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Agri-food importing firms amid a global health crisis

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ABSTRACT

This paper exploits daily customs transaction data on the universe of Swiss agri-food importing firms to assess the response of firms to a global shock. Estimating a linear model that regresses product-level import margins on daily COVID19 shocks and a host of fixed effects, we find that the pandemic had a substantial trade-reducing effect on imports. The trade effects were driven mainly by a reduction in the number of importing firms (i.e., 63% of the total effect), and much less by the number of products imported and the average import value per product per firm. We explore several sources of heterogeneity and show, among others, that larger and incumbent firms were affected more by the trade adjustments. Our results also reveal that the relative contribution of each import margin to the decline in aggregate imports depends on the level of data aggregation (i.e., daily, weekly or monthly). Finally, we validate and confirm our main findings by testing two mechanisms: (i) third-country supply-side effects using insights from structural gravity models and (ii) changes to consumer demand using consumer mobility, and retailer and consumer scanner data.

1. Introduction

This century has seen many multi-country epidemics affecting the health of humans — e.g., SARS, MERS, Ebola — and animals — e.g., avian flu, mad cow disease, African swine fever (Anderson, 2022). These epidemics restructured agricultural trade, exposed the sector to tighter standards and regulations, and disrupted trade at the country-product level (Nicita, 2008). Yet, as these epidemics were more local than global, importers could reallocate market shares to countries not affected by the epidemic. This was not the case for the recent global SARS-CoV-2 virus (henceforth, COVID19) pandemic. First, the global nature of the COVID19 shock meant firms in all parts of the world were directly affected by the pandemic along multiple channels. These included supply- and demand-side effects, financial constraints and increased uncertainty. In particular, the direct impact of the pandemic on firms occurs when workers lose their jobs or become incapacitated leading to lower firm productivity (Pabilonia et al., 2022). Firms also faced changes in demand for certain products due to domestic demand shifts, reduced incomes (ILO, 2020) and supply disruptions in production regions. Second, the public policy response to slow down the spread of the virus also affected firm-level activity. Restrictions on movement created transport disruptions and delays. Ships and trucks were quarantined. Commercial flights, which also convey many high-value agricultural products, were cancelled. These reduced ground fleets and increased product delivery times. Seasonal workers were unable to move to production sites due to travel bans and border closures. Then there were social distancing orders which reduced the number of import inspectors at borders and the number of employees working within a firm at a time (OECD, 2020).

These disruptions are especially detrimental in the agricultural sector given the perishable nature of agricultural and food products. Yet, the margins of agri-food trade adjustment to the pandemic at the firm level remain unclear. Our contribution seeks to assess how importing firms adjusted to the COVID19 shock and its containment measures. Understanding how the pandemic affected importing firms and which margins of their import decisions adjusted the most and why is crucial for policymakers to sustain food security in future global crises. This is relevant because changes in firm performance may result from idiosyncratic shocks or from idiosyncratic reactions to common shocks affecting all firms. While the former channel has been analysed (e.g., Movchan et al., 2020; Shepotylo et al., 2022), we have little evidence for the second channel (Bricongne et al., 2022). However, the answers to these questions are not straightforward but depend on the relative dominance of the supply and demand effects of the pandemic and containment measures. For instance, the demand for imported agri-food products could reduce due to a reduction in domestic income or changes in consumer demand caused by the pandemic and containment measures. Conversely, the pandemic and containment measures could

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also decrease domestic agri-food production (i.e., a supply effect), which could potentially increase import demand for these products, for a given level of domestic demand. If the demand effect dominates the supply effect, then the impact of the pandemic on agri-food imports is expected to be negative. The reverse is true if the supply effect dominates the demand effect.

In this paper, we exploit daily customs transaction data on the universe of Swiss agri-food importing firms to assess the effect of the spread of the COVID19 virus and the containment measures on agri-food imports. As a country with a low food self-sufficiency ratio, and a net importer of agricultural products (Ferjani et al., 2018), Switzerland offers a good case to assess the reaction of agri-food importing firms to the crisis. Our rich high-frequency data enable us to separately identify the direct and indirect effects of the pandemic on imports while accounting for confounding factors using high dimensional fixed effects. Specifically, we decompose daily product level imports into two extensive margins (i.e., the number of firms importing on a day and the number of unique HS8 digit products imported per day) and one intensive margin (i.e., the average import value per product per firm) following Bernard et al. (2007). We then estimate a linear model that regresses the different import margins on daily COVID19 shocks (which we measure as daily case counts), a variable capturing the policy response to the shock, tariffs and a host of fixed effects. Our identification assumption is that the COVID19 incidence rates are exogenous to importing firms.

We find that the pandemic directly led to a reduction in agri-food imports, for a given level of COVID19-related policy stringency within a week. Specifically, a 10% increase in daily domestic COVID19 case counts decreases daily product-level imports by 3%. The negative effect is driven mostly by a decrease in the number of importing firms (i.e. 63% of the total effect), and comparatively less by the average import values per firm or the number of products imported. However, these average effects mask several sources of heterogeneity in the data set. At the sector level, we find that (near-)finished consumer goods were affected more by the pandemic, with intermediate inputs for further manufacturing and processing relatively more insulated. Both small and large importing firms were affected by the crisis. Yet, consistent with related evidence from French data (Bricongne et al., 2022), we find that the largest importing firms suffered more from the effect of the pandemic. We also find that the reduction in trade and the margins were driven mainly by incumbent firms. On the other hand, the containment measures had a positive but minimal effect on imports.

To gain further insights into the factors driving our findings, we test two mechanisms. First, given the global nature of the pandemic, we expect third-country supply-side effects to be at play. Estimating structural gravity models on weekly firm-origin-product level imports, we show that the pandemic-related incidences in other countries led to a decline in Swiss firm-level imports. This also meant an increase in firm-product level import prices. Second, we test a consumer demand-side effect. The pandemic and its related measures affected consumer behaviour, e.g., by reducing food-away-from-home expenditures (Beckman and Countryman, 2021). Since firms and consumers usually interact, we expect a shock to consumer behaviour to affect firm behaviour. Hence, we test how the pandemic affected consumer demand using daily Google mobility data (Aktay et al., 2020). We find a negative effect of the pandemic on visits to grocery shops and recreational centres which provides suggestive evidence of a decline in consumer demand. To confirm this suggestive evidence, we also use information from monthly consumer and retailer scanner data from Nielsen Schweiz (FOAG, 2021) and find that the pandemic indeed led to a decrease in consumer demand.

Our work contributes to the literature in several ways. First, we study the impact of the pandemic on trade using daily customs transaction firm-product-level data. A handful of existing studies have used monthly firm-level data from Colombia (Benguria, 2021), Portugal (Amador et al., 2021), Kenya (Majune and Türkcan, 2022) and France (Bricongne et al., 2022; Lafrogne-Joussier et al., 2022; Brussevich et al., 2022) to examine the effect of the COVID19 on trade and found negative effects. During the crisis, economic activity fell dramatically within a few days but also rebounded quickly after the first wave of lockdowns. Macroeconomic indicators, including trade data, are often released monthly or quarterly. This publication lag hinders their suitability to capture the dynamics of the COVID shock in a timely manner. Our daily firm-level import data allows us to capture changes in firm-level import activity closer to real-time. This is relevant because the COVID19 incident rates occur daily which meant it was important to monitor the impact of the pandemic using high-frequency data. Our findings also support this data requirement. Regardless of the data frequency, the elasticity of imports to the pandemic remains negative and statistically significant. However, the relative contribution of the import margins to the decline in aggregate imports depends on the level of data aggregation. At the daily level, the trade collapse was dominated by the extensive margin. At aggregate levels, the collapse was dominated by the intensive margin.

Second, by examining the trade effects of the pandemic on a firm size – defined based on the number of employees – we enhance our understanding of the role of large firms in international trade and why they react more to common shocks than smaller firms. Di Giovanni et al. (2020) show that the largest French firms are more sensitive to foreign shocks because they trade more while Bricongne et al. (2022) find that the top exporting French firms contributed disproportionately more to the trade collapse during the 2009 Great Financial Crisis and COVID19 pandemic because they exhibit a higher elasticity to foreign demand shocks. We test a potential mechanism linked to firm productivity, i.e., number of employees in a firm. Our findings show that firms that are large employers suffered more from the negative trade effects of the pandemic. Since, at the macro level, large firms capture disproportionately large market shares and import multiple products from multiple sources (Manova and Yu, 2017), we corroborate our finding that large employers were affected more by the crisis using evidence from these alternative definitions of firm productivity and size.

