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ABSTRACT

Sweden's COVID-19 Recession: How Foreign and Domestic Infections Struck against Firms and Workers*

Using highly granular micro data, we document very divergent economic effects of the COVID-19 pandemic on Swedish private-sector firms and their workers. Firms that exported to, or imported from, heavily afflicted countries reduced their output due to disrupted trade. Service firms that operated in locations with many infections reduced their output due to falling local consumption, despite very limited regional restrictions. Workers at the bottom of each social gradient – defined by education, earnings or ethnicity – took a twofold hit: their employers faced the largest output drops and they experienced the largest transmissions from firm output to earnings.

JEL Classification: J23, J31

Keywords: COVID-19, virus transmission, inequality

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The COVID-19 pandemic had massive contractionary effects on most economies across the globe. However, by now it is well documented that the economic effects varied tremendously, both within and across countries (see e.g., Stancheva 2022). The unusual nature of the COVID-19 recession made some economists tap into new forms of data to study the dynamics via which the disease shrank economic activity (see e.g., Chetty et al, 2020). In this paper, we rely on Swedish micro data to study the economic consequences of the pandemic during 2020. Our data is rich in a number of dimensions. It Is population wide (covering all firms, workers and locations), comprehensive (covering output, earnings, imports, exports, mobility, and consumption) and highly resolved in space (starting at zip codes) as well as in time (daily, weekly, and monthly).

Armed with this data, we demonstrate that the virus had a dazzlingly heterogenous impact across firms and workers, even within narrowly defined sectors and regions. Specifically, we are – as far as we know – the first to show how the economic reverberations of COVID-19 transmitted across countries through firm-specific trade patterns.[1] We further show how local infections immediately jolted the output of service firms, even though almost all restrictions and recommendation were set nationally. These patterns allow us to hold market conditions fixed and estimate how idiosyncratic output drops – in otherwise similar firms – transmitted onto the earnings of workers. Our results reveal that the groups, mostly at the bottom of different social gradients, who worked in the most severely affected firms also faced the largest elasticities from output losses to earnings.

During the pandemic's initial phase, Sweden became (in)famous for its relatively permissive set of non-pharmaceutical restrictions. In an international comparison, initial restrictions were muted, which probably contributed to a wider spread of the disease than in the neighboring Nordic countries. Still, the economy contracted rapidly and by as much as the neighboring countries (Andersen et al 2022). While most firms could continue to operate, many struggled with falling demand. As elsewhere, the authorities advised the population to reduce social contacts at all times. Importantly for the interpretation of our results, restrictions and recommendations were almost exclusively nationally determined. Formal restrictions were thus adapted to the national spread of the disease, and rarely responded to local infections.

We highlight two mechanisms that helped shape Sweden's fast and deep contraction, despite its lenient non-pharmaceutical restrictions. The first reflects the economic consequences of infections among Sweden's trading partners. Sweden is a small open economy with a large exporting and importing manufacturing sector. Aggregate data clearly reveals a large output drop in manufacturing during the first wave of the pandemic. Our micro data shows that the trade-related contraction was concentrated among manufacturing firms that traded directly with heavily afflicted countries. The unequal spread of the pandemic across countries exposed exporting and importing firms unequally to

[1] Antras et al (2022) show how trade networks may spread the virus internationally. We do not know of studies of how foreign infections shaped trade and domestic output. This may reflect trade (customs) data being published with long lags and mostly at annual frequencies. (Bilbie and Melitz 2021 study how foreign-supply disruptions affect domestic entry and exit).

foreign COVID-infections depending on what countries they were trading with. To identify the effect of firm-level exposure to infections abroad, we rely on the combination of pre-pandemic trade patterns and pandemic severity (deaths). Our statistical models estimate the effects on trade and output at the monthly frequency. They show that firms trading with heavily afflicted countries at the beginning of the pandemic, (e.g. Italy), suffered much larger falls in output than those trading with more moderately afflicted countries (e.g. Germany).

The second mechanism reflects how local infections contracted local consumption within Sweden. Given the national scope of recommendations, local consumers had to rely on their own judgement when deciding how to adjust their behavior. Aggregate data shows how consumption in the service sector fell drastically in the early phase of the pandemic. But these effects were far from universal, with the largest drop in "contact-intensive" services. Using data on credit-card spending and mobility resolved by municipality or zip-code, we show how the contraction varied greatly across locations, as consumers adjusted to local COVID-19 infections. This is evident from data across metropolitan areas. In the first wave, people in hard-hit Stockholm reduced their consumption by twice as much as in Malmo where infection rates were half as bad. These demand falls afflicted sales in services in proportion to the firm's pre-pandemic share of workers with contact-intensive jobs. Restaurants is a case in point, where the output effects of local infections are strongly related to the pre-pandemic sales of alcohol (which by Swedish law cannot be taken off premises).

Our final results reveal how the economic contraction struck against the earnings of workers in different social segments. We highlight differences across groups in exposure to falling output in the firms where they worked, as well as differences in the transmission from output to earnings. On average, low-wage, low-education, young, female, and immigrant workers were employed in firms where output fell more. To estimate differences in the transmission from output to earnings, we exploit differential exposures to the foreign and domestic pandemic in two separate shift-share IV-designs. We instrument the drops in output by the firm-specific exposure to the pandemic within exporting firms and restaurants respectively. In all dimensions, except gender (where the transmission is relatively similar), we estimate larger elasticities from output to earnings for groups that also experienced the largest drops in firm output. Taken together, these results help us characterize the unequal economic consequences of the pandemic. Workers in socioeconomic groups at the bottom of income, education, and ethnic gradients were hit twice: their employers suffered from larger output falls, and they suffered from greater output-earnings elasticities.

Overall, our paper illustrates how firm-to-firm international trade and domestic consumer responses were important channels from foreign and domestic infections to the economy. Like the study of the US by Chetty et al (2020), our paper relies on a combination of micro data to picture the early dynamics of the pandemic recession.[2] Such data can, in principle, be made available to policymakers in real time. As such, the paper illustrates how better

[2] We do not study the two-way interactions of economic activity and virus spread, stressed in so-called epi-econ models (early examples are Bogman et al 2020, Atkeson 2020, and Eichenbaum et al 2020).

access to micro data could allow policymakers to closer track the dynamics of an economic contraction.

I. Background and Data

In this section, we first give a brief background on Swedish pandemic interventions. Then, we describe the main variables of our data and their sources (detailed variable definitions appear in Table A.1 of the Web Appendix).

Non-pharmaceutical interventions. Compared to many other countries, Sweden had few legal restrictions during the first year of the pandemic, especially in the first wave (spring 2020). The authorities did not impose any outright lockdowns. Schools were generally open, though all high schools used distance education during April-June of 2020 (and universities during most of 2020). Central authorities introduced caps on the size of public gatherings, various fractions for international travel, and limitations on certain business hours. But Sweden's Public Health Authority and government made a number of public recommendations, such as to work from home, keep a distance to others, and avoid domestic travel. Unlike in many other countries, the regional variation in restrictions and recommendations was small. The second report from Sweden's Corona Commission (SOU 2021:89, Vol. 1) surveys and evaluates these restrictions and recommendations. Regulations on restaurants involved bans on serving standing customers, maximal numbers of seated per table, and restricted hours for serving alcohol.

Economic-policy interventions. As in most other countries, Sweden's central bank and government launched an unprecedented set of policies to support firms, jobs and individual disposable incomes in the early stages of the recession. Akerman et al (2022) describe the firm-support systems in detail. One key form of support was a short-time work-scheme, which allowed firms to reduce working hours by between 20 and 80 percent in the first wave, and 20 to 60 percent thereafter. Workers continued to receive their salaries and firms were reimbursed by the government for the cost of non-working hours. Another important program allowed firms to receive fixed-cost compensations if their output losses were larger than 30-50 percent (depending on month) vs. 2019. Fixed-cost schemes were announced *ex post* to reduce moral hazard. The third report from the Swedish Corona Commission (SOU 2022:10, Vol.1) surveys and evaluates these economic policy interventions.

Medical data. We gauge foreign disease loads and restrictions from aggregate (daily, monthly) numbers for all countries from Our World in Data. We measure Sweden's infections by individual-level (daily) data from Social Insurance Board that document deaths. We also use (daily) individual-level information from the Swedish Social Insurance Agency. Here we classify (daily) sick leaves in 2020 as due to COVID-19 when the diagnosis in the doctor's certificate – required for sickness-insurance payout – refers either to COVID-19, or to more diffuse symptoms of COVID-19 which were very uncommon in 2019.

Economic and social data. Our economic and social data are drawn from a variety of sources. Firm-level information on monthly output in the private sector is documented in VAT-data from the Swedish Tax Authority. Turnover is separated by VAT rates. This allows us to measure the share of sales from alcohol in restaurants (following Harju et al 2018), which we exploit in our analyses. Tax-authority information further gives us (monthly) information about earnings and employment for each worker-firm combination. These data come from the income-tax returns each employer has to file in each month (from 2019). We collect monthly firm-level data on exports and imports by country from the Swedish Customs. Individual-level background information about gender, annual income, education, country of birth, occupation, and sector of work are drawn from different administrative registers kept by Statistics Sweden. We use zip-code by age-group level information on weekly total credit-card transactions as a proxy for private consumption. These data are from Swedbank (Sweden's largest private bank with 40 percent of card transactions). Municipality-level weekly mobility data come from Telia (Sweden's largest cellphone operator with about 40 percent of mobile-phone subscribers). Occupation-specific classifications based on O*NET (from Alderling et al 2021) allow us to distinguish firms based on the physical proximity among their workers (here, we exclude workers for whom we do not know the occupation).

