous effects across product types and markets. Medical supplies and personal protective equipment indicate a systematically lower responsiveness to foreign CCMs. Moreover, imports of intermediate input goods appear to experience a marginally stronger contraction in comparison to broadly defined consumer goods. Lastly, products, which were initially sourced from concentrated import markets, contracted systematically more than products with a more diversified sourcing structure. These results are economically significant and indicate that diversification can raise the resilience against foreign supply-side disruptions. We explain this by a presumably more limited scope for substitution possibilities in more concentrated markets.

To better understand the mechanics behind these adjustments, we turn to a more disaggregated sample, which enables us to differentiate between the direct lockdown effect in an individual source country and the effect of lockdowns in other (potentially competing) economies. Our initial baseline estimates are broadly confirmed, though quantitatively somewhat more modest with an overall reduction of imports by about 6.2 percent due to foreign lockdowns. This number masks a substantial amount of trade-partner substitution at an economically significant scale. The reduction in aggregate imports would have been about 4 percentage points larger without the possibility of trade partner substitution. Hence, about one third of the lockdown-induced supply-driven reduction in imports could be compensated for by switching to a different source country and cushion the overall contraction in imports.

Perhaps surprisingly, we find that trade-partner substitution effects played a relatively more prominent role for imports of intermediate input goods. This might seem counter-intuitive, given existing evidence that international supply-chain trade is typically more relationship-intensive; i.e. presumably less flexible (Nunn, 2007; Antràs and Chor, 2013; Barrot and Sauvagnat, 2016). However, such firm-level patterns might turn out differently at the more aggregate (product) level on which our analysis is focused and suggest that the economy *as a whole* appears to be relatively less dependent on individual input suppliers.[2] An alternative explanation could be that firms' imports of intermediate goods follow a strict hierarchy of suppliers, so that their relationships *appear* more stable in "normal times". However, given the economic importance of supply-chain trade, importers might take precautionary measures that enable them to adjust relatively quickly in the case of disruptions and switch to their second-best supplier. While we cannot formally test these competing tentative explanations, given our data, these findings suggest that the Dutch economy has been able to cushion the effects of adverse supply-chain disruptions during the pandemic. Next to the differential effects across product groups, we also document a reduction in the magnitude of the direct lockdown effects over time and an increase in substitution effects. We conclude from this finding that goods-producing sectors have been able to adapt to the operational boundaries imposed by the implementation of CCMs and that importers have improved their flexibility in sourcing from abroad.

Our subsequent analysis focuses on a more detailed evaluation of the evolution of the international sourcing network. Generally, we find that goods that were more exposed to foreign lockdowns also experienced an increase in their import market concentration. This is evident from a higher Herfindahl-Hirschmann Index (HHI), an increased market share of the top supplier, and from a smaller number of trade partners. Overall, these effects appear to be quantitatively modest and materialize mainly during the first half of the year, before being partly offset again in subsequent months. This suggests that the COVID-19 pandemic may have increased the economy's dependence on a smaller number of suppliers, but that this effect might also be temporary.

Finally, we observe a systematic reallocation of market shares during the pandemic. While, not surprisingly, petroleum-exporting countries account for a smaller fraction during 2020 (due to a negative demand shock), also many European economies indicate a relative contraction. In turn, market shares increase among Asian economies (China alone gains 1.5 percentage points). We find that these reallocation patterns are statistically related to countries' experience of a "second wave" that resulted from their differential approach in managing the crisis. Overall, these patterns suggest that both demand shocks and CCM-induced supply shocks have contributed to a reshuffling of the 2020 import market shares in the Netherlands. Countries pursuing a more stringent containment strategy appear — at least temporarily — as the economic winners of the pandemic.

Our paper relates to different strands of the economic literature that is concerned with

[2] In other words, the discrepancy between firm and product level patterns could arise from a substitution effect among importing firms that source from different countries. While some import less, facing stringent CCMs in their source countries, other firms (sourcing from less constrained suppliers) could import more — to satisfy domestic demand — so that the aggregate effect turns out to be modest.

adjustments to economic and other crises. Next to papers documenting the trade impact of natural disasters (e.g. Bluedorn, 2005; Volpe-Martincus and Blyde, 2013; Besedes and Murshid, 2018; Carvalho et al., 2021), economic or political crises (e.g. Freund, 2009; Bems et al., 2011; Biesebroeck et al., 2016; Fajgelbaum et al., 2019), we contribute primarily to the growing body of studies that analyzes the effect of the COVID-19 pandemic on international trade. Early empirical work on this subject has focused on the first months of the pandemic and document adjustments for a broad sets of countries at fairly aggregated levels (e.g. Espitia et al., 2021; Kejžar et al., 2021). More recently, this research is complemented by firm-level studies which focus on the more granular adjustment mechanisms (e.g. Lafrogne-Joussier et al., 2021; Berthou and Stumpner, 2021; Bricongne et al., 2021). While both our overall theme and methodological approach is comparable to these studies, we focus exclusively on the imports of a single economy at an intermediate level of disaggregation, and exploit information for the entire year 2020. Doing so allows us to position our research closer to the related quantitative research, which has outlined the potential aggregate economic consequences of disrupted trade and supply-chain relations (e.g. Bonadio et al., 2020; Eppinger et al., 2021; Sforza and Steininger, 2020).[3] The quantification of our estimated effects confirm the overall economic significance of these disruptions and assesses the relative importance of the different adjustment channels, based on empirical *ex-post* evidence.

A further distinctive contribution of our paper is the documentation of adjustments over time and the role played by different market and product characteristics. They suggest that economies have been able to adapt to CCMs and that the market environment can play a critical role. In particular, the finding that more diversified markets (both at the intensive and extensive margin) appeared to be more resilient to the COVID-19 shock conveys a clear policy implication. In line with conjectures in several other fields and applications, diversification results in less volatile and more stable economic performance.[4] Such implications are not limited to the studied case of the COVID-19 pandemic, but appear to be salient also in the context of other threats that challenge the sustainability of international supply chains and provoke a rethinking of basic principles in international economic relations.

Our paper unfolds as follows. Section 2 presents a brief review of the first year of the COVID-19 pandemic, the policy actions taken by countries and potential economic trans-

[3]In contrast to these studies, which use quantitative computable general equilibrium methods, our approach focuses on the short-to-medium term adjustments and is thereby confined mostly to partial equilibrium effects.

[4]For example, but not surprisingly, Hyun et al. (2020) find that the stock market performance of internationally more integrated firms outperformed that of less diversified enterprises in China during the first lockdown in early 2020. Diversification has been shown to enhance firms' resilience also to other shocks, such as discriminatory tariffs (Flaaen et al., 2020; He et al., 2021), or to facilitate and foster economic development (e.g. Mau, 2016; Ourens, 2018; Caselli et al., 2020).

mission mechanisms. Section 3 describes the data we use in our study, while Section 4 explains our empirical approach. Results are discussed in Section 5 and the paper concludes in Section 6.

2 Background and theoretical intuition

2.1 Timeline of the pandemic and CCMs across countries

The first documented cases of a COVID-19 contraction became known in China in late 2019. In early January 2020, the city of Wuhan, where the first cases were reported, announced the epidemic status of a novel disease. As immediate local containment measures failed to prevent the spread of the virus, increasing numbers of outbreaks were registered in different parts of the world. In early March 2020, the World Health Organization (WHO) declared the status of a pandemic. In the following weeks, most countries took measures to prevent further outbreaks, mainly by imposing more or less stringently enforced sanitary and social distancing guidelines. Depending on their stringency, these measures had a adverse effects on countries' production activity as workers could no longer commute to their workplace or factories were (temporarily) closed.

Data from the *Oxford COVID-19 Government Response Tracker* (henceforth, OxCGRT; Hale et al., 2020) enables us to measure and compare government actions addressing the pandemic. It documents daily, country specific information about the stringency and type of coronavirus containment measures (CCMs). A core metric of this data set is the so-called *Stringency Index* (SI). It is a composite measure that summarizes eight sub-indicators of *Containment and Closure Policies*. They cover (i) school closings; (ii) workplace closings; (iii) cancellation of public events; (iv) restrictions on gathering; (v) closure of public transport; (vi) stay-at-home requirement; (vii) restrictions on internal movement; and (viii) international travel controls.[5] Not all measures are expected to impact operations of goods-producing industries, so we concentrate on a subset of them to construct an *Alternative Stringency Index* (ASI). It is based on the prevalence of school and workplace closings, public transport and stay-at-home regulations, as well as on intra-national travelling restrictions.[6]

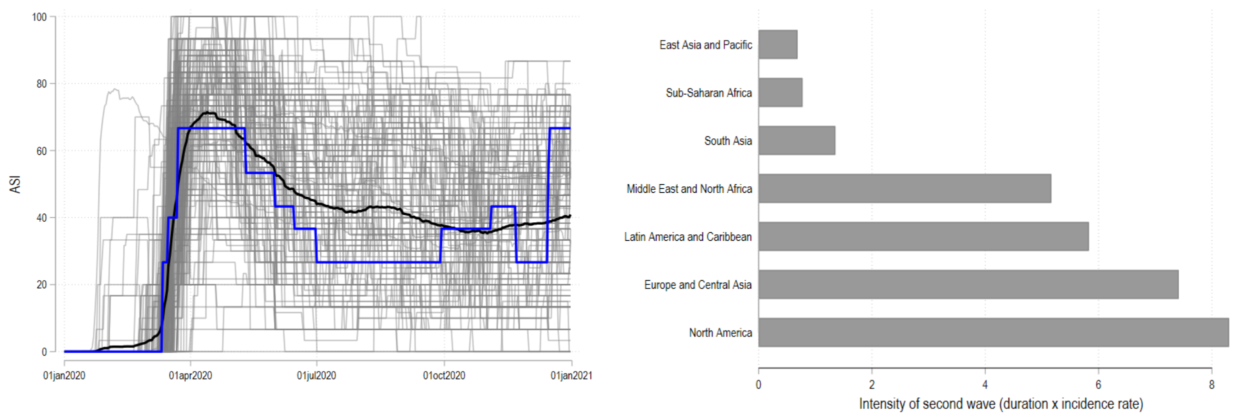
Figure 1(a) depicts the evolution of the ASI on a daily basis throughout the year 2020. Each line represents a country and the bold (smooth) line indicates the unweighted world average. It is evident that the stringency of CCMs increased sharply between March and

[5] We describe the methodology in greater detail in Appendix A, where we also analyze their evolution over time and across countries.

[6] Figure A2 shows a strong positive correlation between the two indices, where the ASI scores on average somewhat lower than the original SI.

Figure 1: Evolution of the COVID-19 pandemic across countries

(a) Stringency of CCMs (b) Regional exposure to the Second Wave



Note: Panel (a) Authors' calculations based on data from OxCGRT for January 01 through December 31, 2020. See text for description and interpretation of the Alternative Strigency Index (ASI). Bold black line indicates daily average ASI for 182-185 countries. Bold blue line indicates the Netherlands. Panel (b) Authors' calculations based on data from OxCGRT and World Development Indicators (WDI). To measure countries' exposure to a second wave, we calculate the fraction of remaining days after the first 150 days in 2020, where the seven-day average of the reported COVID-19 incidence rate in a country exceeded the incidence rate reported at the corresponding peak of its first wave (i.e. within the first 150 days of 2020). To take into account different levels of incident rates across countries, which indicate the "severity" of their early pandemic experience, we multiply this fraction by the average number of reported cases per 100,000 inhabitants for 2020.

April 2020, before it sets on to decline in the middle of the year and rise slightly again towards its end. The figure also illustrates heterogeneity in government responses across countries, which might reflect both different timing and intensity of outbreaks as well as different strategies in managing the crisis. The Netherlands, highlighted by the bold blue line, appears to have pursued a comparatively lenient strategy in the summer and fall of 2020, but returned to stricter measures towards the end of the year. Like many other European countries it experienced a "second wave" of contractions where incidence rates outperformed those reported during the initial breakout period. Figure 1(b) illustrates the average exposure of major geographic regions to a second wave. While Asian and Pacific economies faced limited outbreaks after passing their first peak in early 2020, it appears that containment measures have been less sustainable in Europe and North America. Next to analyzing the direct effects of source-country lockdowns on international trade flows, our analysis will also consider potential repercussions of these differential experiences with a second wave.

2.2 Effects on economic performance and implications for trade

The central hypothesis of this paper is that the COVID-19 pandemic has had an impact on countries' economic performance, which we expect to observe also in international trade data. The first assertion is difficult to reject and we find empirical support for it in the negative correlation between GDP growth rates and various measures of countries' pandemic exposure (see Figure A3).[7] Although we cannot infer any causal relationships from these patterns, it is plausible to assume that both the general health condition of a countries' population and labor force, as well as CCMs taken by governments impact demand and supply in an economy and therefore total GDP.

