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Consumer responses to the COVID-19 crisis: evidence from bank account transaction data*

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Abstract

In this paper, we use transaction-level bank account data from Denmark to study the dynamics of consumer spending during the COVID-19 pandemic. We document that aggregate spending initially dropped by almost 30 percent but recovered almost fully after the first wave. While spending plummeted in categories severely affected by supply restrictions, it increased in unaffected categories. Individual exposure to health risks and supply restrictions was associated with much larger spending cuts than exposure to income risk and unemployment. The findings suggest that the contraction was mainly caused by temporary health risks and supply restrictions, with a limited role for persistent negative spillovers.

Keywords: Consumer spending; COVID-19 pandemic; transaction data
JEL classification: *D*12; *E*2; *E*65; *I*18

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1. Introduction

The COVID-19 pandemic has represented a grave risk to public health and has caused severe disruptions in the economy, with entire industries effectively shutting down. In these uncharted waters, governments have generally responded swiftly with far-reaching interventions to save lives and livelihoods.

A key concern for policymakers in the pandemic is the size and the nature of consumer responses. When activity in entire sectors of the economy comes to a halt, there must be a drop in aggregate consumer spending. This is regardless of whether the drop in activity is caused by government restrictions or by voluntary restraint driven by perceptions that some activities are unsafe. In either case, the drop in activity in the directly affected sectors might reduce aggregate income, thus triggering a demand-driven recession that also affects open sectors (Guerrieri et al., 2022) and persists long after the epidemic has ended and restrictions on economic activity have been lifted (Gourinchas, 2020). In the face of this risk, governments all over the world have initiated massive programs, including fiscal, monetary, and regulatory measures, to support businesses in the closed sector and households more broadly.

In this paper, we use bank account transaction data from Denmark to study the dynamics of consumer spending through the first wave of the COVID-19 crisis. The broad question underlying the analysis is about the nature of the economic consequences of the pandemic: does it merely cause a temporary contraction of one part of the economy, caused by specific health risks and the supply restrictions aiming to contain them, or are there negative and persistent spillovers to other parts of the economy driven by income risk and unemployment? We address this broad question with three types of analysis.

(1) At the macro level, we estimate how much aggregate spending dropped at the onset of the crisis and, equally important, to what extent it recovered when health risks and supply restrictions had largely disappeared.

(2) At the sector level, we estimate the spending dynamics for the open and the closed sectors of the economy separately and investigate whether the crisis negatively affected spending in the open sector.

(3) At the individual level, we analyse whether the aggregate spending drop was mainly driven by those with high exposure to health risks and supply restrictions or by those with high exposure to income risk and unemployment.

Our analysis uses transaction data for about 700,000 individuals who hold their main transaction account at Danske Bank, the largest retail bank

in Denmark, with a customer base that is almost perfectly representative of the Danish population. For each individual, we observe all payments by card and mobile wallet through accounts at the bank as well as cash withdrawals. This allows us to construct a customer-level measure of total spending at the daily frequency. Exploiting a standardized classification of merchants and other features of the transaction data, we measure card spending in three distinct sectors that vary by the severity of the supply constraints: the closed sector (e.g., hairdressers, which were not allowed to operate), the constrained sector (e.g., commuting, as trains and buses continued to operate but at much reduced frequencies) and the open sector (e.g., online retail, which operated freely). Finally, our dataset contains information on income (based on a categorization of incoming transfers), balance sheet components (based on information from security accounts) and demographics (from basic customer records).

Our analysis covers the first wave of the COVID-19 pandemic, from when the first case was confirmed (on 27 February 2020), through a period with high infection rates and severe restrictions in selected parts of the economy (from 11 March 2020), to a period of near-normality with almost no infections (from late May 2020) and very few government restrictions (from late June 2020). We extend the sample period as far as we can (until mid-August 2020) without including the early phases of the second wave (from early September 2020).

Our first finding is that the onset of the pandemic caused a sharp drop in aggregate consumer spending of around 29 percent (relative to a counterfactual trajectory with the same year-on-year growth as in early 2020) and an increase in household liquidity of the same size. The magnitude of the spending drop is much larger than typical consumer responses to idiosyncratic shocks such as unemployment (Ganong and Noel, 2019; Andersen et al., 2021). As the virus subsided and restrictions were gradually lifted, consumer spending recovered quickly. At the end of the first wave, aggregate spending was only 3 percent below the counterfactual trajectory.

These results show that the effect of the pandemic's first wave on the economy was an unusually large but also short-lived contraction. As soon as the impediments to economic activity – health risks and supply restrictions – had vanished, consumer spending bounced back with little signs of a persistent effect on household demand. This key finding is most likely explained by the ambitious stabilization policies adopted by the government, which effectively absorbed most of the losses created by the pandemic. With households' income streams largely unaffected and balance sheets significantly improved, consumer spending went almost back to normal when the first wave was over.

Our second finding is that the spending dynamics varied across expenditure categories with the severity of the government restrictions.

When the restrictions were imposed, spending decreased by around 70 percent in the closed sector while it increased by almost 20 percent in the open sector. When the restrictions were lifted, the differences gradually became smaller but the initial shock exhibited some persistence. At the end of the first wave, spending in the closed sector remained around 20 percent below the counterfactual level, largely driven by a sluggish recovery of travel expenditure, while spending in the open sector was still 10 percent above.

Viewed through the lens of recent macro theory, these results constitute a test of Keynesian supply shocks (Guerrieri et al., 2022). In a two-sector economy where one sector is temporarily shut down, for instance because the government restricts high-contact consumer spending to fight a pandemic, activity can fall below full capacity not just in the closed sector but also in the open sector. This occurs when workers suffering income losses reduce spending a lot and substitution from the closed to the open sector is not strong enough to offset the effect of the overall spending cut on the open sector. Our finding that spending in the open sector remained above the counterfactual trajectory throughout the first wave suggests that the supply shock, combined with the policy measures to stabilize demand, did not lead to such Keynesian effects. In other words, the stabilization policies were sufficient to keep demand in the open sector from falling below its efficient level.

Our final set of results describes the heterogeneity in spending responses by exposure to the various dimensions of the COVID-19 crisis, holding exposure in other dimensions constant. We measure exposure to health risks with an indicator for being over the age of 65, as the elderly are much more likely to suffer severe health consequences and ultimately die if they contract the virus. We measure exposure to the supply restrictions with an indicator for having a large spending share in the closed sector before the pandemic. We measure exposure to the income risk created by the pandemic with an indicator for being employed in the closed sector on the eve of the first wave. Finally, we measure job loss with an indicator for becoming unemployed during the first wave.