Finally, our paper contributes to the literature that assesses the resilience of agricultural trade to the pandemic. Existing studies are limited to the country level. Arita et al. (2022) offer an early empirical assessment of the trade effects of the pandemic, Engemann and Jafari (2022) provide a descriptive analysis of the changes in agri-trade values and Ahn and Steinbach (2022) assess the trade effects of temporary non-tariff measures introduced in response to the pandemic. However, the magnitude and channels of the agricultural trade effects of the pandemic at the firm level are not yet clear. This is important because while countries as an aggregate may have been affected relatively less than expected by the pandemic, this is not necessarily the case for firms. Early works on the pandemic (Bartik et al., 2020; Crane et al., 2022) find that firms closed temporarily or exited some markets completely during the first year of the pandemic. Thus, we provide the first analysis of the trade effect of the pandemic in the agricultural sector using detailed firm-product data.

The rest of the paper is structured as follows. Section 2 presents the data sources and stylised facts. We discuss the conceptual framework and outline the empirical strategy in Sections 3 and 4, respectively. We present and discuss the results in Section 5, followed by an analysis of the potential mechanisms driving the results in Section 6. In Section 7, we conduct robustness checks and offer conclusions in Section 9.

2. Data and stylised facts

2.1. Firm-level agriculture and food imports

Our analysis is based on Swiss firm-level customs transaction data covering the entire universe of agriculture and food-importing firms (i.e., firms importing products within the HS01 to HS24 group) between

Table 1
Swiss agri-food firms and their importing characteristics.

	Origins	Products	Firms	Import value		Origins/firm
				Mean	Median	
Panel a: distribution across years						
Year						
2019	190	2075	26857	5029	386	2
2020	189	2068	28893	5051	365	2
2019 & 2020	196	2292	39535	5041	375	2
Panel b: distribution based on firm structure						
Firm size						
<10 employees	187	2059	30319	2063	156	2
10–49 employees	177	1827	6196	4962	520	3
50–249 employees	169	1754	2827	7091	813	4
>249 employees	161	1690	1195	10000	1385	6

Notes: Origin is the number of countries the firms import from. Products are the number of imported HS8 products. Firms are the number of unique importing firms. Mean is the average import value. The median is the median import value. Origins/firm is the average number of countries a firm imports from. The mean and median values are in Swiss Francs (CHF). Panel b is based on data for both 2019 and 2020.

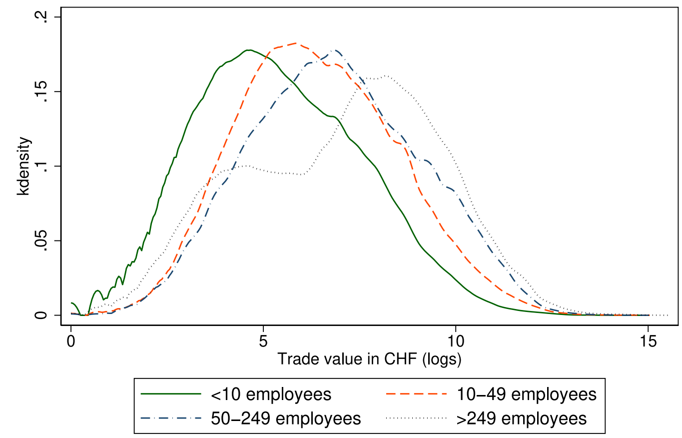


Fig. 1. Imports by firm size.

2019 and 2020. For each import, the data records the day of the transaction, the product classification at the HS8 digit level, the country of origin, the import value in Swiss Francs (CHF), the import volume in kilograms (kg), the most-favoured-nation (MFN) specific tariff applied in CHF/kg and the number of people employed by the firm. There are 39,535 unique firms importing 2292 HS8 digit products from 196 different countries across the years. See Table A1 for a full list of origin countries. There are also some notable differences across the two years. Panel (a) of Table 1 provides a summary of selected variables for each year and for both years.

Figure A2 provides an overview of the structure of Swiss agriculture and food imports in terms of values over the study period. They are dominated by beverages (HS22), fruits and nuts (HS08), coffee (HS09), food preparations (HS18, HS19, HS21) and vegetables (HS07). This distribution will help us understand any potential sector-specific effects that may be present in our empirical findings.

2.1.1. Firm structure

The firm-level data we use contains information on four firm groups defined based on the number of people employed by each firm. Panel (b) of Table 1 provides the distribution of the selected variables using data for both 2019 and 2020. As can be seen, 77% (30,319 out of 39,535) of the firms employ less than 10 people. Also, the number of countries that firms import from and the number of products they import decreases with increasing firm size. This is not surprising because the number of participating firms is also disproportionately skewed towards those with a smaller number of employees. The average and median import values and the number of product origins per firm are, however, increasing with increasing firm size.

A kernel density plot of the distribution of imports by firm size is presented in Fig. 1. Despite their relatively smaller number (i.e., only 3% of the sample of importing firms), the large firms – i.e., those with >249 employees – account for 43% of total imports. We see that firm structure, specifically, firm size (here measured by the number of employees), matters for imports. For Swiss agri-food exporting firms, a similar pattern is observed (Fiankor, 2023).

2.1.2. Decomposing swiss imports into different margins

On aggregate, Swiss agricultural imports did not change much during the pandemic. To depict observed trade patterns prior to and during the pandemic, Panel (a) of Fig. 2 shows weekly cumulative firm-level import values in Switzerland. We see that at the onset of 2020, agricultural import values hovered around 2019 values. This changed dramatically in mid-March when the pandemic reached Switzerland. While our focus here is on the agricultural sector, the dramatic drop in Swiss imports is also reported for all goods (Büchel et al., 2020). Nevertheless, import volumes surged again towards the end of the year.

However, it is not enough to look only at the aggregate import levels since different margins of trade may respond differently to trade costs. To assess the different margins of trade adjustment, we follow Bernard et al. (2007) and express total Swiss imports of HS6 digit product p on day t summed across firms, HS8 digit products and origins (X_{pt}) into extensive and intensive margins as shown in Eq. (1):

$$X_{pt} = F_{pt} \times P_{pt} \times \bar{X}_{fpt} \quad (1)$$

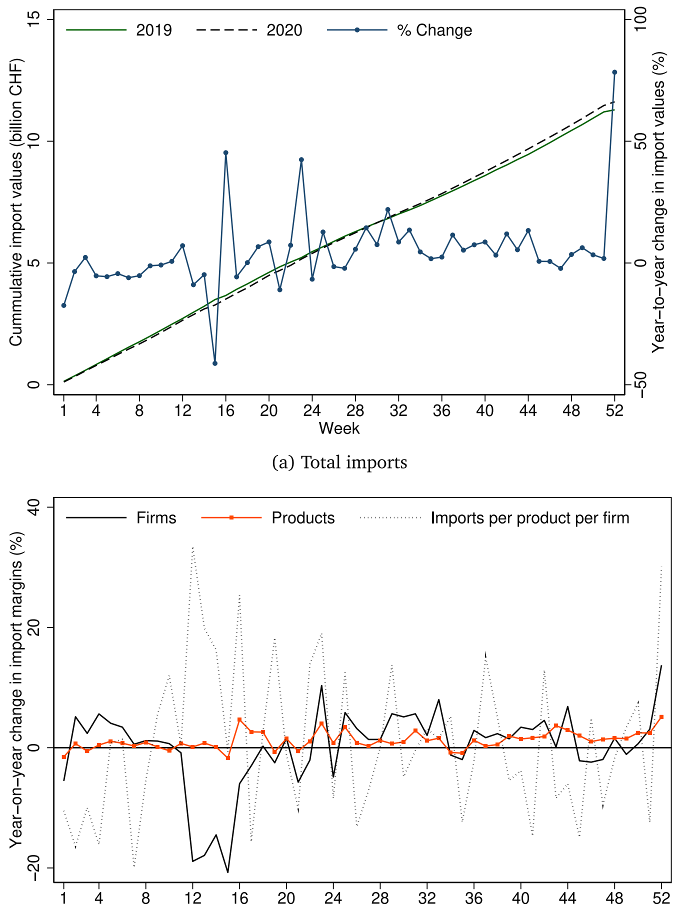
where F_{pt} is the number of active importing firms, P_{pt} is the number of imported products and $\bar{X}_{fpt}$ is the import value per product per firm.