The second assertion is also plausible, but disentangling the mechanisms empirically is challenging. This can be illustrated with the general gravity equation of international trade (e.g. Eaton and Kortum, 2002; Head and Mayer, 2014), which highlights three transmission channels: (i) the total expenditure by a country n, X_n; (ii) the supply-side factors of a specific trade partner i; (iii) as well as the supply-side factors of any other potential trade partner j. Summarizing supply-side factors under a generic unit-cost term c, with respective negative elasticity, θ, and ignoring trade costs, we can express n's purchases from i as:

$$X_{ni} = \frac{c_i^{-\theta}}{\sum_j c_j^{-\theta}} X_n. \tag{1}$$

Noting that X_n includes domestic supply, we can write $X_{ni}/X_{nn} = (c_i/c_n)^{-\theta}$ and sum over i to obtain n's total purchases:

$$X_n = \sum_i X_{ni} = \frac{X_{nn}}{c_n^{-\theta}} \sum_i c_i^{-\theta}. \tag{2}$$

Defining imports as $M_n \equiv X_n - X_{nn}$, we obtain:

$$M_n = \sum_{i \neq n} X_{ni} = \frac{X_{nn}}{c_n^{-\theta}} \sum_{i \neq n} c_i^{-\theta}. \tag{3}$$

Equation (3) states that aggregate imports depend on domestic demand and supply conditions, reflecting the procyclical nature of imports as well as substitution effects if domestic production costs increase. Moreover, they are determined by foreign supply conditions. As

[7] Despite several outliers, panels (a) and (b) suggest a negative relationship between countries' annual real GDP growth rate in 2020 and their average lockdown stringency, as measured by the conventional Stringency Index reported in the OxCGRT data and our alternative measure (ASI). Panels (c) and (d) confirm this relationship when we rely on countries' reported COVID-19 cases and deaths (per 100,000 inhabitants) in 2020.

foreign countries go into lockdown, we expect that foreign supply conditions worsen (reflected in a higher $c_{i \neq n}$) so that — all other things equal — imports decrease. The empirical challenge will be to isolate the effect of foreign lockdowns from the potentially confounding factors that determined domestic supply and demand conditions. We will discuss our data and empirical approach in the following sections.

3 Data and measurement

3.1 International trade data

Our main data source are the monthly disaggregated international trade statistics provided by Eurostat. They report monthly records of the nominal value of import and export transactions for individual EU member states, by partner country and product category. We concentrate on imports reported for the Netherlands and aggregate product-specific information from the 8-digit Combined Nomenclature (CN8) to the internationally comparable 6-digit Harmonized System (HS6) nomenclature. The latter distinguishes approximately 5,000 products and commodity items.[8]

A main advantage of the data is its timely availability and its fairly long time-series, which enables us to exploit advanced panel data techniques to accommodate the identification of pandemic-induced supply-sided disruptions. Moreover, by focusing on the Netherlands, we consider a modern economy with a long history in international trade that is located at the core of one of the world's largest economic gravity centers. These features are convenient for two reasons. First, we study a country with a highly developed trade infrastructure (presumably endowing it with superior capacity to cope with international economic disruptions). Second, its high degree of economic development and diversification endows us with a broad data base and a large number of observations that we can exploit in our analysis.[9]

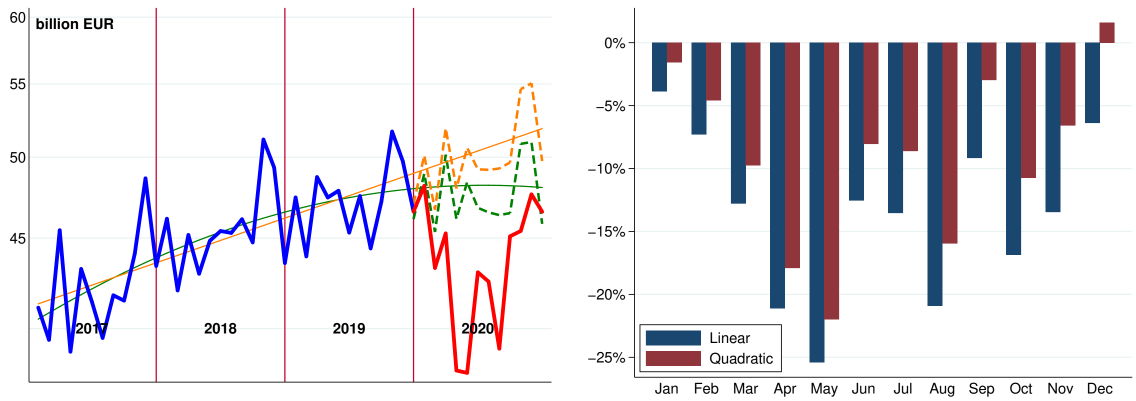
Figure 2(a) depicts the total value of monthly imports by the Netherlands (in billion euros). Regardless of the assumed underlying trend, imports fall significantly short of their predicted values for 2020. On aggregate, imports ranged about 13% below their predicted value, assuming that the "true" counterfactual amount (absent COVID-19) resides between the linear and quadratic projections. In Figure 2 (b) we observe the monthly percentage

[8]We downloaded the data from the Eurostat dataset DS-016893 and focus on imports in products listed under HS Chapters 01-97. In 15 out of the 5,341 HS6 product categories, the Netherlands did not report any imports in the years 2017-2019.

[9]Indeed, imports by the Netherlands are quite diversified. More than 100 partner countries can claim to be the main supplier in at least one product category. Furthermore, the number of countries from which the Netherlands sourced their imports during this base-period varies between 1 and 167 (i.e. the maximum), depending on the product.

Figure 2: Total monthly merchandise imports by the Netherlands, 2017-2020

(a) Monthly aggregate imports (b) Monthly deviations during pandemic



Note: Authors' calculations based on Eurostat data (DS-016893), accessed 07 April 2021. Panel(a): Solid lines show totals monthly imports. Dashed orange (green) line indicate linear (quadratic) predictions of log imports based on pre-2020 observations with month-fixed effects. Panel (b) Bars indicate calculated percentage difference between realized imports by the Netherlands and their predictions based on observed trends and seasonal patterns during the years 2017-2019.

deviations from these linear and quadratic predictions. It illustrates some variation over time, but significant contractions throughout the year. Moreover, comparing their pattern to Figure 1(a), we can see that the contraction of imports coincides with more stringent CCMs in the Netherlands during the early lockdown period, but that their trends diverge later in the year. Despite the aggregate nature of this data, we might interpret this observation as supportive of external (i.e. non-domestic) factors contributing to the variation in imports during the first year the the pandemic.[10]

3.2 Measuring exposure to foreign lockdowns

While we will exploit the full detail of our data in some parts of our analysis, we initially focus on the monthly product-level imports by the Netherlands, aggregated over trade partners. Hence, our empirical approach relies on measuring the exposure of a good that is imported by the Netherlands to lockdowns in its source countries. We compute this measure as a weighted average of partner countries' monthly ASI score, where the weights $\bar{\pi}_{ik}$ reflect the

[10]The extended time period we observe in our data therefore enables us to better distinguish lockdown-induced demand and supply-side forces in our empirical analysis.

average market share of country i in total imports of good k during the years 2017-2019:[11]

$$EXP_{nkt} = \sum_i \bar{\pi}_{nik} \times ASI_{it} \qquad ; \text{where } \bar{\pi}_{nik} = \frac{\sum_{t=2017}^{2019} X_{nikt}}{\sum_{t=2017}^{2019} X_{nkt}}. \tag{4}$$

Matching about 180 trade partners to a corresponding ASI measure allows us to inspect how the exposure to foreign lockdowns changed over time across 5,326 different product categories (Figure 3). While imports for January 2020 are essentially unaffected by foreign government responses to COVID-19, the picture changes drastically in subsequent months. The median good (indicated by the the solid vertical line) moves from a value around 12 in February to its peak near 65 in April, before returning gradually to a value around 30 by September. In the last quarter, exposure rises again to a value close to 60 for the median product. Average goods' exposure follows a similar pattern, as indicated by the dashed vertical lines. Next to the average variation in exposure over time, we also note substantial variation in the shape of the distribution and in the dispersion of our measure (blue horizontal lines on top of each histogram).[12]

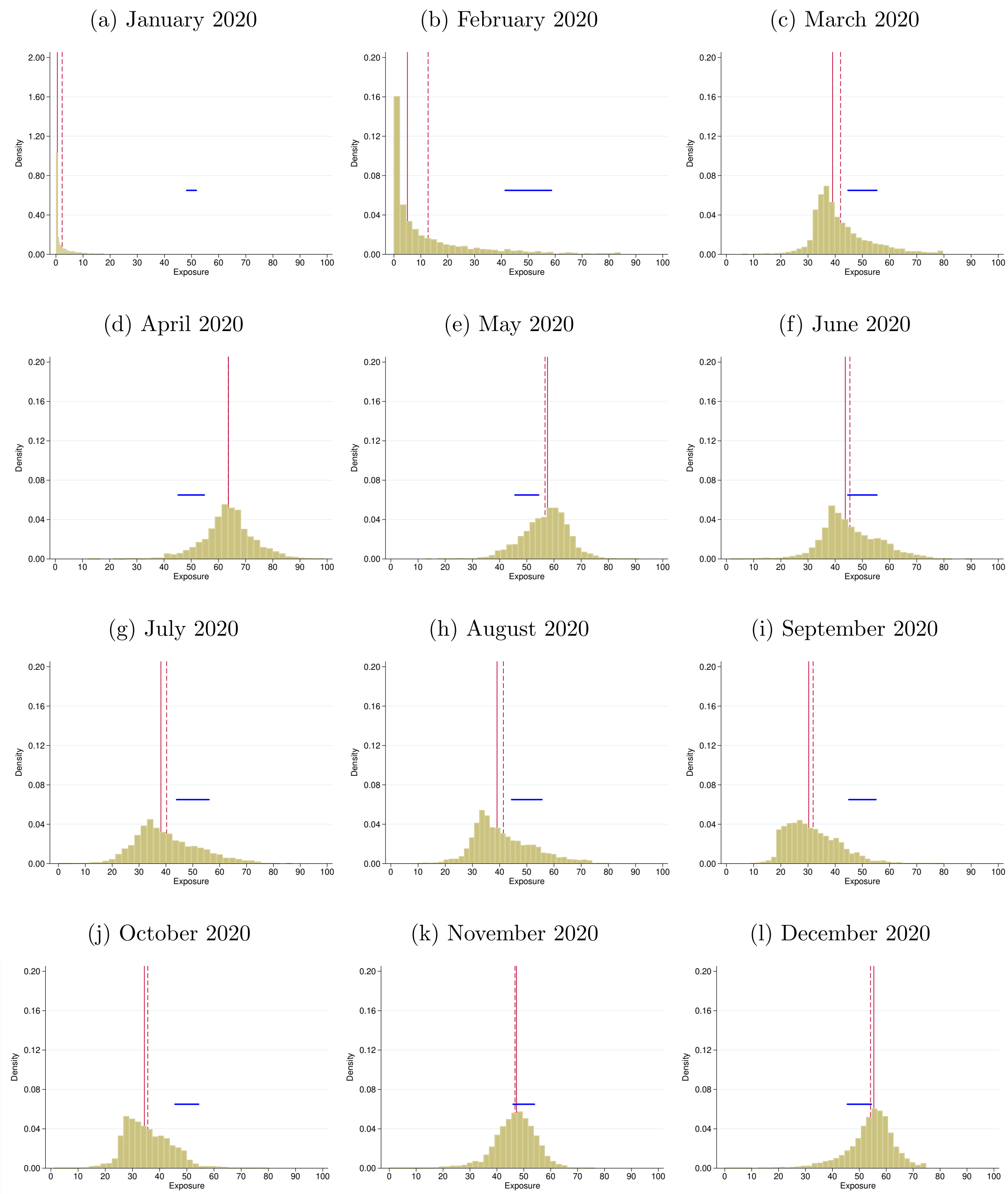
3.3 Descriptive patterns and statistics

Table 1 provides an overview of our measure of exposure, next to summary statistics of the import market characteristics before and during the pandemic. While an average HS6 category was imported from 45 different countries between 2017 and 2019, the annual average only drops marginally from 37 to 35 in 2020. Import market concentration also varies substantially across products. Before the pandemic, the lowest concentration is measured at a Herfindahl index (HHI) of 0.06, while the highest is equal to 1 in 42 different HS6 categories. Comparing the annual averages before and during the pandemic, no significant differences can be observed. Only highly concentrated markets (i.e. 90th percentile) seem to have become less diversified in 2020. The dispersion across products suggests that the goods the Netherlands import are very differentially exposed to foreign lockdowns, depending (i) on its stringency in country i we measure with our ASI and (ii) on the country's relative weight in product-level imports. Moreover, the summary statistics indicate that the pandemic resulted in a general increase in market concentration across all product groups at least in the short-term.