The results suggest that the direct consequences of the pandemic – health risks and supply restrictions – contributed greatly to the aggregate spending dynamics. The elderly, who were most exposed to the health risks, reduced spending much more than others at the onset of the crisis (13 percentage points difference).[1] Similarly, consumers with a strong

[1]We also analyze the geographic variation in spending responses, showing that, on average, spending dropped more in municipalities with high versus low COVID-19 incidence, and in those with high versus low population density. This is consistent with evidence from other countries, as well as with the hypothesis that individual health risk is an important driver of spending responses.

preference for goods and services in restricted supply initially reduced their spending much more than others (11 percentage points difference). As the virus subsided and the supply restrictions were lifted, these differential responses largely vanished and both groups converged almost fully to the spending trajectory of the aggregate economy.

By contrast, the indirect consequences of the pandemic – income risk and actual job losses – explain much less of the aggregate spending dynamics. Individuals employed in the closed sector initially reduced spending only slightly more than public sector employees with high income security (2.5 percentage points difference) and this difference remained roughly constant throughout the first wave. Individuals who became unemployed during the first wave followed the spending trajectory of those who remained employed except for a relatively small differential spending drop at the very end of the sample period (2 percentage points difference). However, although income risk and unemployment are largely irrelevant for the enormous spending drop at the onset of the pandemic, they account for a substantial part of the much smaller spending gap that remained at the end of the first wave. This illustrates the risk of a negative dynamics on the demand side: employees who lose income, or anticipate that they might do so, cut back spending, thus reinforcing and prolonging the contraction of the aggregate economy.

From the perspective of consumer theory, the household response to the pandemic is largely consistent with a negative shock to the marginal utility of consumption: current consumption became less attractive relative to future consumption because of supply restrictions and the health risks associated with some forms of consumer activity. The shock induced significant intertemporal substitution whereby consumers reduced current spending and increased saving with the aim of shifting consumption opportunities to future periods without supply restrictions and health risks.

With supply chains severely interrupted in many sectors, this intertemporal shift in consumption is a likely contributor to the inflationary pressures seen in many countries during later stages of the pandemic. The contribution coming from this specific channel will wear off gradually, however, as consumers run down the extra savings accumulated during the first wave.

Our analysis contributes to a growing empirical literature on the economic consequences of the COVID-19 crisis, which we briefly review in the next section. A key advantage of our study is that our dataset uniquely combines three important features. First, our sample is almost perfectly representative of the overall population in terms of age and income, which is crucial for making inferences about aggregate spending when responses to the pandemic differ across socio-economic groups. Second, our dataset includes information about income, employers, and demographics

at the level of individual consumers, which allows us to investigate the economic mechanisms underlying the spending dynamics. Third, our spending measure includes both card payments and cash withdrawals, which is important when the dominant mode of payment varies across expenditure categories, demographic groups, and over time.

The specific contribution of the present paper is to investigate the nature of the economic contraction caused by the pandemic. Because our data allow us to link both the income and spending of each individual to the open and closed sectors of the economy, we are in a unique position to study the relative importance of spillovers highlighted by recent macro theory. Our results consistently show that the contraction of consumer spending was mainly driven by the temporary consequences of the pandemic, health risks and supply restrictions, with a limited role for persistent negative spillovers to other sectors working through income risk and unemployment. While this conclusion is necessarily specific to the context we are studying – the first wave of the pandemic in Denmark – there is reason to believe it generalizes to many other high-income economies. In European countries, the direct consequences of the pandemic, in the form of health risks and supply restrictions, were often more serious than in Denmark whereas the recorded increase in unemployment was similar. If anything, we should therefore expect spillovers on the demand side to be relatively less important in these countries. In contrast, unemployment rose much more sharply in the United States, so it is possible that income risk played a larger relative role there.

The paper proceeds in the following way. Section 2 provides a short review of the rapidly expanding literature on consumer responses to the COVID-19 crisis. Section 3 briefly accounts for the development of the crisis in the Danish context. Section 4 describes the data sources and provides summary statistics. Section 5 develops the empirical framework. Section 6 reports the results. Section 7 concludes.

2. Related literature

A number of studies have used data from banks, credit card companies, or financial apps to study the high-frequency spending dynamics through the COVID-19 crisis in the US (Baker et al., 2020a; Chetty et al., 2020; Cox et al., 2020), China (Chen et al., 2021), Spain (Carvalho et al., 2021), France (Landais et al., 2020), Denmark and Sweden (Sheridan et al., 2020), the United Kingdom (Chronopoulos et al., 2020; Surico et al., 2021), and Mexico (Campos-Vazquez and Esquivel, 2021). Most of these studies use transaction data from financial apps (Baker et al., 2020a; Chronopoulos et al., 2020; Surico et al., 2021) or aggregated data from banks or credit

card companies (Chetty et al., 2020; Carvalho et al., 2021; Chen et al., 2021). The datasets most comparable to ours comprise individual-level information from large banks in France and the US (Cox et al., 2020; Landais et al., 2020).

All of these papers find pronounced decreases in consumer spending around the onset of the pandemic. Quantitative comparisons are not always straightforward as many studies refrain from reporting estimates of the drop in aggregate spending. However, our central estimate that aggregate spending dropped by around 30 percent in Denmark at the onset of the pandemic is similar to an analogous estimate for the US of around 35 percent (Cox et al., 2020), but notably smaller than the 40 percent drop estimated for the UK (Surico et al., 2021) and the 50 percent drops estimated for France (Landais et al., 2020) and Spain (Carvalho et al., 2021) based on card transactions. These cross-country patterns are consistent with our overall conclusion because they indicate that countries that exhibited a higher virus prevalence and resorted to stricter lockdown measures during the first wave (e.g., France, Spain, and the UK) also suffered considerably larger spending losses.