As an initial exploratory analysis, we depict year-on-year changes in the three trade margins (as generated from Eq. (1)) between 2019 and 2020 in Fig. 2. We see variations over time. The number of products imported per firm remained rather stable over the course of the year. This was not the case for the number of importing firms which even though started the year higher than 2019 levels, dropped substantially within the initial stages of the pandemic before returning to pre-pandemic levels. The average import per product per firm was also very erratic over the course of the year. Our analysis assesses how daily COVID19 shocks influence the daily year-on-year changes that are observed here.

2.2. COVID19 incident rates

In Switzerland, the first case of COVID19 was confirmed on 25 February 2020 (Fig. 3). On March 16, the Swiss government declared an "extraordinary situation" – putting the nation into a semi-lockdown. At this point, the authorities banned all private and public events and closed restaurants, bars, leisure facilities and shops. They only kept grocery stores and pharmacies open. They also introduced border checks and entry restrictions for non-eligible people, while federal authorities stopped processing new work permits and halted the issuing of visas. As the COVID19 cases kept increasing, Swiss borders were finally closed on 24 March 2020. 16 weeks later on 15 June, a substantial step towards normalisation was taken, lifting restrictions on people entering Switzerland from Schengen countries. However, as the nationwide lockdown restrictions were gradually eased, the cantons[1] were able to impose their own restrictions. October 2020 saw a further rapid rise in new infections, in response to which the cantonal governments increasingly introduced more restrictive regulations. A second national lockdown

[1] Cantons are territorial divisions within the Swiss confederation. There are currently 26 Cantons in Switzerland.



(a) Total imports

(b) Import margins

Fig. 2. Decomposing Swiss imports into different margins of trade (2019–2020).

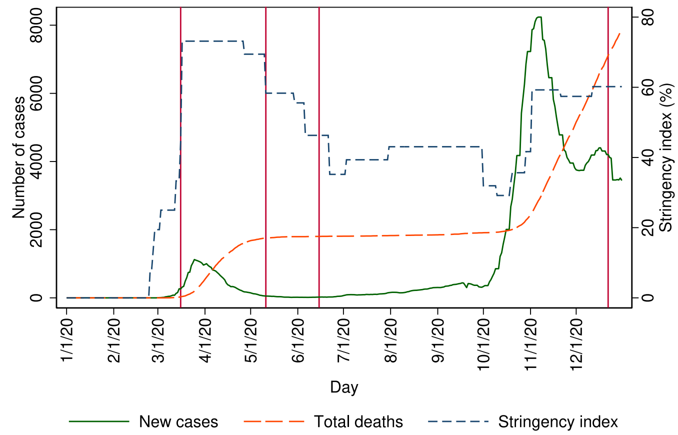


Fig. 3. Swiss daily COVID19 incident rates in 2020.
Notes: This graph also depicts key timelines in Switzerland. The four vertical lines show from left to right (i) the first lockdown on 16/03/2020, (ii) the end of the first lockdown on 11/05/2020, (iii) the border opening on 15/06/2020 and (iv) the beginning of a second lockdown on 22/12/2020. Higher values of the stringency index indicate more stringent policy measures.

was then introduced in December 2020 that lasted till May 2021. For a detailed history and breakdown of Swiss COVID19 related policy measures, see Swiss Tourism Federation (2022). Nevertheless, Swiss anti-COVID19 measures were less strict than other European countries with the Alpine state adopting a liberal implementation of mitigation measures (Moser et al., 2021).

We access the data on COVID19 incident rates (i.e., counts of cases and deaths) and the stringency of government policy measures to contain its spread from Hale et al. (2021). The stringency index is a composite measure based on nine containment response indicators (i.e., school closures, workplace closures, cancellation of public events, restrictions on public gatherings, closures of public transport, stay-at-home requirements, restrictions on internal movements, international travel controls, and public information campaigns) re-scaled to a value from 0 – 100. A higher score indicates a stricter policy response. Clearly, the containment measures included in the stringency index are more targeted to consumers and non-essential services than food-importing firms. However, they can indirectly affect firm activity if changing consumer demand influences the choice of products firms import and the frequency and volume of imports. In Fig. 3, we depict the COVID19 incident rates in Switzerland in 2020. We observe varying stringency of COVID19 policy measures (depicted by the stringency index) and variations in case counts. Stricter COVID19 policy measures do not necessarily correspond with the number of COVID19 cases. In other words, a relatively low number of COVID19 cases might cause strict policy measures such as a total lockdown of the economy, whereas rather lax COVID19 measures were imposed when a high number of COVID19 cases was observed. Depending on what objective they sort to achieve – e.g., worried about available hospital beds – policymakers could tighten or relax their containment measures.

3. Conceptual framework

The conceptual framework of our paper is grounded on recent trade theories with heterogeneous firms (Melitz, 2003; Chaney, 2008). We use the main predictions of the model presented in Chaney (2008) to frame how we expect the COVID19 pandemic to affect agri-food imports, taking into account the fact that the pandemic manifested itself as both a demand and supply shock.

The pandemic affected macro-level domestic income directly and indirectly. First, the pandemic directly reduced investment (Andersson et al., 2022) and likely reduced food demand due to shock to consumer demand and employment (OECD, 2020).[2] Early insights from CGE models showed that the negative impacts of the pandemic on the GDP of many countries from agriculture arise due to reduced food-away-from-home expenditures (Beckman and Countryman, 2021). Second, the various policy measures implemented by Switzerland to prevent the spread of COVID19 could also indirectly affect domestic income via reduced investment and lower demand. As a consequence of the pandemic many firms saw a drop in revenues. In Switzerland, total turnover in the trade sector dropped by 12.6% and 20.6% in the first and second quarters of 2020, respectively with the recovery back to the levels of 2019 not happening until the second quarter of 2021 (Eckert and Mikosch, 2022). Uncertainty induced by shocks reduces the appetite of firms to invest and innovate. Investment into fixed and variable costs of importing is no exception. This implies that demand for imported agri-food products is likely to reduce due to the reduction in domestic demand.

On the other hand, both the pandemic and related policy measures could also decrease domestic production of agri-food products (supply effect)[3] which could potentially increase foreign demand for these

[2] For example, importing firms could halt or postpone their importing activities due to the uncertainty created by the pandemic and to prevent the spread of COVID19 among their workers. Demand could also reduce because more people fell sick (and died) and some consumers may have postponed their consumption.

[3] Due, in part, for example, to border closures reducing the supply of seasonal workers from Eastern Europe who work on Swiss farms.

products, for a given level of demand. Alternatively, the demand could increase due to consumers' stockpiling and panic buying (Ritzel et al., 2022), which in turn could also increase imports of these products, for a given level of domestic supply. Thus, the effect of the pandemic on agri-food imports is an empirical question that depends on the relative magnitude of the demand and supply effect. If the demand effect dominates the supply effect, then the impact of the pandemic on agri-food imports is expected to be negative. The reverse is true if the supply effect dominates the demand effect.

The pandemic and its related travel restrictions accounted for a substantial increase in trade costs because they disrupted freight transport and supply of services (WTO, 2020). An increase in trade costs is likely to reduce the import volume for current importers and also increase the productivity level needed to import. Firms will import a given variety of agri-food products if the expected profits derived from selling them cover at least their cost of importing. This implies only the most productive incumbent firms are likely to import while only the most productive new firms will enter the import market. This would likely affect the number of importing firms and also the number of products they import. In addition, the direct effect of the pandemic could affect the productivity of firms if more workers are laid off or fall sick and isolate themselves.[4] While importing firms were not locked down *de jure* as part of the pandemic, they could still be severely restricted in their activity because of a lack of sanitary regulations. This suggests that the number of importing firms is again likely to reduce due to the decline in labour productivity.

In many exporting countries, agricultural and food production faced significant bottlenecks due to the pandemic and containment measures imposed by governments. For example, acute shortages of seasonal labour and disruptions to input markets due to mobility restrictions such as border closures and lockdowns affected agriculture directly by reducing yields (OECD, 2020). Many countries also introduced food export restrictions following the market uncertainties triggered by the pandemic (Laborde et al., 2020). With increasing COVID19 case counts many countries also introduced export-restricting non-tariff measures (Ahn and Steinbach, 2022). These and many other supply-side factors in major agricultural-producing countries reduced the volume of products available for export and increased export prices. The consequences for importing countries depend very much on their net trade positions. Net importing countries will suffer the effects of these supply shortages relatively more than other countries.