[11]By taking the three-year average, we attempt to mitigate concerns of year selection bias in our trade weights. The subscript n allows for a possible extension of this approach to different importers. Here, we focus only one one importer (i.e. the Netherlands).

[12]In Figure A4 we further display the variation in average exposure across broad industry aggregates along with their relative importance for Dutch imports and in indicator of average import market concentration.

Figure 3: Exposure to foreign lockdown across HS6 products imported by the Netherlands



Note: Authors' calculations based on data from Eurostat and OxCGRT. Distribution across 5,326 HS6 product categories. Exposure measured as explained in Equation (4). Vertical lines denote median (solid) and average (dashed) exposure. Vertical axis scale in Panel (a) differs from others by factor of 10.

Table 1: Summary Statistics - Dutch Import Market Characteristics

HS6-Products: 5,326	Minimum	10th-%.	Median	Mean	90th-%	Maximum
Alternative Stringency Index (2020)						
$EXP_k^{ASI}(t)$	0.10	0.32	0.38	0.39	0.49	0.63
$EXP_k^{ASI}(t-1)$	0.10	0.27	0.34	0.35	0.44	0.57
Import Market (Overall 2017 - 2019)						
HHI-Score	0.06	0.15	0.28	0.35	0.69	1.00
% of Main Partner	0.13	0.26	0.45	0.49	0.82	1.00
No. Partners	1	21	40	45	74	167
Import Market (Annual Avg. 2017 - 2019)						
HHI-Score	0.06	0.16	0.32	0.38	0.72	1.00
% of Main Partner	0.14	0.28	0.48	0.51	0.83	1.00
No. Partners	1	15	34	37	61	148
Import Market (2020)						
HHI-Score	0.07	0.15	0.30	0.38	0.76	1.00
% of Main Partner	0.12	0.26	0.47	0.51	0.87	1.00
No. Partners	1	12	33	35	59	143

Note: Authors' calculations based on data from Eurostat and OxCGRT. Import market characteristics were calculated for the 5,326 HS6-products imported between 2017 and 2020 based on Eurostat data. Exposure is calculated following equation (4). (Overall 2017 - 2019) refers to import market characteristics based on total imports in the three-year period between 2017 and 2019. (Annual Avg. 2017 - 2019) refers to the average import market characteristics based on annual imports of each individual year.

4 COVID-19 effect on the volume of imports

4.1 Econometric specification

To estimate the impact of foreign lockdown measures on Dutch imports, we have to pay attention to the different determinants of trade. Based on the reasoning we outlined at the end of Section 2, we can specify an estimation equation that is in line with the general mechanics of a gravity equation and that accommodates our data structure: product-level imports at monthly frequency covering a period of four years (2017-2020). We adopt our notation accordingly and describe the following log-linear estimation equation for imports:

$$\ln M_{kt} = \beta EXP_{kt-1} + \sum_{k=1}^{K} \gamma_k D_{k,2020} + \delta \textit{pre-trend}_{kt} + \mu_{km} + \varepsilon_{kt}. \quad (5)$$

Our main coefficient of interest is β, denoting the relationship between imports of good k and its exposure to foreign lockdowns, which presumably increase the unit-costs of foreign suppliers and lower imports. Hence, we expect $\beta < 0$. To obtain an unbiased estimate we include control variables and fixed effects into our estimation equation. The summation term with coefficients γ_k denotes unobserved product-specific demand shocks due the pandemic in the year 2020. They are our baseline attempt to control for the demand-driven variation in imports. We account for general product-specific seasonality by including product-month fixed effects μ_{km}. Further, we include a product-specific linear pre-trend variable estimated based on imports before the pandemic (2017-2019).

We acknowledge that identifying the effects of source country disruptions on imports faces several challenges. First, policy measures in a foreign country do not necessarily affect manufacturing production uniformly. For specific goods or countries, strict regulations may exempt particular economic activities and overstate the measured exposure of a good to be imported. In such cases, however, our estimates would be downward biased and imprecise, so that we expect to report a lower bound of potential effects. Next to this, policies in the source countries might not be the only source of disruptions and supply shortages, as these countries might suffer from similar supply disruption in their own source countries. In this case, our estimates could potentially be upward biased and overstate the direct effect of COVID-19 containment policies on import supply. While we cannot directly control for this possibility at the product-level, we stress that for this to happen, the correlation between source countries' policies and disruptions in their own source countries has to be systematic and positive.[13] To further control for potential bias arising from import demand shocks or product specific pre-trends, we carry out robustness checks where we employ various combinations of fixed effects and additional control variables.

4.2 Baseline results

The first two columns of Table 2 depict our baseline results. The specification in column (1) estimates imports including the trend of aggregate Dutch imports pre-pandemic, while column (2) includes a product-specific pre-trend, as specified in equation (5). Moreover, our

[13] Moreover, we find that national lockdown policy measures and other indicators of countries' domestic exposure to the COVID-19 are negatively correlated with their GDP growth over 2020, which lends some support to the existence of a direct effect on economic performance (Figure A3).

baseline specification includes product-specific monthly fixed effect to control for seasonality as well as a product-specific demand shock term in 2020. The use of alternative pre-trends alters our empirical results only marginally. Overall, the coefficients in column (1) and (2) result in magnitudes with 8.3-8.4 percent lower imports than if no lockdowns had occurred.[14] The exposure distribution of the products also implies slightly differential effects between product groups. Imports of goods, which were least exposed to foreign lockdowns (bottom decile), decreased by around four percentage points less than products, which were the most exposed (i.e. above the 90th percentile).[15] Our results indicate that up to two-thirds of the observed contraction in aggregate imports can be attributed to supply-sided disruptions. In the following subsection we expand on our baseline analysis to explore the robustness of these results to the inclusion of additional control variables or to alternative pandemic measures.

[14]The mean lagged exposure of goods in 2020 is 0.393. In column (2): $e^{0.35\times-0.252} - 1 \approx -0.084$.

[15]In column (2) for example: The mean lagged exposure of goods in the top decile is 0.442 and in the bottom decile 0.274. This implies an average reduction of -6.67% for products in the bottom decile and -10.54% for products in the top decile.

Table 2: Import response to foreign lockdowns, baseline results

Dep. var.:	(1)	(2)	(3)	(4)	(5)	(6)
log imports ($\ln M_{kt}$)	Baseline		Additional controls			
EXP_{kt-1}	-0.249**	-0.252**	-0.241**	-0.269**	-0.273**	-0.268**
	(0.019)	(0.019)	(0.041)	(0.053)	(0.069)	(0.065)
HS6×month-FE	✓	✓	✓	✓	✓	✓
Aggregate trend	✓					
HS6 pre-trend		✓	✓	✓	✓	✓
HS6×yr2020-FE	✓	✓				
HS6×qr2020-FE			✓	✓	✓	✓
2020-months-FE					✓	✓
Other controls				Dutch ASI		Belgian Imports
Observations	242,092	241,942	241,447	241,447	241,447	231,893
Clusters (HS6)	5,244	5,232	5,232	5,232	5,232	5,126

Note: Table reports the average estimated effect of COVID-19 related lockdowns in source countries, as measured by ASI, on (log) Euro values of products imported by the Netherlands. The underlying sample consists of monthly observations from Jan. 2017 through December 2020 and features HS6 product categories included in HS2 chapters 01 through 97. Standard errors adjusted for clustering at HS6-product level are reported in parentheses below the estimated coefficients. Statistical significance: ^{a} $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

4.2.1 Controlling for import demand and domestic supply

A primary concern of identification is the possibility of confounding demand-sided effects that inflate our coefficient of interest and mislead our conclusions on the vulnerability of the sourcing network of Dutch imports. Similarly, if domestic supply shocks in the Netherlands are not properly taken into account, the attributed explanatory power of foreign supply-side disruptions may be further biased. While our initial strategy was to include a product-specific year-2020 effect (assuming the product-specific shock evolves uniformly over the year), we attempt to explicitly control for it now.

We do so by estimating several alternative specifications. Firstly, demand-side effects might be more accurately captured by product-specific quarter dummies in 2020, which relaxes the assumption of a uniform demand shock throughout 2020. An alternative control variable for demand-side effects are the monthly product-level imports of Belgium. The reasoning behind including this measures relies on the assumption that Belgium and the

Netherlands are similar economies in many respects — such as size, geographic location, income per capita and preferences. However, the countries are potentially different in their product-specific exposure to foreign lockdowns, due to different trade linkages and networks. Hence, variation in Dutch imports that is correlated with variation in Belgium's imports can be attributed to their commonalities during the period under investigation (including product-specific demand shocks experienced during the pandemic). Consequently, by including this control variable we avoid that this part of the variation is wrongly attributed to our main variable of interest, which measures supply-sided disruptions. Furthermore, we can control for the domestic supply structure in a similar fashion as foreign supply-side disruptions by accounting for the Dutch lockdown stringency index (ASI). Alternatively, we also incorporate a set of 2020-specific month fixed effect, which account for all time-varying unobservables common across all Dutch imports, including domestic supply conditions.

Therefore, Table 2 reports alternative specifications including additional control variables in column (3-6). Regardless of additional controls, the main coefficient of interest remains highly robust. The magnitude of the coefficient increases slightly, once domestic supply conditions are more explicitly controlled for (column 4-6). Nonetheless, this robustness check confirms that our baseline specification with a less restrictive fixed-effect structure does not significantly impact our results.

4.2.2 Other pandemic measures and indices

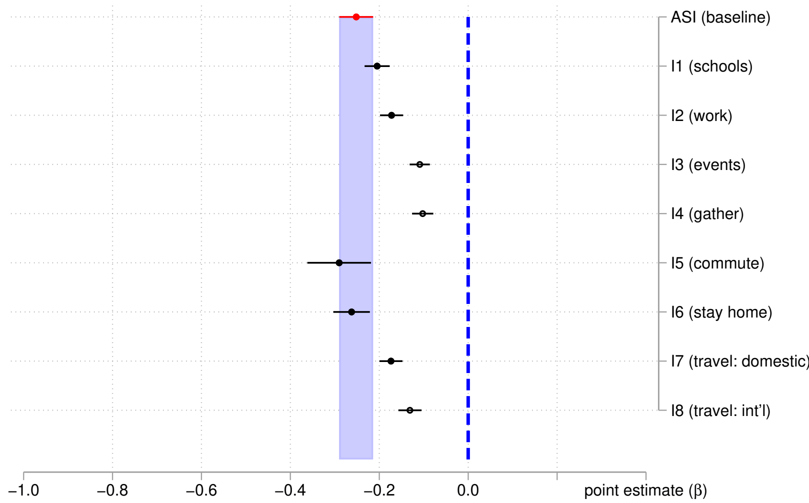
Next to our overall CCMs stringency indicator, *ASI*, we also consider alternative lockdown indicators which are reported as COVID-19 containment measures in the OxCGRT database. Specifically, we use each of the eight sub-indicators individually to explore whether our findings are driven by individual measures or by their combined application.

Figure 4 plots our baseline $\hat{\beta}$ against those form our alternative measures. It suggests that our baseline measure, which combines I1-I2 and I5-I7, captures the most disruptive government measures. In fact, we can observe that school closures as well as restrictions on local/domestic mobility seem to drive the effects. In contrast to this, it is plausible that restrictions placed on public events and private gatherings (I3-I4), as well as international mobility (I8) have minor supply-side impacts, because they can be assumed to be less disruptive for actual business operations in source countries.

Besides stringency indices, which measure the intensity of country's containment measures, we also consider monthly reported COVID-19 deaths and cases in exporting countries as possible proxies for adverse supply shocks.[16] Table A2 in the appendix reports the corre-

[16]Information on daily reported absolute COVID-19 cases and deaths comes from the OxCGRT dataset, and we converted them into per 100 and 1,000 inhabitants measures, respectively, using population figures

Figure 4: Average effects of foreign lockdowns on imports, alternative indicators



Note: Figures shows estimates coefficients $\hat{\beta}^i$ using alternative measures of foreign lockdown exposure and for specifications with lagged treatment effects.

sponding coefficients for reported COVID-19 deaths and cases. COVID-19 deaths, however, suggests that a much smaller share of the observed reduction in imports can be attributed to supply-side interruptions. Based on the results of column (2), imports of goods with average exposure were 2.3 percent lower than in the counterfactual of no pandemic. Similarly, incidence rates of reported COVID-19 infections explain observed import contractions imperfectly (see columns 3-6). While a negative relationship can be identified during the first half of the year 2020, it breaks down in later months and no statistically significant correlation can be found.

