Tracking the Corona Crisis with High-Resolution Transaction Data*

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Abstract

We exploit high-frequency/high-resolution transaction data from BBVA, the second-largest bank in Spain, to analyse the dynamics of expenditure in Spain during the ongoing COVID-19 pandemic. Our main dataset consists of the universe of BBVA-mediated sales transactions from both credit cards and point-of-sales terminals, and totals 1.4 billion individual transactions since 2019. This dataset provides a unique opportunity to study the impact of the ongoing crisis in Spain—and the policies put in place to control it—on a daily basis. We find little shift in expenditure prior to the national lockdown, but then immediate, very large, and sustained expenditure reductions thereafter. Transaction metadata also allows us to study variation in these reductions across geography, sectors, and mode of sale (e.g. online/offline). We conclude that transaction data captures many salient patterns in how an economy reacts to shocks in real time, which makes its potential value to policy makers and researchers high.

*This is a live document and subject to ongoing changes. All analysis is preliminary. All data has been anonymized prior to treatment.

1 Introduction

Accurate, real-time information on the state of the economy can be used to better inform private actions and evidence-based public policy. It also arguably becomes more valuable in crisis times. Yet, the comparatively lower-frequency dynamics in the compilation of key economic statistics—be it from national accounts or economic censuses—implies that both the actual depth and distributional consequences of the corona economic crisis, *on impact*, is still unclear, let alone what the path ahead is.

Clearly the COVID-19 pandemic and governments' adoption of measures to limit its spread have generated enormous economic costs. Jobless claims in the US in the past month exceed 16 million, which is an historically unprecedented surge. Other economic statistics releases in the US and other countries are similarly dramatic. Moreover, there are ongoing efforts by researchers to use bespoke surveys and statistical models to assess the impact of the corona crisis ((Aaronson, Burkhardt, & Faberman, 2020; Adams-Prassl, Boneva, Golin, & Rauh, 2020)).

One disadvantage of the traditional survey-based approach to indicator construction is the sparsity and delay of the resulting measures. Of great interest to policymakers—especially in times of crisis when events unfold quickly—is how the economy reacts to events and policy interventions *in real time*. From this perspective, harnessing the naturally occurring data held by commercial banks is potentially very fruitful. Such data is rich, plentiful, granular, and directly connected to economic behavior, which makes it uniquely suited to real-time tracking of economic activity.[1] This not only makes it a means for providing a backward-looking account of how COVID-19 has impacted the economy, but also provides a way to assess the effect of policies with minimal delay. For example, over the coming weeks and months governments will grapple with how to relax social distancing measures, but have few means of understanding the impact of different policies on economic activity. Transaction data can provide immediate feedback on how spending patterns across space and sectors react to restriction measures and their relaxation.

In this paper, we use the universe of transactions mediated by Banco Bilbao Vizcaya Argentaria, S.A (BBVA) to build a daily expenditure measure and we assess the ability of transaction data to capture the economic dynamics in Spain during the corona crisis. Our main dataset builds up from 1.4 billion individual card transactions, the universe of BBVA

[1]Other sources of granular and/or high-frequency data have also been released since the COVID-19 pandemic. Examples include time-use data derived from mobile phones (`https://www.placer.ai/covid-19/`, `https://www.google.com/covid19/mobility/`); information on social networks (`https://dataforgood.fb.com/tools/social-connectedness-index/`, see also Kuchler, Russel, & Stroebel (2020)); and electricity usage (Cicala, 2020)). This data is also useful for understanding the dynamics of the pandemic, but provides a less detailed account of spending patterns. For example, decreased footfall to retail stores can be substituted by online purchases.

transactions—be it from its own clients or Points of Sales terminals it operates—and provides a daily account of expenditures. We build on previous work by BBVA research in Bodas, López, López, de Aguirre, Ulloa, Arias, de Dios Romero Palop, Lapaz, & Pacce (2019) which develops and benchmarks a subset of this data covering retail sales. Given the metadata associated with each transaction, we are also able to disaggregate the high-frequency national level expenditures data into geographical, sectoral and online/offline daily expenditures, providing more micro-detail on the unfolding of the corona crisis in Spain.

Our main findings are as follows. First, we find a large, abrupt and persistent decline in expenditures in the period immediately following the 14th of March announcement of a nationwide lockdown by the Spanish Government. For an average day in this period, aggregate (nominal) expenditures in Spain are roughly half as low (-49%) when compared to the same day one year before, in 2019.

Second, we find evidence for stockpiling behavior in the days immediately preceding the lockdown. During this brief period, at its maximum, Year-on-Year daily expenditure growth was 20 percentage points above of the mean growth observed in the first two months of 2020.

Third, during the lockdown, we find that offline expenditure, at physical points of sale, declines substantially more than the online, internet enabled, expenditure (which also declines). This implies a large increase in the market share of online expenditure in our sample, which grew by about 50%. Fourth, we find substantial heterogeneity across categories of expenditure during the lockdown period. Consistent with the nature of the lockdown - allowing only essential market interactions - we find that expenditure in commodities related to basic necessities (such as foodstuffs and health/pharmacy), or that cater goods with very low demand elasticity (such as Tobacco) more than doubled during the lockdown period, relative to the same period in the previous year. In reverse, expenditure in goods and services with higher demand elasticities (related to food and entertainment away from one's residence, fashion, or personal services) as all but vanished. This gives rise to large swings in expenditure across categories. Considering only the top 10 best performing categories of expenditure during the lockdown, have increased their market share from an average of 10%, in the first two months of 2020, to 50% by late March, after the lockdown was imposed.

Fifth, we explore regional variation in expenditure growth in the data. Spain's "Comunidades Autónomas" display differential onset and growth of the pandemic. Yet, variations in expenditure across time and regions seems only to reflect the nationwide lockdown and its restrictions to mobility and market interactions. In particular, we do not find evidence that differential exposure to the pandemic (across regions) affected regional expenditure dynamics. Moreover, we find no strong statistical evidence that poorer re-

gions adjusted their expenditure differently from richer regions.

Sixth, we examine expenditure patterns at a much more micro level using zipcode level expenditure from the Madrid region. Here we find more evidence of heterogeneous effects across space. Dispersion in expenditure across zipcodes begins rising significantly a week before the lockdown and remains significantly higher post-lockdown than in January and February. We conduct a preliminary analysis of what drives this zipcode level heterogeneity, and find that zipcodes with a higher incidence of COVID-19 cases suffer more from the lockdown as measured by expenditure falls.

Apart from the quantitative chronology of the Corona Crisis described above, the contribution of the paper is two-fold. We first provide a unique and novel set of facts about how spending patterns evolved during the build-up of the corona crisis and in the aftermath of lockdown measures. This helps quantify the impact of these events, as well as how their costs are distributed in the economy. Second, and perhaps more importantly, we show that these facts can be established with an index derived from a vast well of naturally occurring data. Because such data is available in nearly every country, exercises such as ours can be replicated and extended in many different environments. These should be of immediate value for dealing with the corona crisis, but also into the longer-term future as well. We hope that our results stimulate efforts to exploit financial transaction data more broadly in economics and finance, which will necessarily require collaborations between private-sector, public-sector, and academic entities.

A complementary paper to ours is Baker, Farrokhnia, Meyer, Pagel, & Yannelis (2020), which uses financial transaction data from a personal finance application to study spending patterns in the US during March 2020. Baker et al. (2020) have access to a sample of 4,735 individuals, in contrast to our data series which is made millions of individual users. This arguably makes our index better suited for tracking macroeconomic activity. Our expenditure data also has a richer sectoral classification, as well as a decomposition of sales into online and offline components. On other hand, Baker et al. (2020) has access to household metadata that allows a more detailed description of the drivers of individual consumption.

The structure of this paper is as follows. Section 2 gives further details and limitations of the BBVA transaction sample we use. Section 3 provides an overview of the evolution of the COVID-19 pandemic in Spain. Section 4 summarizes our main findings. Section 5 concludes.

2 Background on the BBVA transaction dataset

Our data consists of a join between (a) the universe of transactions at BBVA-operated Point of Sales (PoS) and (b) the universe of transactions by BBVA-issued Credit and

Debit cards (in non-BBVA-owned PoS, to avoid double counting). The bulk of our analysis aggregates individual transactions to the daily frequency, for a daily sample running between January 1st, 2019 and the 30th of March 2020. Note that the last 60 days of the dataset run concurrently to the evolution of the pandemic in Spain where the first confirmed Covid-19 infection in Spain dates from the 31st of January 2020. As such, our dataset provides a high-frequency account of the evolution of expenditures throughout the first two months of the pandemic in Spain.