4. Empirical strategy

Our benchmark model analyses the effect of daily variations in Swiss-specific COVID19 shocks on Swiss aggregate agri-food imports, extensive margin (the number of active importing firms and the number of imported products) and intensive margin (import value per product per firm). This allows us to understand how the different margins adjusted as a result of the pandemic and by how much. To that end, we estimate a linear model wherein we regress aggregate import, and each of the three margins defined in Eq. (1) on lags[5] of daily COVID19 shocks, a measure of the stringency of policy response to the pandemic on the day of imports, most-favoured-nation tariffs and a set of product and week-year fixed effects. Our benchmark estimation equation is the following:

$$\ln X_{pt} = \beta_0 + \beta_1 \ln \text{Covid}_{t-5} + \beta_2 \text{Stringency index}_t + \beta_3 \ln(1 + \text{Tariff}_{pt}) + \theta_p + \lambda_w + \varepsilon_{pt} \quad (2)$$

where X is one of the four measures defined in Eq. (1): total imports (X_{pt}), the number of active importing firms (F_{pt}), the number of imported products (P_{pt}) and the import value per product per firm ($\bar{X}_{fpt}$). Our explanatory variables of interest are Covid and the Stringency index.[6] Covid is measured as the number of confirmed deaths reported on day t in Switzerland, an intuitive proxy for the direct effect of the pandemic. Lockdowns and other containment measures of various stringency were implemented in reaction to the COVID19 shock. Thus, we capture the effect of the policy measures (indirect effect) introduced to control the spread of the virus using the contemporaneous Stringency index$_t$ measure. The inclusion of both COVID19 related case counts and the stringency of policy measures in the same regression allows us to capture the direct and indirect effects of the pandemic.[7] Our estimates are likely to be biased if either of them is omitted from the model.[8] It also allows us to interpret the direct effect of the Covid shock while controlling for the policy regime in force. In addition, the granularity of the data allows us to capture the conditional individual effect of each of the variables. This and the fact that we use the lagged case count variable and the contemporaneous policy stringency variable should allay any concerns about multicollinearity.

The variable Tariff_{pt} is the product-specific most-favoured-nation tariff imposed on imports at time t. Summary statistics on all the variables used in the regression are presented in Table A2 in the Appendix. We also include a set of fixed effects to limit concerns about omitted variables. In particular, we include product fixed effects, θ_p, to account for all observable and observable time-invariant products and importing firm characteristics, and time (week-year) fixed effects, λ_w, to account for all common global shocks, seasonality and Switzerland specific country-level time-varying variables that could affect trade. We cluster the error terms at the product level.

The identification assumption is that the COVID19 pandemic is an exogenous shock to the firms because it was sudden and affected all firms. Our identification strategy, therefore, exploits variations in daily

[4] For instance, there were reported cases of outbreaks in many work settings: 15 EU/EEA countries and the UK reported 1376 clusters of COVID19 in occupational settings which occurred between March and early July 2020 resulting in 18,170 cases and 166 deaths. The food packaging and processing sector ranked third in the settings with the most reported cases with 153 clusters and 3856 cases (ECDC, 2020).

[5] We use a 5 day lag because according to the Swiss Federal office of Public Health, this is about the incubation period – defined as the time between infection and the appearance of the first symptom – of the coronavirus. This result is also confirmed by some meta-analyses in the health literature (Quesada et al., 2021). Nevertheless, our results are robust to different lag lengths. We present results from the contemporaneous measure and one to nine-day lags in the appendix Table A4.

[6] The daily frequency of our trade and COVID19 dataset is possibly subject to measurement errors. These data were rarely collected initially to monitor the economy. As such, they may be subject to some forms of bias. However, we have no reason to believe that these potential measurement errors are systematic. And as long as they remain random, our coefficients estimates should be well-identified.

[7] The Covid19 case counts and the policy stringency index capture two related yet different things: (i) the case counts measure the direct shock and (ii) the stringency index measures the policy response to the shock. The question "how severe is the shock" can be measured by how many cases are being recorded while the question of "how severe is the policy response to the shock" can be answered by how strict the policy environment is. A low policy stringency regime does not mean the spread of the COVID shock is minimal (or vice versa). This situation only means that the policy response (stringency index) – which is under the control of the policymakers – has been relaxed. However, for firms, if a worker gets infected (which is a lot more likely if on average Covid-related cases and deaths are higher) it affects the firm's productivity directly. This is also the channel that is most likely to directly affect firm response to the pandemic. In many cases, importing firms and ports were allowed to operate, even if they had to make operational adjustments. But, the public policy decision to lockdown offices, schools, cafeterias (as is captured in the stringency index) will not directly affect firm's activity as long as those firms are allowed to operate.

[8] That notwithstanding, our main conclusions remain the same if we include each of the two variables in the model at a time as done by Arita et al. (2022).

Table 2
OLS estimates of the effect of COVID19 on Swiss firm-level import margins.

	Total imports X_{pt}	Firms F_{pt}	Products P_{pt}	Imports/product/firm $\bar{X}_{fpt}$
	(1)	(2)	(3)	(4)
Log Covid$_{t-5}$	−0.276***	−0.174***	−0.031***	−0.071**
	(0.039)	(0.015)	(0.006)	(0.032)
Stringency index$_t$	0.011***	0.006***	0.001***	0.005***
	(0.002)	(0.001)	(0.000)	(0.001)
Log Tariff$_{pt}$	−0.224***	0.035	0.130***	−0.389***
	(0.069)	(0.037)	(0.018)	(0.031)
Product FE	Yes	Yes	Yes	Yes
Week-year FE	Yes	Yes	Yes	Yes
N	223680	223680	223680	223680
adj. R^2	0.521	0.566	0.754	0.521

Notes: Data are in daily frequency. The dependent variable in column (1) is total Swiss imports – summed across all firms, HS8 digit products and origin countries – of product p on day t. F_{pt} is the number of active importing firms on day t, P_{pt} is the number of products imported on day t and $\bar{X}_{fpt}$ is the import value per product per firm on day t. All models are estimated using ordinary least squares. p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported.

COVID19 incident rates as a predictor of daily product-level imports, i.e., the identification relies on variation in daily import growth of the same product with varying degrees of COVID severity, while accounting for product-level and weekly common shocks. We estimate Eq. (2) using ordinary least squares (OLS).

5. Results

5.1. Decomposing the trade effect of the crisis

Table 2 reports our benchmark results. The dependent variable in the first column is the total imports value, while that of the next three columns are the number of firms, number of products and the average imports per product per firm, respectively. The sum of the coefficients across the last three columns should equal that of the first column.

In column (1), we observe that the COVID19 shock had a negative effect on Swiss imports, i.e., for a given stringency of COVID19 containment measures and domestic demand within a week, the COVID19-related deaths led to a reduction in the import of agri-food products. Specifically, a 10 percent increase in the number of COVID19-related deaths in Switzerland reduced daily Swiss product level imports by 2.8%. Using the summary statistics from Table A2, we can translate our estimate of the import elasticity into monetary values. The import loss due to a 10% increase in case counts per day ranges from a mean of 1,898 CHF per day to a maximum of CHF 208,813 per day.[9]

If we then decompose the reduction in total import values into different trade margins (columns 2 – 4), we find that the COVID19-induced trade shock worked mostly through a reduction in the number of importing firms, i.e., approximately 63% of the total effect. A 10% increase in daily COVID19-related deaths reduced the number of importing firms (i.e., extensive margin) by 1.7%, the number of imported product varieties (i.e., extensive margin) by 0.3% and the average import value per product per firm (i.e., intensive margin) by 0.7%. Cumulatively, the two extensive margins contribute 74% of the negative trade effect of the COVID19 shock, with the intensive margin accounting for the remaining 26%. The negative direct effect of the pandemic on imports implies that the demand effect outweighs that of the supply effect, thus reducing the number of firms that import. A likely explanation is that some firms no longer found it profitable to import and thus reduced their investment/importing activities in response to the shock, which likely affected their productivity and overall firm performance. The decline in productivity also implies that the firms that are not productive enough to cover their cost of importing cease to import. In the end, this finding is intuitive given the high-frequency nature of our data. At more aggregate levels, existing works find that the trade reduction is driven mostly by the intensive margin (Bricongne et al., 2022; Benguria, 2021; Amador et al., 2021).

On the other hand, the stringency index – which proxies the policy response to the shock and captures the indirect effect of the shock on firms – has a positive effect on imports. In this case, the supply effect dominates the demand effect, i.e., for a given level of COVID19-related deaths within a week, the containment measures induced firms to import more agri-food products to meet a given level of domestic demand. The magnitude of the effect is, however, negligible. Specifically, a one standard deviation increase in the stringency index (i.e., a large increase of about 26 points), increases imports by about 33.5%.[10] To put this into context many papers assume stringency indices above 25 as lockdown episodes (e.g., Nitsch, 2022). Thus, a jump in the policy stringency environment from zero to a full lockdown increases import demand by 33.5%. Given the miniscule size of the policy variable, we focus the rest of our discussion on the direct COVID19 effect.