II. Broad Economic Outcomes

This section first paints a background by showing economy-wide evolutions of central variables during the course of 2020 and beginning of 2021. Then, we point to large heterogeneities in sectoral-output developments, as well as firm exposures to the pandemic.

Aggregate outcomes. Figure 1a displays our measures of (private-sector) output, employment and earnings during 2020 and early 2021 (obtained by aggregating firm and worker-level data). The three series all show the percentage decline of 2020 monthly outcomes relative to the same months in 2019.

Output falls drastically in the first wave of the pandemic during the spring of 2020, but recuperates towards the initial 2019-level at the end of the year, despite the arrival of the second wave. Employment falls in the spring by some 5 percent below its 2019 level but starts rising again during the fall and towards the end of the year. Average (nominal) earnings start out higher than the year before (thanks to annual wage drift), but fall by more than five percent in the spring, before recovering quite strongly from the end of the year.

Overall, these numbers indicate a severe and sudden recession, but less dramatic than in some other countries during the period. As Andersen et al (2022) show, economic activity fell about as much as in the other Nordic countries although these neighbors relied on stricter restrictions than Sweden, especially in the early stages of the pandemic.

[Figure 1 about here]

Outcomes differed across sectors. Figure 1b shows the monthly fall of output – again as a percent decline relative to 2019 – during each month of 2020 and early 2021 in the sectors that will figure most prominently in our subsequent analysis. (Figure A.1 of the Web Appendix shows a more conventional set of sectors.)

In the first wave of the pandemic, manufacturing firms (black curve) experience a large output fall. At the bottom in May 2020, output is down by 25 percent relative to 2019, but recovers over the rest of the year. Domestically-oriented service firms (solid red curve) lose about 12 percent of their output in the same month.

But the service sector mixes pockets of large pandemic exposure – like hotels, restaurants or cultural activities – and other sectors – like health or education – with essentially unchanged demand. Figure 1b shows that output falls more in service firms with an above-median share of workers in high-contact jobs (dashed red curve) throughout the period. But differences grow even larger the thinner we slice the data. Our analysis will stress restaurants. This is because their services are consumed locally, which allows us to link consumer spending and output in a relatively direct manner. The average restaurant (solid blue curve) loses more than 35 percent of its output relative to 2019 at the bottom of the first wave (April 2020) as well as the bottom of second wave (December 2020). Some restaurants are more affected than others, partly because they have different ability to adjust towards take-out services. A crucial adaptability condition is the restaurant's reliance on alcohol sales, since Swedish law prohibits alcohol to be taken off premises. As the figure shows, restaurants whose pre-pandemic sales relied heavily on alcohol (an above-median share of VAT paid at the higher alcohol rate in 2019) lose between 45 and 50 percent of output (dashed blue curve).

The key insight from figure 1b is that the economic exposure to the pandemic differs substantially both between and within finely defined sectors. In what follows, we show that exposure to COVID-19 amongst customers and input providers add to these differences. We use international data by country to capture the international transmission through firm-level trade. Figure 1c illustrates the wide span of exposure among manufacturing firms that engage in international trade. For each week and firm, we calculate a weighted average of COVID-19 deaths per million in the countries the firm trades goods with, using pre-pandemic (2019) export shares as weights. The figure shows the exposure of the median exporting firm (dashed curve) as well as the difference between firms at the 90^{th} and 10^{th} percentiles of foreign pandemic exposure. The graph clearly illustrates the two waves of the pandemic as well as the dramatic differences across firms.

Analogously, service firms that operate locally – like restaurants – face different local COVID-19 exposures over time depending on their location in Sweden. Figure 1d illustrates the median and 90-10 gap of exposure to the local pandemic among Sweden's 290 municipalities. The local infection rate is again measured by deaths per million. As does

Figure 1c, this figure clearly shows the pandemic's first two waves and the large variation in exposure across municipalities over time (the median municipality does not experience any deaths at the weekly level throughout the first wave).

III. From Virus Infections to Economic Outputs

In this section, we study how foreign and local domestic infections transmit to the output of different types of firms.

Exposure to the foreign pandemic. To illustrate the transmission of the foreign pandemic to Swedish manufacturing firms, we split these firms into those with above-median and below-median exposure to foreign deaths over the whole of 2020 (by the measure introduced in Figure 1c).

Figure 2a shows how exports and output in 2020 relative to 2019 for these two types of manufacturing firms (more exposed solid line, less exposed dashed line) evolve relative to January 2020. Evidently, more-exposed firms face a much larger drop in exports (blue solid line) than the less-exposed (blue dashed line). The difference at the peak of the first wave is almost 45 percentage points. We see the same pattern in output, even though the differences are smaller: more-exposed firms (red solid line) see a 5 percentage-point larger output drop than less-exposed firms (red dashed line). A substantial export difference remains throughout the first pandemic year. Figure 2b shows that the patterns for importing firms are very similar (albeit somewhat more muted).

Regression analysis. We proceed with a more formal analysis, where we replace the binary foreign exposure measure with a continuous "shift-share" variable $F_{j,t}$. The latter is defined as the trade-weighted COVID-19 exposure of firm *j* at time *t*. Weights s_c^j capture the share of trade with each country *c* in 2019 (weights sum to one within each firm). Country-by-month-specific exposure levels $d_{c,t}$ are measured by deaths per million residents in trade-partner country *c* in month *t*. Thus, $F_{j,t} = \sum_c s_c^j d_{c,t}$. Alternatively, we replace foreign deaths with either an index for the strictness of pandemic interventions (lockdowns), or an index for reductions in workplace visits, in country *c* at time *t*.

We use this shift-share measure to estimate the effects of infections in a firm's trading-partner countries on the firm's output in the same month. Our model also includes firm and month dummies (fixed effects). Thus, we estimate

$$\ln(Y_{j,t}) = \alpha_j + \delta_t + \gamma \ln(F_{j,t}) + u_{j,t} \qquad (1)$$

where δ_t denotes month dummies and α_j firm dummies. The latter remove, among other things, all aspects directly related to the firm's trade intensity in 2019. Our parameter of interest is γ. The sample includes all manufacturing firms in 2020. For firms that do not trade in 2019, or only trade with countries without COVID-19, we set their log foreign COVID-19 exposure to zero. For firms with no output in certain months, we set their log output to zero. We cluster standard errors at the firm level to allow for serially correlated shocks within firms.

The results in Table 1 (panel A, first column) shows an estimated elasticity of -0.037. This implies that a one-percent hike of deaths in a firm's export destinations decreases the firm's output by about 0.04 percent in the same month. This magnitude is non-trivial. In March 2020, the COVID-19 death rate in Italy was 205 per million compared to Germany's 9 per million. Thus, the estimates suggest that a Swedish firm only exporting to Italy faced an output fall in March that was 46 percent larger than a firm only exporting to Germany. In the following two columns of panels A and B (exports and imports), we use foreign stringency and workplace restrictions instead of foreign deaths. Qualitatively, the results are very similar. As stringency and deaths are closely correlated, we are not able to separately identify the impacts of restrictions from the effects of infections. But it seems that restrictions on workplace visits have a larger impact than overall stringency. This could be because the former captures forced closures of manufacturing plants that trade in intermediates with Swedish firms.

In Web Appendix Table A.2, we show that the results remain robust if we allow non-parametric trends in each (two-digit) sector (month-by-sector fixed effects). This is reassuring, as it points further to a *firm-specific* trade channel. The appendix table also shows that removing all firms that did not trade in 2019 from the sample does not affect the estimates related to foreign deaths. The estimates for import exposure to foreign restrictions (rather than deaths) are slightly more sensitive to model specification. Export estimates are robust also in this dimension.

Exposure to the domestic pandemic. Next, we consider responses across Swedish localities more or less exposed to the domestic pandemic. Figure 3 plots the relation between the municipal (average population approximately 35,000) infection rate in the first wave and relates it to key indicators of local economic activity. In all cases, we use infection rates by the share of people (per 100,000) on paid sick-leave due to COVID-19 during the peak of the first wave on the x-axis. In each graph, circle sizes are proportional to municipality populations – the two largest cities (Stockholm and Gothenburg) are clearly visible.

Figure 3a plots essentially two long differences: the increase in first-wave local COVID-19 incidence (from zero) until late April 2020 vs. the *change* in weekly within-municipality mobility, from early January to late April 2020. Mobility is measured by cellphone connections switching between different towers. Almost all municipalities saw a decline in mobility – think about this downward shift as the country-wide effect of the pandemic. But local variations are very large and clearly related to local infections. The regression line illustrates that, on average, a rising local disease burden from 50 to 300 cases/100,000 is associated with an almost 15 percentage-points larger decline in mobility. This slope implies that the impact in the most affected municipalities is nearly twice as large as in the least affected. The impact is more pronounced, and more responsive to local infections, in the two largest cities/circles.