Our daily dataset covers roughly 2.2 million distinct merchants (i.e. PoS locations) and more than 1.4 billion annual transactions. Further, we are able to distinguish whether the card initiating each transaction was issued by a Spanish bank or by a foreign bank. Throughout, we mainly focus on national card transactions, which account for 93% of the transactions in the sample and about 90 million unique card identifiers.

It is worth noting that these transactions include not only households' card expenditures but also corporate spending, whenever the transaction is backed by a debit or credit card that is issued to a corporation as a 'company card'. We cannot, currently, distinguish the identity of the buyer in each transaction. Our expenditure data therefore likely contains a mix of final consumption expenditures by households and corporate firms' intermediate input purchases (or investment, if the good is sufficiently durable). To make matters concrete, if we observe a transaction at, say, an hotel's PoS, the value we observe in our dataset is the sale, i.e. the expenditure on a given transaction. We cannot distinguish whether this was a (final consumption) service bought by a household or a business trip (i.e an intermediate input) purchased for by a firm. As such, we refer to our series as "Expenditures" throughout.[2]. Additionally, it is important to emphasize that expenditures are measured in nominal terms and our data does not include any price-level information. It is likely these are changing substantially as the crisis deepens. At this time, our findings are all presented in nominal terms.

Note also that, by covering only card transactions, we are unable to speak to the dynamics of expenditures backed by cash. As we write, it is not clear whether the share of transactions in cash has remained stable throughout the crisis. Anecdotally, there are reports of merchants and customers backing away from cash due to fears of viral infection through bank notes and coins. If this is true, then aggregate (cash and electronic) expenditure declines are likely to be larger than what we document.

Beyond time and amount spent, each transaction in the dataset is also geo-tagged with longitude and latitude information, allowing us to disaggregate the expenditure series both regionally (for all 19 regions in Spain) and also by zip-code. This allows us to explore spatial variation in the data. Additionally, for each PoS, we have a classification

[2]We do not, at this point, know what is the percentage of household consumption and corporate investment and intermediate good card spending. We plan to refine the data in this way in the next installment of this document

Fig. 1: Quarterly growth rate of BBVA expenditures series vs. Quarterly growth rate of GDP in Spain. Left panel: raw data; Right panel: standardized BBVA expenditure series. All source data is nominal and not deseasonalized. The quarterly nominal GDP series is sourced from the National Accounts.

of the principal activity of the firm selling goods and services through that PoS. This classification breaks down the universe of transactions into 76 categories, ranging from Toy-Stores to Funeral Homes. This allows us to document shifts in expenditures over the crisis.

Finally, each transaction is also tagged with information on whether the transaction was carried out online (e.g. internet purchases) vs. offline, at a physical PoS. Note that all online expenditures are necessarily completed with a debit or credit card while offline expenditures can occur via either card (which we observe) or cash (which we do not). This means that our sample of expenditures is biased towards online expenditures, which helps explain some of the large rates of expenditure growth before the pandemic that we document below. At this point, we do not re-weight the our sample to correct for this bias.

Before turning to the analysis of this daily transaction record of the crisis, we briefly compare properties of our transaction data to the baseline measure of economic activity in Spain, GDP.To do this, we deploy a quarterly aggregate of the same universe of transactions reported above. This lower frequency allows us to track expenditure back to the first quarter of 2015.

Figure 1, compares the quarterly growth rate of our nominal transactions-aggregate with nominal Gross Domestic Product from 2015:Q2 to 2019:Q4. As can be observed on the left panel of the figure our expenditure growth series tracks the quarterly nominal

GDP growth series well, for an overall in-sample correlation of 0.93, which improves slightly in later subsamples: if measured from 2017Q1, this correlation increases to 0.96. Despite the fact that peaks and troughs line up well,[3] our expenditure series is 3.23 times more volatile than GDP itself. By rescaling the growth rates of the BBVA expenditure series by this latter number, the right panel Figure 1 brings into clearer focus that our series may be a good coincident indicator for GDP. Below, we will occasionally use this rescaling to express movemements in the expenditure series in implied "GDP" units.

3 A bird's eye chronology of the Corona crisis in Spain: from pandemics to transactions, via mobility

The Spanish COVID-19 pandemic has been playing out dramatically over the last ten weeks. The first confirmed Covid-19 infection in Spain dates from the 31st of January 2020 (in the Canary Islands). During the month of February, gradual spatial diffusion of the disease ensued such that, by the 9th of March, every province in Spain reported at least one confirmed case. March was to witness the pandemic intensify throughout Spain, with 94,417 confirmed cases and 8,189 confirmed deaths by March 31st.[4]. There was also substantial regional heterogeneity in the intensity of pandemic across regions in Spain with high incidence, for example, in Castilla-La Mancha, Castilla y Leon and in the Madrid region and relatively lower incidence in Andalucia.[5] Figure 2 details the aggregate progression of COVID-19 pandemic in Spain.

As in many other countries, policy response at initial stages of this pandemic was sluggish. The first set of responses were in place by early March with localized quarantines and lockdowns of five towns and municipalities in the regions of La Rioja (Haro, 7th of March) and Catalunya (multiple municipalities, 12th of March). Between the 9th and 12th of March, multiple regional authorities proceeded to suspend all educational activities and some flight routes were also suspended. Finally, on the 13th of March policy response ramped up substantially, with a central government announcement of a nationwide "State of Alarm" and, with it, a national lockdown effective from the 15th of March onwards. This lockdown implied that all citizens were to stay in their residences except for food and medicines, work or deal with emergency situations. Further it implied the temporary shutdown of most leisure and retail spaces, such as bars, cafes,

[3]Part of this very high correlation is clearly driven by synchronized seasonality patterns across the two series. In future iterations of our work, we will be studying further properties of the deseasonalized series as well as comparing to other aggregate series.

[4]Official numbers form the Spanish Health Ministry: "Actualizacion no 61. Enfermedad por el coronavirus (COVID-19)"

[5]See, for more details, Spanish National Center for Epidemiology, Ministry of Health. "Vigilancia de los excesos de mortalidad por todas las causas. MoMo. Situacion a 06 de Abril de 2020."

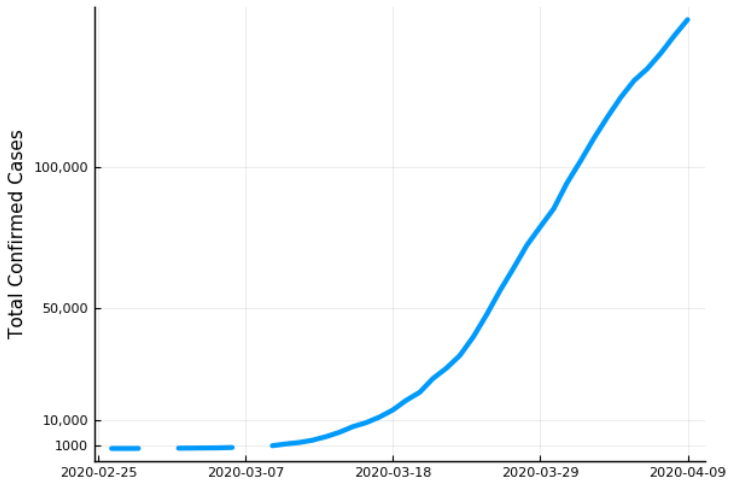


Fig. 2: Accumulated number of confirmed cases of COVID-19 in Spain. Source, Ministerio de Sanidad. Centro de Coordinación de Alertas y Emergencias Sanitarias. Actualización 69 (and all previous). Enfermedad por el coronavirus (COVID-19)

restaurants, cinemas and non-essential commercial and retail businesses. In the face of rapid progression of the pandemic, this lockdown was further tightened on the 28th of March, when all non-essential activity was banned.

The impact of this lockdown policy can be tracked in real time by resorting to individual mobility data. In particular, we source data for Spain from Google's COVID-19 Mobility reports (Google, 2020). The latter exploits accurate "Location History" metadata associated to Google account holders' logins as they move through space. It then aggregates it at various levels of geographic resolution.