5.2. Sector-specific effects

The HS2 sector-specific findings are reported in Table 3. We find that all import sectors had at least one trade margin affected negatively by the pandemic, with most having to adjust along multiple import margins. The exceptions were cereals (grain handling and processing are highly automated and less labour intensive), live animals (probably seem to have adapted more easily probably due to experience gained from past experiences like the BSE), cocoa and products of the milling industry. This observation is largely in line with the 2020 FAO Food Outlook (FAO, 2020). Oil crops experienced a COVID19-related stagnation in terms of demand by the food and non-food sectors and sugar consumption declined due to COVID19-related lockdown and containment measures. The pace of production expansion across all meat sectors was moderated by pandemic-related disruptions to production processes and output restraints. The fruits and vegetables sectors were among the most affected during the pandemic as their production is highly labour-intensive and their perishable nature requires efficient logistics and transportation. The general observation, however, is that finished or near-finished consumer goods were affected more by the pandemic, with intermediate inputs for further manufacturing and processing relatively more insulated.

5.3. Which firms were more affected by the crisis?

5.3.1. Firm size

There remains considerable debate in the theoretical and empirical literature about the differences in the cyclical dynamics of firms by size — which is a measure of productivity (Fort et al., 2013). The trade literature has also established a clear consensus between firms' trade potentials and their productivity (Mayer and Ottaviano, 2008; Bernard et al., 2012). In light of these papers, we assess how the COVID shock affected firms based on their size.

Our first measure of firm size is based on the distributions in Fig. 1. We define two groups of firms: (i) small — those with less than 240 employees — and (ii) large — those with more than 240 employees — firms.[11] Fig. 4 summarises the results of this analysis. We find that the COVID19 shock affected both large and small firms. This finding

9 i.e., $0.028 \times 67,777$ CHF = 1,898 CHF and $0.028 \times 7,457,590$ CHF=208,813 CHF.

10 $[\exp(0.011 \times 26.25) - 1] \times 100 = 33.5\%$.

11 If we alternatively define four groups of firms: those with (i) < 10 employees, (ii) 10–49 employees, (iii) 50–249 employees and (iv) > 240 employees, we find that in all cases larger firms were more affected by the

Table 3
HS2 sector-specific effects of COVID19 on import margins.

2 digit HS group	Imports X_{pt}	Firms F_{pt}	Products P_{pt}	Import/prod/firm $\bar{X}_{fpt}$	N
HS01: Animals, live	0.661	0.429**	−0.055	0.287	1139
HS02: Meat	−0.066	−0.215***	−0.011	0.161	10763
HS03: Fish and crustaceans	0.049	−0.026	−0.003	0.078	26596
HS04: Dairy produce	0.321	−0.034	−0.114***	0.469**	7858
HS05: Animal products, nes	0.222	−0.179	−0.034	0.435**	2193
HS06: Trees and other plants	−0.630***	−0.508***	−0.038	−0.084	8492
HS07: Vegetables	−0.489***	−0.403***	−0.120***	0.034	26580
HS08: Fruits and nuts	−0.580***	−0.357***	−0.013	−0.210**	26240
HS09: Coffee, tea, mate, spices	−0.308*	−0.077	−0.003	−0.228*	11688
HS10: Cereals	−0.253	0.041	0.038	−0.331	3702
HS11: Products of the milling industry	−0.123	−0.079	−0.026	−0.017	7698
HS12: Oil seeds	−0.332	−0.191***	−0.047**	−0.095	9321
HS13: Lac; natural gums, resins	−0.127	−0.090	0.044	−0.081	2116
HS14: Vegetable plaiting materials	0.165	−0.014	0.006	0.173	1299
HS15: Animal, vegetable fats and oils	−0.485***	−0.074*	−0.030	−0.382**	9527
HS16: Meat, fish; preparations	−0.315***	−0.132***	−0.006	−0.177	11619
HS17: Sugars and sugar confectionery	−0.800***	−0.173*	−0.110*	−0.518*	5044
HS18: Cocoa and cocoa preparations	0.369**	−0.004	0.025	0.348**	3467
HS19: Preparations of cereals	0.005	−0.127**	−0.061**	0.193	7367
HS20: Preparations of vegetables, fruits	−0.196	−0.049	0.034	−0.182	16548
HS21: Miscellaneous edible preparations	−0.492	−0.204*	−0.048	−0.239	7540
HS22: Beverages, spirits, vinegar	−0.463***	−0.268***	0.025	−0.220*	9941
HS23: Residues of food industry	−0.392***	−0.211***	−0.068	−0.114	4429
HS24: Tobacco	−0.027	0.038	−0.019**	−0.046	2513

Notes: Data are in daily frequency. All models are estimated using ordinary least squares. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported. X_{pt} is total Swiss imports – summed across all firms, HS8 digit products and origin countries – of product p on day t. F_{pt} is the number of active importing firms on day t, P_{pt} is the number of products imported on day t and $\bar{X}_{fpt}$ is the import value per product per firm on day t. All other controls are included but not reported for brevity. p values are not reported because of space constraints.

confirms that Swiss firms were not prepared to deal with this type of shock, regardless of their size. However, we also see that larger firms suffered more from the effects of the pandemic (Panel (a) of Fig. 4). A possible reason for this is that firms with higher numbers of employees are more likely to work in close physical proximity to other people and thus more exposed to and at higher risk of COVID19.

Before we take this evidence as conclusive, it is possible that some large firms with a high number of employees may have importing activities forming only a small part of their business activities. This does not appear to be the situation in our case as the firm group employing the most employees also accounts for 46% of overall imports. Nonetheless, we also define firm size based on import activity; precisely total import values in 2019 (Fig. 4b). We define firms with a total import value in 2019 above the median import value of 3,292,961 CHF as large firms.[12] Otherwise, they are defined as small firms. The disproportionately large effect for larger firms is also here confirmed. This points to the fact that larger importers – who we know, following stylised facts from the literature (Manova and Yu, 2017), are also more likely to employ more workers – are more integrated into global values chains, import from multiple destinations, and thus more prone to suffer negative shocks that affect supply chains globally.[13] Overall, our finding confirms recent evidence that points towards a more pronounced negative reaction of large importing and exporting firms to economic shocks that affect all firms within an economy (Bricongne et al., 2022; Di Giovanni et al., 2020; Amador et al., 2021).

5.3.2. Incumbent and new firms

We also assess the differential impact of the pandemic on incumbent and new importing firms. The trade literature emphasises that entrants are relatively small compared to incumbents in terms of their trade value and thus contribute less to aggregate trade (Eaton et al., 2008; Lederman et al., 2011; Fernandes et al., 2013). Assessing this source of heterogeneity is important in understanding the reaction of these firm types to the COVID19 pandemic. We define incumbents as firms that imported at least one product in both 2019 and 2020 while new importing firms (i.e., entrants) as firms that did not import any product in 2019 but imported at least one product in 2020.

The results are presented in Table 4. For incumbent firms (Columns 1–4), a statistically significant negative effect of the pandemic on imports and the margins is observed, while for entrants (columns 5–8), the effect is either statistically insignificant or small in economic magnitude. This suggests that the negative effects of the COVID19 shock on the imports and the three margins were largely driven by incumbent firms. A likely explanation for this is that incumbent firms command a larger market share and thus suffered the impact of the exogenous shock more as argued by the existing literature (e.g., Di Giovanni et al., 2020).[14] It is also possible that the new importing firms entered the market after observing the shock and thus were more prepared to cope with the shock than the incumbent firms.

5.4. Does the level of data aggregation matter?

The COVID19 pandemic has required monitoring economic activity in real-time, a feature that usual data could not provide. Our daily firm-level import data offers a level of data aggregation that is of a higher frequency than any from existing works. As a result, we estimate our models by aggregating our daily import data to weekly and monthly levels. The aim is to see how the lower frequency data influence our findings and if our aggregate findings support existing evidence. For the

COVID19 shock than smaller ones. The exception is with firm sizes 3 (i.e., 50–249) where in three out of the four cases there were no statistically significant effects. See Figure A1 in the Appendix.

[12] The maximum total import value by a firm was 876 million CHF.