Besides using transaction data to describe spending dynamics through the COVID-19 crisis, the literature also provides several types of causal evidence. First, one set of papers uses similar data to study consumer spending responses to stimulus payments from the government. The key finding is that these payments were associated with large spending responses even in the very short run, notably among low-income households (Baker el al., 2020b; Chetty et al., 2020). Second, another set of papers attempts to isolate the effect of lockdowns and re-openings on consumer behavior using variation in lockdown policies across countries with similar *ex ante* exposure to the virus (Sheridan et al., 2020) or across geographical areas in the US (Chetty et al., 2020; Goolsbee and Syverson, 2021). The results suggest that lockdowns had a limited effect on spending despite the striking temporal correlation between lockdowns and spending drops.[2] Lastly, a set of papers estimates the effects of local virus prevalence by comparing spending responses or labor market outcomes across within-country regions subject to the same restrictions on economic activity but characterized by different virus prevalence (Chetty et al., 2020; Landais et al., 2020; Aum et al., 2021; Waldenström and Angelov, 2021). These studies typically find that spending drops are somewhat larger in local areas with more

[2]In Sheridan et al. (2020), we also use transaction data from Danske Bank while exploiting the fact that the bank has customers in both Denmark and Sweden – two countries with similar exposure to the pandemic but a very different policy response – to compare spending responses through the very earliest phase of the pandemic.

COVID-19 cases and hospitalizations, which is consistent with a direct effect of local health risk on consumer behavior.

A separate literature studies consumer stockpiling in the context of the pandemic. While our data do not allow for a clear test of stockpiling, as we do not observe which specific goods consumers purchase, other papers report evidence of stockpiling of necessity goods such as toilet paper, and correlate stockpiling behavior with personal characteristics (Garbe et al., 2020).

3. Background

3.1. The pandemic

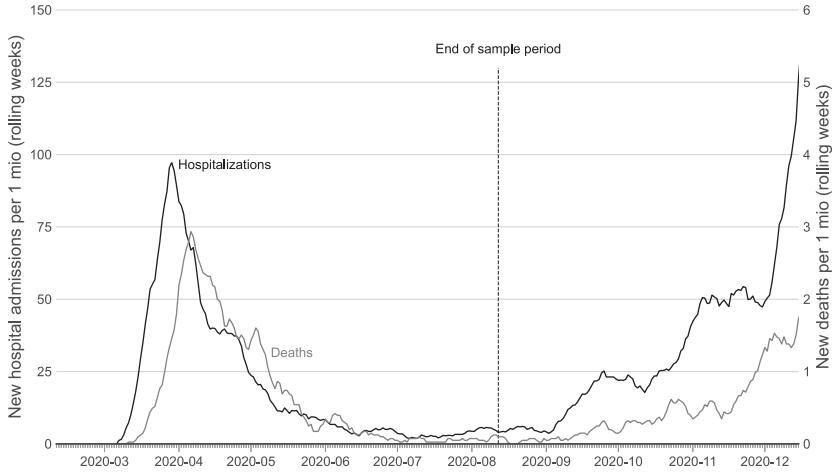
The first case of COVID-19 in Denmark was confirmed on 27 February 2020 and more cases quickly followed. Initially, all cases were related to travelling in the most affected areas of Europe, but the virus soon started spreading within the country. As shown in Figure 1, the number of new hospitalizations (left axis) peaked in late March and the number of new deaths (right axis) a few weeks later. The epidemic then quickly subsided and the prevalence of the virus was generally low between late May and August. However, a second wave started building up from September with notable increases in both hospitalization and mortality. The focus of the present paper is the first wave and the ensuing period with low virus prevalence.

The epidemiological dynamics were similar in most countries in Europe and North America (see Figure A1 in the Online Appendix) although the overall severity varied considerably across countries (see Figure A2 in the Online Appendix). The cumulative mortality through the first wave was 107 deaths per million inhabitants in Denmark (as of 11 August 2020), which is comparable to Germany (110), lower than in France, Sweden, the UK, and the US (all more than 400), but higher than in Finland and Norway (both 60 or less).

3.2. Supply constraints

The key policy to fight the pandemic, in Denmark as well as in other countries, was to introduce restrictions on activities involving physical proximity. On 11 March 2020, the Prime Minister announced a national lockdown in a televised speech: all non-essential parts of the public sector were shut down (including schools, libraries, and universities); private sector employees were urged to work from home; borders were closed for foreign nationals, and air traffic therefore virtually closed; the population was generally encouraged to stay at home and avoid social contact. One week later, facing a still escalating epidemic, the government announced

Figure 1. The COVID-19 pandemic in Denmark



Notes: The figure shows the weekly number of new hospitalizations related to COVID-19 (left axis) and the weekly number of new deaths related to COVID-19 (right axis) per million inhabitants. On each day, the figure shows the sum over the day itself and the six previous days. The vertical dashed line indicates the end of our sample period.
Source: Statens Serum Institut (2020).

further restrictions banning congregations of more than 10 individuals, shutting down shopping malls, hairdressers, and nightclubs, and restricting restaurants to take-away service.

As the epidemic subsided, the government initiated a gradual reopening. Daycare and primary schools opened on 15 April, and over the next four to five weeks, almost all restrictions on economic activities were lifted: shopping malls, restaurants, personal services, cafes, etc., were allowed to resume business. Only a few restrictions remained in place throughout our period of analysis: travel to destinations outside Europe was discouraged; concerts and sports events were restricted (with a maximum of 100 people); and night clubs remained closed (see Table A1 in the Online Appendix for a time line).

Overall, the timing and severity of the measures were comparable to most of Northern Europe (such as Finland, Germany, the Netherlands, and Norway). They were generally less restrictive than in Southern Europe (such as France, Italy, and Spain) where the pandemic was more severe, but more restrictive than the light-touch approach adopted in neighboring Sweden (Sheridan et al., 2020).

3.3. Stabilization policies

The Danish lockdown was accompanied by massive government programs to mitigate the financial damage to businesses and households. First, to

help firms overcome temporary liquidity problems, deadlines for making tax payments were postponed and regulatory constraints on bank credit were loosened. Second, to prevent mass lay-offs, the government committed to paying 75 percent of the salary of private sector employees who were temporarily sent home, as long as the employer committed to keeping them on the payroll at full salary. Third, to mitigate business failures, separate policies offered partial compensation to all firms for fixed costs and to the self-employed for lost revenue. These programs were all proposed by the government within the first week after the lockdown and received unanimous support in the Danish Parliament.

The programs were roughly similar in scale and scope to those launched by many other governments in Europe (International Monetary Fund, 2020). The magnitude of the discretionary government spending in Denmark through the first wave of the pandemic (5.9 percent of GDP) was somewhat smaller than in Germany, the UK and the US (all above 8 percent of GDP) but comparable to France, Norway, and Sweden (all between 5 percent and 6 percent of GDP; see Figure A3 in the Online Appendix).