Figure 3 presents the daily evolution of Spain-wide Google's mobility index, disaggregated by implied time-use across broad spatial categories. Not surprisingly, after the lockdown is announced, we see that time spent at home increases by about +30% towards late March. Also consistently with the lockdown directive, we see that time spent in non-essential retail and recreation spaces decreases the most, by over -80%, with a similarly large decline for time spent in transit and time in parks. While still witnessing substantial declines, time spend at workplaces and at essential grocery stores and pharmacies declines by less than the aforementioned categories (with, respectively, roughly -70% and -50% growth rates). In particular, notice additionally that, starting on the 8th of January and up till the lockdown coming into force itself, there is a noticeable increase in time spent in grocery stores and pharmacies, consistent with reports of households stocking up in anticipation of the lockdown.[6]

Clearly, infection, fear of infection, social distancing and, particularly, lockdown poli-

[6]Notice that on the 8th of March there were also massive gatherings and demonstrations throughout Spain, being held in celebration of International Women's Day. Thus, we cannot exclude that the first spike we observe in time-usage is associated to this rather than stockpiling behavior.

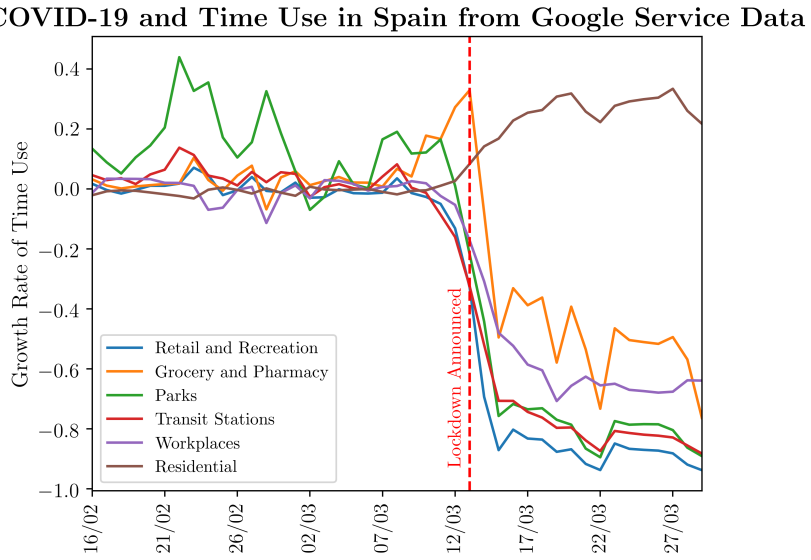


Fig. 3: Growth rate across categories of time use by Google services' users in Spain. Computed by Google from location metadata generated by individual users and aggregated to a Spain-wide growth rates by location category. Source, Google Mobility Reports (2020).

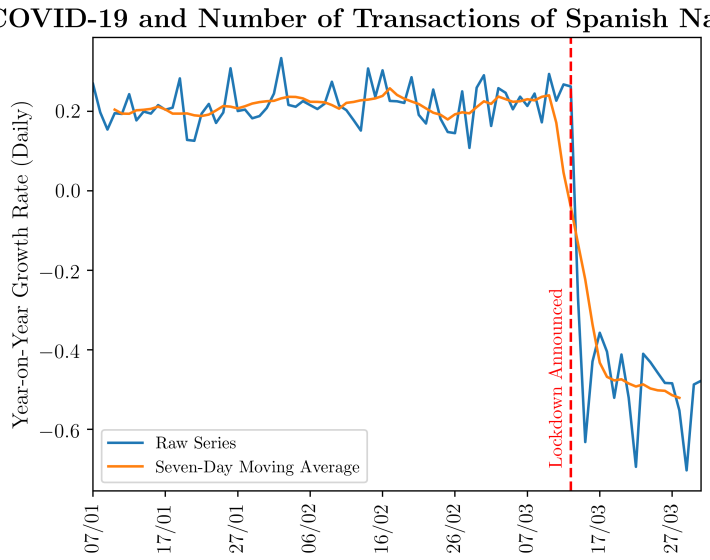
cies - by prohibiting citizens from leave their homes except in special cases - have diminished activity in public spaces, particularly in retail and leisure areas areas. This, together with supply-chain disruptions, stockouts and mandated business closures, must have impacted daily economic activity. The question we ask in this paper is, by how much and where in the economy? A first glimpse at the scale of disruption can be garnered from our transaction data.

To do this we start by analysing the (Y-o-Y) growth rate of the total number of transactions. We display both raw daily (Y-o-Y) expenditure growth rates and their 7-day centered moving average. In order to control for weekly seasonality in the behaviour of expenditures we proceed as follows: we pair every day following January 8th, 2020 with its equivalent weekday in the equivalent week of the previous year. Thus, we pair the first Tuesday after the Epiphany holiday [7] in 2020 (January 8th) with the first Tuesday after Epiphany in 2019 (January 7th), and we then proceed daily, always pairing days of the week (first Wednesday with first Wednesday, etc.). We then measure the 2019-2020 Y-o-Y growth in total number of transactions, for the same day of the week.[8]

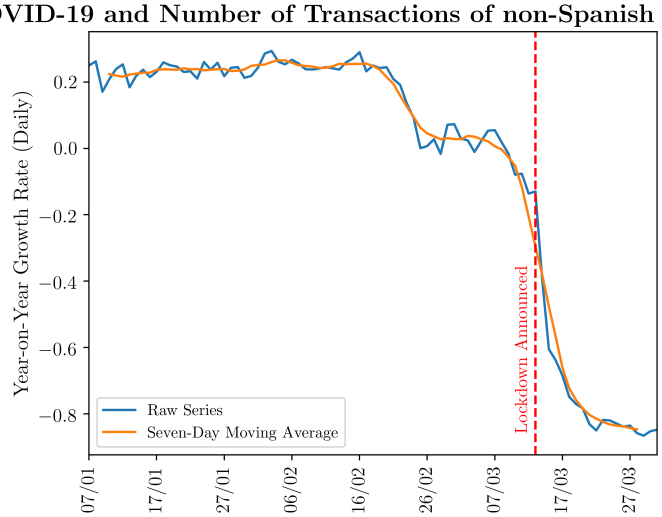
Figure 4 uses this metric to provide a first real time indicator of the scale of decline in the extensive margin of expenditures. The top panel of (Figure 4b gives the resulting series for the number of transactions settled by Spain-issued credit and debit cards. It is clear that there was a large extensive margin adjustment in expenditures and that this

[7]Epiphany is one of the most important holidays of the year in Spain and we exclude Y-o-Y comparison over the holiday period.

[8]Notice that this strategy additionally deals with the issue that 2020 is a leap year.



(a) Year on Year growth rate of daily number of transactions settled with Spain-issued debit or credit cards. Blue line: Raw data. Orange line: seven day, centered moving average of raw data.



(b) Year on Year growth rate of daily number of transactions settled with Foreign-issued debit or credit cards. Blue line: Raw data. Orange line: seven day, centered moving average of raw data.

Fig. 4: Total Number of Transactions by Card Nationality.

adjustment coincided exactly with the enactment of the lockdown policy. Year on year, the number of daily transactions has declined by -48.5%. This compares to a relatively stable pre-lockdown average of +21.4% growth.[9]

For completeness, the bottom panel of Figure 4 gives the corresponding series for Foreign-issued debit and credit cards. This decline of foreign-card expenditures is both stronger in the lockdown - for a late March decline of more than 77.0% Y-o-Y - and predates the lockdown itself, with about -20% decline in the latter third of February. The latter is consistent with the decline in international travel and tourism in face of a global pandemic. While this economically meaningful in itself - Tourism is a substantial sector in Spain - for the remainder of the paper we focus only on the subsample of all Spanish card transactions.

4 The crisis through the lens of 1.4 billion transactions

The chronology presented above provides a first glimpse on the scale of disruption brought about by the pandemics, the lockdown policies put in place to flatten its peak and the ensuing change in behavior by Spanish citizens. As Spain approached the peak of the COVID-19 pandemic by late March economic agents dramatically altered the time and scale of their market activities.

In this section, we present evidence on how this impacted expenditure in Spain. We provide both aggregate evidence and offer a first analysis of broad substitution patterns across modes and categories of expenditure. Additionally we provide a first-pass analysis of regional and local heterogeneity in expenditure dynamics during the Corona crisis.