Figure 3b instead shows long differences in local consumption, as proxied by changes in credit-card spending by customers who reside in the municipality. The overall negative shift

is apparent (on average, about 8 percent) in the graph, as is the strong association between local infections and local consumption. On average, an increase in local infections from 50 to 300/100,000 is associated with a 10 percentage-points larger decline in consumption. A larger effect in large metropolitan areas is clearly visible also in this graph. To validate our results, we estimated separate responses by age group. That analysis (see Figure A.2), shows the largest responses for the oldest residents, which makes eminent sense as these faced the strongest incentives (and clearest recommendations) to stay home and thus indirectly diminish their consumption.

[Figure 3 about here]

Together, Figures 3a and 3b suggest that people move less and spend less when local infections are more prevalent. Demand for local services should thus fall. In line with this conjecture, Figure 3c shows a clear sales decline in the service sector at the average location (to account for multi-plant firms, we apportion the output of firms to localities based on where their employees reside). Moreover, this fall is about 15 percentage points larger in the hardest-hit municipalities compared to the least-afflicted ones. For restaurants, in Figure 3d, we see a larger average downward output shift, and a steeper slope – about 25 percentage points from the softest to the hardest hit – than for overall services.

Regression analysis. Finally, we estimate how the impact of local infections on log monthly output differ depending on the *nature* of services. We first consider the general-service sector, where we estimate how the local-infections impact varies with the firm share of employees with contact-intensive occupations. Next, we study the restaurant sector where we estimate how the impact of local infections varies with the sales share from alcohol (recall alcohol can only be consumed in-house). The specification is very similar to equation (1), and relies on similar notation:

$$\ln(Y_{j,t}) = \alpha_j + \delta_t + \gamma_1 \ln\left(C_{L(j),t}\right) + \gamma_2 A_j \ln\left(C_{L(j),t}\right) + u_{j,t} \qquad (2)$$

where *C* denotes local infections at time *t* in location *L(j)* where firm *j* operates.[3] In the services application, *A* is the (pre-pandemic) share of the firm's workers with a contact-intensive occupation. In the restaurant application, *A* is instead its (pre-pandemic) share of alcohol sales. We demean the contact-intensity and alcohol shares, such that parameter γ_1 captures the impact of infections for the average service firm or restaurant. Our sample spans the full year of 2020 and the first two months of 2021.

The estimation results are presented in Panel C (for services) and Panel D (for restaurants) of Table 1. The different columns vary the definition of locality: (1) municipality (290 in total), (2) region (21 in total), (3) *within* municipality neighborhoods (zip codes, of which there are about 10,000 in total).

[3] As we study firm outputs and a single firm can have more than one branch, we use modal locations. We set $\ln(Y_{j,t})$ to zero when the firm has no output and $\ln\left(C_{L(j),t}\right)$ to zero when there are no local infections.

The estimates in the two panels are qualitatively similar. They show a clear negative impact of local infections on firm output, though the magnitudes are larger in restaurants than general services. Interaction terms with the shares of high-contact workers (for service firms) and alcohol dependence (for restaurants) are both negative and estimated with similar precision, even though the number of restaurants is much smaller than the number of service firms overall. This may suggest that alcohol is a more precise measure of COVID-exposure than occupational contact intensity. Output in the most sensitive firms (as measured by the interaction terms) respond even to *very* local (zip codes) infection rates. In sum, the results in this section suggest that demand and mobility fall – as do outputs by service firms – with the local, temporal incidence of COVID-19. The large variation in infections across localities imply large differences even within heavily affected sectors. The large variation in contact intensity and alcohol dependence means that differences are large also within equally affected localities.

IV. Earnings for Different Groups of Individuals

This section shifts the perspective from firms to individuals. We first present estimates of output contractions for workers in different socioeconomic groups. Next, we present estimated output-earnings elasticities for workers in the same groups. Finally, we combine these two sets of results.

Output falls. We first compute the output drop (the negative change) between February and April 2020 for each firm. This period spans the first and economically most serious pandemic wave. Then, we exploit the individual-level socioeconomic data and our employer-employee links to calculate the average-output drop suffered by employers of workers in different socioeconomic groups (weighting each firm by its number of workers in the group). Figure 4a thus shows output falls (black circles) for the employers of groups divided by cohorts, gender, income, education, and place of birth.

The average output fall across all workers (the first row) is around 5 percent. But that average masks a great deal of heterogeneity: from 3 percent among the oldest employees to 10 percent for the youngest, from 4 percent for men to 7 percent for women,[4] from 2 percent for the highest income quartile to 9 percent for the lowest, from 4 percent for the most educated to 6 percent for the least educated, and from 4 percent for those born in Sweden to 10 percent for those born outside Europe. In each case, the output falls describe a social or ethnic gradient, with the strongest group at the bottom and the weakest group at the top.

[Figure 4 about here]

[4] As for economy-wide gender differences, many more women than men work in the largely unaffected public sector (not included in these estimates).

Output-earnings elasticities. Next, we exploit the linked employer-employee data to estimate elasticities of earnings to output. We run panel IV-regressions of two kinds, exploiting some of the results on output and pandemic exposure discussed in Section III.

The first IV-design exploits the variation across manufacturing firms in their exposure to the foreign pandemic over time as shown in Table 1, Panel A. Specifically, the first stage instruments each firm's output in a given month with its export-weighted exposure to foreign deaths in that month. The second stage regresses the earnings of individuals from pre-pandemic employers on the instrumented output of these firms. We do this separately for different socioeconomic groups (one classification at a time). The resulting shift-share estimates will produce unbiased estimates as long as the composition of the firm's pre-pandemic trade is unrelated to the cross-country distribution of pandemic deaths. The model thus follows equation (1) closely. One slight difference arises because we now analyze data at the individual, rather than the firm, level. Thus, our estimates are weighted by workers and not by firms. For the same reason, we replace firm fixed effects by individual fixed effects (we still cluster standard errors at the firm level).

Our second IV-design exploits the local-infection variation together with firms' differential dependence on alcohol sales in the restaurant sector, as specified in equation (2) and estimated in Table 1, Panel D. The first stage uses the contemporaneous municipal infection rate interacted with the pre-pandemic alcohol share to instrument restaurant monthly output. The second stage relates the monthly earnings of (pre-pandemic) workers to instrumented output. As in the first design, we weight by workers, include worker fixed effects, and cluster standard errors at the firm level. In both settings, we include all months in year 2020 and the first two months of 2021.

Results. By estimating the output-earnings elasticities in two sectors with different production and employment conditions, we hope to get relatively robust conclusions. The estimates from both versions of the first stage appear in Table A.3. Most *F*-statistics vary between 10 and 100 for the different groups (we also show results below with aggregated groups for more precise estimates in both stages). Figure 4b shows the elasticities from the second stages by blue (manufacturing) and red (restaurants) circles.

Average elasticities for all employees (the top row) are close to 0.11 in the two sectors, with a slightly higher restaurant elasticity. The rest of the graph shows an intriguing pattern. The group with the weakest labor-market stance in each classification almost always has the highest estimated output-earnings elasticity, whether we look at manufacturing or restaurants. The two exceptions are that both elasticities are lower for women than for men, and that the 21-29-year-old elasticity is slightly lower than the 30-49-year old one in manufacturing. Moreover, most estimated elasticities are monotonically ordered: highest for the weakest group and lowest for the strongest, whether groups are defined by age, income, education or ethnicity.

These results suggest social and ethnic gradients in earnings, where weaker groups are hit twice. By Figure 4a, their employers faced larger pandemic drops in output. By Figure 4b, workers which are the youngest, poorest, least educated, and born the farthest from Sweden faced larger earnings falls for the same output drop. A plausible driver of these results is that these workers have shorter employment spells than others, which make them less experienced and thus more dispensable when firms have to downsize. In addition, last-in-first-out is an important notion in Swedish employment-protection legislation.

A possible concern is that labor-market features are correlated: e.g., immigrants in Sweden are less educated and overrepresented in the lowest income quartile. To address this concern, we create a full set of indicators for all (144) *combinations* of demographic features, except gender, as discussed above. One such combination thus picks out all 21-29-year-olds with less than high-school education who belong to the first income quartile, and are born outside of Europe. Then, we order these cells by the output drop of their pre-pandemic employers and divide the resulting distribution into quartiles. Finally, we estimate an output-earnings elasticity – in manufacturing and restaurants, respectively – for each quartile group.

The estimated elasticities with 95-percent confidence bands appear in Figure 4c (and first-stage estimates in Table A.5). Clearly, this graph strongly supports the "double-whammy" conclusion. Demographic cells with larger exposures to output losses systematically have larger output-earnings elasticities. Notably, elasticities of the bottom quartile are two to three times larger than those of the top quartile. This is true even though we have defined the groups to maximize the heterogeneity of output losses across them: between 6 and 22 percent in the bottom quartile vs. around 0 in the top quartile.

We have also verified that the conclusion regarding heterogeneity across quartile groups is robust to estimating the heterogeneity within firm-months. We do this by pooling the data and including month-specific firm dummies, which allows us to estimate *differences* in elasticities between quartile groups. The results (in Figure A.3) show that the elasticities are significantly larger in the top (relative to the bottom) quartile within firms. Another robustness check (Figure A.4) includes gender when defining quartiles. There, we find a flatter heterogeneity profile, as women's firms reduced output by (substantially) more than men's, whereas women's output-earnings elasticity is (marginally) smaller than men's.