Our baseline results suggest that reported COVID-19 case numbers and deaths in source countries are less appropriate to measure the exposure of imports to foreign supply-side disruptions. While the reasons might be manifold, our main explanation stresses the fact that countries have not consistently tested and reported such numbers and also responded very differently to outbreaks. The actual political response to COVID-19 matters, however, as imposed lockdowns and other regulations determine to what extend economic activity was inhibited during this period. This is also supported by the findings using Google mobility data. The dataset measures to what extent mobility has been inhibited due to containment measures in 2020 and was used in related papers (see Espitia et al., 2021). The results can be found in the appendix (see Table A3) and imply a contraction of approximately 7%, similar

2017-19 from the World Bank. Population numbers for Taiwan are not reported at the World Bank and were obtained from their national statistical agency.

to our baseline results. We, therefore, consider our alternative stringency index (ASI) as the preferred measure.

4.3 Heterogeneous effects

4.3.1 Heterogeneous effects across products

In this subsection, we investigate potentially heterogeneous patterns across products. Even though we cannot observe differential lockdown stringency for individual goods within source countries, we expect that foreign lockdowns have a less detrimental effect on imports if goods face a strong positive demand shock during the pandemic. This is most obviously the case for medical equipment and machinery, which were deemed to be critical goods or inputs and therefore likely to be partially exempted from regular CCM regulations in source countries. We identify such goods based on product codes listed in the Eurostat database DS-1180622, and measure them with a binary indicator variable.[17]

Next to this, we consider the trade elasticity of products according to a measure constructed by Fontagné et al. (2019) using trade responses to tariff changes. Goods with a higher trade elasticity should be more responsive to price changes and other supply-sided disruptions, so that we expect the effects of foreign lockdowns to be comparatively larger. Finding such a differential effect would also lend support to our identification strategy by passing a plausibility check. In fact, if our exposure measure captures variation from the demand side, we should not see any differential effects, because demand shocks have unit-elasticity across goods in standard gravity frameworks.

Another reason for differential effects across products could be their "relationship stickiness". Martin et al. (2021) argue that such products are more resilient to economic shocks, such as increased economic uncertainty. While they do not provide a structural interpretation explaining the determinants of their resilience, we should expect that "sticky" products reveal smaller reductions in imports as trade linkages remain viable also during the pandemic.

Lastly, we might also observe heterogeneous effects among different product classes. Using Broad Economic Categories (BEC), we distinguish between intermediate and consumer goods.[18] Intermediate goods are usually part of established supply chains with designated suppliers and might therefore be characterised by more resilient trade relationships than con-

[17] The database is dedicated to tracking trade in these products. After aggregating this data from the 8-digit combined nomenclature (CN8), we obtain 103 HS6 goods which we consider as medical supplies facing increasing demand during the pandemic.

[18] We follow the definition of the UN Statistical Division (UNSD). Intermediate goods include categories 22, 42 & 53 (excluding primary goods and fuels). Consumption goods include categories 112, 122, 321, 522, 61, 62 & 63. More information at: https://unstats.un.org/unsd/tradekb/Knowledgebase/50090/Intermediate-Goods-in-Trade-Statistics.

sumer goods. On the other hand, global value chains were more easily interrupted throughout the pandemic due to further disruptions in other countries further upstream, which might imply that intermediate goods were more sensitive towards foreign lockdowns.

Our results for differential effects are displayed in Table 3. Column (1) and (2) reflect our baseline specification in Table 2, augmented by the interaction term of COVID-19 related medical supplies. The coefficient is positive and significant with its magnitude even suggesting that the reduction of their imports due to foreign lockdowns is completely offset. This result implies that imports of COVID-19 medical supplies remained unaffected by supply-side disruptions in source countries. In the following columns, we add interaction terms for products with above-median trade elasticities, in columns (3)-(4), and for goods with an above-median stickiness score, in columns (5)-(6). While we obtain the expected signs in those specifications, their statistical significance remains fragile. Evidence on differential effects for different product classes are displayed in the last four columns: columns (7) and (8) include an interaction term for intermediate goods and columns (9) and (10) for consumption goods. We find that intermediate goods experienced a marginally larger reduction in imports due to foreign lockdowns, while imports of consumer goods seem to have been more resilient.

Table 3: Import response to foreign lockdowns, product characteristics

Dep. var.: log imports ($\ln M_{kt}$)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Product characteristic	Medical Supplies		Trade Elasticity		Stickiness		Intermediate		Consumption	
Source:	Eurostat		Fontagné et al. (2019)		Martin et al. (2021)		UNSD		UNSD	
$EXP_k^{ASI}(t-1)$	-0.256**	-0.259**	-0.211**	-0.213**	-0.260**	-0.265**	-0.215**	-0.221**	-0.272**	-0.275**
	(0.019)	(0.019)	(0.024)	(0.024)	(0.028)	(0.028)	(0.026)	(0.026)	(0.023)	(0.024)
× Medical supplies	0.343**	0.346**								
	(0.086)	(0.086)								
× High trade elasticity			-0.071[a]	-0.074[a]						
			(0.038)	(0.039)						
× Sticky					0.022	0.027				
					(0.037)	(0.038)				
× Intermediate Inputs							-0.067[a]	-0.060		
							(0.037)	(0.038)		
× Consumption Goods									0.083*	0.084*
									(0.037)	(0.037)
HS6×month-FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
HS6×yr2020-FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Aggregate trend	✓		✓		✓		✓		✓	
HS6 pre-trend		✓		✓		✓		✓		✓
Observations	242,092	241,942	220,650	220,534	242,092	241,942	242,092	241,942	242,092	241,942
Clusters (HS6)	5,244	5,232	4,764	4,755	5,244	5,232	5,244	5,232	5,244	5,232

Note: Tables reports the average estimated effect of COVID-19 related lockdowns in source countries, as measured by ASI, on (log) Euro values of products imported by the Netherlands. Additionally, interaction terms with ASI are included to investigate potential product heterogeneity. Medical supplies are measured with a binary indicator variable, based on a list provided by Eurostat (i.e. the database DS-1180622); high trade elasticity and sticky denote binary variables indicating that the products' corresponding measure ranges above the median of all products. Intermediate and consumer goods are defined based on their BEC-class following the definition of the UN Statistical Division. Standard errors adjusted for clustering at HS6-product level are reported in parentheses below the estimated coefficients. Statistical significance: ^{a} $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

4.3.2 The role of pre-pandemic market conditions

Besides product characteristics, the import market conditions for the various products could lead to differential effects of foreign supply shocks. For example, it should make a difference whether imports are sourced from many different suppliers or from very few or very dominant suppliers. In the latter case, it might be more difficult to substitute for other import sources, if the main supplier goes into lockdown. Hence, contracting effects should be comparatively larger in less diversified and more concentrated import markets. To test this, we interact our main variable of interest with three measures of market concentration (or diversification): the Herfindahl-Hirschmann Index (HHI), the percentage market share held by the main supplier, and the number of countries from which a good is typically sourced. All these measures are based on the pre-pandemic product-specific trade record of the Netherlands during the years 2017-19 and are included as continuous measures (i.e. taken their true values instead of a binary indicator for above and below threshold realizations).

Table 4: Import response to foreign lockdowns, import market characteristics

Dep. var.: log imports ($\ln M_{kt}$)	(1)	(2)	(3)	(4)	(5)	(6)
Import Market Characteristic:	HHI-Score		% of Main Partner		No. Partners	
$EXP_k^{ASI}(t-1)$	-0.154**	-0.150**	-0.103*	-0.098*	-0.320**	-0.334**
	(0.037)	(0.037)	(0.049)	(0.049)	(0.059)	(0.060)
× HHI-Score	-0.277*	-0.298*				
	(0.124)	(0.126)				
× % of Main Partner			-0.302**	-0.318**		
			(0.115)	(0.116)		
× No. Partners					0.002	0.002^a
					(0.001)	(0.001)
HS6×month-FE	✓	✓	✓	✓	✓	✓
HS6×yr2020-FE	✓	✓	✓	✓	✓	✓
Aggregate trend	✓		✓		✓	
HS6 pre-trend		✓		✓		✓
Observations	242,092	241,942	242,092	241,942	242,092	241,942
Clusters (HS6)	5,244	5,232	5,244	5,232	5,244	5,232

Note: Tables reports the average estimated effect of COVID-19 related lockdowns in source countries, as measured by ASI, on (log) Euro values of products imported by the Netherlands. Additionally, interaction terms with ASI are included to investigate potential heterogeneity caused by import market characteristics. To do so, we use three different measures of market concentration: the Herfindahl Index (HHI) pre-COVID-19, the average import share of the main trade partner in 2017-19 and the number of trade partners pre-COVID-19. Standard errors adjusted for clustering at HS6-product level are reported in parentheses below the estimated coefficients. Statistical significance: ^{a} $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

The results are displayed in Table 4. All interaction terms have the expected sign with the HHI-Score and share of main supplier being statistically significant. The number of trade partners is only marginally significant in the specification with product-specific pre-trends. The baseline coefficients for exposure are comparable to our previously reported findings, which we can infer by multiplying them with the average value for our interaction terms.[19] In columns (1)-(4) we observe that higher import market concentration is significantly correlated with a stronger contraction of imports during lockdowns in source countries. We interpret this as a lack of import-source substitution possibilities, which indicates the risks of depending on a few and powerful suppliers.

To quantify this differential effect, we consider the coefficients for the HHI-interaction in column (2) of Table 4. The coefficients imply that lockdowns in source countries lead to a 11.8 percent reduction of imports for goods with the highest market concentration (i.e. those residing in the top decile of the distribution).[20] On the other end of the distribution (i.e. residing in the bottom decile), goods with a diversified import market (average HHI-score of 0.15) experience a 6.7 percent reduction in imports due to foreign lockdowns. Similar magnitudes are obtained from column (3) and (4), in which we proxy market concentration with the share of the main trade partner. Hence, the estimated effects of foreign lockdowns on imports can vary by a factor of almost two, depending on the initial concentration of the import market. The number of trade partners in columns (5) and (6) also have the expected sign with a diversified market of more trade partners being more resilient. However, the coefficients are less statistically significant and the implied differential effect is quantitatively smaller. Nevertheless, these results suggest that imports respond differently to foreign supply-sided disruptions and that the diversification of import sources can improve the resilience of an international sourcing structure.

5 COVID-19 effect on the structure of imports

Next to investigating the trade-volume effects of the COVID-19 pandemic, a core objective of our paper is to analyze how the structure of imports adjusted. As outlined in the introduction, we address this question from three different angles. First, we attempt to document empirical evidence on trade partner substitution. Second, we ask whether markets become

[19] For example, in column (1), we can multiply our $\hat{\beta}$ with the mean HHI-Score in our sample to obtain $-0.154 + (-0.277 \times 0.35) \approx -0.251$, which is equivalent to the coefficient reported in column (5) of Table **??**.

[20] We obtain this number by calculating the average baseline effect of foreign lockdown exposure (0.348×-0.154) and adding the additional average effect on goods with highly concentrated markets, where the mean HHI-score is equal to about 0.69, so that $[e^{0.348 \times -0.154} \times e^{0.348 \times 0.69 \times -0.298}] - 1 \approx -0.118$.

more or less concentrated as a result of supply-sided disruptions. Finally, we document how import market shares shifted during the pandemic and analyze how these patterns are related to countries' experience during the pandemic.

5.1 Trade partner substitution

5.1.1 Econometric specification

To track import source substitution effects, we turn to a more disaggregated sample in which we observe monthly imports by product and partner country. Our empirical specification is adjusted accordingly:

$$\ln M_{ikt} = \beta_1 ASI_{it-1} + \beta_2 comp_{ikt-1} + \sum_{k=1}^{K} \gamma_k D_{k,2020} + \delta pre\text{-}trend_{kt} + \mu_{ikm} + \varepsilon_{ikt}. \tag{6}$$

Using this specification, we no longer estimate the (net) effect of average foreign lockdown exposure of a good on its imports, but observe directly how a change of the alternative stringency index (ASI) in a country affects imports. We obtain this effect from the estimate of β_1, which we expect to be negative.

Following Espitia et al. (2021), we also include an indicator of competition intensity, which proxies the pandemic situation in other countries that typically supply the Dutch market (i.e. $comp_{ikt}$). The indicator combines the average market share of exporter $j \neq i$ in imports of product k before 2020 with the ASI of that country, so that a higher score implies stricter CCMs in competing economies:

$$comp_{ikt} = \sum_{j \neq i}^{J} w_{jk} \times ASI_{jt}. \tag{7}$$

The competition effect of the pandemic is expected to be positively related to imports from i, if it is able to supply some of the demand that is typically captured by third countries (i.e. we expect $\beta_2 > 0$). Since we found a negative net-effect in our baseline results and substitution possibilities are likely to be imperfect, we further expect that compensation is incomplete so that $\beta_1 + \beta_2 < 0$.