4.1 Aggregate daily expenditures

We start by analysing the behaviour of aggregate daily (nominal) expenditures of nationally-issued cards. In Figure 5 we plot the Y-o-Y growth of the total amount of daily expenditures in Spain during the first quarter of 2020.

It is remarkable both how stable the series is till early March, ahead of the lockdown, and how large and sudden the fall is, subsequently to it. Thus, we observe that through the first week of March, total card nominal expenditures were growing at a stable 16% rate. This is large, but consistent with the longer run, quarterly growth rate, properties of our expenditure series (going back to 2015) as reviewed in Section 2 above.

Starting on the 8th of March, and till the enactment of the lockdown, we see a noticeable Y-o-Y increase in the nominal amount of expenditures, reaching growth rates

[9]We additionally note that there is no obvious increase in the number of transactions just ahead of the lockdown date. We return to issues possibly related with stockpiling just ahead of the lockdown in the next section.

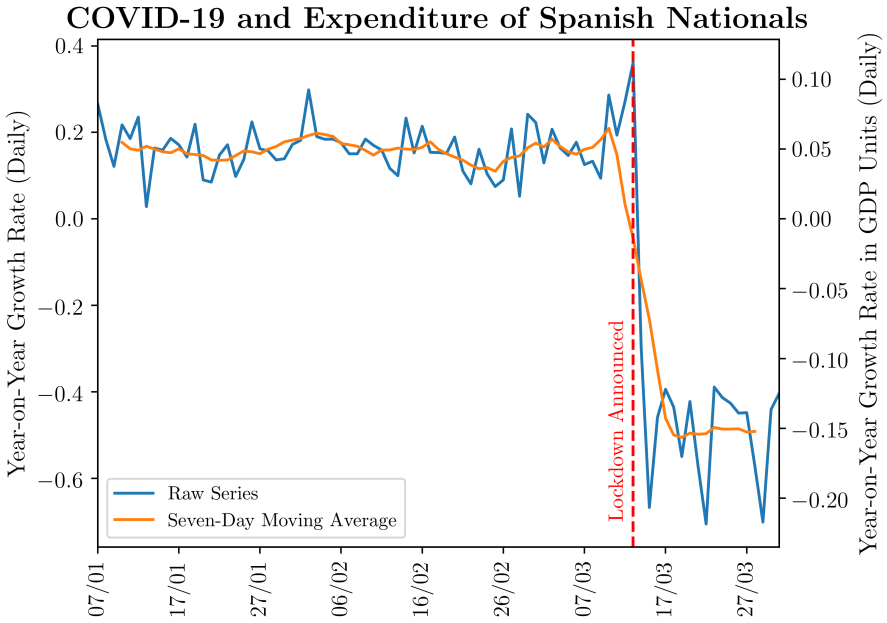


Fig. 5: Year on Year growth of daily total expenditures by nationally-issued cards. Blue line: Raw data. Orange line: seven day, centered moving average of raw data. Left Y-axis: BBVA daily expenditure growth; Right Y-axis: Implied GDP daily Y-o-Y growth by rescaling expenditure growth.

of 36.2% in the day immediately before the legislation coming into force. Recall further that the number of transactions does not appear to display this pre-lockdown increase. This implies that, on the eve of the lockdown, expenditures adjusted mainly on the intensive margin, with larger purchases per transaction. Finally, it is worth noting that, as we will document below, this growth in expenditures in the lead-up to the lockdown was very unequally distributed across sectors of activity.

Finally, upon the enactment of lockdown measures, we see a steep and large decline in Y-on-Y expenditures. Aggregate nominal daily expenditures decline by 48.6% in this period, with substantial day-on-day volatility being apparent. Taking the pre-lockdown Y-on-Y growth rate as a benchmark for normal expenditure patterns this, in turn, implies roughly a 70 percentage points decrease in the growth rate of expenditure starting from mid-March. The magnitude of this decline tracks well the decline in the total number of transactions presented in Section 3. Finally, this also implies that, in the aggregate, the decline in expenditures is largely an extensive margin adjustment, mirroring a large decline in market activities.

The magnitude of the decline in expenditure that we observe in the data is so large that it becomes difficult to benchmark the depth of expenditure adjustment in Spain. However, as reviewed in Section 2, while the BBVA expenditure series is substantially more volatile than GDP, we also know that it tracks it very closely. Moreover, as we have seen above it is possible to rescale our expenditure series (by the ratio of its standard

deviation relative to nominal GDP) and translate its implied Y-o-Y daily growth rates in terms of GDP units. We can read the results of this back-of-the-envelope calculation for daily, nominal GDP movement during the pandemic, using the right Y-axis scale in Figure 5.

As can be seen, the stable pre-lockdown pattern in our expenditure series implies a Y-o-Y nominal GDP growth of just under 5%.[10] Post-lockdown enactment, our series implies a sharp -15% Y-o-Y decline in GDP. We stress that these numbers are simple fitted values and that we do not observe daily GDP. As such considerable uncertainty surrounds these back-of-the-envelope calculations. Still, given observed correlations it seems hard to construct a scenario where GDP is not declining sharply, between -10% and -20%, during the period of the lockdown.

4.2 Online vs. Offline Expenditures

The drastic change in mobility and expenditures observed above also likely implies that there is an increased value to market interactions which did remain available while under lockdown. In particular, online, internet-enabled interactions with the marketplace present an alternative for households now spending more time in their place of residence and can smooth the decline in offline, physical expenditure opportunities.

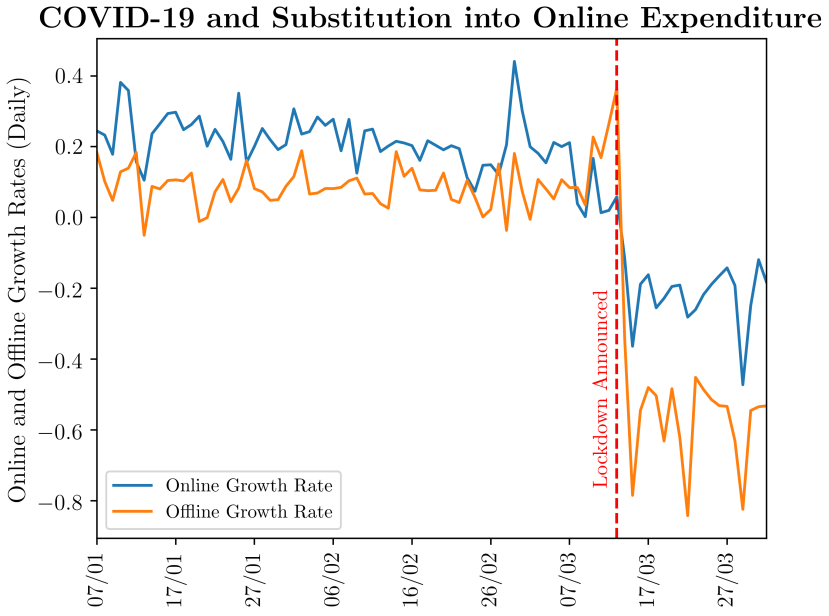
In this section, we provide a first evaluation of the extent of substitution between online and offline expenditures. We are able to do this since, as discussed in Section 2, transactions in our data are tagged with information on whether it took place at a physical PoS or via an online merchant.[11]

The top panel of Figure 6 plots the daily Y-o-Y growth rates of online vs. offline expenditure amounts. We again observe that both modes of expenditure are relatively stable up through the 7th of February, with online growth almost three times larger that of offline growth (for 22.2% and 8.4% average daily growth rates, respectively). Further, in the days leading-up to the lockdown, we see that the increase in expenditures noted above was led by offline transactions.

