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Articles

The Economic Impact of the Pandemic in Rwanda: An Analysis of Firm-Level VAT Data

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Abstract

There are substantial differences in the spread of the covid-19 pandemic and policy responses to it between high- and low-income countries. While evidence on the former is growing, there remain more unanswered questions on the latter. This paper addresses this gap by providing insights on the impact of the pandemic in Rwanda, based on firm-level administrative data from Value Added Tax (VAT) returns. We find that VAT sales in 2020 declined by 11.4 % compared to 2019. These losses are particularly associated with a lockdown imposed around April 2020, after which sales quickly rebounded to pre-crisis levels once restrictions were lifted. In absolute terms, the economic cost is concentrated among the largest firms. However, small firms have been most affected in proportional terms. Disaggregating our results further, we show that firms in accommodation and food, transport services, wholesale and retail trade, as well as those registered in the capital, have been particularly affected by the crisis. Overall, the decline in sales translated to a similarly large percentage loss in VAT revenue for the government.

Keywords: Administrative data, COVID-19, economic shock, VAT sales

JEL classification: H25, H32, H61, O12

1. Introduction

The covid-19 pandemic played out differently in higher- and lower-income countries (LICs) in 2020.[1] LICs experienced a much lower spread of the virus, compared to higher-income

1 An article published in The New Yorker on 22 February 2021 discusses the open questions on how the pandemic is playing out in LICs and provides a summary of the various factors at play (article accessed on 19 March 2021 at this link: https://www.newyorker.com/magazine/2021/03/01/why-does-the-pandemic-seem-to-be-hitting-some-countries-harder-than-others).

countries (HICs): deaths associated to covid-19 remained well below 1 per million people in the former, compared to a typical range of 5–10 (with peaks above that) for many countries in the latter group.[2] Despite these differences, LICs have, by and large, responded with restrictions of comparable severity to those adopted in HICs (Ray & Subramanian, 2020; Carnap *et al.*, 2020). These restrictions were also generally adopted at an earlier stage: when median cases per million people were 0.57, as compared to 97.3 in HICs (Walker *et al.*, 2020).

Is this aggressive policy response appropriate, given the differences in the spread of the virus? The answer is far from straightforward. On the one hand, lockdowns might not be an effective or desirable policy response in contexts characterised by high poverty rates, low state capacity, large informal sectors and less digitised economies (Alon *et al.*, 2020; Hevia & Neumeyer, 2020). Some studies have suggested that the highest impact of the pandemic in these countries might come from the restrictions themselves, rather than the health crisis more broadly (Caselli *et al.*, 2020; Goldberg & Reed, 2020; Mahmud & Riley, 2020; Ray & Subramanian, 2020; Teachout & Zipfel, 2020). On the other hand, the relative weakness of LIC's health systems means that they can be overwhelmed more easily and rather quickly. In this context, governments might have to act more forcefully to fully interrupt transmission early on, rather than simply slowing it down (Walker *et al.*, 2020), and be ready to reintroduce restrictions as soon as case numbers rise again (Caselli *et al.*, 2020). While this strategy might indeed have been effective in containing the pandemic in LICs, it also presents potentially large economic, and other, costs. In 2020, African economies contracted by 3%, the worst performance on record, and they are projected to grow more slowly than the global economy in 2021 (IMF, 2020).

This paper cannot directly address the question of whether severe lockdowns are an appropriate policy response in LICs. However, we contribute to this debate by quantifying the actual economic impact of the pandemic in a low-income context: Rwanda. This country presents many typical features of LICs, both in terms of the spread of the pandemic (relatively limited) and its policy response (severe and early lockdowns), as discussed in Section 2.1. By using real-time data from Value Added Tax (VAT) declarations (see Section 2.2), we can measure the actual impact of the crisis, rather than providing projections or estimates that have already been reported elsewhere (Aragie *et al.*, 2021; Arndt *et al.*, 2020; Bachas *et al.*, 2020). More precisely, we analyse high-frequency data for the population of formal firms, obtained from VAT returns filed for 2017, 2018, 2019 and 2020. These data allow us to provide more nuanced insights than previously available on the actual impact of the pandemic, and the policy response to it, in a low-income context. More specifically, we report four key results.