Despite the massive government interventions, unemployment surged throughout Europe and North America in the first wave of the pandemic. Between February and August 2020, the unemployment rate in Denmark increased by around 1.4 percentage points, which is the same as in Sweden, slightly more than in Finland, France, and Norway (all 1.5–2 percentage points), but less than in Germany and the UK (both below 1 percentage point; see Figure A4 in the Online Appendix).

4. Data

We measure consumer spending with transaction-level data from Danske Bank, the largest retail bank in Denmark. For each customer, our dataset includes information about all payments with card and mobile wallet, all cash withdrawals, and all incoming money flows. We also retrieve basic demographic information such as age and gender from the bank's customer records.

We use two criteria to define a sample of individuals (above the age of 18) who consistently use Danske Bank as their main bank: customers who held their main transaction account at Danske Bank between 1 January 2018 and the end of the sample period on 11 August 2020 and made at least one card payment in each month.[3]

[3]In Denmark, all residents need to register a bank account for monetary transactions with the public sector (e.g., tax refunds, child subsidies, pensions, student loans, unemployment benefits, housing support, and social welfare payments). We assume that this is also the main transaction account.

We create a daily measure of total spending by summing the card payments, mobile wallet payments, and cash withdrawals by a given individual on a given day. Further, we create measures of spending in specific categories, such as groceries, travel, and restaurants, based on a standardized coding of the type of goods and services each shop provides.[4] Finally, we create three composite spending categories that aggregate individual spending categories based on the extent to which the supply was restricted. At one extreme, we consider travel, restaurants, personal services (e.g., dentists and hairdressers), and entertainment (e.g., cinemas, theatres, and bars) as a "closed sector". These businesses were, in principle, not allowed to operate, although there were exceptions. For instance, restaurants were not allowed to seat guests, but could sell take-away food; dentists were closed, but could take emergency patients; international travel was virtually impossible as borders were closed, but domestic tourism was possible. At the other extreme, we consider online retail (except airlines, etc.), groceries, and pharmacies to be an "open sector", as such businesses faced only very mild constraints. For instance, the government instructed consumers to keep distance in stores. As an intermediate case, we consider retail (except online), fuel, and commuting to be a "constrained sector". Within the retail sector, shopping malls were shut down but high-street shops were generally allowed to remain open, subject to some restrictions. In the public transport sector, trains and buses continued to operate but at much reduced frequencies.[5] We also construct a daily measure of saving in transaction accounts by computing the change in transaction account balances relative to the day before.

Finally, we construct indicators capturing exposure to the various dimensions of the COVID-19 crisis. First, we use customer records to define age groups with different exposure to health risks. In our main analysis, we employ an indicator for being 65 years old or more as a measure of high health risk, but we also conduct an auxiliary analysis with more granular age indicators. Second, we use spending data to construct groups with different *ex ante* spending shares in the closed sector and thus a different exposure to the supply restrictions. Third, we use industry information about the firms making salary payments to define groups with different exposure to income losses due to the industry in which they are employed on the eve of the pandemic (December 2019). Specifically, we

[4]Following Ganong and Noel (2019), we categorize spending by the four-digit Merchant Category Code, an international standard for classifying merchants by the type of goods and services they provide. We show the composition of spending at this level of aggregation in Table A2 in the Online Appendix.

[5]We provide more details on the aggregation of spending categories into sectors in Table A3 in the Online Appendix.

distinguish between individuals employed in the closed part of the private sector, the constrained part of the private sector, the public sector, and a residual group (also containing non-employed individuals).[6] Finally, we use counterpart information on incoming payments to distinguish labor earnings and government transfers, which allows us to define a group affected by unemployment during the first wave of the pandemic (April–June 2020), and a group employed throughout. Specifically, we consider that an individual became unemployed in month m if the individual received unemployment benefits of at least \$1,200 in month m, no benefits in months $m-3$ to $m-1$, and salary income of at least \$1,200 in one of the months $m-6$ to $m-1$. As shown in Figure A6 in the Online Appendix, such events coincide with very substantial drops in labor income.

Table 1 reports summary statistics for our estimation sample (Column 1) and compares them with socio-economic information for the full adult population (Column 2). Our sample of 715,000 individuals is almost perfectly representative of the adult population of 4,645,000 individuals in terms of gender, age, income, and stock market participation. This reflects the fact that Danske Bank is a broad retail bank present in all parts of the country and caters to all types of customers.[7] We also provide summary statistics on spending by sector, and on saving in transaction accounts, which are only available for the bank sample.

5. Empirical strategy

The main aim of the empirical analysis is to measure the change in consumer spending induced by the COVID-19 crisis: in the aggregate, across sectors of the economy, and across consumers with different exposure to the crisis.

To capture the sharp change around the lockdown, we use spending information at the daily frequency. To address the cyclicality of consumer spending over the week, the month, and the year, we compare spending on each day in the window of analysis to consumer spending on a reference day 364 days earlier. The reference day is always the same day of the week and

[6]We provide more detail on the aggregation of industries in Table A4 in the Online Appendix. As shown in Figure A5, the labor income of employees in the closed sector did, in fact, drop relative to others during the first wave of the pandemic, validating our use of *ex ante* employment in this sector as an indicator for income risk exposure.

[7]Our sample seemingly includes a smaller fraction of individuals working in the closed sector than the full population. This might reflect the fact that we impose a three-month tenure requirement when assigning individuals to industries, combined with the fact that at-risk sectors generally have a higher turnover. By comparison, the industry distribution in population-wide statistics is a snapshot with no tenure requirement.

Table 1. Summary statistics

	Sample (1)	Population (2)
Female	51.6%	50.6%
Age		
18–29 years	21.6%	19.9%
30–44 years	22.2%	22.7%
45–64 years	33.5%	32.9%
65+ years	22.6%	24.5%
Annual disposable income, 2019 (USD)	37,596	38,893
Stockholder	27.8%	24.5%
Employment shares by sector		
Closed private	3.7%	7.0%
Non-closed private	34.7%	37.9%
Public	20.2%	17.6%
Total annual spending, 2019 (USD)	19,674	–
Spending shares by sector		
Closed sector	24.6%	–
Constrained sector	24.1%	–
Open sector	38.2%	–
Annual net saving in transaction accounts, 2019 (USD)	2,098	–
Number of individuals	714,748	4,645,697

Notes: This table presents summary statistics for our analysis sample of Danske Bank customers (Column 1) and for the entire adult population of Denmark (Column 2) on the eve of the COVID-19 crisis in 2019. The summary statistics for the sample of bank customers are based on customer data from Danske Bank while those for the population are based on publicly available data from Statistics Denmark using the most comparable variable definitions and sample restrictions. There are three main differences. First, disposable income and stock ownership in the population sample are averages for individuals aged over 20 (compared with those aged over 18 in the Danske Bank sample). Second, stock ownership is defined as having realized income from stocks in the population sample (compared with owning securities in the Danske Bank sample). Third, employment shares in the population sample are for individuals aged over 14 and with no tenure requirement (compared with age over 18 and a three-month tenure requirement in the Danske Bank sample).

almost exactly the same place in the monthly and annual spending cycle. For example, we compare 8 February 2020 (a Saturday) to the reference day 9 February 2019 (also a Saturday).