Next to these refinements in the measurement of supply-sided disruptions, we follow our baseline specification (5) by including a product-specific pre-trend and a summation term to account for product-specific demand shocks in 2020. In contrast to the more aggregated sample, we now control for exporter-product specific seasonality patterns μ_{ikm}.

5.1.2 Main findings

Table 5: Import source substitution, baseline specifications

Dep. var.: log imports ($\ln M_{ikt}$)	(1)	(2)	(3)	(4)	(5)	(6)
	Naïve model		Fully specified model			
				Interaction effects		
				Inputs	Consumer	2nd half
$EXP_i^{ASI}(t-1)$	-0.252**	-0.204**	-0.311**	-0.278**	-0.324**	-0.315**
	(0.017)	(0.009)	(0.013)	(0.018)	(0.016)	(0.017)
$\times k =$ input				-0.075**		
				(0.027)		
$\times k =$ consumer					0.033	
					(0.028)	
$\times t =$ 2nd half '20						0.062**
						(0.021)
$comp_{ik}(t-1)$			0.200**	0.152**	0.234**	0.126**
			(0.017)	(0.023)	(0.022)	(0.021)
$\times k =$ input				0.108**		
				(0.035)		
$\times k =$ consumer					-0.095**	
					(0.036)	
$\times t =$ 2nd half '20						0.173**
						(0.023)
HS6-country × month FE	✓	✓	✓	✓	✓	✓
HS6 × time FE	✓					
HS6 pre-trend		✓	✓	✓	✓	✓
HS6 shock 2020		✓	✓	✓	✓	✓
Observations	5,937,722	5,947,297	5,947,297	5,947,297	5,947,297	5,947,297
Clusters (HS6)	5,081	5,209	5,209	5,209	5,209	5,209

Note: Tables reports the average estimated effect of COVID-19 related lockdowns in source countries, as measured by ASI, on (log) Euro values of bilateral products imports by the Netherlands. A competition shock variable $comp_{ikt}$ based on equation (7) is also included to measure the extent of trade substitution. Additionally, interaction terms with ASI and $comp$ are included to investigate potential heterogeneous effects. Intermediate and consumer goods are defined based on their BEC-class following the definition of the UN Statistical Division. Standard errors adjusted for clustering at HS6-product level are reported in parentheses below the estimated coefficients. Statistical significance: ^{a} $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

Columns (1) and (2) of Table 5 reports findings from two naïve specifications that focus exclusively on the direct relationship between imports and lockdowns in a source country, ignoring potential substitution effects. It is nevertheless useful to investigate our baseline strategy to control for potentially confounding demand-sided disruptions. While column (1) includes product-time fixed effects to control for demand shocks, column (2) uses our conventional approach. If unobserved (or inappropriately handled) demand shocks significantly inflated our coefficient of interest, we would expect the estimate of column (2) to be quantitatively larger than in column (1). The opposite is the case, however, so that we are confident to report relatively conservative estimates of the true supply-sided disruptions.

Moving on with our baseline specification, columns (3)-(6) report findings for the complete specification. Coefficients of both variables of interest show the expected signs and relative magnitudes, suggesting that import-source substitution effects are observable and statistically significant. In fact, the implied magnitudes are also economically meaningful about two-thirds of the direct lockdown effect is offset by trade-partner substitution. According to our preferred specification in column (3), a foreign lockdown entailed an average reduction in bilateral imports by about 10.0% (with an average lagged ASI score of 0.338 in our sample). However, once we account for the competition shock, the reduction in bilateral imports is only 3.6% on average. These numbers are somewhat different if we aggregate the predicted values taking into account the relative importance of trade partners in Dutch imports. Doing so results in an overall estimated reduction of imports due to lockdowns by about 6.2% (i.e. about half of the contraction we observed in the aggregate trade data), whereas it would have been about 4 percentage points larger had no trade-partner substitution occurred. This is also illustrated graphically in Figure A5 in the appendix, where the aggregate contraction of imports is split into the different types of shocks.

In the remaining columns we investigate differential effects across products and over time. Columns (4) and (5) include interaction terms for intermediate and consumer goods respectively. We observe that imports of intermediate goods react more adversely to foreign lockdown, which is simultaneously offset by better substitution capabilities in comparison to other goods. On the other hand, imports of consumer goods seem to be slightly more resilient to supply-sided disruptions and also less frequently substituted. Lastly, column (6) includes an interaction term for the second half of the year 2020. The coefficients show that lockdowns in foreign source countries decrease imports by less in the last six months of 2020. Simultaneously, the substitution effect gains considerable explanatory power in the second half, more than doubling in magnitude. These results imply that (i) domestic lockdowns have become less disruptive for economic activity and export behaviour over time and that (ii) substitution between source countries occurred more strongly in the second half of 2020.

5.2 Import market concentration and reshuffling market shares

5.2.1 Did the pandemic undermine diversification?

Next to the general substitution effects, our investigation of the import structure concerns also the concentration of import markets. This is particularly relevant in the light of current debates on "strategic autonomy" in Europe and similar discussions in industrialized countries. Our findings are shown in Table 6, columns (1), (5), and (9). They suggest that all three measures indicate increasing concentration in lockdown-exposed product markets. Both the Herfindahl-Hirschman Index (HHI) and the market shares of principal top-suppliers increase significantly in product import markets where source countries imposed stricter lockdowns. This suggests that some suppliers might have been able to exploit supply disruptions elsewhere. The final two columns further indicate that markets became more concentrated also at the extensive margin, as the number of trade partners decreased in exposed markets relative to non-exposed ones.

The remaining columns explore heterogeneous patterns across industries (i.e. intermediate goods versus consumer goods) and over time. We typically do not observe a significantly differential impact on market concentration measures for these broad product groups, except for the number of trade partners where inputs reveal a systematically stronger stability than consumer goods imports. We furthermore observe a significant attenuation of the overall adjustments in market concentration over time, which suggests that most of these effects have been temporary. When we quantify the implied change in market concentration and comparing them to our summary statistics reported in Table 1, we further note that implied and aggregate changes along these dimensions have been modest.

Table 6: Foreign lockdowns and import market concentration

Dep. var.:	(1) Herfindahl-Hirschmann Index	(2)	(3)	(4)	(5) Share main supplier	(6)	(7)	(8)	(9) Number trade partners	(10)	(11)	(12)
	Overall	Inputs	Consumer	2nd half	Overall	Inputs	Consumer	2nd half	Overall	Inputs	Consumer	2nd half
$EXP_{ik}^{ASI}(t-1)$	0.022**	0.023**	0.019**	0.025**	0.035**	0.036**	0.032**	0.038**	-0.659**	-0.866**	-0.547**	-1.480**
	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.007)	(0.007)	(0.006)	(0.075)	(0.106)	(0.090)	(0.080)
× Int. inputs		-0.003				-0.001				0.412**		
		(0.006)				(0.006)				(0.151)		
× Cons. goods			0.009				0.011[a]				-0.405*	
			(0.006)				(0.006)				(0.163)	
× 2nd half 20				-0.010**				-0.009**				2.462**
				(0.003)				(0.003)				(0.081)
HS6-month FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
HS6-year FE	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Observations	241,920	241,920	241,920	241,920	241,920	241,920	241,920	241,920	241,920	241,920	241,920	241,920
Clusters (HS6)	5,212	5,212	5,212	5,212	5,212	5,212	5,212	5,212	5,212	5,212	5,212	5,212

Table reports the average estimated effect of COVID-19 related lockdowns in source countries, as measured by ASI, on import market characteristics in the Netherlands. Regressions are run on three different measures of market concentration: the Herfindahl Index (HHI), the average import share of the main trade partner and the number of trade partners. Standard errors adjusted for clustering at HS6-product level are reported in parentheses below the estimated coefficients. Statistical significance: ^{a} $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

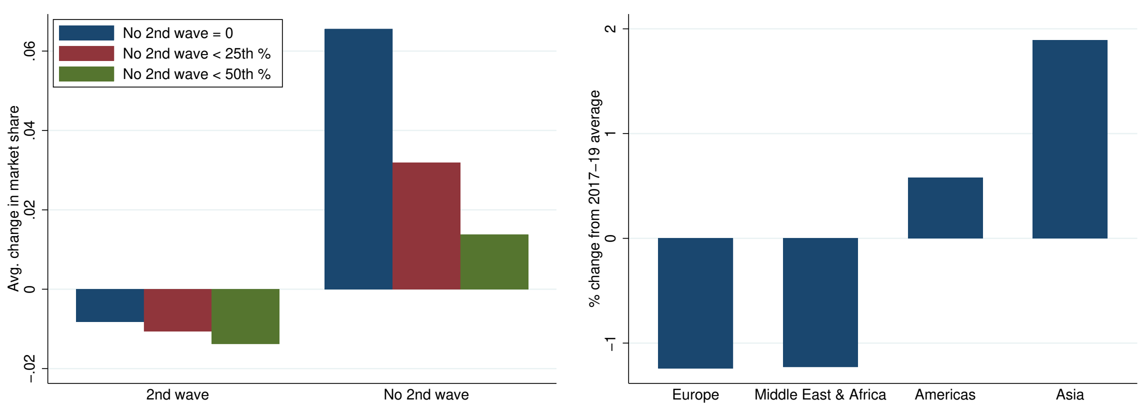
5.2.2 Reallocation of import markets shares

Finally, we are interested in the question whether the differential pandemic experience of countries has led to a systematic reallocation of import market shares. To investigate such a relationship, we distinguish countries based on their experience of a "second wave".[21]

Descriptive patterns. To define a second wave, we consider the daily information from OxCGRT and compute each country's peak in 7-day incidence rates of reported cases within the first 150 days of 2020. We next look at their respective incidence rates during the remaining days of the year and count each day where the 7-day average exceeds its early peak. Finally, we express the prevalence of a second wave as the fraction of these remaining days where a country's incidence rates exceeded that of its first peak to obtain a normalized measure. To account for the fact that countries with very low number of cases throughout the year are not over-represented, we multiply the obtained fraction by their average annual incidence rate.

Figure 5: Market share reallocation during the pandemic

(a) By 2nd wave (b) By region



Note: Authors' calculations. Panel (a): Graphs displays the average change in market shares in 2020, relative to the pre-pandemic average (2017-2019). Countries are split into two groups based on the prevalence of a second wave, using alternative definitions. Second wave is defined as incidence rates exceeding peak that was reached during first 150 days of 2020, weighted by "fraction of days on which first peak was exceeded and the corresponding population-weighted number of reported cases". Blue-colored bars define 'No 2nd wave' as countries, which did not exceed the first peak in the second half of 2020. The red and green-colored bars define 'No 2nd wave' as countries, which had a second wave that is below the 25th-percentile and 50th-percentile, respectively. Panel (b): observed change in import market shares by region.

We identify countries that did not face a second wave using three alternative thresholds. The most stringent one requires a fraction of zero, while the next two consider the lowest

[21]Recall that we highlighted regional differences along this dimension already in Figure 1(b).

quartile and the median country respectively. Using this classification, Panel (a) in Figure 5 illustrates that countries with no second wave gained relative market share (on average), while countries with a stronger second wave lost market shares. This difference appears to be more pronounced, the stricter our measure to distinguish the countries in our sample: When we split the sample between countries that never exceeded their first peak and countries that did (blue bars), we observe that countries with no second wave increased their market share on average by 0.06 percentage points. Countries that never exceeded their first peak are for example Taiwan, China and Singapore. China gained the most market share with an 1.5 percentage point increase. Furthermore, the green bar indicates that countries with a second wave below the median gained on average 0.015 percentage points in market share, while countries with a stronger second wave above the median lost the respective amount. In overall terms, this implies that the group of countries without a second wave increased their market share by approximately 1.3 percentage points in total.

If we split Dutch trade partners into their respective regions, as done in Panel (b), we observe that Asian economies can be identified as the temporary winners of the pandemic. While the Asian region increased their market share by around 2 percentage points, the market share of both European and African countries decreased by more than 1 percentage points each. The Americas increased their market share by around 0.5 percentage points. However, these descriptive patterns do not shed light on the mechanism underlying the redistribution. In fact, contractions in market shares for Middle East might be plausibly explained by lower demand and the prevalence of oil exporters. Nevertheless, the reduction in market shares for European economies and the corresponding increase for Asia, might actually be driven by the supply-sided disruptions and trade partner substitution effects we have analyzed above.

Econometric analysis. Following the descriptive patterns, we analyse the concrete mechanisms that drive the redistribution of market shares. Table A4 in the appendix displays the observed change in market shares for the top 30 trade partners of the Netherlands. Furthermore, it shows the estimated change in market shares, which can be attributed to supply-side disruptions caused by lockdowns. Those values are based on the coefficients of column (6) in Table 5, and the obtained difference in predicted market shares assuming no lockdowns had taken place (i.e. $EXP_i^{ASI}(t-1) = 0$ and $comp_{ik}(t-1) = 0$).