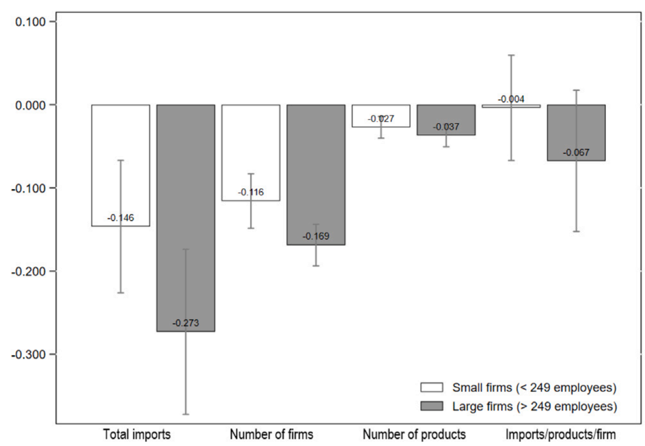
[13] We test the latter channel in the next section.

[14] In our sample, the average import value per product per entrants is about 75% that of incumbents in 2020. We also assess based on firm size which types of incumbent firms were more likely to exit. The results presented in the Appendix Table A7 show that larger firms were more likely to exit than smaller firms.

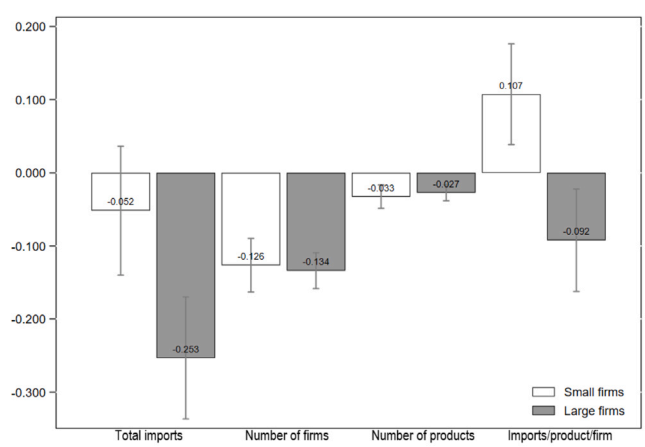
Table 4
OLS estimates of the effect of COVID19 on import margins (Incumbents vs Entrants).

	Incumbents				Entrants			
	X_{pt} (1)	F_{pt} (2)	P_{pt} (3)	$\bar{X}_{fpt}$ (4)	X_{pt} (5)	F_{pt} (6)	P_{pt} (7)	$\bar{X}_{fpt}$ (8)
Log Covid$_{t-5}$	−0.296***	−0.186***	−0.035***	−0.075**	−0.102	−0.002	−0.032*	−0.068
	(0.042)	(0.016)	(0.007)	(0.035)	(0.135)	(0.029)	(0.017)	(0.129)
Stringency index$_t$	0.010***	0.006***	0.001***	0.003**	0.011*	0.001	0.001	0.009
	(0.002)	(0.001)	(0.000)	(0.001)	(0.006)	(0.001)	(0.001)	(0.005)
Log Tariff$_{pt}$	−0.218***	0.027	0.124***	−0.370***	−0.202***	0.035**	0.028***	−0.265***
	(0.073)	(0.039)	(0.019)	(0.032)	(0.070)	(0.014)	(0.009)	(0.069)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Week-year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	199486	199486	199486	199486	11225	11225	11225	11225
adj. R^2	0.524	0.563	0.747	0.529	0.322	0.395	0.468	0.330

Notes: Data are in daily frequency. All models are estimated using ordinary least squares. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported. X_{pt} is total Swiss imports – summed across all firms, HS8 digit products and origin countries – of product p on day t. F_{pt} is the number of active importing firms on day t, P_{pt} is the number of products imported on day t and $\bar{X}_{fpt}$ is the import value per product per firm on day t. Incumbents are firms that imported in both 2019 and 2020. Entrants are firms that imported in 2020 but not in 2019.



(a) Firm size defined by the number of employees



(b) Firm size defined by import volumes

Fig. 4. Heterogeneity across firm size.
Notes: The results presented in these graphs are based on two different samples of small and large firms. In essence, we calculate the total imports and the three import margins for each firm size grouping. The coefficient estimates that are plotted here are then retrieved from regressions of Eq. (2) on the two samples of small and large firms. The tables on which these figures are based are presented in the Appendix (Tables A5 and A6).

COVID19 related variables, we use simple means to bring them from the daily to weekly or monthly levels.

The results are presented in Table 5. Overall, we still see the direct trade-reducing effects of the pandemic. A 10% increase in the case count per week (month) decreased imports by 0.3% (0.09%). This translates to an average (maximum) import reduction of 1,830 CHF (158,021 CHF) per week.[15] At the monthly level, this translates to an average and maximum reduction of 2,172 CHF and 179,193 CHF respectively per month.[16] Compared to the 1,898 CHF per day average trade reduction we estimate at the daily level, the trade effects of the pandemic decrease when we consider longer time horizons. Given the short-lived nature of the trade shock, this finding is not surprising. With more aggregated data, short-run firm-level import behaviour is averaged out over time. Nevertheless, consistent with existing works (Bricongne et al., 2022; Benguria, 2021), we find that at more aggregate levels, the import reduction is dominated by the intensive margin, specifically, the drop in the average imports per product per firm.

6. Mechanisms

Our findings thus far confirm the product-level impacts of the pandemic on import demand. Given that this was a global pandemic, it also affected other countries that export to Switzerland. The direct effect of the pandemic on consumers could also be a factor. As such, in this section, we explore some of the possible mechanisms that could explain the negative trade effects we see in Section 5. First, we assess how shocks to other countries affected Swiss firm-level import volumes and prices. We then assess how the pandemic affected Swiss consumer behaviour.

6.1. *Third-country effects*

Here, we estimate the effect of partner countries' COVID19 shocks on firm-product-level imports. We measure the dependent variable as the weekly[17] import value and quantity of HS8-digit product p between firm f and origin country o (i.e., X_{fpot}) and estimate a structural gravity model using OLS and Poisson Pseudo-Maximum Likelihood Estimator

[15] The average and maximum import value per week is CHF 609,939 and CHF 52,673,530 respectively.

[16] The average and maximum import value per month is CHF 2,412,804 and CHF 199,103,445 respectively.

[17] For the gravity model estimations we aggregate the data set to the weekly level to allow for the most likely scenario that firms are not importing from a particular origin country every day.

Table 5
The effect of COVID19 on firm-level imports: different levels of data aggregation.

	Weekly data				Monthly data			
	X_{kt} (1)	F_{kt} (2)	P_{kt} (3)	$\bar{X}_{fkt}$ (4)	X_{kt} (5)	F_{kt} (6)	P_{kt} (7)	$\bar{X}_{fkt}$ (8)
Log Covid$_{t-1}$	−0.030***	−0.011***	0.000	−0.020***	−0.009**	0.003*	0.001	−0.012***
	(0.007)	(0.002)	(0.001)	(0.006)	(0.004)	(0.001)	(0.001)	(0.003)
Stringency index$_t$	0.002***	−0.000	−0.000	0.002***	0.003***	0.001**	0.000	0.002***
	(0.001)	(0.000)	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Log Tariff$_{pt}$	−0.369***	−0.051	0.161***	−0.479***	−0.455***	−0.049	0.148***	−0.553***
	(0.079)	(0.032)	(0.019)	(0.048)	(0.121)	(0.043)	(0.025)	(0.076)
Product FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Month-year FE	Yes	Yes	Yes	Yes	No	No	No	No
Year FE	No	No	No	No	Yes	Yes	Yes	Yes
N	70808	70808	70808	70808	16872	16872	16872	16872
adj. R^2	0.841	0.932	0.931	0.778	0.906	0.959	0.953	0.859

Notes: Data in columns (1) – (4) are at weekly frequency. Data in columns (1) – (4) are at monthly frequency. All models are estimated using ordinary least squares. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported. X_{pt} is total Swiss imports – summed across all firms, HS8 digit products and origin countries – of product p on day t. F_{pt} is the number of active importing firms on day t, P_{pt} is the number of products imported on day t and $\bar{X}_{fpt}$ is the import value per product per firm on day t. Control variables include product-specific most-favoured-nation tariff and the stringency index.