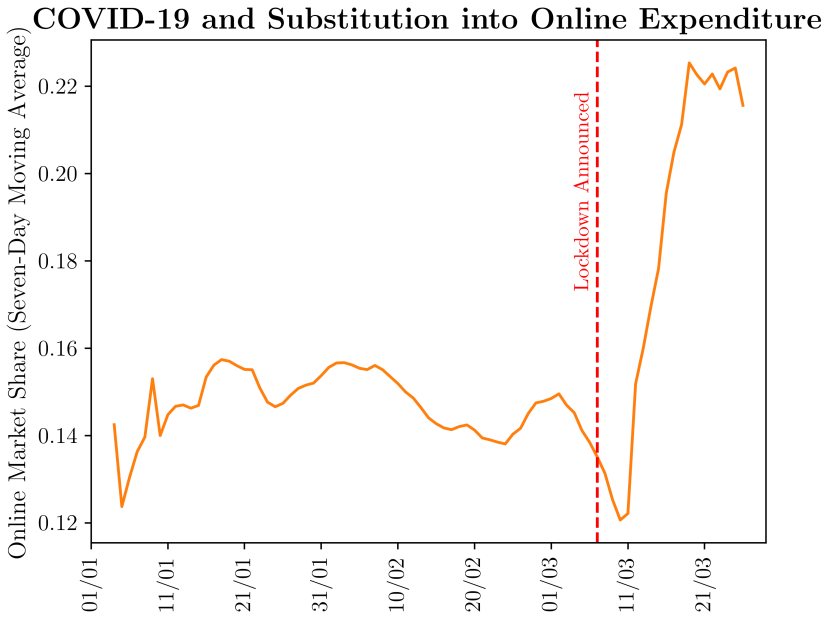
Finally, we see the reversal of this pattern during the lockdown period: daily offline purchases decline Y-o-Y by an average of -56.9% during this period, while the decline in online purchases is smaller, at -22.2%. Thus, consistently with the dramatic decline in mobility across Spain, offline, physical purchases were the most affected category. At

[10] Recall that our transaction data is biased towards online transactions which, as we will see below, are growing much faster than offline transactions. This may justify this large pre-lockdown rate of growth in nominal expenditures. But note also that, if cash transactions were indeed reduced following the lockdown, our series is more likely to track aggregate expenditures accurately during the lockdown as this bias is lessened.

[11] There is a non-negligible number of transactions that fall into an unclassified residual category and for which we cannot distinguish whether the transaction took place offline or online. While we have included them in our aggregate series, for the purposes of the current exercise, we ignore these transactions.



(a) Daily Year on Year growth rate of online (blue) and offline expenditures (orange) by nationally-issued cards.



(b) Seven day moving average of daily market share of online transactions by nationally-issued cards.

Fig. 6: Effect of Crisis on Online vs Offline Sales

the same time, the fact that total online purchases do decline Y-on-Y, implies that the substitution across modes of expenditure was limited during the lockdown.[12] This maybe be due to supply-side reasons whereby the product offerings of online merchants in Spain may not replicate well that of their physical, offline counterparts.

Nevertheless, the disparate performance of expenditures across modes of expenditure over the crisis, is large enough to have induced substantial changes in offline vs. online market shares, which we plot, as a centered seven day moving average, in the bottom panel of Figure 6. The market share of online expenditures in our sample was relatively stable up to late February, for an average of 14.7 percent. After briefly dipping below that, as a result of offline stocking up expenditures, the online market share grew by about 50%, such that by the end of March it stood at 22.3 percent.

4.3 Categories of Expenditure

The nature of the lockdown is likely to affect different expenditure categories in very different ways. In this section we use the structure of our data to study the cross sectional dynamics of different expenditure categories. We aim to understand the extent in which the pandemic has affected in a different manner these categories, and to document which categories are suffering more by it, and which ones, if any, are benefiting from it. Doing it may help us learn about patterns of consumer behavior, and separate basic individual necessities from social and luxury goods.

BBVA classifies any merchant in one of 76 categories [13], which themselves aggregate into 18 broad aggregates.This classification is tailored to the necessities of the Bank, so they do not coincide (and there is no immediate mapping) with standard sector definitions. In Table 1 we include a brief description of each of the categories in English and a somewhat more detailed description in Spanish. These categories constitute a fine grid of economic activity, each of them being also easy to interpret.

We start by exploring the differential degree in which the crisis has affected different categories. We compute the Interquartile Range (IQR) of the Y-o-Y growth of daily expenditures across categories, and we plot it in Figure 7. The IQR compares the "median" of the upper half of the distribution with the "median" of the bottom half; a larger value implies that the distribution is more heterogenous.[14]

The degree of heterogeneity in the performance across categories had a large increase in the week previous to the lockdown. This indicates that there was already a noticeable

[12] This likely also implies that in countries where online commerce offers greater variety across product categories, online expenditure may have permitted more substantial smoothing.

[13] We drop an "Unclassified" category for the purposes of this section.

[14] IQR is a measure of heterogeneity that in small samples is less sensitive to outliers than the more commonly used standard deviation. We have 77 categories, but when we perform the same exercise with regions (see below) we have only 17, and we want to maintain the same metric throughout.

id	subcategory_key	Name	id	subcategory_key	Name
1	es_travelweb	Agencias de viajes: venta a distancia y web	39	es_fashionsme	Moda y complementos: pequenho comercio
2	es_travelagency	Agencias de viajes: venta en local	40	es_leather	Peleteria, marroquineria y complementos
3	es_foodsme	Alimentacion: pequenho comercio	41	es_shoe	Zapaterias
4	es_supermarket	Supermercados	42	es_bet	Loterias y apuestas
5	es_mall	Grandes almacenes	43	es_leisuretime	Espectaculos y entretenimiento
6	es_hypermarket	Hipermercados	44	es_museum	Museos y lugares de interes turistico.
7	es_hotel	Hoteles y alojamiento	45	es_ticketsale	Venta de entradas
8	es_realestate	Inmobiliaria	46	es_pharmacy	Farmacias y parafarmacias
9	es_wash	Autolavado	47	es_hospital	Hospitales y clinicas
10	es_cartest	ITV	48	es_opticians	Opticas
11	es_car	Motor: Concesionarios, talleres y recambios	49	es_airline	Aerolineas
12	es_cafe	Bares y cafeterias	50	es_carrental	Alquiler de automoviles
13	es_fastfood	Comida rapida y a domicilio	51	es_boatrental	Alquiler de embarcaciones y aeronaves
14	es_pub	Pubs y discotecas	52	es_bus	Autobus de media y larga distancia
15	es_restaurant	Restaurantes	53	es_gas	Gasolineras
16	es_drugstorebig	Drogueria y perfumeria: cadenas	54	es_parking	Parkings
17	es_drugstoresme	Drogueria y perfumeria: pequenho comercio	55	es_toll	Peajes
18	es_wellness	Masajes y cuidado personal	56	es_taxi	Taxi
19	es_beauty	Peluqueria y estetica	57	es_seatransport	Transporte maritimo
20	es_sport	Actividades deportivas	58	es_urbantransport	Transporte urbano: bus, metro, tren
21	es_sportbig	Articulos de deporte: cadenas	59	es_train	Tren de media y larga distancia
22	es_sportandtoys	Jugueterias y articulos de deporte	60	es_tax	Administracion publica: tributos y certificados
23	es_toys	Juguetes: cadenas	61	es_goods	Bazar
24	es_photo	Fotografia	62	es_atm	Cajeros
25	es_techbig	Informatica, electronica y electrodomesticos: cadenas	63	es_donation	Donaciones
26	es_techsme	Informatica, electronica y electrodomesticos: pequenho comercio	64	es_dutyfree	Duty free
27	es_musicalinstrument	Instrumentos musicales	65	es_education	Enseñanza
28	es_telephony	Telefonia: venta de terminales	66	es_tobacconists	Estancos
29	es_diybig	Construccion y bricolaje: cadenas	67	es_funeral	Funerarias
30	es_diysme	Construccion y bricolaje: pequenho comercio	68	es_phonebooth	Locutorios y cibercafes
31	es_floristsbig	Jardineria y floristeria: cadenas	69	es_branch	Oficinas
32	es_floristssme	Jardineria y floristeria: pequenho comercio	70	es_others	Otros
33	es_homebig	Mobiliario y decoracion: cadenas	71	es_mail	Paqueteria y almacenamiento
34	es_homesme	Mobiliario y decoracion: pequenho comercio	72	es_fplenish	Recarga de moviles
35	es_books	Libros, discos y papeleria	73	es_insurance	Seguros
36	es_press	Prensa y revistas	74	es_drycleaner	Tintorerias y lavanderias
37	es_jewelry	Joyeria y relojeria	75	es_veterinarian	Veterinarios y mascotas
38	es_fashionbig	Moda y complementos: cadenas	76	es_video	Videoclub y TV pago

Table 1: Description of categories of expenditure.