We can observe large discrepancies between the actual change in market shares and the estimated change in market shares due to lockdowns. For many trade partners, supply-sided disruptions captured by domestic and competitors' CCMs explain only a small fraction of the actual change or even go in the opposite direction. For example, China increased its market share considerably in 2020 (by 1.5 percentage points). However, our estimates indicate that in the absence of CCMs in China and its export-competing economies, market shares would have increased even more. This implies that China's relative expansion in the Dutch import market is primarily driven by demand forces and less by potential substitution effects of among suppliers. Despite resuming economic and trade activity in the 2nd half of 2020, China remained one of the countries with the strictest lockdown measures throughout the year, according to our data.

On the other hand, Germany, the second largest exporter to the Netherlands, benefited relatively from the lockdown measures. Supply-side disruptions are estimated to have led to an 0.43 percentage point increase of German market share. Nevertheless, the actual market share only increased by 0.3 percentage points, which implies a negative demand shock for German goods. Taiwan also gained from worldwide lockdown measures. 50% of its observed increase in market share can be attributed to supply-side disruptions.

In addition, we can distinguish the estimated lockdown effect between the direct effect caused by domestic lockdowns and the substitution effect caused by foreign lockdowns. These two effects are displayed in the last two columns of Table A4. For most countries, the direct effect explains the largest share of estimated changes. Nevertheless, some countries benefited relatively stronger from substitution possibilities. These mainly include European countries such as Belgium, France, Italy, Poland and the Czech Republic, but also Asian economies like Malaysia, Taiwan, Vietnam and Thailand.

The large discrepancies between observed and estimated changes indicate that changes in the relative import composition seem primarily demand-driven. This is also supported by the observation that the market share of predominately petroleum exporters such as Russia, Norway and Nigeria dropped considerably in 2020, despite the estimated supply-side change indicating an unchanged or increased market share for those countries in 2020.

To verify which mechanisms significantly impact the composition of trade partners, we regressed the observed changes of market shares in 2020 compared to the pre-pandemic period on supply and demand measures. Following the descriptive patterns, we use the existence of a second wave as an indicator for continuous supply-side disruptions in the source country. To measure demand-driven changes, we define a new variable, which aims to capture country-specific demand shocks in 2020.

$$demand_i = \underbrace{\left(\sum_{k=1}^{K} RCA_{ik} \times \hat{\gamma}_k \right)}_{\text{Demand shock exposure}} \times share_i \tag{8}$$

The variable $demand_i$ is based on pre-pandemic trade data (2017-19) and reflects the sum of a product, which multiplies the product-specific revealed comparative advantage (RCA) of a country with the estimated product-specific effect $\hat{\gamma}_k$ from equation (6).[22] The size of this effect is based on the specification in column (6) of Table 5 and captures a product-specific demand shock in 2020. We multiply the sum with the pre-pandemic import market share of the source country to ensure correct weighting.

Table 7 shows the results of a simple cross-sectional regression. In column (1), the change in market share is regressed on dummy variables indicating whether a country faced a "second wave". The first column shows that countries, which experience no second wave at all, increased their market share on average by 0.076 percentage points more than countries with a second wave. The coefficient is close to being statistically significant at the 10% level and is in line with the descriptive results in Figure 5. Column (2) shows that Asian economies gained systematically more market shares than countries from other regions, irrespective of any other characteristics. In column (3), we find that the change in countries' market shares is well explained by their exposure to demand shocks, as measured in Equation (8). Combining all measure in column (4) confirms this finding.

Column (5-6) also include additional interaction terms. The results in column (5) indicate that especially countries that experienced no second wave and had a positive demand exposure gained in market share. Column (6) draws a slightly different picture by including the initial import share of the trade partner as a proxy for production capacity. This specification infers that mainly countries with an high initial import share and no second wave were able to increase their market share in the Netherlands. This findings are inline with the observed increase in market concentration during 2020 displayed in table 6.

Although supply-side disruptions led to an substantial reduction of imports in absolute terms, our results suggest that changes in the market share are predominately driven by other forces. A large share of observed changes can be attributed to demand factors. Moreover, the initial import share of a sourcing country, which is used as a proxy for production capacity, was found to be an influential factor for a country's ability to gain market share relative to others. Nevertheless, countries without a second wave did gain relatively more market share than countries which struggled with the pandemic. Mainly countries without a long-lasting and production-hindering pandemic were able to realise their positive demand exposure or large production capacity into actual market share gains.

[22] The revealed comparative advantage is specific for exports to the Netherlands and is calculated following the mathematical definition: $\frac{M_{ik}/M_I}{M_K/M}$, where i (I) denotes one (all) source countries and k (K) denotes one (all) HS6-products.

Table 7: Determinants for changes in market shares

Dep. var.: Δs_i	(1)	(2)	(3)	(4)	(5)	(6)
No 2nd wave = 1	0.076			0.052	0.035	-0.025
	(0.048)			(0.049)	(0.042)	(0.042)
Asia = 1		0.071^a		0.060		
		(0.039)		(0.040)		
Demand exposure			0.039^{**}	0.039^{**}	0.022^a	0.025
			(0.015)	(0.015)	(0.013)	(0.022)
Initial share (capacity/size proxy)						-0.016
						(0.011)
No 2nd wave × Demand					0.569^{**}	-0.078
					(0.079)	(0.164)
Initial share × Demand						0.001
						(0.004)
No 2nd wave × Initial share						0.115^{**}
						(0.025)
Observations	180	180	180	180	180	180
R-squared (adjusted)	0.014	0.019	0.037	0.062	0.268	0.328

Note: Table reports the average estimated effect of supply and demand measures on changes in market shares for the 180 trade partners of the Netherlands. The dependent variable is the observed change in market share in 2020 in comparison to the pre-pandemic period 2017-19. 'No 2nd wave' is defined as countries, which did not exceed the first peak in the second half of 2020. In column (2), Asia is a dummy variable, which is one if the source country is from Asia. In column (3), the independent variable is defined following equation (8). Statistical significance: ^{a} $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

6 Conclusion

Combining monthly product-level trade data between 2017 and 2020 for the Netherlands with information on the timing and stringency of coronavirus containment measures (CCMs) in source countries, we investigate how the value and trade-partner composition of Dutch imports developed throughout the pandemic. Our results suggests that up to two-thirds of the observed contraction in imports can be attributed to supply-side disruption due to foreign CCMs. We also find that more diversified import markets appeared significantly more resilient in the pandemic and that the overall reduction in imports was substantially cushioned by the possibility to switch source countries.

Moreover, two simultaneous phenomena were observable in the Dutch import market in 2020. Firstly, the pandemic led to a modest increase in market concentration, especially on the extensive margin. Secondly, a systematic reallocation of market shares occurred with Asian economies relatively expanding. While the first trend appears to be most likely temporary, an reallocation of market shares towards Asian economies might prevail as a result of their differential pandemic experience in the second half the year 2020. This would suggest that countries' approach in managing the COVID-19 pandemic with a strong focus on preventing recurring waves of outbreaks could benefit economically, in the short run, by taking over activities and market shares of economies that struggle to contain the virus. However, since most of the redistribution of market shares appears to be demand-driven, the long run effects might be different as preference structures return to their pre-pandemic equilibrium.

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A Appendix

Data on Government Response to COVID19

The individual indicators can be used to compute the so-called *Stringency Index* (SI) of the lockdowns in a country. Hale et al. (2020) describe a two-step procedure which we adopt also in this paper. We first harmonize the individual indicators v_{jt} by converting them into subindices $I_{jt} \in [0, 100]$:

$$I_{jt} = 100 \times \frac{v_{jt} - 0.5(F_j - f_{jt})}{N_j}, \tag{A.1}$$

where v_{jt} is the observed value of indicator j at time t, which can take a maximum value of N_j on an ordinal scale. F_j indicates whether the indicator distinguishes between country-wide and geographically focused regulations. If there exists such a distinction $F_j = 1$ (and $F_j = 0$ otherwise). The variable f_{jt} indicates whether the particular CCP measure j is applied in the whole country (in which case $f_{jt} = 1$) or only in a part of the country (in which case $f_{jt} = 0$). In the second step, subindices I_{jt} are combined to compute the composite index as the simple average of all $j \in J$:

$$I_t = \frac{1}{J} \sum_{j}^{J} I_{jt}. \tag{A.2}$$

The general SI published by OxCGRT considers all eight CCP sub-indices, as well as the *Health System Policy* indicator H1 (i.e., governments' activity in launching information campaigns about the coronavirus).

Sub-indicators vary on an ordinary scale of different length (see Table A1).[23] A value equal to zero means that no measures were taken (in case of missing information no value is reported). Normally, a value equal to 1 corresponds to recommendations, while higher values reflect partial or full enforcement of a policy. The data starts on January 1st, 2020, when only China and a handful of other countries reported any government actions (which were related mainly to health system policies, including public information campaigns, testing and contact tracing).[24] Since then it reports daily records of the different indicators and composite indices for 185 countries.

In Figure A1 we report the evolution of the eight CCP indicators up until 31 August 2020.[25] We can observe differences in both timing and dispersion of stringency across coun-

[23] The following website publishes original and updated descriptions of the indicators: https://github.com/OxCGRT/COVID-policy-tracker/blob/master/documentation/codebook.md.

[24] Early responses are reported for eight countries: Botswana, Brunei, Canada, China, Hong Kong, Macao, Mongolia, and Slovak Republic. As the only country, Hong Kong adopted CCP via international travel controls (C8) by screening arrivals.

[25] More recent records are available but incomplete. Going one week back from the most recent date

Table A1: OxCGRT Indicators for Containment and Closure Policies

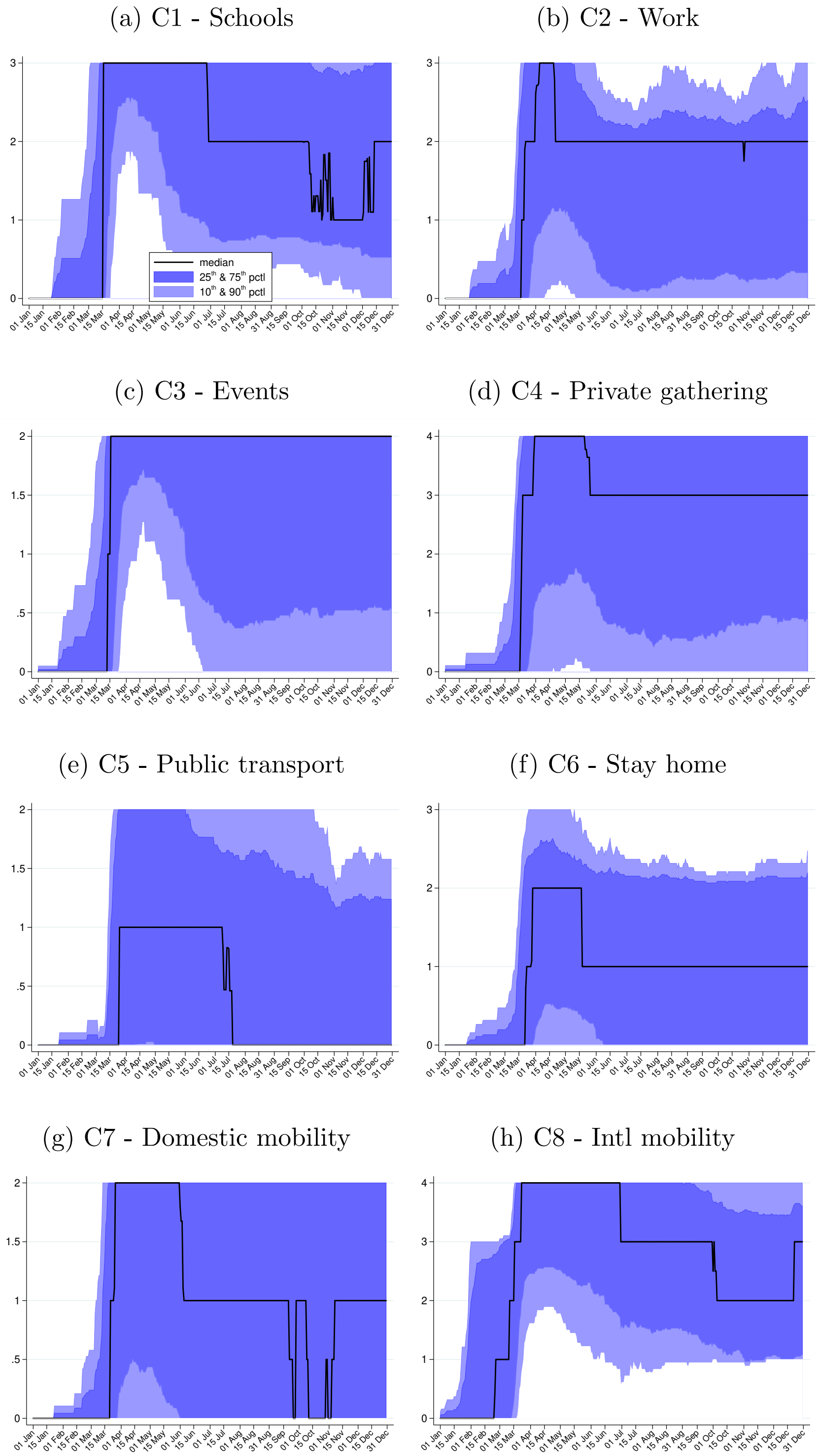
Indicator name and description	Coding - ordinal scale
`C1_School closing`: closing of schools and universities	0 (no measures) 1 (recommended) 2 (enforced, partial) 3 (enforced, full)
`C2_Workplace closing`: closing of workplaces (or work from home)	0 (no measures) 1 (recommended) 2 (required, partial) 3 (required, full - exc. essential)
`C3_Cancel public events`: canceling public events	0 (no measures) 1 (recommended) 2 (required, full)
`C4_Restrictions on gathering`: limits on private gatherings	0 (no measures) 1 (large only; $> 1,000$ people) 2 (medium sized; 101-$1,000$ people) 3 (small gatherings; 11-100 people) 4 (almost any; < 10 people)
`C5_Close public transport`: closing of public transport	0 (no measures) 1 (recommended; incl. limited operations) 2 (required; mostly prohibited)
`C6_Stay at home requirements`: order to "shelter-in-place" and otherwise confine to the home	0 (no measures) 1 (recommended) 2 (required, partial; essential only) 3 (required, strict; minimal exceptions)
`C7_Restrictions on internal movement`: Ristricted internal movement between cities/regions	0 (no measures) 1 (recommended) 2 (required)
`C8_International travel controls`: Restrictions on international travel (for foreign travellers, not citizens)	0 (no restrictions) 1 (screening arrivals) 2 (quarantine some arrivals; specific regions) 3 (ban some arrivals; specific regions) 4 (ban on all arrivals; total border closure)