Firstly, we find a strong association between the economic impact of the crisis and restrictions adopted in response to it (see Section 3.1). We document a sharp drop (37%) in VAT sales in April 2020, corresponding to the implementation of the first nation-wide lockdown. Sales then quickly rebounded to pre-crisis levels right after restrictions were lifted.

2 Among others, Rwanda, Ethiopia, Nigeria, Uganda, Pakistan and Bangladesh have all remained well below one death per million people since the start of the pandemic. In comparison, Italy, France, Germany, the US and the United Kingdom all had peaks above 10 deaths per million (often well above that value). Source: Ritchie *et al.* (2021).

This result is consistent with the view that economic losses in LICs are particularly related to lockdowns rather than citizens' health concerns (Goldberg & Reed, 2020; Teachout & Zipfel, 2020). It is in contrast with results from HICs, where economic activity remained weak even after restrictions eased (Caselli *et al.*, 2020; Chetty *et al.*, 2020). However, data on case numbers suggests that restrictions were effective in containing the spread of the virus (see Figure A1). Containment is particularly important in LICs, whose vaccination campaigns are expected to progress more slowly and that are therefore set to live with the virus for longer than HICs. Still, the associated economic cost requires attention from policymakers and the international community, as households do not have the basic means to cope with restrictions (Egger *et al.*, 2020) and governments lack the required fiscal space to implement adequate relief measures alongside lockdowns (Cirera *et al.*, 2020; Ray & Subramanian, 2020).

Secondly, in Section 4.1, we investigate the distributional patterns of the crisis' impact, documenting two important findings. Since revenue in Rwanda is highly concentrated at the top of the income distribution, the economic losses in absolute terms are dependent on the performance of the largest firms. They are responsible for virtually all losses in sales and VAT revenue that we observe at the aggregate level. However, in proportional terms, small firms experienced much greater losses than larger ones (see Section 4.1). Our results are consistent with similar evidence from Honduras (Bachas *et al.*, 2021) and with expectations that the poor in Sub-Saharan Africa would be most-affected by the crisis (Djiofack *et al.*, 2020). This second fact points to the importance of ensuring that appropriate relief and support programs reach small businesses too, as they are especially vulnerable.

Thirdly, the aggregate drop in sales we document in Section 3.1 translates into a VAT revenue loss of approximately 36% in April 2020—with some of these losses being recouped in the subsequent months (see Section 3.2). The total drop in VAT revenue in 2020 amounts to 8.8% compared to 2019. Other studies estimate that losses for other tax types may be higher. For example, Lees *et al.* (2020) predict a 25% drop in Corporate Income Tax (CIT) revenue in Rwanda in 2020, based on simulations for a three month-long lockdown scenario. Estimates for South Africa project a similar (32%) drop across all tax types and suggest that import taxes are the most-affected type (Arndt *et al.*, 2020). While the literature on the economic effects of lockdowns is growing fast, there is still limited evidence on the actual impact on tax revenue—despite tax being key to funding both crisis response and recovery plans. Our results contribute to filling this gap.

Finally, in Sections 4.2 and 4.3, we also investigate disaggregated impacts by sector and geographical location. Section 4.2 shows that accommodation and food service, transportation and storage and wholesale and retail trade suffered the greatest losses, in line with predictions from simulations for CIT in Lees *et al.* (2020). While all sectors were affected by the pandemic, particularly during the lockdown, there is substantial heterogeneity both within and across sectors. Section 4.3 reports data disaggregated by firm location, which reveals that firms registered in the capital, Kigali, were hit particularly hard. Nonetheless, firms across all Rwandan provinces experienced severe losses, especially during the lockdown quarter.