V. Insights

Our paper shows how COVID-19 infections struck Swedish private-sector firms and workers in the first two waves in 2020. The pandemic dynamics in Sweden's trading partners directly obstructed trade flows and reduced output of Swedish manufacturing firms. The pandemic dynamics in Sweden's localities shrank local consumption and outputs for service firms such as restaurants. A common insight is thus that firm-level output responded forcefully to variations in client exposure to COVID-19, whether the clients were local households buying

local services or foreign firms buying (or supplying) manufacturing products or services. Both responses generated large variations in output losses across similar Swedish firms operating under similar domestic restrictions.

A clear picture emerges where the COVID-19 recession struck very unevenly across workers. Seemingly arbitrary pre-pandemic variations in firm locations, type of services (alcohol vs. no alcohol), and international trading partners forged largely different firm-level contractions even within sectors. Socio-economic differences across workers of these firms determined whose earnings suffered the most. Groups at the bottom of each social gradient took a twofold hit: their employers faced larger output drops and, for the same drop, their earnings fell more.

Notably, all our regressions could have been run *during* the recession if micro data, which is already collected in real time, had been made available without administrative delay. With such real-time data, policymakers could have tracked which sectors, locations, firms and workers needed economic support. Our analysis thus highlights the value of timely access to administrative data for policy analysis during crises. In that sense, it accords with ongoing attempts to construct such data in the US and elsewhere.[5]

[5] See the websites *Economic Tracker* (described in Chetty et al 2020) and *Real-Time Inequality* (described in Blanchet et al 2022).

References

Akerman, Anders, Karolina Ekholm, Torsten Persson, and Oskar N. Skans (2022). ”Företagsstöden under pandemin (Firm Support-Schemes during the Pandemic)”, Report to the Swedish Corona Commission.

Alderling, Magnus, Hanna Augustsson, Theo Bodin, Emma Cedstrand, Helle Molsted Alvesson, Anna Nyberg, and Sara Sanchez-Bengtsson (2021). “A Participatory Intervention to Improve the Psychosocial Work Environment and Mental Health in Human Service Organisations: A Mixed-Methods Evaluation Study,” *International Journal of Environmental Research and Public Health* 18, 1-19

Andersen Torben M., Steinar Holden, and Seppo Honkapohja (2022). “Economic Developments and Policies during the COVID-19 crisis – Nordic Experiences,” *Nordic Economic Policy Review* 2022:1, 13-50.

Antras, Pol, Stephen J. Redding, and Esteban Rossi-Hansberg (2022). “Globalization and Pandemics,” unpublished manuscript, Harvard University.

Atkeson, Andrew (2020). “What Will Be the Economic Impact of Covid-19 in the US? Rough Estimates of Disease Scenarios,” NBER Working Paper No. 26867.

Bilbie, Florin, O. and Marc J. Melitz (2021). “Aggregate-Demand Amplification of Supply Disruptions: The Entry-Exit Multiplier,” NBER Working Paper No. 28258.

Blanchet, Thomas, Emmanuel Saez, and Gabriel Zucman (2022). “Real-Time Inequality,” unpublished manuscript, in preparation.

Bogman, Mark, Doug Hanley, Daniel Kolliner, and Kurt Mitman (2020). “Economics and Epidemics: Evidence from an Estimated Spatial Econ-SIR Model,” unpublished manuscript, IIES, Stockholm University.

Chetty, Raj, John N. Friedman, Nathaniel Hendren, Michael Stepner, and the Opportunity Insights Team (2020). “The Economic Impacts of COVID-19: Evidence from a New Public Database Built Using Private Sector Data,” unpublished manuscript, Harvard University.

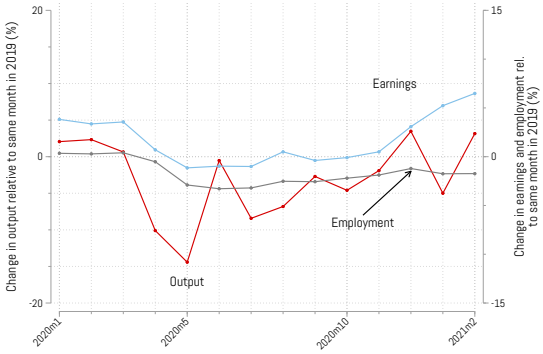
Eichenbaum, Martin S., Sergio Rebelo, and Mathias Trabandt (2020). “The Macroeconomics of Pandemics,” NBER Working Paper No. 26882.

Harju Jarko, Tuomas Kosonen, and Oskar N. Skans (2018). “Firm Types, Price-Setting Strategies, and Consumption-Tax Incidence,” *Journal of Public Economics* 16, 48-72.

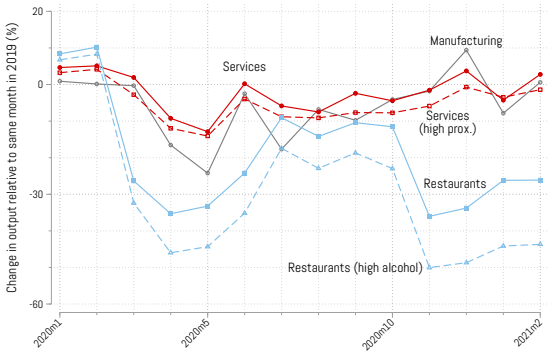
SOU 2021:89. Sverige under pandemin (*Sweden during the Pandemic*), second report by the Corona Commission to the Swedish Government, Elanders: Stockholm.

SOU 2022:10. Sverige under pandemin (*Sweden during the Pandemic*), final report by the Corona Commission to the Swedish Government, Elanders: Stockholm.

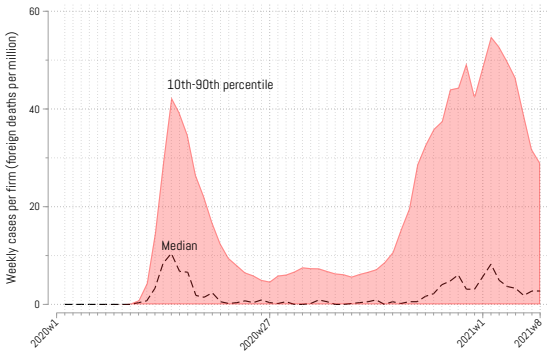
Stancheva, Stefanie (2022). “Inequalities in the Times of a Pandemic,” *Economic Policy* 37, 5-41.



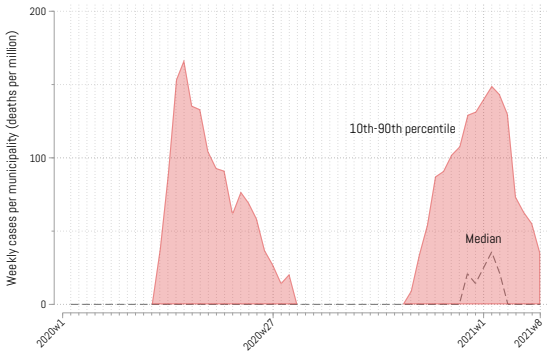
(a) Aggregate output, earnings and employment.



(b) Output in more versus less exposed sectors.



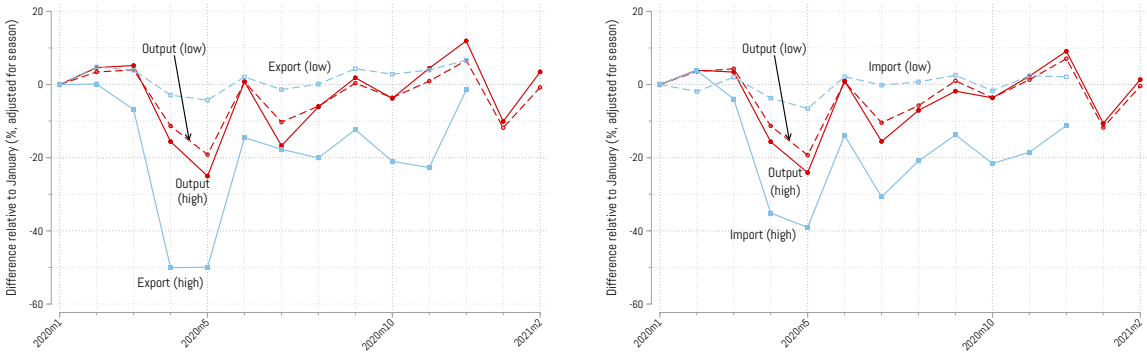
(c) Foreign COVID-19 by export firms.



(d) Domestic COVID-19 by municipalities.

Figure 1. Sweden's COVID-19 Pandemic.

Note: Data span January 2020 to February 2021. Panel (a) shows percent differences (by month) relative to the same month in 2019 for aggregate output, earnings and employment (Source: Swedish Tax Authority). Panel (b) shows percent differences in output by sector. "Services (high prox)" are sectors with a (firm-weighted) share of "high proximity occupations" (Source: Alderling et al 2021) above the service-sector (output-weighted) median. "Restaurants (high alcohol)" are restaurants with an above-median share of alcohol sales measured as sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Panel (c) shows firms' exposure to foreign deaths through firm-level exports. To compute these, weekly country-specific COVID-19 deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports to each destination country according to 2019 annual data (Source: Swedish Customs). The panel shows weighted exposure for the median manufacturing firm and the 90-10 percentile spread across manufacturing firms. Only firms that exported in 2019 are included. Panel (d) shows the weekly median and the 90-10 spread of deaths per million individuals across Swedish municipalities (Source: Swedish Social Insurance Board). See the text and Web Appendix Table A.1 for details on data.