5.1. Aggregate spending

In a first step, we compute the difference between aggregate spending on each day and aggregate spending on the reference day, and we scale this with average daily spending around the reference day. This yields a measure of excess spending on a given day expressed as a fraction of the normal level of spending,

$$excess\ spending_t = \frac{spending_t - spending_{t-364}}{average\ spending_{t-364}}, \quad (1)$$

where $spending_t$ is aggregate spending on day t and $average\ spending_{t-364}$ is daily aggregate spending averaged over one year centered at day $t-364$.

We measure the effect of the crisis on aggregate spending as the difference between average excess spending in a given month and average excess spending in a reference month before the crisis. To capture the sharpness of the shock, we do not use calendar months, but define event months relative to the onset of the national lockdown. Hence, month 0 runs between 12 March and 11 April 2020; month 1 runs between 12 April and 11 May 2020; and so on. We use month −2, running from 12 January to 11 February 2020, as the reference month, as month −1 might include anticipation effects. We thus measure the effect of the crisis on aggregate spending in month m as

$$\Delta spending_m = \underbrace{E[excess\ spending_t | t \in m]}_{\substack{average\ excess\ spending \\ \text{in month } m}} - \underbrace{E[excess\ spending_t | t \in pre]}_{\substack{average\ excess\ spending \\ \text{in month } -2}}. \tag{2}$$

We effectively use excess spending in the pre-lockdown period as a counterfactual for excess spending in the post-lockdown period. In plain words, we assume that absent the COVID-19 crisis, year-on-year spending growth would have been the same after the lockdown as in the reference month just before the lockdown. We assess the credibility of that identifying assumption by inspecting estimates for the pre-lockdown period.

5.2. Heterogeneity across municipalities, sectors, and households

We proceed in a completely analogous way to capture the effect of the crisis on aggregate spending in sector s, which we denote by $\Delta spending_{m,s}$. We first construct a daily measure of excess spending in sector s by applying equation (1) to aggregate spending in sector s. We then estimate the monthly effect of the crisis on spending in sector s by applying equation (2). Similarly, we construct municipality-level estimates of the effect on spending by going through the same steps for total spending (i.e., summed across sectors) by residents in each of the 98 Danish municipalities.

To assess how spending was affected differentially for individuals with different types of exposure to the crisis, we first apply analogous steps to define $\Delta spending_{m,i}$. This is the excess spending of individual i in month m relative to excess spending in month −2: an individual-level estimate of the effect of the crisis on total spending in month m. After winsorizing this variable lightly (at the 1st and 99th percentiles), we estimate the following regressions (one for each event month m):

$$\Delta spending_{m,i} = \alpha + \beta X_{m,i} + \epsilon_{m,i}. \tag{3}$$

The vector X contains indicators for a rich set of individual characteristics and β thus captures how differences in one dimension correlate with the spending trajectory through the crisis, holding differences in other dimensions constant.

We generally include indicators for the following types of *ex ante* exposure to the COVID-19 crisis: health risk (five age groups); supply restrictions (four groups defined by spending share in the closed sector); income risk (four groups defined by sector of employment). Moreover, we always control for the following *ex ante* characteristics: income (100 income groups); balance sheet (two groups – stockholders versus non-stockholders); urban residence (two groups – address in the capital versus in the provinces). To study the role of unemployment, we run a separate regression where the unemployment indicator is added to X.[8]

We present the individual-level results by displaying the estimated effect of the pandemic on the spending trajectory of individuals with a specific characteristic in one dimension (e.g., high health risk) and characteristics that are identical to the overall sample in all other dimensions.

6. Results

6.1. Aggregate spending responses

As shown in Figure 2, our estimates imply that the COVID-19 crisis caused a sharp decrease in aggregate spending of around 29 percent at the time of the lockdown. As the virus subsided and restrictions were lifted over the following months, consumer spending gradually recovered. At the end of the sample period, aggregate spending was only 3 percent below the counterfactual level.

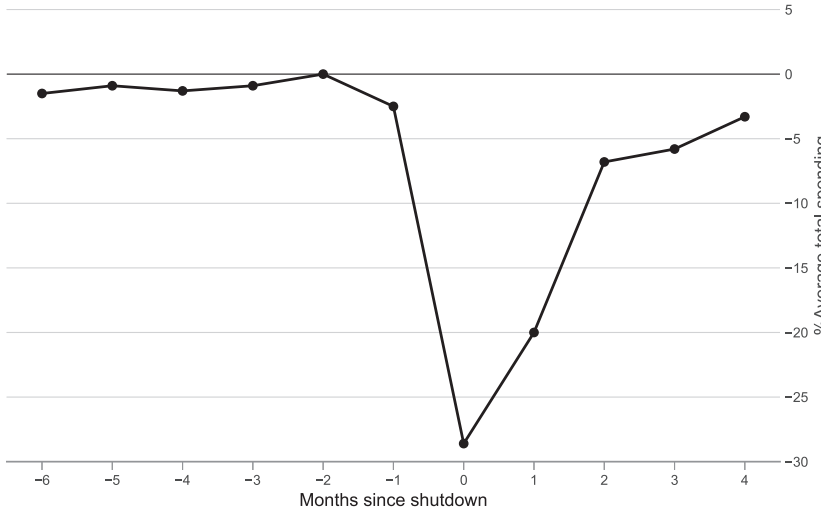
We note that the estimates for the months before the onset of the pandemic are close to zero, reflecting that the year-on-year growth rate in aggregate spending through this period was stable and very similar to the year-on-year growth rate in the reference month ($m = -2$). This lends credibility to the identifying assumption that the counterfactual growth rate absent the pandemic would have been the same as the actual growth rate in the reference month.

6.2. Spending responses by sector

As shown in Figure 3, the spending dynamics varied massively across sectors and correlates strongly with the severity of the supply restrictions.