Our results are both novel and highly policy-relevant. We quantify the impact of the crisis in an LIC, in a literature that has largely focussed on higher-income contexts. In addition, we are able to measure the crisis' impact on actual economic activity, as captured in VAT declarations, rather than providing estimates or projections. The substantial differences in

the pandemic between HICs and LICs make it particularly relevant for policymakers to rely on evidence that is context-specific. More specifically, our results shed more light on the economic costs of lockdowns: while these severe restrictions might indeed be necessary to contain the spread of the pandemic, they account for the lion's share of the overall impact of the crisis and affect small businesses particularly hard.

More broadly, our analysis highlights the key role that administrative tax data can play in assessing a country's economic performance in real-time, during but also beyond the current pandemic. The crisis has pushed researchers to look for new sources of high-frequency data to provide real-time insights into the economic shock and to inform policy responses.[3] For instance, Chetty *et al.* (2020) used anonymised data from private companies in the US, Campos-Vazquez & Esquivel (2021) analysed data on the universe of point-of-sale (POS) transactions from Mexico, and Beck *et al.* (2020) relied on information from stock exchanges such as financial statements and stock prices. These sources of data are, however, either not available or hardly relevant in LICs where stock exchanges are shallow, bank penetration is low and cash transactions are dominant. As an alternative, studies on LICs have primarily used surveys, either one-off as in Krishnan *et al.* (2020) or repeated as in Bishi *et al.* (2020). High-frequency survey data is indeed helpful to evaluate the impact of the crisis in real-time, but it also presents several challenges.[4] In this context, administrative data from tax returns present a more promising option for firm-level analysis, particularly in LICs—where, in recent years, they have increasingly been used for research.[5] While other studies in LICs have used historical administrative data to forecast or simulate the likely effects of covid-19 (such as in Rauschendorfer & Spray (2020) and Bachas *et al.* (2020)), our paper shows how these data can be used for real-time analysis of the actual impact on the pandemic for a low-income economy.[6]

2. Rwandan context and data

2.1 Rwandan context

Rwanda is a low-income African country, with a population of about 13 million people. It reported its first covid-19 case on 14 March 2020. On the same day, it introduced restriction measures, such as school closures and a ban on public gatherings. A week later, on 21 March, the government announced a national lockdown that further restricted all movement and introduced a requirement for all but essential workers to work from home. These measures were strictly enforced and lasted until early May. They were implemented very early on, with the aim of preventing an uncontrolled spread of the pandemic. This prompt reaction is in line with decisions made in other LICs (see Section 1). For example, Kenya, Ethiopia and Uganda introduced severe restrictions as soon as the first cases appeared in each country, including

3 Here, we specifically refer to studies looking at real-time impacts, rather than forecasts or simulations, of which a few focus on LICs, for instance Younger *et al.* (2020) and Teachout & Zipfel (2020).

4 Among others, survey data is expensive to collect, and implementing multiple high-frequency rounds might increase attrition.

5 For a review of some papers using administrative data for tax analysis, see Slemrod (2019) and Mascagni (2018).

6 Bachas *et al.* (2021) provide an application from a middle-income country using data from Honduras. Other studies, such as James (2020), use aggregate data to evaluate the impact of the crisis.

school closures, bans on social gatherings, travel restrictions and requirements to work from home for everyone except essential workers. Other countries, such as Sierra Leone, applied similar restrictions, such as curfews and limitations on national and international movements, but only short and targeted full lockdowns.

In parallel to restrictions, the Rwandan government started a programme of support and relief for businesses, and for the most vulnerable, including food support and tax deferrals. As far as VAT is concerned, support measures adopted by the Rwanda Revenue Authority (RRA) included fast-tracking VAT refunds, especially for small businesses, a waiver of fines, penalties and interest related to late payments, and a short extension of the deadline to declare and pay VAT in March and April.[7] There is, as yet, no evidence on the reach of this relief programme and its effectiveness in alleviating the effects of the lockdown.

The number of cases in Rwanda has remained relatively low since the start of the pandemic (see Appendix Figure A1). Although the spread of the virus remains much more limited than in other countries, the first weeks of 2021 saw a sharp increase in case numbers.[8] This development pushed the government to introduce another lockdown in Kigali, the capital city, while other areas are subject to a curfew from dusk to dawn. This second lockdown started on 19 January and lasted for three weeks. The sharp reduction in cases since suggests that it has been effective in reducing the spread of infection. In general, Rwanda has responded to the crisis with relatively strict restrictions, fully comparable to countries that have been affected much more severely (see Appendix Figure A1 for details from the Government Stringency Index).