Note: Indicator name and descriptions adapted from OxCGRT Codebook version 2.2. All indicators are supplemented with an additional binary variable flagging whether policy applies generally (country wide) or with geographic scope.

tries and indicators. Restrictions for schools, public events and international border crossings were most widely applied between the end of March and the beginning of May. Since then a sizable group of countries began to relaxations these and other restrictions. Nevertheless, the median lines indicate that many restriction remain widely applied, including school, workplace closings and international mobility. Intra-national mobility, however, has largely been restored and most countries allow their citizens to leave their home, us public transport or travel within their country.

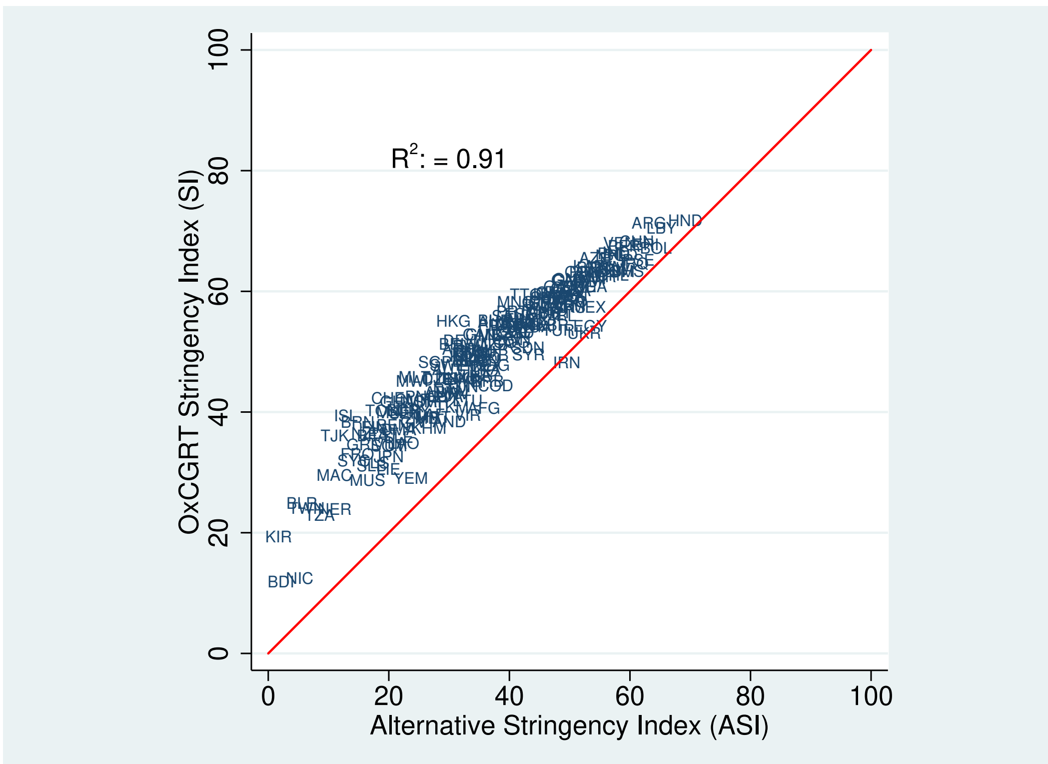
reported delivers information for about half of the countries in the sample. The dataset is almost complete for records dating back 2-3 weeks from the most recent release date.

Figure A1: Timing and strictness of 8 CCPs applied across countries



Note: Author's calculations based on OxCGRT data. Sample size can vary on daily basis and across indicators between 177 and 185.

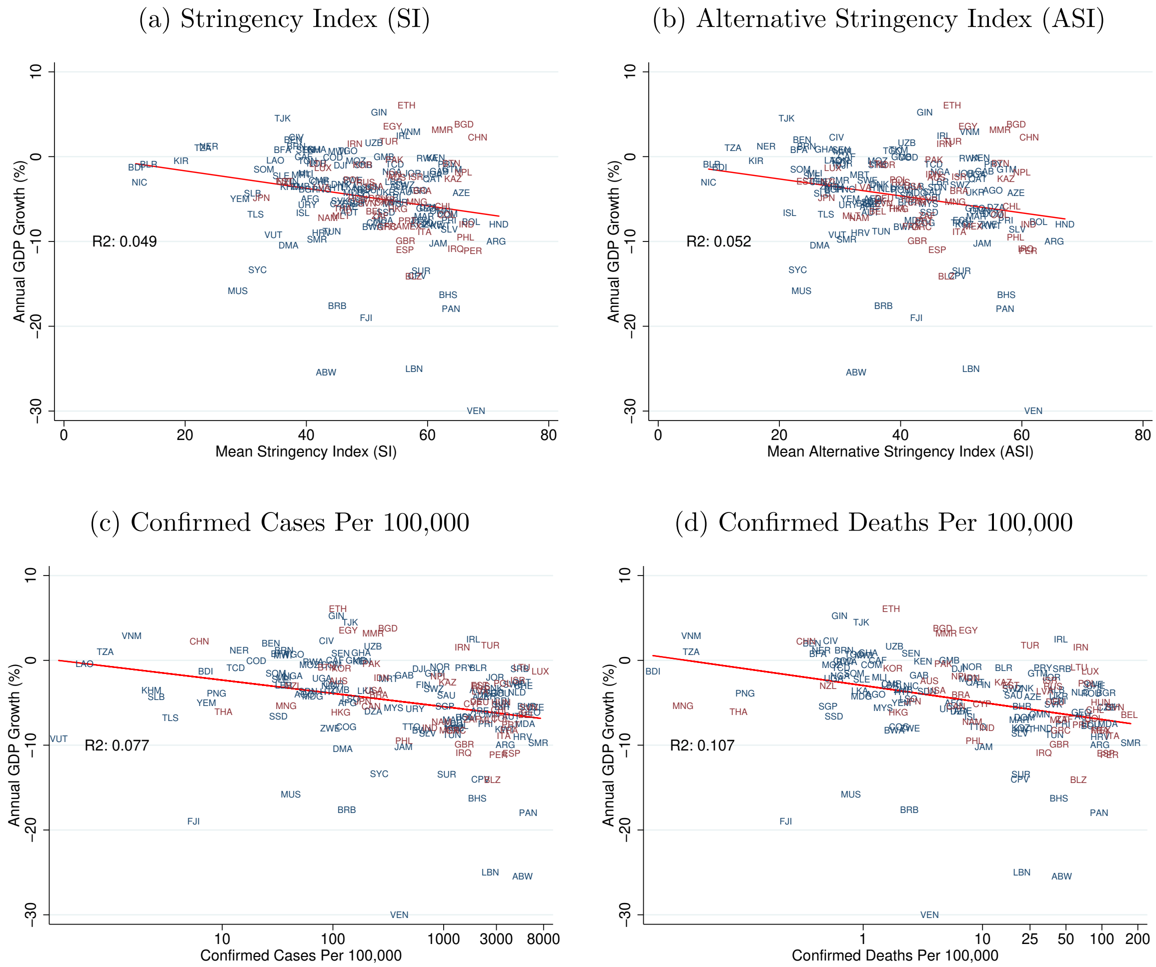
Figure A2: Standard and Alternative Stringency Index



Note: Author's calculations based on OxCGRT data for 185 countries and average index observations between 01 January and 31 August 2020. The Standard Stringency Index (SI) is based on subindices C1-C8 and H1. The Alternative Stringency Index (ASI) only uses C1-C2 and C5-C8. Red line indicates 45-degree line.

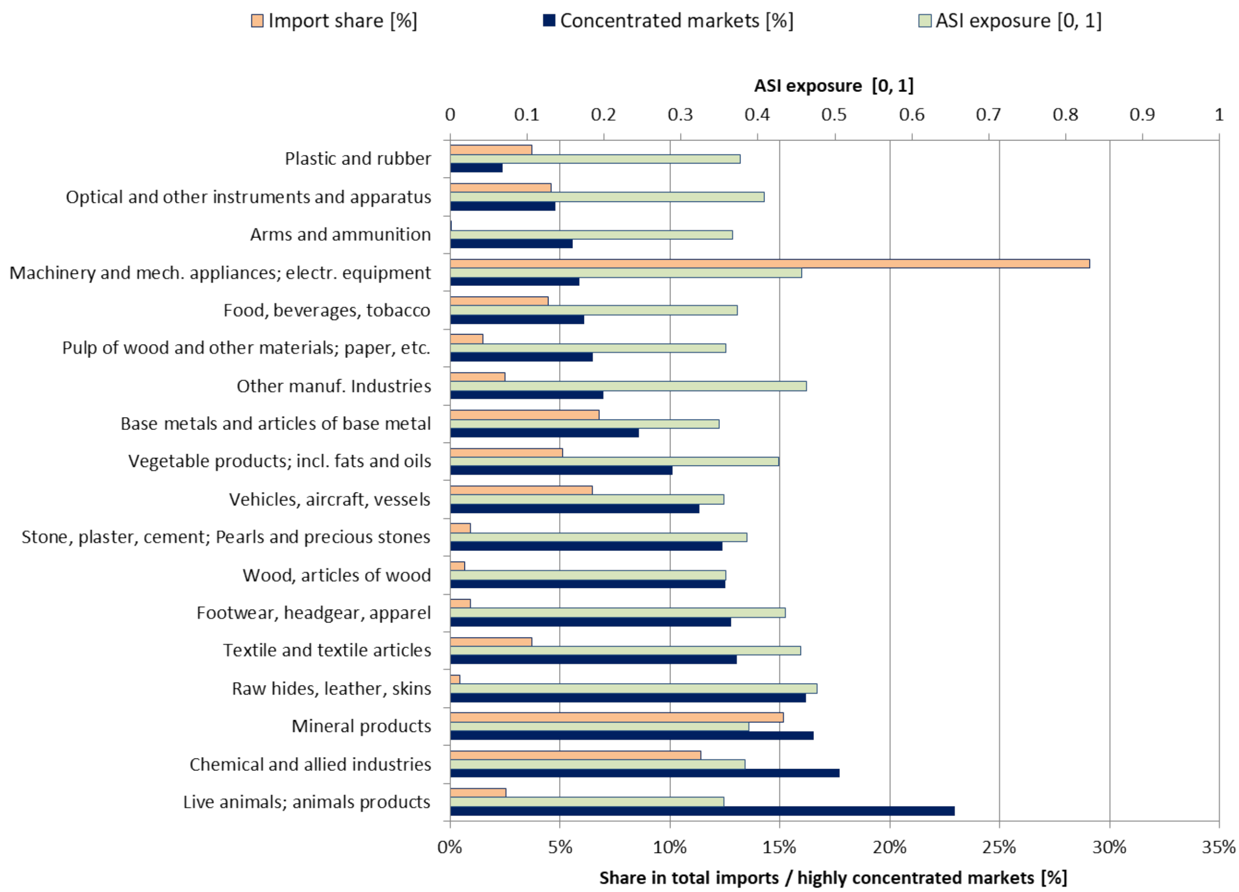
Additional descriptives and empirical results

Figure A3: Annual real GDP growth versus pandemic indicators across countries (2020)



Note: Authors' calculations based on data from the IMF, World Bank and OxCGRT. Stringency Indices were calculated following (A.2). Confirmed COVID-19 cases and deaths were taken from the OxCGRT data and normalised based on World Bank population data in 2019. GDP growth is based on data from the IMF Economic Outlook April 2021. Red countries are based on actual data, while blue countries represent IMF estimates for 2020. Extreme outliers, i.e. countries with GDP growth three standard deviations away from the mean GDP growth, were excluded from this figure.