(a) Exports. **(b)** Imports.

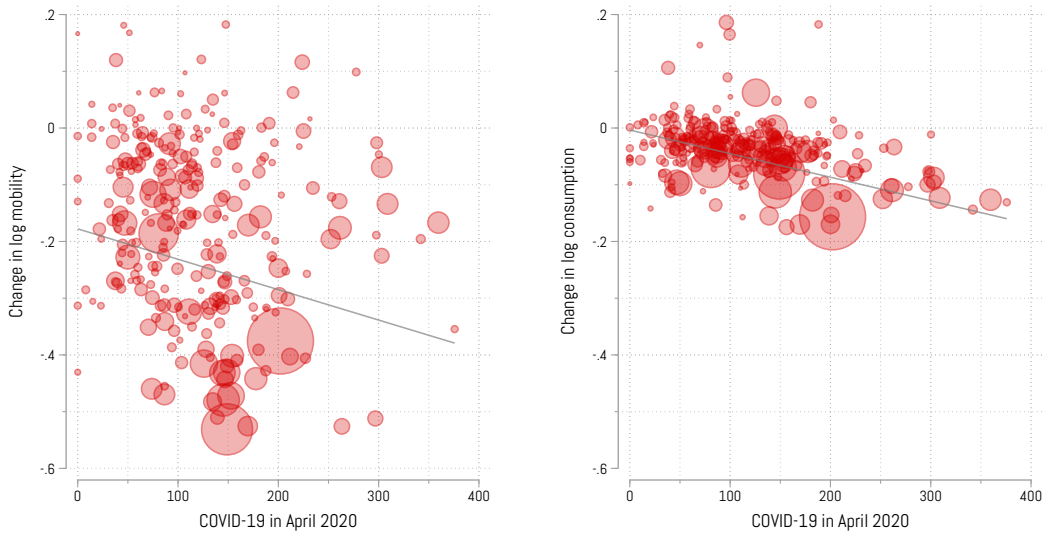
Figure 2. Firm-level trade and output responses to foreign COVID-19.

Note: Data span January 2020 to February 2021. Weekly country-specific COVID-19 deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports (Panel a) or imports (Panel b) to each destination/source country according to 2019 annual trade (Source: Swedish Customs). Firms without exports/imports in 2019 are defined as having zero exposure. "Output (low)" refers to the percent average change in monthly output relative to the same month in 2019 for firms with a below-median trade exposure among manufacturing firms. "Output (high)" refers to the average for firms with above- median exposure. "Imports/exports (low)/(high)" are defined in analogous ways. All series are rebased, such that units are expressed relative to January 2020. Data for output is from the VAT register (Source: Swedish Tax Authority). See the text and Web Appendix Table A.1 for details on data.

Dep. var.:	Output (log)	Output (log)	Output (log)
	(1)	(2)	(3)
Measure of foreign COVID-19	*Deaths*	*Stringency index*	*Workplace visit reductions*
Panel A: Export based			
Export-weighted	-0.037	-0.061	-0.071
exposure to COVID-19 (log)	(0.003)	(0.004)	(0.004)
Observations	408,602	408,602	408,602
Panel B: Import based			
Import-weighted	-0.032	-0.046	-0.054
exposure to COVID-19 (log)	(0.003)	(0.005)	(0.004)
Observations	408,602	408,602	408,602
Geographic agg. of local COVID-19	*Municipality*	*Region*	*Zip code*
Panel C: Service based			
Local deaths (log)	-0.005	-0.006	-0.001
	(0.002)	(0.004)	(0.000)
Local deaths (log) × share of high	-0.046	-0.056	-0.022
proximity occupations	(0.005)	(0.005)	(0.002)
Observations	2,432,739	2,432,739	2,432,739
Panel D: Restaurant based			
Local deaths (log)	-0.017	-0.025	0.001
	(0.004)	(0.013)	(0.001)
Local deaths (log) × share of alcohol	-0.053	-0.054	-0.016
	(0.005)	(0.007)	(0.005)
Observations	173,495	173,495	173,467
Fixed effects			
Firm	✓	✓	✓
Month	✓	✓	✓

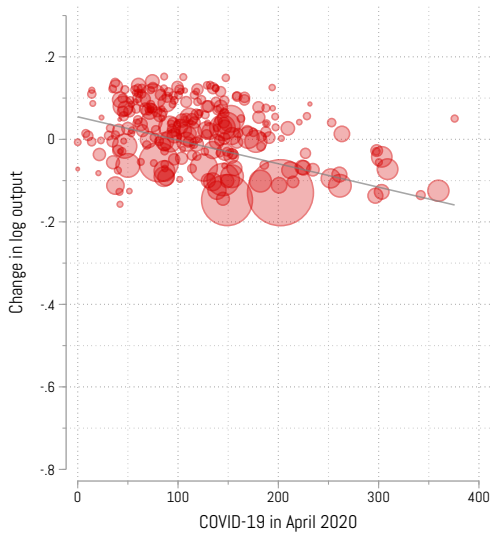
Table 1. COVID-19 and Output.

Note: Panel A and B: Regression results based on equation (1) in the text, using monthly data from January-December 2020. Estimates are elasticities from log foreign COVID-19 deaths to log output at the firm level in the same month. Log foreign COVID-19 exposure is set to zero for firms not trading in 2019 (Source: Swedish Customs) and for firms only trading with countries without COVID-19 (Source: Our World in Data). Monthly log output is set to zero for firms with no output in certain months (Source: Swedish Tax Authority). Monthly deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports (Panel A) or imports (Panel B) to each destination/source country according to 2019 annual data (Source: Swedish Customs). Columns (2) and (3) replace foreign deaths by a general Strictness Index and Reductions in workplace visits by destination/source country (Source: Our World in Data). Panel C and D: Regression results based on equation (2) using monthly data covering January 2020 to February 2021. Estimates are elasticities from log local COVID-19 deaths (Source: Swedish Social Insurance Board) to log output at the firm level (Source: Swedish Tax Authority) in the same month. Physical proximity of occupations by firm according to O*NET (Source: Alderling et al 2021). Restaurants' shares of alcohol sales are measured as share of sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Standard errors are clustered at the firm level. Data contain 290 municipalities, 20 regions and 10,000 zip codes. All regressions include firm and month fixed effects. Column 3 in Panels C and D also includes month-specific municipality-fixed effects. See the text and Web Appendix Table A.1 for details on data.

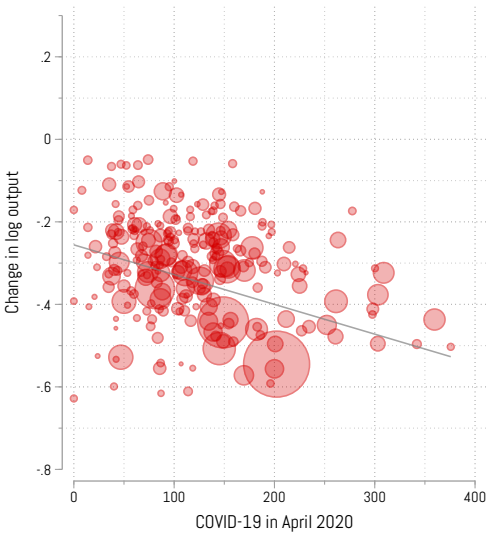


(a) Mobility.

(b) Credit card spending.



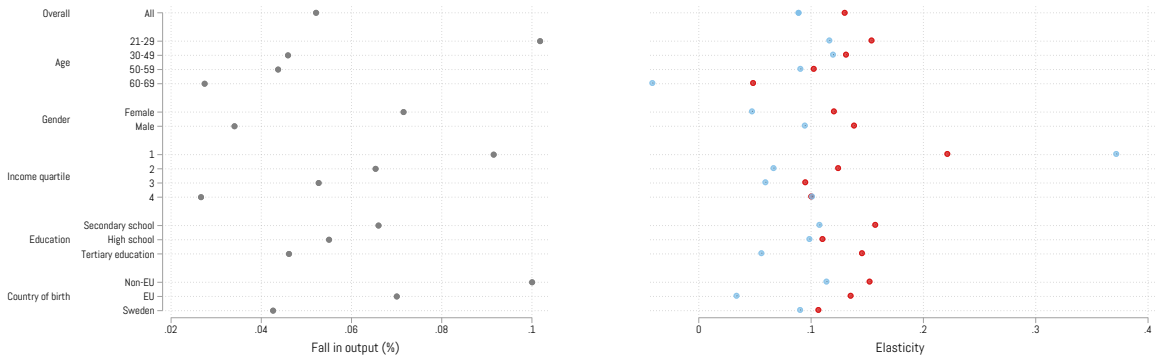
(c) Output in services.



(d) Output in restaurants.