Despite the relatively low incidence of cases, Rwanda is projected to experience severe losses in economic activity and tax revenue. A recent report based on historical administrative data from past corporate income tax returns estimates the economic effects of the crisis on Rwandan corporations, using two scenarios with lockdowns lasting for three or five months (Lees *et al*., 2020). For the three months lockdown scenario, these projections suggest that just 55% of firms remain profitable, compared to 72% of firms in the baseline scenario pre-covid. The resulting losses in sales that the authors calculate also imply large losses in payroll for employees (5.2%) and in tax revenue for the government (25%). The results we present in this paper complement these estimates by showing the actual impact of the crisis, based on sales reported in VAT declarations.

7 The deadline for declaring and paying VAT is normally on the 15th of the month for monthly taxpayers, and on the 15th of the second month after the end of the quarter for quarterly taxpayers. It was extended to 18 March and 24 April, then returned to normal from May. Other tax relief measures included: the softening of tax arrears collection; extending the deadline for filing and paying income tax (PAYE and CIT); a temporary PIT waiver for school teachers, and tourism and hotel employees with incomes less than RWF 150,000 per month; a waiver of fines, penalties and interest accrued from late payment of PAYE and withholding tax (in addition to VAT); a temporary suspension of physical post-clearance and comprehensive tax audits; and taxpayers were permitted to adopt current-year basis in determining provisional taxes for the 2020 tax period.

8 The peak in 2020 of 140 new cases corresponds to 11 new daily cases per million people. This figure is much lower than the peaks seen in HICs, which are typically above (or much above) 500 new cases per day, per million people. Source: Ritchie *et al.* (2021).

2.2 Data

Our analysis uses firm-level data from VAT declarations to evaluate the extent of the economic shock in Rwanda and its implications across the income distribution, sectors and geographical locations.[9] This is the most suitable source of microeconomic data to answer these macroeconomic questions about the crisis—at least in the Rwandan context. It has several advantages: it captures the entire population of formal firms; it is available at a higher frequency than the typical survey or income tax declarations;[10] and it is routinely collected by the revenue administration, thus not requiring additional data collection efforts. It is also highly relevant for policy purposes, especially when estimating losses in tax revenue (Section 3.2), since it represents the tax base currently available to the government. As anticipated in Section 1, other data options used to assess the impact of the crisis elsewhere are either not available or not relevant (mostly due to very limited coverage) for LICs like Rwanda.

Our dataset encompasses all VAT declarations for 2017, 2018, 2019 and 2020. We deflated all data to 2017 prices, to observe the impact of the crisis net of inflation.[11]

VAT declarations in Rwanda are filed either monthly or quarterly, depending on business size.[12] As expected, annual average sales are much higher for taxpayers filing monthly, the largest ones, compared to quarterly ones. Relatedly, over 90% of total VAT declared is generated by firms declaring monthly. Monthly declarations are due on the 15th of each month, while quarterly ones should be submitted within 1.5 months after the relevant quarter has ended.[13]

Among the fiscal measures taken to support businesses during the covid-19 crisis, discussed in Section 2.1, was a deferral of a few days for VAT filing and payment. However, this deferral only affects the time of reporting, not the reference tax period for the information contained in the declaration. Therefore, it does not affect our analysis.[14] Other tax relief measures, such as fast-tracking VAT refunds or waiving penalties, might affect the impact of the crisis on VAT revenue. In Section 3.2, we explore and discuss this possibility.

Appendix Table A1 shows that our dataset includes a total of over 27,700 firms in 2020, a number that as been growing progressively from 20,585 in 2017. Despite the crisis, the

9 These data were obtained from the Rwanda Revenue Authority following a direct request, in the context of a broader collaboration between the RRA and the International Centre for Tax and Development.

10 Income tax declarations are typically filed only once a year and they are available with a longer delay, usually 3 to 6 months, compared to VAT declarations.