Figure A4: Average exposure and import market shares by industry



Note: Authors' calculations based on Eurostat data (DS-016893), accessed 07 April 2021. Figure displays average import market shares of sector in total imports (pre-pandemic). Fraction of concentrated markets reflects percentage of HS6 product lines, where market share of top-supplier exceeds 67%. ASI exposure reflects average product level exposure within sector throughout 2020.

Table A2: Import response to foreign lockdowns, alternative measures

Dep. var.: log imports ($\ln M_{kt}$)	(1)	(2)	(3)	(4)	(5)	(6)
Pandemic measure	Deaths per 1000		Cases per 100			
Sample period (2020)	Jan-Dec		Jan-Dec		Jan-Jun	
$EXP_k(t-l)$	-0.569**	-0.575**	0.025[a]	0.027*	-1.557**	-1.583**
	(0.056)	(0.056)	(0.013)	(0.013)	(0.100)	(0.100)
HS6×month-FE	✓	✓	✓	✓	✓	✓
HS6×yr2020-FE	✓	✓	✓	✓	✓	✓
Aggregate trend	✓		✓		✓	
HS6 pre-trend		✓		✓		✓
Observations	242,092	241,942	242,092	241,942	211,511	211,447
Clusters (HS6)	5,244	5,232	5,244	5,232	5,239	5,232

Note: Table reports the average estimated effect of COVID-19 related deaths and cases in source countries on (log) Euro values of products imported by the Netherlands. Data on COVID-19 cases and deaths were taken from the OxCGRT dataset. Deaths and cases are given per 100 and 1000 inhabitants, respectively. The underlying sample consists of monthly observations from Jan. 2017 through December 2020 and features HS6 product categories included in HS2 chapters 01 through 97. Standard errors adjusted for clustering at HS6-product level are reported in parentheses below the estimated coefficients. Statistical significance: ^{a} $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

Further evidence from mobility data. Our disaggregated sample allows us to implement a further robustness check that uses an alternative measure of lockdown stringency. Similar to the early work of Espitia et al. (2021), we run our disaggregated specifications using monthly Google mobility data as a proxy for foreign supply-side disruptions. The data is provided by the COVID-19 Global Community Reports and covers 132 countries.[26] While it covers most of the trade partners of the Netherlands, it does not include China, which is a major supplier, accounting for 15-17% of imports during our sample period. A specification in the aggregate or including a competition shock is therefore not suitable and we consider the following results with caution.

Table A3 displays the results of equation (6) using mobility data but excluding the competition shock variable. The signs of the coefficients confirm our previous findings; a decrease in mobility, especially work mobility, results in lower exports to the Netherlands. Quantifying the results of the baseline specification in column (5) and taking the average reduction in work mobility in 2020, both bilateral and aggregate exports decreased by around 6-7% due to limited mobility in the foreign economy. Interestingly, the interaction term for the second half of 2020 still indicates that the effect became smaller over time. Firms were therefore able to adapt to the new situation over time and resume economic activity despite similar mobility restrictions.

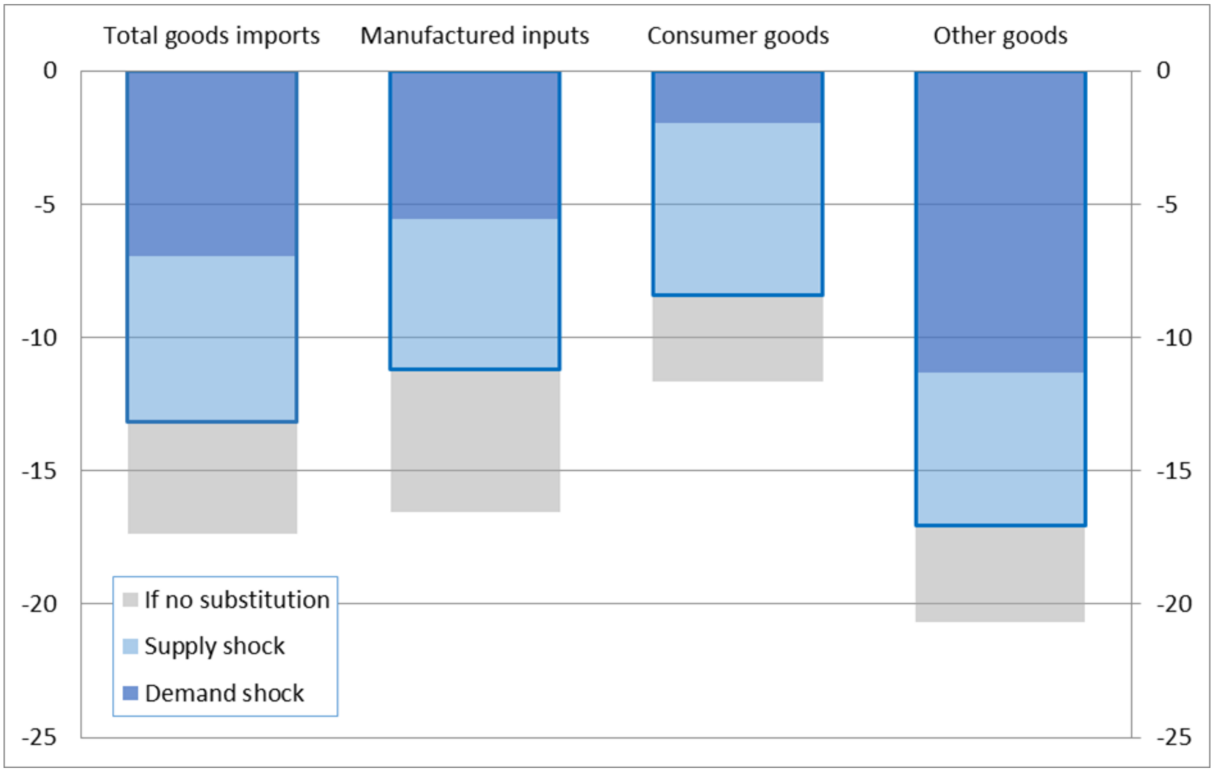
[26] Available at: `https://www.google.com/COVID19/mobility/`.

Table A3: Bilateral import responses to foreign lockdowns, alternative indicators

Dep. var.: log imports ($\ln M_{ikt}$)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Foreign lockdown timing	contemporaneous ($l = 0$)				lagged ($l = 1$)			
Panel A: Average Mobility								
$EXP_i^{AVG}(t-l)$	0.445**	0.516**	0.382**	0.576**	0.503**	0.528**	0.463**	0.618**
	(0.015)	(0.022)	(0.018)	(0.019)	(0.015)	(0.021)	(0.018)	(0.020)
$\times k =$ input		-0.149**				-0.052[a]		
		(0.031)				(0.031)		
$\times k =$ consume			0.208**				0.130**	
			(0.033)				(0.033)	
$\times t =$ 2nd half '20				-0.281**				-0.239**
				(0.026)				(0.028)
Panel B: Work Mobility								
$EXP_i^{WORK}(t-l)$	0.376**	0.417**	0.341**	0.441**	0.382**	0.365**	0.382**	0.440**
	(0.015)	(0.021)	(0.019)	(0.016)	(0.015)	(0.021)	(0.019)	(0.016)
$\times k =$ input		-0.086**				0.035		
		(0.031)				(0.031)		
$\times k =$ consumer			0.115**				-0.001	
			(0.032)				(0.032)	
$\times t =$ 2nd half '20				-0.277**				-0.263**
				(0.019)				(0.020)
HS6-country × month FE	✓	✓	✓	✓	✓	✓	✓	✓
HS6 pre-trend	✓	✓	✓	✓	✓	✓	✓	✓
HS6 shock 2020	✓	✓	✓	✓	✓	✓	✓	✓
Observations	5,681,489	5,681,489	5,681,489	5,681,489	5,681,519	5,681,519	5,681,519	5,681,519
Clusters (HS6)	5,183	5,183	5,183	5,183	5,183	5,183	5,183	5,183

Tables reports the average estimated effect of COVID-19 related lockdowns in source countries, as measured by Google mobility data, on (log) Euro values of bilateral products imports by the Netherlands. Average mobility describes the simple average of all mobility sub-indicators, while work mobility refers to the specific workplace sub-indicator. Additionally, interaction terms with the independent variable are included to investigate potential heterogeneous effects. Intermediate and consumer goods are defined based on their BEC-class following the definition of the UN Statistical Division. Standard errors adjusted for clustering at HS6-product level are reported in parentheses below the estimated coefficients. Statistical significance: [a] $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

Figure A5: Estimated contraction in Dutch imports in 2020, by type of shock (in %)



Note: Authors' calculations based on data from Eurostat. The contractions are given for aggregate imports based on the coefficients of column (3-5) of Table 5. Demand and supply shock sum up to the observed reduction in imports for the respective product group. The contraction associated to the supply shock is the difference between the estimated aggregate imports and the estimated aggregate imports in the counterfactual of no lockdowns (setting ASI_{it} and $comp_{ikt}$ to 0). The bar "if no substitution" is determined by the difference between the counterfactual of only domestic lockdowns (setting $comp_{ikt}$ to 0) and the counterfactual of no lockdowns (both 0).

Table A4: Top 30 trade partners - Observed change in market shares vs. estimated change in market shares due to lockdowns

Country	Market share	Obs. change	Est. change due to lockdowns		
	2017-19	2020	Overall	Direct	Substitution
China	16.50	1.50	-1.24	-0.88	-0.39
Germany	15.04	0.306	0.432	0.431	0.003
Belgium	8.49	-0.228	0.222	0.186	0.036
United States	7.43	0.392	-0.138	-0.075	-0.057
United Kingdom	5.02	-0.813	-0.034	-0.063	0.036
Russia	3.88	-1.471	0.051	0.065	-0.012
France	3.35	-0.245	0.051	0.023	0.029
Italy	2.07	0.149	0.002	-0.029	0.032
Norway	1.95	-0.498	0.069	0.068	0.001
Japan	1.94	-0.045	0.107	0.097	0.009
Poland	1.82	0.139	0.053	0.032	0.021
Spain	1.77	-0.010	0.010	-0.005	0.015
Ireland	1.51	0.342	-0.016	-0.033	0.019
Sweden	1.41	-0.023	0.038	0.041	-0.002
Malaysia	1.28	0.530	0.013	-0.007	0.021
South Korea	1.17	-0.071	0.020	0.016	0.004
Brazil	1.16	-0.094	-0.049	-0.035	-0.014
Taiwan	1.14	0.230	0.133	0.100	0.029
Czech Republic	1.12	-0.042	0.058	0.034	0.023
Vietnam	1.02	0.329	0.017	-0.016	0.033
Switzerland	0.95	0.577	0.068	0.056	0.011
Israel	0.94	-0.086	-0.056	-0.025	-0.033
Thailand	0.92	-0.014	0.030	0.014	0.017
India	0.86	-0.095	-0.017	-0.026	0.011
Turkey	0.84	0.027	-0.004	-0.012	0.009
Singapore	0.81	-0.142	0.024	0.017	0.007
Denmark	0.81	0.135	0.027	0.015	0.012
Finland	0.80	0.018	0.035	0.039	-0.004
Nigeria	0.76	-0.197	0.002	-0.005	0.008
Indonesia	0.71	-0.047	0.006	0.003	0.003
Total	87.49	0.554	-0.083	0.026	-0.004

Note: Authors' calculations based on data from Eurostat. Table displays the top 30 trade partners of the Netherlands based on import market shares in 2017-19. The estimated changes in market shares are based on the coefficients of the specification in column (6) of Table 5. Column (4) displays the difference in market shares estimated by the specification vs. the estimated market shares in the counterfactual of no lockdowns (setting ASI_{it} and $comp_{ikt}$ to 0). Column (5) shows the difference between the counterfactual of only domestic lockdowns (setting $comp_{ikt}$ to 0) and the counterfactual of no lockdowns (both 0); column (6) between the counterfactual of only foreign lockdowns (setting ASI_{it} to 0) and the counterfactual of no