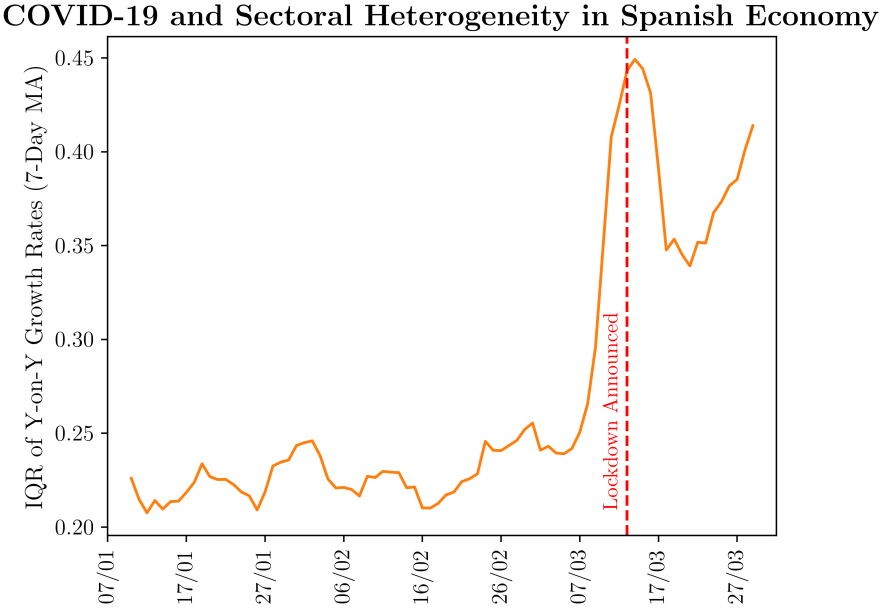


Fig. 7: Evolution of the dispersion of the Y-o-Y growth rate across categories.

Top 10 Sectors in Market Share Growth		Bottom 10 Sectors in Market Share Growth	
(decreasing order of gain)	*Growth.*	{(decreasing order of loss)}	{*Growth.*}
Food: Small Stores	2.24853	Pubs and Disco Clubs	-0.93504
Tobacco Store	2.22432	Furniture and Decoration Chains	-0.932594
Mobile Phone Credit	2.06751	Leather Shops	-0.93121
Supermarkets	1.98371	Shoe Shops	-0.928647
Hypermarkets	1.67307	Toys: Chains	-0.920665
Pharmacy and Parapharmacy	1.52951	Massage and personal Care	-0.894873
Gifts and Donations	1.12815	Fashion: small shops	-0.892908
Insurance	0.835929	Restaurants	-0.883958
Veterinary and pets	0.719036	Automobile Inspection (ITV)	-0.871738

Table 2: Best and Worst performing categories of expenditure by market share post-lockdown growth

change in economic behavior in anticipation to the general lockdown. Different categories of expenditure start to behave quite differently around March 7th (the lockdown in Italy, which is a useful reference point, started on March 9th), and they differ dramatically during that week. This is most likely a consequence of people stockpiling necessities (or perceived necessities) in anticipation of the lockdown, suggesting an increase in Y-o-Y growth in the expenditure categories that cater for those needs.

The second thing to notice is that the performance across categories gets somewhat more equalized in the week after the implementation of the lockdown, but still remains at a much higher level than it was in normal times. That is, under the new conditions imposed by the lockdown there were large changes in the relative position of expenditure category shares.

To identify the expenditure categories most altered by the Coronavirus crisis we proceed to order them by the relative change in their average market share, defined by comparing the average share before March 8th with the average share after March 14th. They are identified in Table[15] 2 along with the growth rate of their average share between the periods.

As expected, the expenditure categories that suffered most from the lockdown are those that either (1) were essentially closed by direct imposition during the State of Alarm (such as Pubs, bars or restaurants), (2) sell goods of scarce utility during the lockdown period (such as leather goods or fashion), or (3) are personal services, such as Massages, of impossible implementation.

The goods and services that coped better in the new circumstances are those attending to basic necessities (such as food), or that cater goods with very low demand elasticity (such as Tobacco). In addition there are categories supplying services to the business industry and that due to them being classified as "strategic" faced few restrictions of activity in the first phase of the lockdown, such as Insurance and the Notaries.[16]

[15]From the 77 categories in which BBVA divides the data we have further eliminated the sector ATM (presumably ATM fees).

[16]Notaries are termed "Gifts and Donations". In Spain Notaries have a very important role in legal and business activities. By their nature most of their services can not be provided online. Thus, there

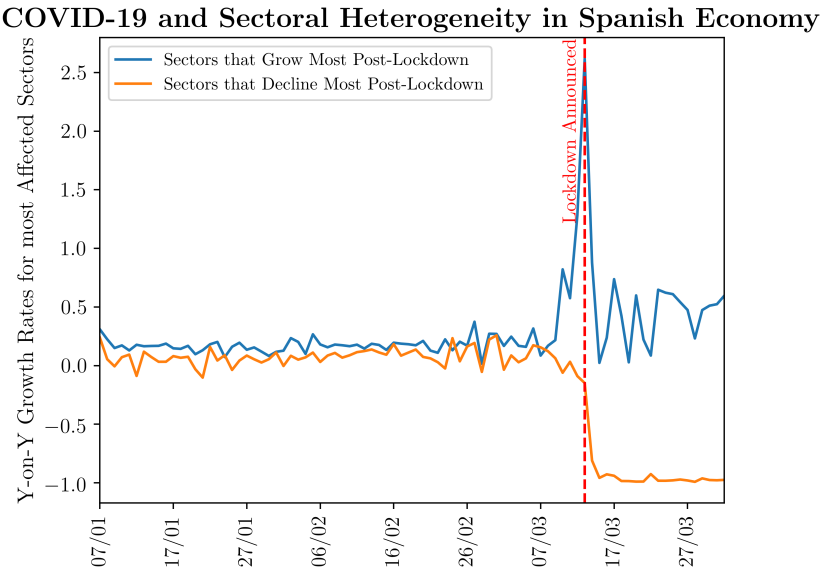
It is interesting to note that the expenditure category that improved most are small food shops, not only its share has risen even more than that of its larger competitors, Supermarkets and Superstores ('Hipermercardos'). This is most certainly a result of the restrictions to movement. Proximity to the customer is now of key importance, and by their very nature, small shops and convenience stores do compete favorably versus large sellers that are more sparsely located.

Looking at the aggregate evolution of these two sets of expenditure categories is very illustrative of the dynamics of the crisis. In Figure 8 we present the time series of the Y-o-Y Growth rates and market shares of the 10 best performing categories (aggregated together) and the 10 worst ones (again, aggregated together). From Panel 8a it is apparent that the top categories mainly had a very large increase in activity during the week preceding the lockdown; once the dust of the first week of the lockdown settled, they went back to a growth performance similar to that observed before the crisis. This is, expenditure growth on these goods and services with low demand elasticity remains at approximately the same levels than their "natural" level in absence of the pandemic. In Panel 8b we show that their share in the market has increased dramatically. These expenditure categories have gone from accounting for about 8% of the total sales on average in the period before the crisis, to represent almost half of the sales in the lockdown period (48.81%). Importantly, this is not because they sell more, but mostly because expenditures in other categories has almost evaporated.

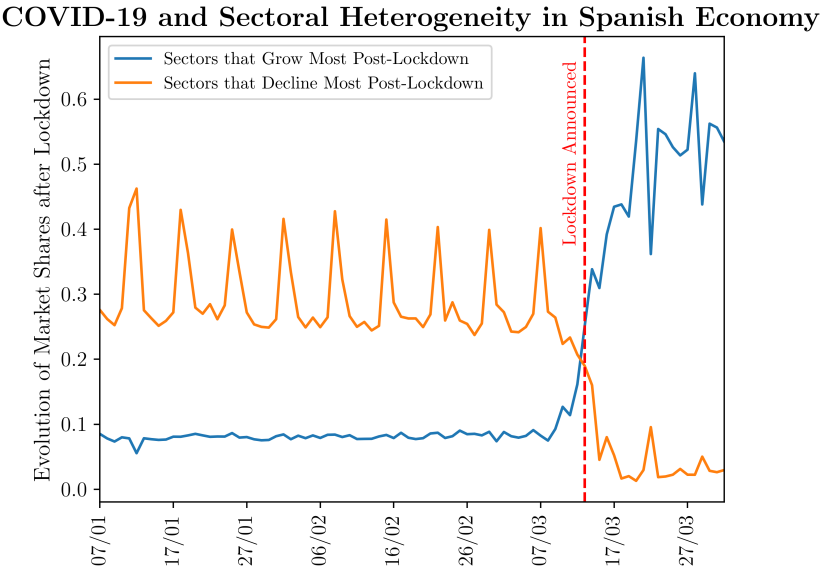
The evolution of expenditures in the bottom 10 categories (again in panel 8a) shows that they plummeted upon the implementation of the lockdown (not before), and they have remained at much lower sales than what would have been expected without Coronavirus ever since. Their share has moved from around one third of the market before the crisis (an average of 29.3%) to about 4.1% in the lockdown period.