11 Data were deflated using the year-on-year consumer price index from the National Bank of Rwanda (2021).

12 According to the Code of Value Added Tax (Law 37/2012), taxpayers with turnover below RWF 200 million (roughly US$200,000) can file quarterly, while others file monthly (Parliament of Rwanda, 2012).

13 For example, declarations for the fourth quarter of 2020—the most recent one in our analysis – were submitted by 15 February 2021.

14 The VAT dataset includes both the submission date and the tax period of reference. We use the latter to determine the relevant time when economic activity took place. The fact that the deferral was granted might have generated a compliance effect (e.g. firms complying more or less because of the presence of the crisis) but we are not able to measure it here. It is unclear what the direction of this effect would be or whether the effect would be sizeable at all given the deferral was only a few days long.

total number of VAT-registered firms in 2020 is higher than in 2019. However, this aggregate figure is still consistent with the possibility that some firms may have exited the market due to the crisis. We have not performed a detailed analysis of firm exits because our data does not allow us to observe it in any accurate way.[15] However, recognising that exits are likely to occur during our data period, we repeat our analysis both with a balanced (quarterly and yearly) and an unbalanced panel to make sure our results are not driven by a different composition of firms in the population.[16] Our results remain essentially unchanged regardless of the panel we use.

For our analysis, we use both a complete dataset including all VAT declarations, aggregated at the quarter level, and one of monthly declarations only, which allow us to obtain a more disaggregated picture.[17] The latter, while incomplete, is still highly relevant as it represents the vast majority of VAT sales and revenue. These data are then used to compute the basic statistics presented in Section 3, where we also provide some brief methodological notes on our calculations. It might only be worth mentioning here that we compute growth rates in two ways: at the aggregate level and at the firm level. The former is computed as the growth rate of total sales (as in Section 3.1) or of total sales disaggregated by sector or location (as in Sections 4.2 and 4.3), quarter-on quarter or year-on-year. The latter is the mean of growth rates calculated at the firm-level (as in Section 4.1). Both are relevant for policy, from a more macro- or micro-perspective, respectively.

While we believe that the VAT dataset is the most suitable source of real time information on the Rwandan economy, it comes with a few caveats. Perhaps the most important one is that, naturally, VAT declarations data only capture the economic activity of firms that are registered for this tax—thus excluding both fully informal firms and micro firms that are not required to register for VAT.[18] Our dataset therefore reflects trends in VAT sales, rather than economic activity or GDP more broadly. While it allows us to produce new insights into the economic impact of the crisis, it cannot provide any direct indication on how the crisis affected GDP. Importantly, the sectoral composition of GDP and VAT sales differs in substantive ways. Most notably, the agricultural sector is grossly under-represented in VAT

15 The data on declarations tells us if firms declare or not, not if firms have actually exited the market. It is likely that at the height of the crisis a firm might remain closed for several months, thus not filing declarations, but still resume operations at a later stage. Still, we do see a slight increase in 'exits' in April 2020 in the declarations dataset, defined as firms whose last declaration is in the previous month. However, it would be enough for these firms to miss just one or two tax periods (which would be beyond our data period) for this not to be indicative of a true exit.

16 The unbalanced panel includes any observation we have available in every period. The balanced panel requires firms to be present every quarter (quarterly balanced) or at least once in the year (yearly balanced). The definition of quarterly or yearly balanced panel does not affect our results in a significant way.

17 To obtain the quarterly dataset, we sum up monthly declarations for the relevant quarter for each firm, and merge the data with the quarterly declarations.