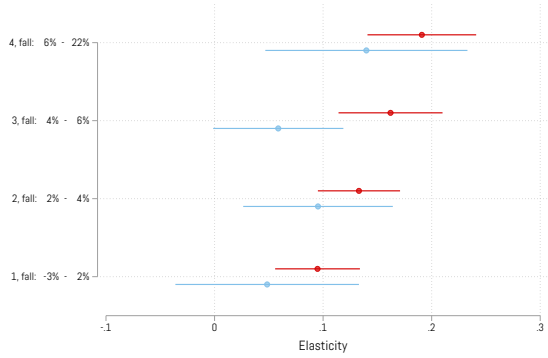
Figure 3. Municipal-level Responses to First COVID-19 Wave.

Note: Changes in outcomes by municipality from January 2020 to April 2020 (y-axes) are related to local incidence of COVID-19 during April 2020 (x-axis), which is equal to the change from January (as COVID-19 was zero). Incidence of COVID-19 is measured by sick leaves when the diagnosis in the doctor's certificate – required for sickness-insurance payout – refers either to COVID-19, or to more diffuse symptoms of COVID-19 which were very uncommon in 2019 (Source: Swedish Social Insurance Agency). Size of circles reflect municipality populations in 2019. The fitted regression line is weighted by population. Mobility data in panel (a) (Source: Telia) measure new connections between cell phones and towers, while credit-card spending in panel (b) refers to total spending by bank customers residing in the municipality (Source: Swedbank). Data for outputs in panels (c) and (d) come from the VAT register (Source Swedish Tax Authority). To account for multi-plant firms, we apportion the output of firms to localities based on where employees reside. See the text and Web Appendix Table A.1 for details on data.



(a) Output fall by group.

(b) Elasticities from output to earnings.



(c) Elasticity across groups based on fall in output.

Figure 4. Employer Exposures and Output-earnings Elasticities by Group.

Note: The falls in firm output in panel (a) are computed from VAT data from February 2020 to April 2020. Output fall is defined as the negative of change in mean log output of firms (Source: Swedish Tax Authority). Worker-firm links use employment data for February 2020 (Source: Swedish Tax Authority). Output fall by group is recovered by weighting firm-level output by each group's share of total employment in each firm. The group-specific elasticities in panel (b) are estimated from employer output to employee earnings, according to payroll tax records (Source Swedish Tax Authority), by the methods described in the text. All models include fixed effects for workers and months. Red circles are for the restaurant sector, where we instrument employer's output by the alcohol exposure times month-by-municipality death rates due to COVID-19. Restaurants' share of alcohol sales are measured as the share of sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Blue circles are for the manufacturing sector, where we instrument the employer's output by its exposure to foreign deaths. Monthly country-specific COVID-19 deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports to each destination country according to 2019 annual trade (Source: Swedish Customs). We set log foreign COVID-19 exposure to zero for firms that do not trade in 2019 or only trade with countries without COVID-19. Likewise, we set the log of local infections to zero when there are no local infections. For firms with no output in certain months we set their log output to zero in these months. In panel (c), we define cells from all combinations of socio-demographic traits in panels (a) and b), except gender. We rank the output falls in these cells into quartiles. The elasticity estimates are computed as in panel (b). The 95% confidence intervals are based on standard errors clustered at the firm level. See the text and Web Appendix Table A.1 for details on data.

Appendix A (for online publication): Additional tables and figures

Table A.1. Variable definitions

Variable	Description
Domestic COVID-19	Source: Social Insurance Board (deaths) and Swedish Social Insurance Agency (sick leave with COVID-19).
Deaths	Death of an individual diagnosed with COVID-19 (daily).
Assumed COVID-19 infection	Diagnosis of individual with diagnosis code correlated with COVID-19 outbreak (daily).
Foreign COVID-19	Source: Our World in Data, Johns Hopkins University and Google LLC "Google COVID-19 Community Mobility Reports".
Deaths	Deaths per country as deemed caused by COVID-19 (daily).
Strictness Index	An index describing how strict policies to control COVID-19 are. The nine metrics used to calculate the Stringency Index are: school closures; workplace closures; cancellation of public events; restrictions on public gatherings; closures of public transport; stay-at-home requirements; public information campaigns; restrictions on internal movements; and international travel controls.
Workplace visits	Mobility trends towards locations designated as workplaces as provided by Google COVID-19 Community Mobility Reports.
Mobility	Source: Telia (Sweden's largest cellphone operator).
Mobility	Movement of individuals across and within municipalities based on connections between cell phones and cell towers (monthly).
Credit card spending	Source: Swedbank (Sweden's largest private bank).
Spending	Usage of credit cards (by age, post code and week).
International trade	Source: Tullverket (Swedish Customs).
Exports	Exports by firm, destination, product and month.
Imports	Imports by firm, source country, product and month.
Value added tax	Source: Swedish Tax Authority.
Output	Sales reported by firms through VAT declarations by month.
Tax paid	Value added tax paid per firm, month and tax bracket.
Earnings and employment	Source: AGI (firms' income tax returns).

Variable	Description
Wage payments	Wages paid per firm and worker pair (monthly).
Employment	Positive wages paid between firm and worker pair (monthly).
Individual background	Source: Swedish Corona Commission
Income quartile	Income quartile of individuals based on income during 2015–2019.
Education	Education of individuals by 2019.
Gender	Gender of individual.
Country of birth	Aggregated into three groups: Sweden, EU, and non-EU.
Age	Aggregated into four groups: 21–29, 30–49, 50–59, and 60–69.
High proximity occupation	O*NET-based information on proximity to other people by occupation, as reported by Alderling et al (2021).

Dep. var.:	Output (log)	Output (log)	Output (log)
	(1)	(2)	(3)
Measure of foreign COVID-19	*Deaths*	*Stringency index*	*Workplace visit reductions*
All firms			
Panel A: Export based			
Export-weighted	-0.031	-0.052	-0.062
exposure to COVID-19	(0.003)	(0.004)	(0.004)
Observations	408,602	408,602	408,602
Panel B: Import based			
Import-weighted	-0.027	-0.039	-0.046
exposure to COVID-19	(0.003)	(0.005)	(0.004)
Observations	408,602	408,602	408,602
Only trading firms			
Panel C: Export based			
Export-weighted	-0.017	-0.021	-0.033
exposure to COVID-19	(0.004)	(0.007)	(0.007)
Observations	119,874	119,874	119,874
Panel D: Import based			
Import-weighted	-0.010	0.002	-0.007
exposure to COVID-19	(0.004)	(0.006)	(0.006)
Observations	119,874	119,874	119,874
Geographic agg. of local COVID-19	*Municipality*	*Region*	*Zip code*
Panel E: Service based			
Local deaths (log)	-0.004	-0.007	-0.000
	(0.001)	(0.003)	(0.000)
Local deaths (log) × share of high	-0.023	-0.027	-0.010
proximity occupations	(0.003)	(0.003)	(0.002)
Observations	2,432,739	2,432,739	2,432,739
Panel F: Restaurant based			
Local deaths	-0.017	-0.025	0.001
	(0.004)	(0.013)	(0.001)
Local deaths × share of alcohol	-0.053	-0.054	-0.016
	(0.005)	(0.007)	(0.005)
Observations	173,495	173,495	173,467
Fixed effects			
Firm	✓	✓	✓
Month × sector	✓	✓	✓

Table A.2. COVID-19 and output (with month-sector fixed effects)

Note: Panels A to D: Regression results based on equation (1) in the text, using monthly data from January-December 2020. Estimates are elasticities from log foreign COVID-19 deaths to log output at the firm level in the same month. Log foreign COVID-19 exposure is set to zero for firms not trading in 2019 (Source: Swedish Customs) and for firms only trading with countries without COVID-19 (Source: Our World in Data). In Panel C and D firms that did not trade in 2019 are excluded. Monthly log output is set to zero for firms with no output in certain months (Source: Swedish Tax Authority). Monthly deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports (Panels A and C) or imports (Panels B and D) to each destination/source country according to 2019 annual data (Source: Swedish Customs). Columns (2) and (3) replace foreign deaths by a general Strictness Index and Reductions in workplace visits by destination/source country (Source: Our World in Data). Panel E and F: Regression results based on equation (2) using monthly data covering January 2020 to February 2021. Estimates are elasticities from log local COVID-19 deaths (Source: Swedish Social Insurance Board) to log output at the firm level (Source: Swedish Tax Authority) in the same month. Physical proximity of occupations by firm according to O*NET (Source: Alderling et al 2021). Restaurants' shares of alcohol sales are measured as share of sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Standard errors are clustered at the firm level. Data contain 290 municipalities, 20 regions and 10,000 zip codes. All regressions include firm and sector-specific month fixed effects. Column 3 in Panels E and F also includes month-specific municipality-fixed effects. See the text and Web Appendix Table A.1 for details on data.