[8]We do not generally want to control for unemployment, an *ex post* outcome, when we study the role of *ex ante* exposure.

Figure 2. Aggregate spending response

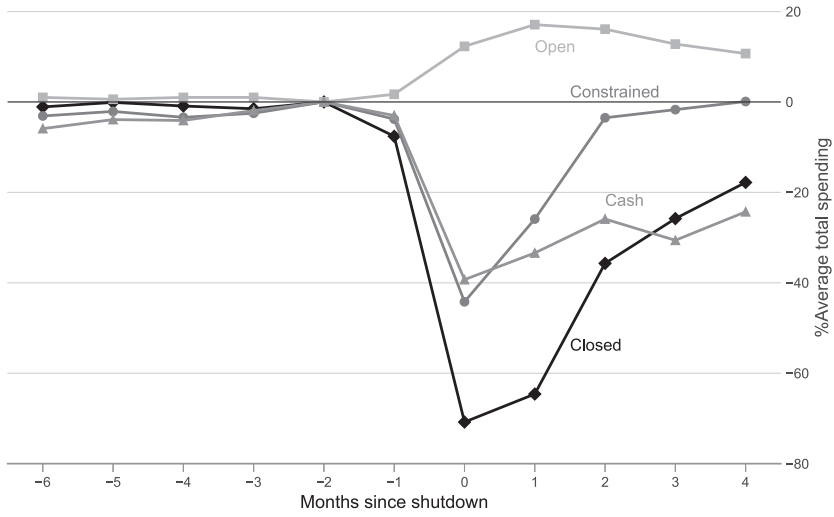


Notes: The figure shows the estimated effect of the COVID-19 crisis on aggregate spending through the first wave of the pandemic. The *x*-axis measures months relative to the lockdown on 11 March 2020, so month 0 includes the period from 12 March to 11 April, month 1 includes the period from 12 April to 11 May, and so on. The estimates are based on aggregate data and do not have standard errors. The estimates are also reported in Table A5 in the Online Appendix.

In the closed sector, consumer spending dropped by a staggering 70 percent during the lockdown and remained depressed at the end of the sample period, around 20 percent below the counterfactual level. In the constrained sector, spending initially dropped by around 40 percent, but then gradually returned to the counterfactual level. In the open sector, spending has consistently been more than 10 percent above the counterfactual level after the lockdown. Figure A7 in the Online Appendix provides evidence for granular expenditure categories within each sector: the persistent increase in the open sector reflects substantial increases in both online retail, take-away food, and groceries, whereas the persistent decrease in the closed sector is mainly driven by travel.

Our finding that spending in the open sector remained above the counterfactual trajectory suggests that the supply shock, in combination with the stabilization policies, did not lead to Keynesian spillover effects in the sense of Guerrieri et al. (2022). Even the groups most likely to carry the effects of the contraction in the closed sector into the open sector – those employed in the closed sector at the verge of the pandemic and those becoming unemployed during its first wave – generally increased their spending in the open sector.

Figure 3. Spending responses by sector



Notes: The figure shows the estimated effect of the COVID-19 crisis on spending through the first wave of the pandemic by sector of the economy: the open sector (squares), the constrained sector (dots), the closed sector (diamonds), and cash spending that cannot be allocated to sectors (triangles). The *x*-axis measures months relative to the lockdown on 11 March 2020, so month 0 includes the period from 12 March to 11 April, month 1 includes the period from 12 April to 11 May, and so on. The estimates are based on aggregate data and do not have standard errors. The estimates are also reported in Table A5 in the Online Appendix.

Finally, we note that cash withdrawals, which cannot be allocated to a sector, dropped more sharply and did not recover to nearly the same extent as other types of spending. This might reflect that consumers shied away from cash due to the perceived health risk of touching coins and bills or that cash was a relatively more important mode of payment in the closed sector than in the open and constrained sectors. In either case, the differential drop in cash payments highlights the importance of accounting for all modes of payments when estimating the dynamics of aggregate spending.

6.3. Spending responses by municipality

Figure 4 illustrates the variation across municipalities in virus prevalence (left panel) and the size of the spending drop (right panel), both measured over the full length of the first wave (12 March to 11 August). Darker colors indicate more severe impacts. There is considerable geographical variation in virus prevalence with around one-quarter of the municipalities experiencing fewer than 100 cases per 100,000 inhabitants and around one-quarter experiencing more than 350 cases. The Copenhagen region in North-Eastern Denmark generally exhibited the highest virus prevalence but there

Figure 4. Spending responses and virus prevalence by municipality

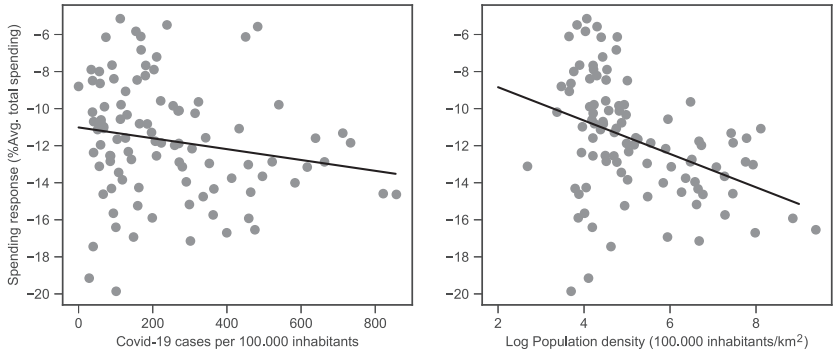
Notes: The left panel of the figure indicates the virus prevalence, measured as the cumulative number of COVID-19 cases per 100,000 inhabitants over the period from 12 March to 11 August 2020, for each of the 98 municipalities in Denmark. The right panel indicates the estimated effect of the crisis on spending in each municipality over the same period. The ranges are constructed so that the number of municipalities is (approximately) the same in each range.

were local outbreaks in less affected regions, such as Western Denmark. Simple visual inspection does not reveal a strong correlation between virus prevalence and spending dynamics. The decrease in spending is pronounced in the North-East where virus prevalence was high, but also in the North-West where the virus prevalence was low.