18 The Rwandan VAT system includes a threshold of RWF 20 million (over US$20,000) below which firms are not legally required to register for VAT. These firms are only liable to pay income taxes, often under simplified regimes that minimise their compliance costs. The VAT threshold in Rwanda is relatively low (Mascagni *et al.*, 2021), which implies the exclusion of micro firms, while small ones are still part of our dataset.

sales, compared to GDP, while, for example, wholesale and retail trade is overrepresented (see Appendix Table A2). Still, to provide some indication on how value added changed during the crisis, we also compute the crisis' impact on a measure of value added, as calculated from our tax data, in addition to our core results on the impact on sales and tax revenue. These results are reported in Appendix Table A4 and largely aligned with our core results.[19]

Our dataset presents three other caveats or limitations. Firstly, it is at the firm-level, not at the consumer-level. Therefore, in Section 4.1, we can only show distributional patterns across firms, not across consumers or households. Secondly, the data includes information on sales, but not on other variables, such as employment, because they are not relevant to the calculation of VAT payments. Employment has been highly affected by the crisis (Ranchhod & Daniels, 2020) and it does not necessarily follow the same pattern of recovery as sales (Bishi *et al.*, 2020; Ranchhod & Daniels, 2020). Thirdly, by definition our data only capture what is reported by firms, thus excluding any under-reported income linked to evasion, even among firms that are VAT-registered. Changes in VAT sales can be due to real changes in economic activity and/or changes in compliance. Although we cannot distinguish between these two elements in this analysis, a separate study, also from Rwanda, suggests that compliance has increased during the pandemic (Mascagni & Santoro, 2021). Based on this finding, the results on revenue losses presented here should be a lower bound for real changes in economic activity.

3. Aggregate impact of the crisis on economic activity and tax revenue

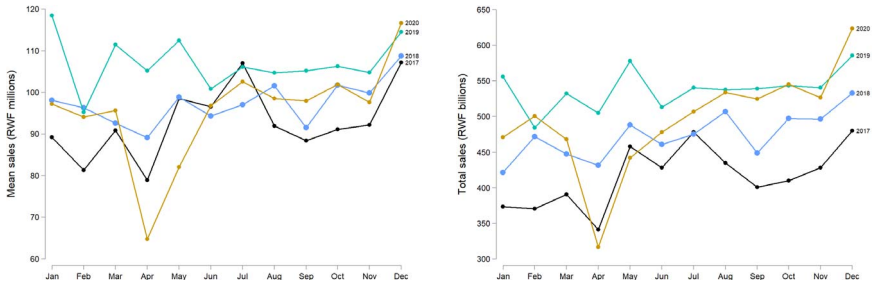
3.1 Aggregate impact on firm sales

We start by looking at the aggregate impact of the crisis on sales,[20] as reported by Rwandan firms in their VAT declarations. Figure 1 uses the more disaggregated data from monthly declarations, while the corresponding data using all declarations aggregated at the quarterly level is reported in Appendix Figure A2. Both panels of Figure 1 report four lines corresponding to the four years in our dataset (2017–2020) to allow for comparisons across years. Panel (a) shows mean sales across firms by month while panel (b) shows total sales. Both panels show a clear drop in sales concentrated particularly in April 2020 (37%, as reported in Table A3), the month most affected by the lockdown (see Section 2.1).

Table 1 reports aggregate sales by quarter, for all VAT taxpayers for each quarter. It also reports aggregate year-on-year growth rates in total sales, by quarter. In years prior to the

19 Value added is not directly observed in the tax data. While declarations include information on the value of outputs (sales), they only report VAT paid on inputs, and not the value of inputs. We therefore had to impute the value of inputs using the standard VAT rate of 18%. This is an imperfect imputation for several reasons: (1) some inputs might be subject to reduced rates; (2) some inputs might refer to different periods, as firms are allowed to claim them after they occurred; and (3) we know from other research that some firms fail to claim for some or all of their inputs (see Mascagni *et al.* (2021)). Using this imputed value of inputs, we then calculate value added as the difference between total taxables sales and the value of inputs (output - input). Total taxable sales excludes exports and sales of VAT exempt or zero-rated goods and services. We use this rather than the total value of all sales since taxpayers typically cannot claim input credits for non-taxable sales.

20 For this analysis, we define sales as the total value of supplies, including VAT-exempted and zero-rated sales.



(a) Mean sales by month (b) Total sales by month

Figure 1: Aggregate Impact on Mean and Total Sales. Notes: These graphs show mean and total VAT sales for monthly taxpaying firms in 2017, 2018, 2019 and 2020. Firms that report no sales across the relevant year (nil-filers) are excluded from the mean calculations. Total sales are calculated as the sum of all sales reported by all monthly taxpaying firms in each month.