Thus, we conclude that expenditure categories delivering necessities have mostly not altered their sales with respect to what would have been expected in the absence of the Coronavirus crisis. There was a process of hoarding of these goods in the week previous to the lockdown, but their sales have returned fast to normal levels and remain there. On the other hand some other goods and services have dramatically decreased their sales upon implementation of the lockdown, and without any apparent anticipation of it. These are expenditure categories whose activity has been either prohibited or made impossible in the circumstances of the lockdown.

was a special provision allowing them to be open in the first phase. They are considered essential, and remain open even in the second, more restrictive, phase, albeit with restrictions



(a) Y-o-Y Growth rate of the 10 best and worse performing categories



(b) Aggregate Market Share of the 10 best and worse performing categories.

Fig. 8: Evolution of the Y-o-Y Growth rates and market share of the best and worst performing categories of expenditure.

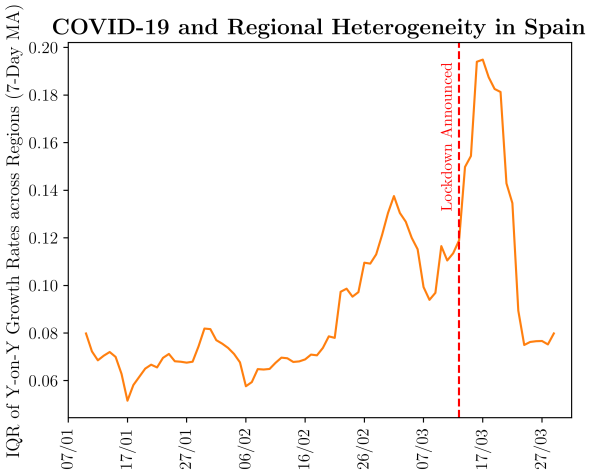


Fig. 9: Dispersion (IQR) of Year on Year Daily growth of Expenditures across regions

4.4 Regional Dynamics

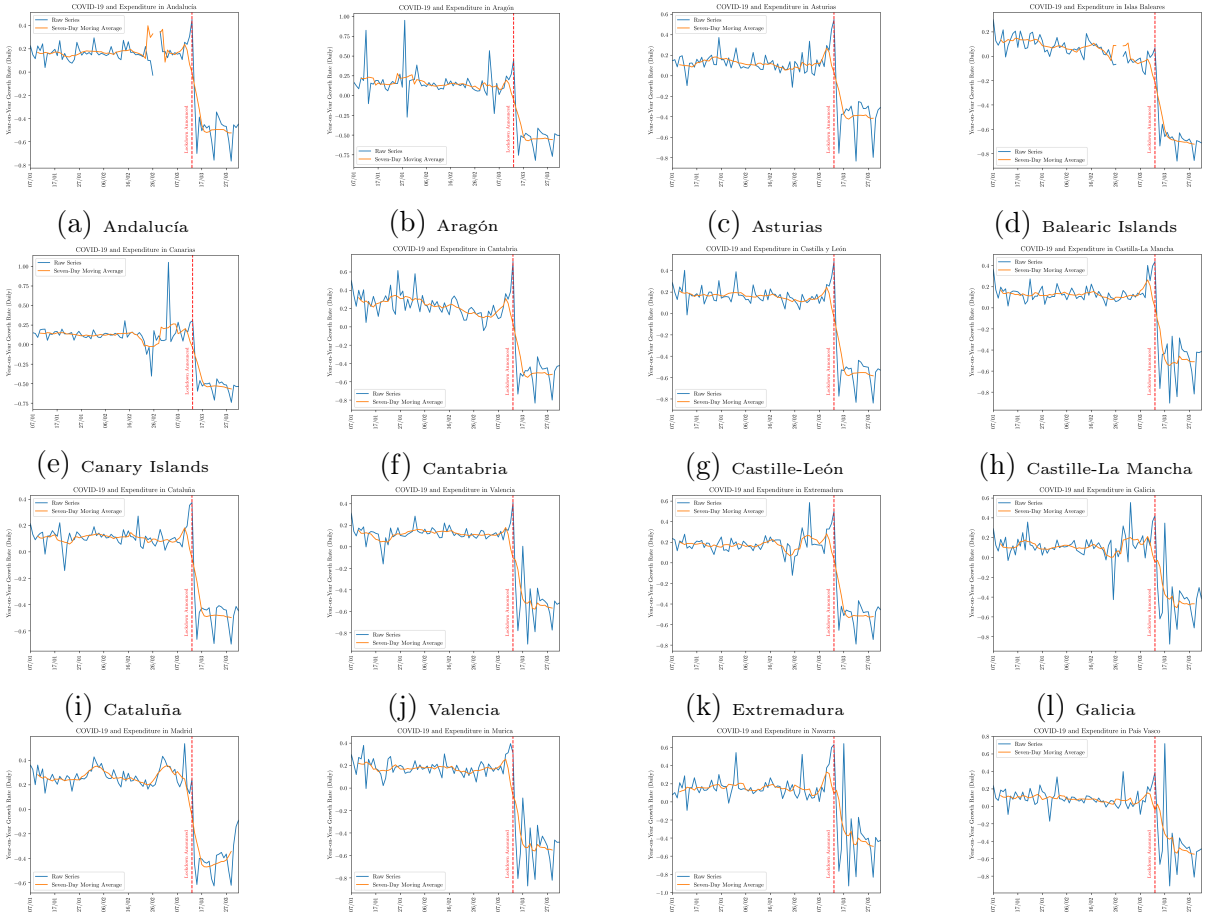
Spain is composed of 17 autonomous regions ("Comunidades Autónomas") with a large degree of self-rule in many fields, including Health, only overridden by the National Government in exceptional circumstances, such as the current emergency. At the same time, while the lock-down policy was implemented nationwide overnight, both the incidence of the illness, and its timing, has varied substantially across the regions.

Thus, while on the one hand the national lockdown and the State of Alarm legislation, would have induced homogeneous expenditure dynamics across space, spatial heterogeneity in the pandemic (and health sector resources in place), on the other hand, may have induced disparate dynamics in the spatial evolution of expenditures. In this section, by exploiting geo-tagging of our transaction data, we offer a first pass at the analysis of the regional evolution of expenditures over the crisis.

In figure 10 we plot the evolution of expenditures in each autonomous region[17] The observed dynamics are very similar and reproduce the pattern observed in the whole of the country. We supplement this by plotting the dispersion of Y-o-Y growth in daily expenditures across regions in Figure 9. While we do observe a noticeable increase in the lead-up and immediately after the implementation of the lockdown measures, this spike in dispersion seems to fade away in the last ten days of our sample. Thus, unlike the dynamics of sectoral categories of expenditures, the regional evolution of expenditure growth does not show a clear tendency to diverge.

Taken together, this suggests that across Spanish regions, the timing of the (immediate) response to the lockdown in a given area may have depended of specific conditions, either economic or due to differential incidence of the illness. Nevertheless, soon after

[17]We omit the smallest region (La Rioja) for reasons of space.



(a) Andalucía (b) Aragón (c) Asturias (d) Balearic Islands

(e) Canary Islands (f) Cantabria (g) Castille-León (h) Castille-La Mancha

(i) Cataluña (j) Valencia (k) Extremadura (l) Galicia

(m) Madrid (n) Murcia (o) Navarre (p) Basque Country

Fig. 10: Time Series of Year to Year change in Expenditures across 16 Spanish regions.