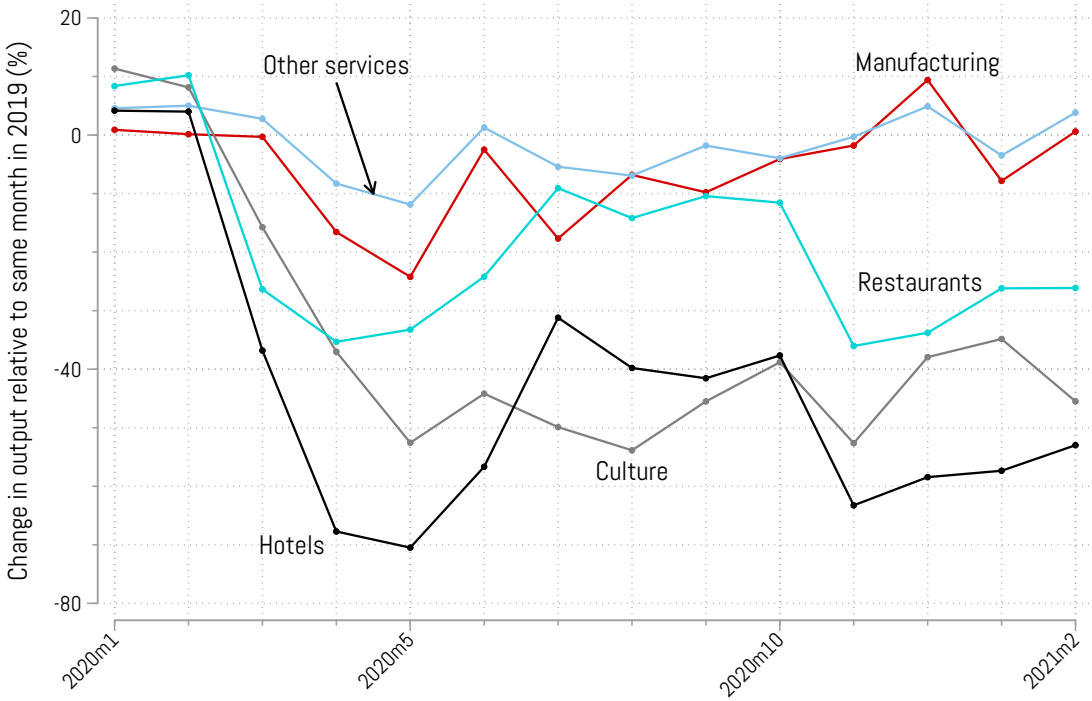
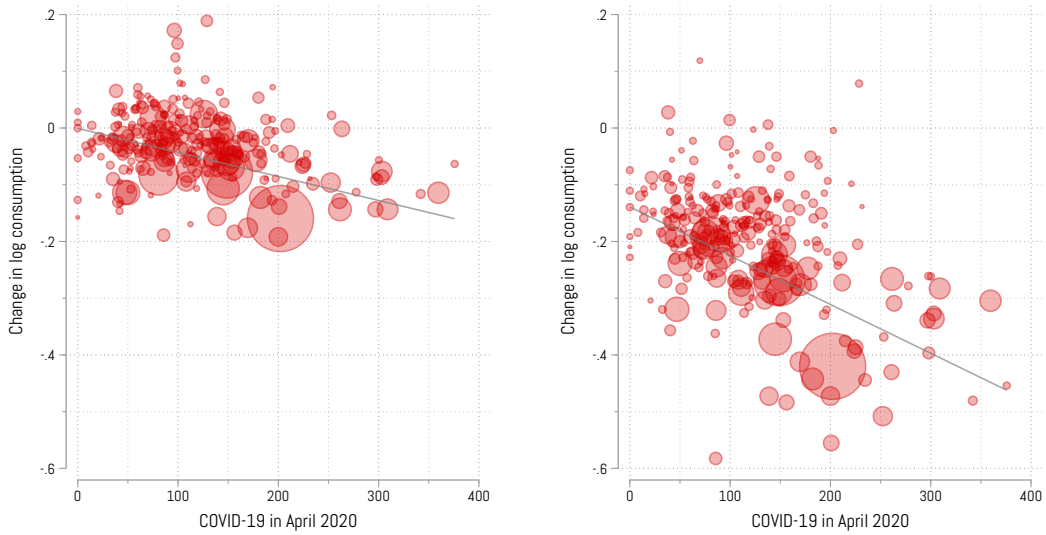


Figure A.1. Output in detailed sectors.

Note: Data span January 2020 to February 2021. The Figure shows percent differences in output by sector (Source: Swedish Tax Authority). See the text and Web Appendix Table A.1 for details on data.



(a) Credit card spending (youngest). **(b)** Credit card spending (oldest).

Figure A.2. Municipal-level responses to first COVID-19 wave by local exposure.

Note: Changes in outcomes by municipality from January 2020 to April 2020 (y-axes) are related to local incidence of COVID-19 during April 2020 (x-axis), which is equal to the change from January (as COVID-19 was zero). Incidence of COVID-19 is measured by sick leaves when the diagnosis in the doctor's certificate – required for sickness-insurance payout – refers either to COVID-19, or to more diffuse symptoms of COVID-19 which were very uncommon in 2019 (Source: Swedish Social Insurance Agency). Size of circles reflect municipality populations in 2019. The fitted regression line is weighted by population. Credit-card spending refers to total spending by bank customers residing in the municipality (Source: Swedbank). The youngest workers (Panel a) are defined as aged 35 and below, while the oldest workers (Panel b) are defined as aged 70 and above. See the text and Web Appendix Table A.1 for details on data.

Dep. var.:	Output (log)							
		Age				Education		
	Overall	21-29	30-49	50-59	60-69	Sec. sch.	High sch.	Ter. edu.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Export based								
Export-weighted exposure to	-0.032	-0.034	-0.031	-0.034	-0.030	-0.032	-0.034	-0.031
foreign COVID-19 deaths	(0.007)	(0.008)	(0.007)	(0.007)	(0.006)	(0.005)	(0.006)	(0.010)
Observations	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466
F-statistic of excl. instrument	22.0	16.22	18.74	26.9	26.3	34.5	28.7	10.0
Panel B: Local COVID-19								
Local deaths	0.023	0.033	0.020	0.011	0.010	0.014	0.027	0.025
	(0.003)	(0.004)	(0.003)	(0.005)	(0.006)	(0.003)	(0.004)	(0.005)
Local deaths $\times$ share of alcohol	-0.142	-0.183	-0.131	-0.097	-0.092	-0.128	-0.149	-0.134
	(0.012)	(0.016)	(0.011)	(0.011)	(0.014)	(0.012)	(0.012)	(0.014)
Observations	942,128	942,128	942,128	942,128	942,128	942,128	942,128	942,128
F-statistic of excl. instrument	76.6	76.1	68.3	40.1	21.7	56.5	78.9	50.0
Fixed effects								
Firm	✓	✓	✓	✓	✓	✓	✓	✓
Month	✓	✓	✓	✓	✓	✓	✓	✓

Table A.3. First stage results for group-specific elasticities.

Note: Regression results are based on equation (2) using monthly data covering January 2020 to February 2021, and contain the first stage results for Figure 4b. Panel A: Estimates are elasticities from log foreign COVID-19 deaths to log output at the firm level in the same month. Log foreign COVID-19 exposure is set to zero for firms not trading in 2019 (Source: Swedish Customs) and for firms only trading with countries without COVID-19 (Source: Our World in Data). Monthly log output is set to zero for firms with no output in certain months (Source: Swedish Tax Authority). Monthly deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports. Panel B: Estimates are elasticities from log local COVID-19 deaths (Source: Swedish Social Insurance Board) to log output at the firm level (Source: Swedish Tax Authority) in the same month. Restaurants' shares of alcohol sales are measured as share of sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Standard errors are clustered at the firm level. The regressions include firm and month fixed effects.

Dep. var.:	Output (log)								
	Income quartile				Country of birth			Gender	
	1	2	3	4	Non-EU	EU	Sweden	Female	Male
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A: Export based									
Export-weighted exposure to	-0.009	-0.022	-0.037	-0.040	-0.024	-0.032	-0.033	-0.027	-0.033
foreign COVID-19 deaths	(0.006)	(0.005)	(0.007)	(0.009)	(0.009)	(0.007)	(0.007)	(0.007)	(0.007)
Observations	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466	6,430,466
F-statistic of excl. instrument	2.2	24.0	25.3	20.6	6.9	20.1	23.8	14.5	23.3
Panel B: Local COVID-19									
Local deaths	0.015	0.020	0.030	0.031	0.014	0.030	0.031	0.021	0.025
	(0.003)	(0.004)	(0.005)	(0.006)	(0.003)	(0.006)	(0.005)	(0.004)	(0.003)
Local deaths $\times$ share of alcohol	-0.127	-0.140	-0.148	-0.145	-0.133	-0.134	-0.145	-0.132	-0.148
	(0.011)	(0.014)	(0.012)	(0.015)	(0.015)	(0.013)	(0.013)	(0.015)	(0.011)
Observations	942,128	942,128	942,128	942,128	942,128	942,128	942,128	942,128	942,128
F-statistic of excl. instrument	64.0	54.0	81.0	49.4	40.8	50.5	66.7	40.8	96.3
Fixed effects									
Firm	✓	✓	✓	✓	✓	✓	✓	✓	✓
Month	✓	✓	✓	✓	✓	✓	✓	✓	✓

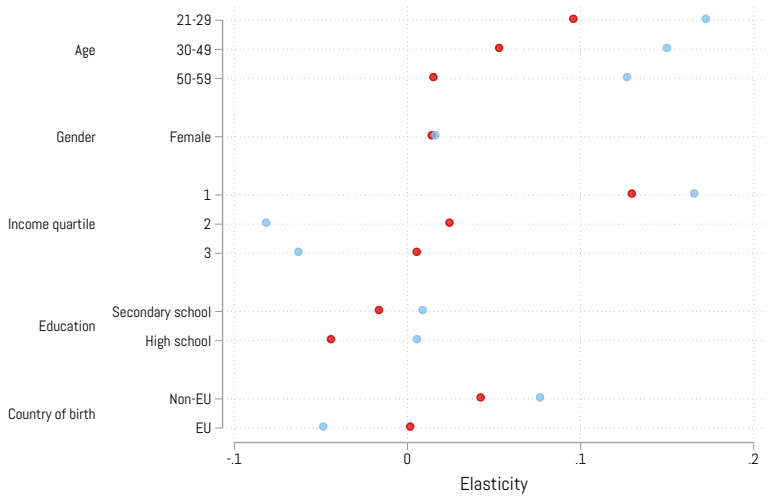
Table A.4. First stage results for group-specific elasticities.