The left panel of Figure 5 explores this more systematically, plotting the two outcomes against each other. There is in fact a weak negative correlation: on average, the municipalities with the highest prevalence (more than 800 cases per 100,000 inhabitants) experienced a 3 percentage points larger drop in spending than those with the lowest prevalence. While the association is clearly not very strong (p-value of 0.03), it is qualitatively consistent with evidence from other countries (e.g., Chetty et al., 2020; Landais et al., 2020; Aum et al., 2021; Waldenström and Angelov, 2021), as well as with the hypothesis that individual health risk matters for consumer responses.[9] Also consistent with this hypothesis, we find a clear negative correlation (p-value < 0.0001) between municipality-level spending responses and population density, as shown in the right panel

[9]A plausible reason for the quite weak association shown in the left panel of Figure 5 is that in a geographically small country such as Denmark, with substantial cross-municipality economic and social interaction, citizens might base their assessment of pandemic severity, and hence health risk, on national rather than local incidence rates (Bor et al., 2021).

Figure 5. Municipality-level spending responses, COVID-19 prevalence, and population density



Notes: The figure illustrates the municipality-level correlations between spending responses to the COVID-19 crisis and (left panel) virus prevalence and (right panel) population density. Spending responses are measured as the estimated effect on spending over the period from 12 March to 11 August 2020. Virus prevalence is measured as the cumulative number of COVID-19 cases per 100,000 inhabitants over the same period. Population density is measured as of 31 December 2019. Each observation represents a municipality.

of Figure 5; in the most densely populated municipalities – where the health risk associated with consumption-related activities is presumably higher – spending dropped by around 5 percentage points more, on average, than in the most thinly populated areas. We explore the relationship between spending responses and individual health risk further in the next subsection.

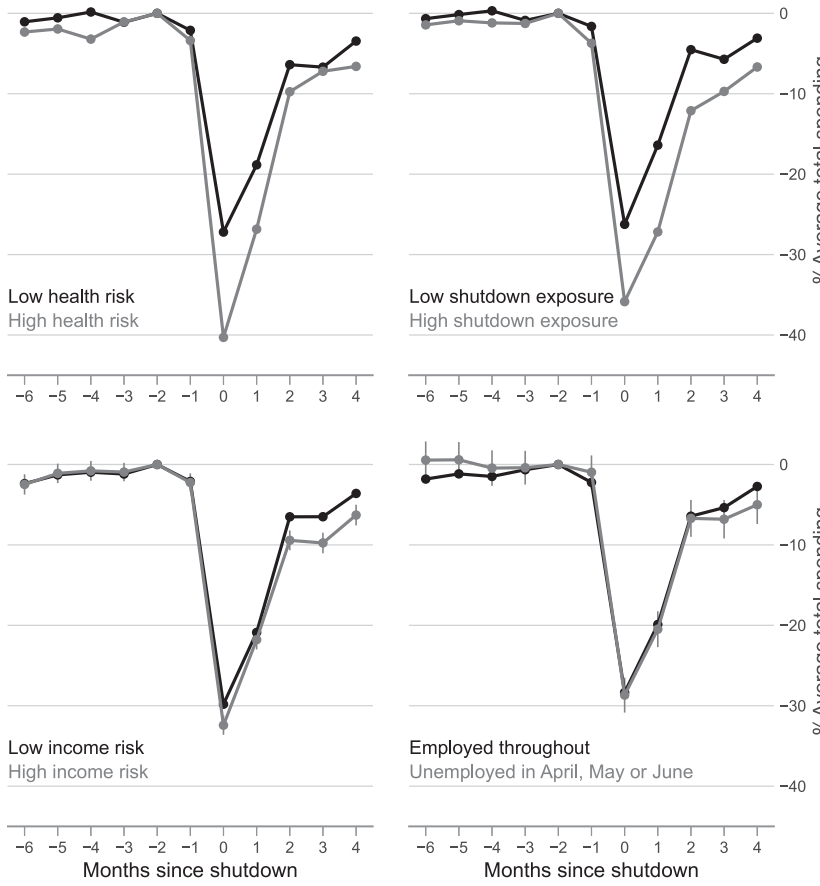
6.4. Spending responses by consumer characteristics

Figure 6 illustrates how the spending drop varies across individuals with different exposure to the various dimensions of the COVID-19 crisis: health risk, supply constraints, income risk, and job loss. Each panel shows the estimated spending trajectory for individuals whose characteristics vary in one dimension (e.g., high and low health risk), but have the same characteristics in all other dimensions.

As shown in the upper-left panel, the initial drop in spending at the time of the lockdown was considerably larger for individuals aged 65 and above (high health risk) than for younger individuals (low health risk), but the gap narrowed quickly as the virus subsided. Specifically, the differential spending drop for older versus younger individuals was around 13 percentage points in the first month after the lockdown, but only 0–3 percentage points after the first wave of the pandemic.[10]

[10]We report results for more granular age groups in Figure A8 in the Online Appendix. Whether controlling for other types of exposure to the pandemic or not, the estimated age gradient in

Figure 6. Spending responses by individual exposure



Notes: The figure shows the heterogeneous effects of the COVID-19 crisis on spending through the first wave of the pandemic. Each panel shows predicted values from equation (3) at different levels of exposure in one dimension, while evaluating exposure in other all dimensions at sample averages. The upper-left panel compares individuals whose exposure to health risk is high (age >65) and low (age <65). The upper-right panel compares individuals whose exposure to supply restrictions is high (*ex ante* spending share in closed sector above the 75th percentile) and low (*ex ante* spending share in closed sector below the 25th percentile). The bottom-left panel compares individuals whose exposure to income risk is high (employed in the closed sector) and low (employed in the public sector). The bottom-right panel compares individuals whose exposure to unemployment is high (job loss in April–June) and low (employed throughout). The *x*-axis measures months relative to the lockdown on 11 March 2020, so month 0 includes the period from 12 March to 11 April, month 1 includes the period from 12 April to 11 May, and so on. The 95 percent confidence intervals are based on robust standard errors and illustrated by vertical bars but are in some cases too narrow to be visible. The estimates are also reported in Table A5 in the Online Appendix.

spending responses is almost zero for individuals aged 40–55, negative in the age groups 56–80, and even more negative for individuals older than that. This pattern mirrors the age gradient in the actual mortality risk (e.g., Demombynes, 2020).

Similarly, consumers with a high *ex ante* spending share in the closed sector (high exposure to the supply restrictions) reduced spending considerably more than consumers with a low *ex ante* spending share in this sector (low exposure to supply restrictions), as shown in the upper-right panel of Figure 6. The difference was initially as large as 11 percentage points, but gradually narrowed to around 3 percentage points as the supply restrictions were lifted.