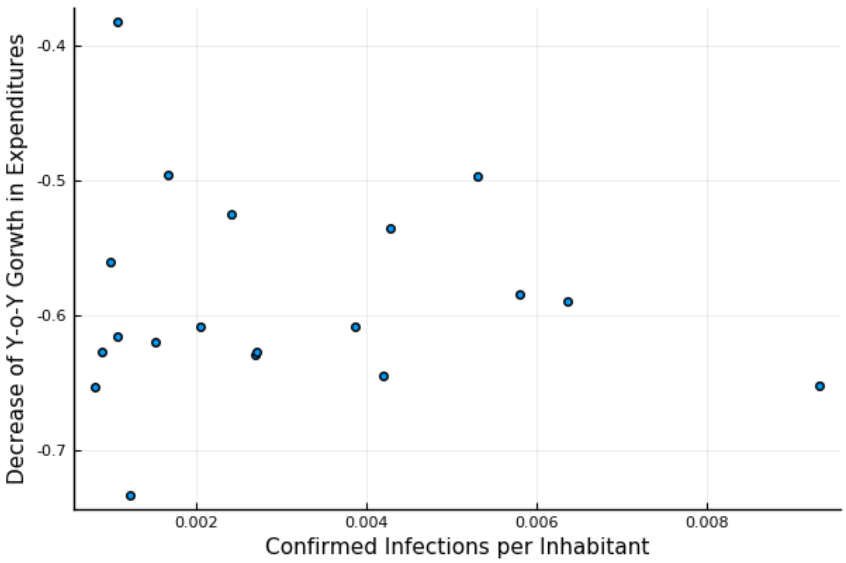


Fig. 11: Average fall in Y-o-Y growth rate versus number of confirmed infections per capita across Spanish Regions.

the lockdown is imposed, this dispersion starts declining, suggesting that regions follow a similar pattern once they have adjusted their behaviour. Thus, by the end of March, the effect of the lockdown on expenditure growth was very similar across regions, irrespective of the incidence of the illness. This lack of correlation between expenditure growth and the regional extent of the pandemic can be observed graphically in Figure 11.[18]

Overall, we tentatively conclude that all regions endure the lockdown, independently of the incidence of the pandemic, and the manner in which they suffer its *economic* consequences is independent of how prevalent the disease is in that particular region.

5 Local Dynamics: Zip Codes in Madrid

Our data includes also the postal code of the location where the transaction took place. Thus, we are also able to calculate these measures of spatial dispersion at a much more granular level than the Spanish regions. Given the size and economic importance of the Region of Madrid, and the fact that it is one of the areas of Spain with more incidence of the pandemic (it is the region with the highest total absolute of cases, and close to it in relative numbers), we have opted to concentrate our attention to this region. Our objective is to learn the manner (if any) in which socioeconomic differences within the subareas of the region, and/or differences in the incidence of the pandemic across them

[18]To further explore this hypothesis, we sourced data on daily cumulated cases per region (from the Spanish Ministry of Health) and data on 2018 GDP per capita across regions. In a panel context, we confirm that neither GDP per capita neither the daily evolution of the regional incidence of the illness correlate robustly with the daily regional expenditure growth rate. This again suggests that regional dynamics follow in unison from the enactement of the lockdown.

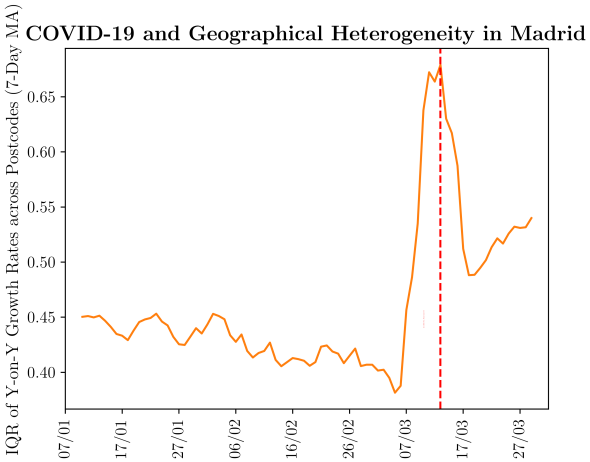


Fig. 12: Dispersion (IQR) of Year on Year Daily growth of Expenditures across ZIP codes in Madrid

affect the behavior of expenditures within this subareas.

In Figure 12 we plot the same measure of dispersion in expenditure growth across Madrid's zip codes as we had done for Spanish regions in the previous section. First, it is interesting to note that the level of dispersion is much larger within these narrow spatial units than across the autonomous regions. Second, across zip codes we observe an even sharper increase of the dispersion around the lockdown date. Third, albeit less pronounced, we again observe a decline in the local dispersion of expenditure growth as we move into the lockdown period.

The Health authorities of the Autonomous Community of Madrid divide the region in 286 Health Districts ("Zonas básicas de salud", ZBS) as their basic unit for the provision of health services. We additionally collect the accumulated incidence of COVID-19 in each of these areas by early April.[19] From the Spanish Statistical Office we collect information on population and population structure for all the "secciones censales" (equivalent to US census tracks) of the region.[20]. And we proceed to merge these datasets with our dataset.[21]

In what follows we have used as our basic unit the health district (ZBS). We proceed to evaluate whether the daily Y-o-Y growth rate of expenditures within the ZBS is affected

[19]The data is updated daily starting on the 8th of April and can be obtained from: https://www.comunidad.madrid/servicios/salud/2019-nuevo-coronavirus. We have not been able to find daily data on incidence at this level of disaggregation for earlier dates.

[20]This information is available from: https://www.ine.es/experimental/atlas/exp$_a tlas_t ab.htm$

[21]There are some technical caveats. The postal codes in our data do not coincide neither with the ZBS nor with the "secciones cenales". Fortunately the "secciones censales" are very small units (of around 1500 individuals in average), and we have geolocation definitons for the three levels of aggregation. We have aggregated starting from the smallest unit, the "seccion censal", and we calculate the socioeconomic variables of each ZBS by their closer match aggregating "secciones censales", not including those that are not completely within a ZBS. In a similar manner we have matched ZBS to postal codes by matching them via the "secciones censales" that they share.

	Y-o-Y Daily Growth of Expenditures for Madrid Units		
	(1)	(2)	(3)
Lockdown Dummy	-0.633***		-0.593***
	(0.102)		(0.024)
Total Infected per capita		25.578*	27.959**
		(13.546)	(13.732)
Lockdown * Infected p.c.			-12.047*
			(7.077)
N Units	286	286	286
N Observations	24,596	24,596	24,596
R^2	0.008	0.331	0.339

Table 3: Regression of Madrid micro unit daily Y-o-Y growth rates on lockdown dummy variable, cases per capita and interaction of lockdown dummy with cases per capita. Standard errors clustered at the Madrid ZBS (Basic Health Zones)

by the lockdown (which affects all ZBS at the same time) and the incidence of the disease within the ZBS.

In Table 3 we run a panel regression of the Y-o-Y growth of expenditure within the ZBS on a dummy for the implementation of the lockdown and interactions between the lockdown and the per capita incidence of the pandemic at that ZBS. We find that the lockdown has a large effect on the Y-o-Y growth sales, regardless of further controls. Additionally, in areas with a larger incidence of COVID-19 Y-o-Y daily growth of expenditures, we find that the effect of the lockdown on expenditures is larger.

6 Concluding Remarks

The ability to track economic conditions at high frequency is important for making effective and timely policy choices. This is especially the case when conditions are changing rapidly and are subject to high levels of uncertainty, as is currently the case throughout the world due to the COVID-19 pandemic. The current crisis comes at a time when the world is as rich in digital data as it has ever been, including detailed and granular information about transactions and exchange stored by banks and payments processors. A pressing challenge is to use this data to provide signals to policymakers about the impact of coronavirus and the policy interventions made to limit its spread. This paper takes some of the first steps in the economics literature to show how transaction data can be used to assess economic conditions in real time during times of crisis. We show that such data is able to capture many relevant patterns in spending and, most importantly, does so in near-real time. The availability of indicators like ours will, for example, allow policymakers to assess the impact of the easing of lockdown measures going forward, an issue that will become important for all countries in the next several months including Spain.

Besides its timeliness, another important feature of transaction data is its granularity. In this paper, we have demonstrated its ability to capture different spending patterns

across geography, expenditure categories, and online vs offline purchases. Further work in this direction is an obvious next step. Pairing the expenditure categories with household and firm metadata would allow one to pin down the determinants of expenditure, to assess the distributional consequences of policy interventions for households, and to examine which types of firms weather crisis periods best.

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