(PPML). Our OLS estimation equation takes the following form:[18]

$$\ln X_{fpot} = \beta_0 + \beta_1 \ln \text{Covid}_{ot-1} + \beta_2 \text{Stringency index}_{ot-1} + \alpha_{fpm} + \alpha_{opm} + \varepsilon_{fpot} \quad (3)$$

where Covid$_{ot-1}$ is the one-week lag of COVID19-related deaths per million inhabitants in origin country o, in week t. Stringency index$_{ot}$ measures the policy environment in the exporting country on the day t. α_{fpm} and α_{opm} are firm-product-month and origin-product-month fixed effects which control for the theoretical multilateral resistance terms (Anderson and Van Wincoop, 2003).[19] The inclusion of α_{fpm} means that we exploit the within-firm-product variation in our data set. α_{fpm} also accounts for all firm-specific effects. Because there is no importing country variation in our dataset, α_{fpm} also accounts for COVID19 incidence and stringency levels in Switzerland.[20] α_{opm} accounts for all observable and unobservable variables that vary along that dimension, e.g., product-specific custom tariffs and non-tariff measures[21] but also traditional gravity variables such as GDP, distance, contiguity, and language. The error term, ε_{fpot}, is clustered at the firm-product-origin level. Summary statistics on the variables used in this part of the analysis are presented in Table A3.

The results of the structural gravity estimations are presented in Table 6. The severity of the Covid shock in foreign countries indeed impacted Swiss firm-level imports.[22] In particular, a ten percent increase in the COVID death count per million inhabitants decreases Swiss imports by about 0.4 percent. From the supply side, the sudden halt in production following strict lockdowns and outright closings of establishments would also imply a contraction in the exports of trading partners or equivalently the bilateral imports of trading partners. We also find that importing firms that sourced their products from multiple countries were more negatively affected by the crisis (Table A8). As the multi-origin status of a firm is another proxy for firm productivity and size (see, e.g., Curzi et al., 2020), these results support those in Section 5.3.1 that bigger importing firms were more negatively affected by the crisis.

We also assess how COVID19 shocks in partner countries affected firm-product-level import prices. Using data on import values in CHF and import volumes in kg, we calculate unit values in CHF/kg as a proxy for import prices. Empirically, we estimate a linear model akin to Eq. (3) but replace the dependent variable with the price of imports of firm f of HS8 digit product p from origin country o in week t (i.e., UV$_{fpot}$). The results are presented in columns (3) – (5) of Table 6. A 10 percent increase in the case count per million inhabitants increased firm-product level import prices by 0.05 percent. However, it is possible that price effects vary across product quality groups. Following Szewerniak et al. (2019), we define high-value (low-value) as products that have a value-to-weight ratio higher (lower) than the median across all products in our sample. In column (4), we introduce a control for high-value products. We see that high-value products are sold at high prices. We interact the control for high-value products with the COVID shock in column (5) and find that the price effect is more

[18] We run the PPML estimations on the same sample as the one for the OLS regressions. Squaring the firm-product-origin-week-year trade data set to include zeroes results in too many observations. The estimation equation for the PPML is the following:

$$X_{fpot} = \exp\left[\beta_0 + \beta_1 \ln \text{Covid}_{ot-1} + \beta_2 \text{Stringency index}_{ot-1} + \alpha_{fpm} + \alpha_{opm}\right] + \varepsilon_{fpot}.$$

[19] Ideally, the multilateral resistance terms should vary at the weekly level. However, defining them at this level will not allow us to identify the COVID shock which we in this step define at the weekly level.

[20] This is not a problem in our case, as we already identify the Swiss-specific COVID effect in Section 5. In our case, a gravity specification that attempts to identify COVID19 shocks in the single importing country case will require that we drop the firm-level fixed effects. We believe doing this will weaken our identification strategy as our inward multilateral resistance terms will in that case not be defined correctly.

[21] In response to the pandemic, 38 countries notified non-tariff measures (NTMs) to the World Trade Organisation (WTO, 2022). Using this data, Ahn and Steinbach (2022) find that the pandemic progression played an essential role in the decision of countries to implement import-facilitating and export-restricting NTMs against agricultural and food products. However, in all cases where an exporting country introduced a Covid-related NTM, they were unilateral measures and thus affected all countries equally. Such unilateral measures are accounted for by the exporter-product-time fixed effects in our gravity model.

[22] The EU is the biggest source of Swiss imports and their most important trading partner. To assess how the third-country effects from the EU affected Swiss imports we interact the COVID19 variable with an EU dummy. We find that being a member of the EU did not moderate the effects of the pandemic. Quantitatively, we do see less pronounced negative effects for imports from EU member states, but the effect is not statistically significant. We also test whether the physical distance to the exporting country moderates the effects. We interact data on the bilateral distance between the capital cities of Switzerland and the exporting country (CEPII) and the Covid shock. We find no moderating role of distance.

Table 6
COVID19 shocks in other countries and Swiss firm-level import values and prices.

	Import values in CHF		Import prices in CHF/kg		
	(1)	(2)	(3)	(4)	(5)
Log Covid$_{t-1}$	−0.014***	−0.035***	0.005***	0.005***	0.003*
	(0.005)	(0.013)	(0.002)	(0.002)	(0.002)
Stringency Index$_t$	0.000**	0.002***	−0.000**	−0.000	−0.000
	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
High value product				0.763***	0.754***
				(0.007)	(0.008)
Log Covid$_{t-1}$ ×High value product					0.005***
					(0.001)
Firm-product-month FE	Yes	Yes	Yes	Yes	Yes
Origin-product-month FE	Yes	Yes	Yes	Yes	Yes
N	1111926	1111926	1049615	1049615	1049615
Estimator	OLS	PPML	OLS	OLS	OLS

Notes: Data are in weekly frequency. The dependent variable in columns (1) – (2) are the import values of firm f of HS8 digit product p from origin country o in week t of years 2019 and 2020. The dependent variable in columns (3) – (5) are the prices of imports – measured as CIF unit values – of firm f of HS8 digit product p from origin country o in week t of years 2019 and 2020. p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported. We define high-value (low-value) products as products that have a value-to-weight ratio higher (lower) than the median across all products in our sample.

pronounced for products of higher quality. This can be explained by the perishable and time-sensitive nature of high-value-to-weight products (usually consumables such as fruits, vegetables, meat, and flowers) vis-à-vis low-value-to-weight products (usually commodities such as cocoa, coffee, and wheat). Furthermore, high-value agri-food products are usually transported as air cargo on commercial flights. The substantial drop in commercial flights induced by the pandemic increased the cost of air transportation and distribution.

6.2. Changes in consumer demand

The COVID19 pandemic constituted both a demand and a supply shock. National COVID19 policy measures such as a total lockdown of the economy, an obligation to work from home or isolation of infected persons also affected consumer behaviour. During the first lockdown in Switzerland, all stores, restaurants, bars, schools, entertainment and leisure establishments were closed. Furthermore, the closed borders with the European Union prevented the cross-border shopping tourism behaviour of Swiss consumers (Ritzel et al., 2022). Since consumers and firms interact with each other (e.g., increasing consumer demand leads firms to increase production and/or imports, and marketing activities of firms cause a change in consumer demand), we test the impact of the pandemic on consumer behaviour. We test this mechanism using consumer mobility data and consumer purchase data.

First, we use daily data on mobility sourced from Google's COVID19 community mobility reports (Aktay et al., 2020). The data covers the periods 15th February to 31st December 2020, and tracks changes in the observed pattern in daily mobility across different classifications of places relative to a baseline. The baseline is the median value from the 5–week period between January 3rd to February 6th 2020. We use Cantonal mobility trends from two categories of places that consumers regularly visit, i.e., (i) grocery and (ii) retail & recreation. Grocery is defined as the daily trend in visits to grocery markets, food warehouses, farmers' markets, specialty food shops, drug stores, and pharmacies compared to a baseline. Retail & recreation is defined as the daily trend in visits to restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres compared to a baseline. The results are shown in Table 7. The pandemic led to a drop in the mobility patterns to grocery stores and retail and recreation centres. This provides suggestive evidence that the pandemic led to a drop in consumer demand. Even though, the pandemic led to an increase in online grocery shopping, it was not enough to replace all food-away-from-home expenditures at restaurants, school and office canteens or demand from firms who used these products as intermediate inputs.

We also test the effect of the pandemic on consumer demand using Nielsen Schweiz homescan and retailer scanner data for the years 2009 and 2020. (FOAG, 2021). This data set draws on two data sources: a consumer panel and a retail scanner panel. The consumer panel covers data on monthly purchase quantities and costs of 4000 Swiss households from channels such as traditional retailers, direct farm sales, butcheries and bakeries. In the retail scanner panel, all products scanned on the conveyors at retailers participating in the panel are recorded. This includes all the players in the Swiss stationary retail trade but excludes the two German discounters Aldi and Lidl. Demand quantities for both organic and conventional food products are available on a monthly basis and cover four basic product categories: meat, milk products, vegetables, and fruits.[23] The combined retail/consumer panel provides the most precise sales and turnover figures for the Swiss retail sector (FOAG, 2021).