By contrast, consumer spending dropped only slightly more for individuals employed in the closed sector (high income risk) than for those employed in the public sector (low income risk), as shown in the lower-left panel. The initial spending gap of around 2.5 percentage points did not narrow over time, but remained roughly constant throughout the sample period.[11]

Finally, individuals who became unemployed in the first wave of the pandemic (in April–June 2020) initially followed almost the same spending trajectory as individuals who remained employed, as shown in the lower-right panel. Only in the last two months of the sample period, after the virus had subsided and the supply restrictions were lifted, a small gap of around 2 percentage points emerged.

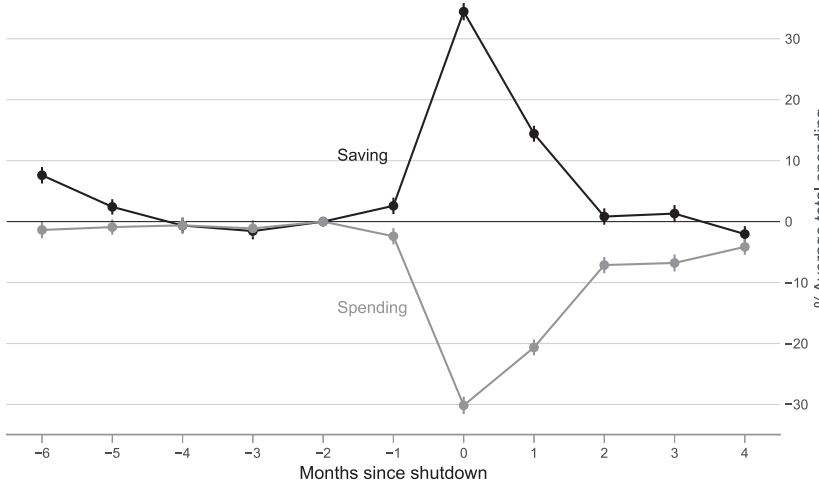
The results suggest that the massive drop in spending at the time of the lockdown was largely driven by the direct consequences of the pandemic in the form of health risks and supply restrictions. The indirect consequences in the form of income risk and unemployment appear to play a limited role in the early period of the pandemic. However, at the end of the sample period, when health risks were low and the supply restrictions had largely been lifted, there is some indication that negative demand-side dynamics represented an impediment to a full recovery.

6.5. Saving responses

The analysis so far has shown that consumer spending dropped very significantly through the early phase of the pandemic. Combined with the modest effect on income, this suggests an important improvement of household balance sheets. We employ our empirical framework to study the effect on the balance sheet component most likely to absorb shocks to spending and income in the short run: liquid assets in transaction accounts. Concretely, for each month we compute the average effect of the COVID-19 crisis on saving in transaction accounts and compare it to the average effect on spending. We scale the kroner changes in both saving and spending

[11]We provide evidence on the spending dynamics for more granular industries of employment in Figure A9 in the Online Appendix. The variation across industries is generally limited. For all employees in all industries, spending drops were very significant at the onset of the pandemic (in the range between 25 percent and 35 percent) and more modest spending drops at the end of our spending period (in the range between 3 percent and 8 percent).

Figure 7. Saving in transaction accounts



Notes: The figure shows the effects of the COVID-19 crisis on spending (gray line) and saving in transaction accounts (black line) through the first wave of the pandemic. The x-axis measures months relative to the lockdown on 11 March 2020, so month 0 includes the period from 12 March to 11 April, month 1 includes the period from 12 April to 11 May, and so on. The vertical bars illustrate the 95 percent confidence intervals, based on robust standard errors. The estimates are also reported in Table A5 in the Online Appendix.

with average monthly spending in order to make the two sets of estimates directly comparable.[12]

The estimated saving responses mirror the spending responses closely, as shown in Figure 7. This is most striking in the first month after the lockdown where saving was higher than the counterfactual by 32 percent of average monthly spending, whereas spending was lower than the counterfactual by 30 percent.[13] In other words, the entire decrease in spending caused by the pandemic was accumulated in transaction accounts. Later in the sample period, the saving responses were generally somewhat smaller than the spending

[12]To be precise, after defining $saving_{m,i}$ as the change in individual i's transaction account balances over month m, we compute for each individual–month

$$excess\ saving_{m,i} = \frac{saving_{m,i} - saving_{m-12,i}}{average\ spending}.$$

We then compute $\Delta saving_{m,i}$ completely analogously to $\Delta spending_{m,i}$ in equation (2), which produces an individual-level estimate of the effect on saving in month m. Finally, we estimate equation (3) with both $\Delta saving_{m,i}$ and $\Delta spending_{m,i}$ as dependent variables, without including controls.

[13]The estimate for spending presented here is very similar but not identical to the one presented in Figure 2, as the methodologies differ. While Figure 2 shows the effect on aggregate spending, Figure 7 shows the average effect on individual spending.

responses. Over the entire first wave of the pandemic, the estimated increase in transaction account balances corresponds to around 70 percent of the decrease in spending, suggesting that some of the funds released by the decrease in spending eventually flowed to other parts of household balance sheets (e.g., repayment of debt and purchases of stocks).

The saving responses have important implications for the economic recovery in the post-pandemic period. The finding that households have accumulated significant liquid assets during the pandemic suggests that consumer spending might become extraordinarily strong after the restrictions are lifted and thus contribute importantly to a post-pandemic recovery through its effect on aggregate demand.

7. Conclusion

This paper uses transaction-level bank account data from the largest Danish bank to study the dynamics in consumer spending through the COVID-19 crisis. We present three key results. First, the immediate effect of the pandemic was to lower aggregate spending by around 29 percent; but, at the end of the first wave, spending had almost returned to the counterfactual trajectory. Second, the spending drop was concentrated to the closed sector of the economy whereas the effect on spending in the open sector was positive throughout the first wave. Third, individuals with high exposure to the direct consequences of the pandemic (health risks and supply restrictions) initially exhibited large differential spending drops but converged to the general spending trajectory as the virus subsided and restrictions were lifted; by contrast, individuals with high exposure to the indirect consequences (income risk and job loss) initially exhibited much smaller differential spending drops (if any), but diverged slightly from the general spending trajectory over time.

All three findings are consistent with the large drop in aggregate spending being driven primarily by disease risks and government restrictions in specific sectors with a limited role for persistent spillovers to other sectors through income risk and unemployment. While this conclusion is necessarily specific to the context we are studying (i.e., the first wave of the pandemic in Denmark), there is reason to believe it generalizes to other high-income economies that have pursued similar stabilization policies.

Supporting information

Additional supporting information can be found online in the supporting information section at the end of the article.

Online appendix
Replication files

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