Note: Regression results are based on equation (2) using monthly data covering January 2020 to February 2021, and contain the first stage results for Figure 4b. Panel A: Estimates are elasticities from log foreign COVID-19 deaths to log output at the firm level in the same month. Log foreign COVID-19 exposure is set to zero for firms not trading in 2019 (Source: Swedish Customs) and for firms only trading with countries without COVID-19 (Source: Our World in Data). Monthly log output is set to zero for firms with no output in certain months (Source: Swedish Tax Authority). Monthly deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports. Panel B: Estimates are elasticities from log local COVID-19 deaths (Source: Swedish Social Insurance Board) to log output at the firm level (Source: Swedish Tax Authority) in the same month. Restaurants' shares of alcohol sales are measured as share of sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Standard errors are clustered at the firm level. The regressions include firm and month fixed effects.

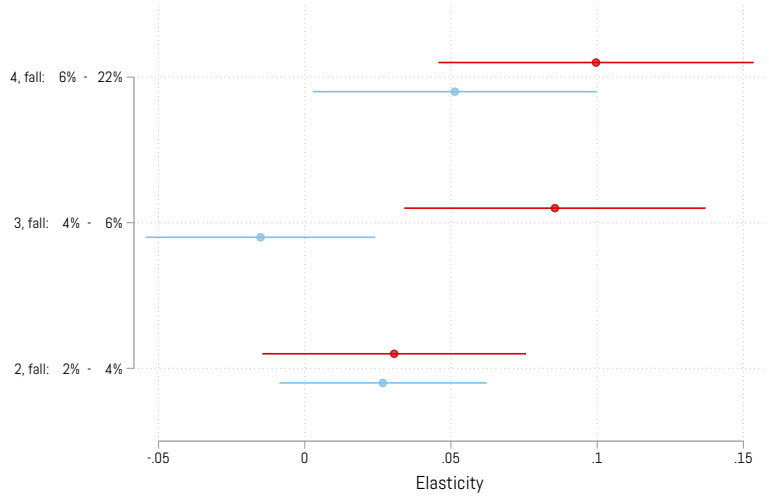
Dep. var.:	Output (log)			
	Quartiles based on fall in output			
	1	2	3	4
	(1)	(2)	(3)	(4)
Panel A: Export based				
Export-weighted exposure to	-0.030	-0.035	-0.042	-0.045
foreign COVID-19 deaths	(0.009)	(0.008)	(0.009)	(0.010)
Observations	5,858,884	5,858,884	5,858,884	5,858,884
F-statistic of excl. instrument	11.5	20.9	23.4	20.6
Panel B: Local COVID-19				
Local deaths	0.017	0.021	0.030	0.018
	(0.003)	(0.003)	(0.004)	(0.005)
Local deaths $\times$ share of alcohol	-0.155	-0.141	-0.142	-0.113
	(0.017)	(0.012)	(0.013)	(0.012)
Observations	942,128	942,128	942,128	942,128
F-statistic of excl. instrument	43.3	69.8	70.7	45.8
Fixed effects				
Firm	✓	✓	✓	✓
Month	✓	✓	✓	✓

Table A.5. First stage results for quartile-specific elasticities.

Note: Regression results are based on equation (2) using monthly data covering January 2020 to February 2021, and contain the first stage results for Figure 4c. Panel A: Estimates are elasticities from log foreign COVID-19 deaths to log output at the firm level in the same month. Log foreign COVID-19 exposure is set to zero for firms not trading in 2019 (Source: Swedish Customs) and for firms only trading with countries without COVID-19 (Source: Our World in Data). Monthly log output is set to zero for firms with no output in certain months (Source: Swedish Tax Authority). Monthly deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports. Panel B: Estimates are elasticities from log local COVID-19 deaths (Source: Swedish Social Insurance Board) to log output at the firm level (Source: Swedish Tax Authority) in the same month. Restaurants' shares of alcohol sales are measured as share of sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Standard errors are clustered at the firm level. The regressions include firm and month fixed effects.



(a) Elasticities from output to earnings with firm-month fixed effects.



(b) Elasticity across groups based on fall in output with firm-month fixed effects.

Figure A.3. Individual-level labor-market elasticities by group with firm-month fixed effects.

Note: Regression results are based on monthly data covering January 2020 to February 2021. Worker-firm links use employment data for February 2020 (Source: Swedish Tax Authority). The group-specific elasticities in Panel (a) are estimated from employer output to employee earnings, according to payroll tax records (Source Swedish Tax Authority), by the methods described in the text. All models include worker and firm-month fixed effects. Red circles are for the restaurant sector, where we instrument employer's output by the alcohol exposure times month-by-municipality death rates due to COVID-19. Restaurants' share of alcohol sales are measured as the share of sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Blue circles are for the manufacturing sector, where we instrument the employer's output by its exposure to foreign deaths. Monthly country-specific COVID-19 deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports to each destination country according to 2019 annual trade (Source: Swedish Customs). We set log foreign COVID-19 exposure to zero for firms that do not trade in 2019 or only trade with countries without COVID-19. Likewise, we set the log of local infections to zero when there are no local infections. For firms with no output in certain months we set their log output to zero in these months. In panel (b), we define cells from all combinations of socio-demographic traits in panels (a) and b), except gender. We then compute falls in firm output from VAT data from February 2020 to April 2020. Output fall is defined as the negative of change in mean log output of firms (Source: Swedish Tax Authority). Output fall by cell is recovered by weighting firm-level output by each cell's share of total employment in each firm. We rank the output falls in the socio-demographic cells into quartiles. The elasticity estimates are computed as in panel (a). The 95% confidence intervals are based on standard errors clustered at the firm level. See the text and Web Appendix Table A.1 for details on data.

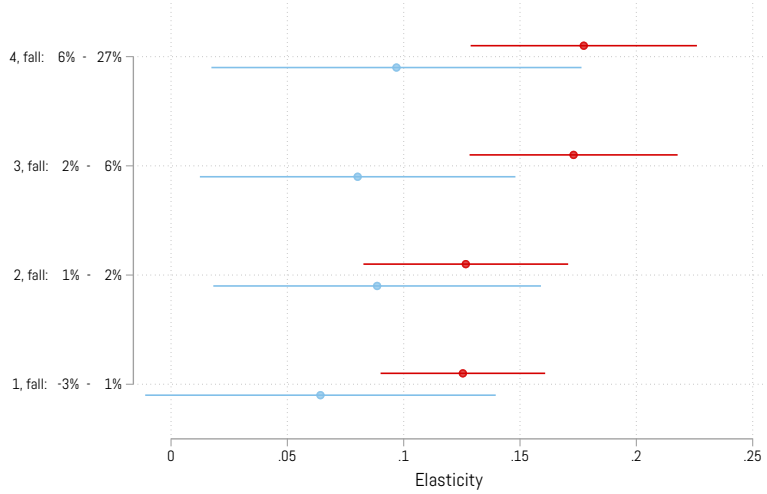


Figure A.4. Elasticity across groups based on fall in output (including gender).

Note: Regression results are based on monthly data covering January 2020 to February 2021. Worker-firm links use employment data for February 2020 (Source: Swedish Tax Authority). Quartile-specific elasticities are estimated from employer output to employee earnings, according to payroll tax records (Source Swedish Tax Authority), by the methods described in the text. All models include fixed effects for workers and months. Red circles are for the restaurant sector, where we instrument employer's output by the alcohol exposure times month-by-municipality death rates due to COVID-19. Restaurants' share of alcohol sales are measured as the share of sales at 25 percent VAT in 2019 (Source: Swedish Tax Authority). Blue circles are for the manufacturing sector, where we instrument the employer's output by its exposure to foreign deaths. Monthly country-specific COVID-19 deaths per million individuals (Source: Our World in Data) is weighted by the share of firm-level exports to each destination country according to 2019 annual trade (Source: Swedish Customs). We set log foreign COVID-19 exposure to zero for firms that do not trade in 2019 or only trade with countries without COVID-19. Likewise, we set the log of local infections to zero when there are no local infections. For firms with no output in certain months we set their log output to zero in these months. We first define cells from all combinations of socio-demographic traits as described above, now also including gender. We then compute falls in firm output from VAT data from February 2020 to April 2020. Output fall is defined as the negative of change in mean log output of firms (Source: Swedish Tax Authority). Output fall by cell is recovered by weighting firm-level output by each cell's share of total employment in each firm. We rank the output falls in the socio-demographic cells into quartiles. The elasticity estimates are computed as in Figure A.3b. The 95% confidence intervals are based on standard errors clustered at the firm level. See the text and Web Appendix Table A.1 for details on data.