We regress the COVID19 case count variable and the policy stringency index on the quantity demanded of each of the product categories. We find that the COVID19 shock had a negative effect on the consumption of vegetables, meat and milk products while the policy stringency increased the consumption of these products. This finding supports existing evidence from Switzerland: using debit card transaction data, Pleninger et al. (2022) show that consumption decreased with increasing infections. While the product categories considered here do not cover all the categories in Table 3, the negative direct effect of the pandemic on consumption is consistent with the negative direct effect of the pandemic on agri-food imports.

7. Robustness checks

This section contains a series of sensitivity checks to examine the robustness of the results obtained in Section 5. First, in our benchmark models, we measure the COVID19 shock as the number of confirmed deaths in a day. To check if the result is sensitive to the definition of COVID19 shock, we use three other proxies: (a) total COVID19 cases on day t, (b) new COVID19 deaths on day t, and (c) new COVID19 cases on day t. The results are presented in the Tables A9, A10, and A11 respectively. As can be seen, the results are similar to those presented

[23] Meat products include veal, lamb, beef, pork, chicken and charcuterie. Milk products include butter, cheese and yogurt. Vegetables include fruit vegetables, lettuces, cabbages, root and tubers, onions and leeks, and mushrooms. Fruits include apples, pears, berries, stone fruits, grapes, citrus fruits and exotic fruits.

Table 7
OLS estimates of the effect of COVID19 on consumer demand.

	Consumer mobility		Consumer demand			
	Grocery	Retail & Recreation	Vegetables	Fruits	Meat	Milk products
	(1)	(2)	(3)	(4)	(5)	(6)
Log Covid$_{t-h}$	−7.197***	−4.853***	−0.059***	0.067	−0.034***	−0.021***
	(1.062)	(0.617)	(0.007)	(0.053)	(0.005)	(0.003)
Stringency index$_t$	0.215***	−0.585***	0.008***	0.005	0.008***	0.005***
	(0.021)	(0.028)	(0.001)	(0.005)	(0.001)	(0.001)
Observation	5411	5411	1104	937	1356	782
adj. R^2	0.178	0.829	0.879	0.507	0.958	0.982

Notes: The data on consumer mobility are in daily frequency and at the canton level while the data on consumer demand are in monthly frequency and the country level. Grocery is the daily change in visits to places like grocery markets, food warehouses, farmers' markets, specialty food shops, drug stores, and pharmacies compared to a baseline day. Retail & Recreation is the daily change in visits to places like restaurants, cafes, shopping centres, theme parks, museums, libraries, and movie theatres compared to a baseline day. The baseline day is the median value from the 5–week period between January 3rd to February 6th 2020. Columns 1 and 2 control for the interaction between 2019 Canton level variables(population and GDP growth) and a linear time trend, canton and week-year fixed effects. Columns (3) – (6) include product and week-year fixed effects. For columns (1) to (2) the lag length $h = 5$ days. For columns (3) to (6) the lag length $h = 1$ month. p values are in parentheses. ***, ** and * denote significance at 1%, 5% and 10% respectively. Intercepts included but not reported.

in Section 5. Thus, the choice of proxy for COVID19 shock does not appear to be driving our findings.

We also check whether accounting for time-varying factors in the origin country alters the main findings of the paper. Specifically, we define the trade margins in Eq. (2) at the product-origin-time level instead of the product-time level. This allows us to flexibly control for the origin country's time-varying factors — including their daily domestic COVID19 cases with origin-time fixed effects. The results as presented in Table A12 are in line with the main findings.

Given the erratic and short-lived nature of the pandemic, we examine how the impacts change over the course of the pandemic. To do so, we follow Arita et al. (2022) and estimate quarter-specific regressions throughout 2020. The results presented in Table A13 of the Appendix show that the direct impact of the pandemic is negative and statistically significant across all four quarters except for the third quarter. The magnitudes of the estimated effects also differ showing that the negative effects were not uniform during the different quarters of 2020. On the other hand, the indirect effect is positive and statistically significant in the 1st and 4th quarters, while it is negative and statistically significant in the 2nd and 3rd quarters.

8. Policy implications

Our findings have policy implications for the resilience of agricultural trade to current and future global shocks, especially those that affect all countries simultaneously. First, the agricultural and food sector is highly integrated into the global economy, and thus not immune to global shocks. As a result, the sector faced several challenges during the recent SARS-CoV-2 virus pandemic. As our findings show, these challenges induced substantial trade-reducing effects at the firm level. Our work corroborates the early country-level findings of Arita et al. (2022) but also highlights the importance of considering the effects at more micro-levels. Since our findings show that the trade-reducing effects of the pandemic operated mainly through a reduction in the number of importing firms, the mechanism to cushion firms in the short term could include a targeted reduction or elimination of custom tariffs at least on a temporary basis on goods critical for food security, relaxing existing regulations (e.g., border and behind-the-border technical measures) during the emergency, and implementing expedited licensing and certification processes related to sanitary and phytosanitary standards. Secondly, given that we find the relative contribution of each import margin to the decline in total imports depends on the level of data aggregation, we underscore the need for timely and high-frequency data to assess the impact of the pandemic and other global shocks. Third, agriculture accounts for a comparatively small share of the global economy but remains central to the lives of a great many people (Alston and Pardey, 2014). Thus, shocks that lead to reductions in production, or disruptions to supply chains have implications for food security. In particular, these shocks threaten the role of global food trade as a balancing mechanism for food demand and supply across the world. As we observed at the initial stages of the pandemic, unforeseen shocks to the global economy can lead to autarky reactions from many countries, which will further dampen the goal of globalisation.

9. Conclusion

This paper assesses the resilience of agricultural imports to the COVID19 pandemic using daily firm-level import data on the universe of Swiss importing firms between 2019 and 2020. We extend the international trade literature by contributing one of the first sets of studies that exploit firm-product level trade data of very high frequency, specifically, on a daily basis. We also assess the reaction of large and small firms to the crisis. Furthermore, global agricultural trade has been described as resilient to the impacts of the COVID19 pandemic. However, the size and channels of its quantitative impacts at the firm level are not yet clear. We extend the agricultural trade literature by offering the first firm-level evidence to that effect.

Our benchmark models exploit variations in daily Covid incident rates to explain changes in daily firm-product level imports while controlling for the policy environment on the day, MFN tariffs and a host of product and week-year fixed effects. We find that the pandemic led to a reduction in firm-level imports at the product level. The reduction was driven more by a decrease in the number of importing firms and less by the average imports per product per firm and even less so by the number of products imported. Swiss agri-food importing firms, regardless of their sizes, were generally not prepared to deal with the exogenous Covid shock. Both small and large firms – defined here based on the number of employees – were affected by the crisis. These large firms form only about 3% of the sample of importing firms, yet account for 43% of total imports. But larger firms suffered more from the negative effects. The drop in the number of importing firms was mainly driven by incumbent firms — i.e., firms that imported pre- and post-pandemic. This supports our finding that larger firms were more affected by the pandemic as incumbents usually also control a larger share of the market. At the sector level, we see that products closest to the final consumer were affected more by the pandemic, with intermediate goods relatively more insulated. We also show that the level of data aggregation matters for the findings. The elasticity of imports to the pandemic becomes smaller in magnitude as we move to more aggregate data levels. The relative contribution of each margin to the decline in aggregate imports also depends on the level of data aggregation.

We also test different mechanisms that may drive the negative effects we find for firm-level imports. First, third-country supply-side effects were present. Estimating structural gravity models, we show that the pandemic-related closures in origin countries drove the drop in Swiss firm-level imports. This also meant an increase in firm-product level import prices which were higher for products of high value-to-weight ratios compared to products with low value-to-weight ratios. Second, we test how the pandemic affected consumer demand since this has the potential to influence firm behaviour. Using daily google mobility data, we find negative effects of the pandemic on visits to grocery shops and recreational centres which provides suggestive evidence of a decline in consumer demand. To confirm this suggestive evidence, we also use information from monthly consumer and retailer scanner data and find that the pandemic indeed led to a decrease in consumer demand.

CRediT authorship contribution statement

Dela-Dem Doe Fiankor: Conceptualization, Methodology, Formal analysis, Visualisation, Writing – original draft, Writing – review & editing. **Abraham Lartey:** Conceptualization, Methodology, Formal analysis, Visualisation, Writing – original draft, Writing – review & editing. **Christian Ritzel:** Conceptualization, Methodology, Formal analysis, Visualisation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.foodpol.2023.102507.

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