Table 1: Impact of COVID-19 on Aggregate Sales and VAT Revenue

	(1) 2017 (RWF bn)	(2) 2018 (RWF bn)	(3) Growth (%)	(4) 2019 (RWF bn)	(5) Growth (%)	(6) 2020 (RWF bn)	(7) Growth (%)
PANEL A: Sales							
Jan–Mar	1,240.3	1,432.3	15.5	1,693.3	18.2	1,564.6	-7.6
Apr–Jun	1,352.3	1,619.5	19.8	2,033.1	25.5	1,324.1	-34.9
Jul–Sep	1,448.0	1,559.8	7.7	1,781.3	14.2	1,719.3	-3.5
Oct–Dec	1,469.9	1,674.1	13.9	1,850.2	10.5	1,912.7	3.4
Total	**5,510.5**	**6,285.8**	**14.1**	**7,357.9**	**17.1**	**6,520.6**	**-11.4**
PANEL B: VAT Revenue							
Jan–Mar	49.4	56.0	13.4	68.2	21.7	65.0	-4.6
Apr–Jun	51.8	57.5	11.1	66.1	14.9	52.4	-20.6
Jul–Sep	53.0	58.7	10.9	73.0	24.2	66.0	-9.6
Oct–Dec	55.7	65.1	16.7	74.6	14.6	73.5	-1.5
Total	**209.9**	**237.3**	**13.1**	**281.8**	**18.7**	**256.9**	**-8.8**

Notes: Total sales and VAT revenue are reported in billions of Rwandan Francs (RWF) in constant 2017 prices. These figures are total sales reported by all taxpayers, both quarterly and monthly, aggregated at the quarterly level. Columns 3, 5 and 7 report year-on-year growth rates, calculated based on the difference between the relevant quarter in year t and (t-1).

crisis, VAT sales grew consistently at double digits, in line with the strong performance of Rwanda's economy. The year 2020 started with a lower level of sales compared to the last quarter of 2019, which, at least partly, captures an early effect of the pandemic. As discussed in Sections 1 and 2.1, the government of Rwanda moved promptly to contain the health risk at a very early stage. It was one of the first countries to stop travel to and from China as early as February 2020, with likely implications for imports and exports. Although the lockdown started on 21 March (which is captured in the first quarter), Appendix Figure A3 shows that mobility had already started decreasing at least a week prior to that.

While the crisis is at least partly responsible for the sluggish growth in the first quarter (Q1), the most dramatic decrease in sales (nearly 35%) occurs in the second quarter (Q2),

corresponding to the national lockdown which ended in early May. Sales then rebounded quickly in the third and fourth quarter (Q3 and Q4) of 2020, consistent with the mobility data reported in Appendix Figure A3. While total sales in Q3 remained below the levels seen for the same quarter of 2019, Q4 recorded a 3.4% increase in sales year-on-year largely thanks to strong sales in the month of December (see Appendix Table A3). Overall, total sales in 2020 were still over 11% less than in 2019—indicating that the lockdown generated a real loss rather than a mere deferral of sales. In absolute terms, the total loss in sales for 2020, compared to 2019, amounts to RWF 837.3 billion—roughly equivalent to US$823.9 million at current exchange rates.

As anticipated in Section 2.2, these results on sales do not capture the impact of the crisis on GDP. In fact, the National Institute of Statistics of Rwanda (2020) reports that GDP contracted by 3.3% in 2020, compared to 2019—a figure substantially lower than ours. To provide a sense of how value added changed during the crisis, in addition to sales, we also repeat the same analysis reported in Table 1 using value added, as calculated from our tax data (see Section 2.2). Appendix Table A4 shows that the impact of the crisis on value added displayed a similar pattern to sales and tax revenue, but was lower in magnitude—and closer to the decline in GDP, as expected. We calculate a total decline in value added of 6.3% in 2020, compared to 2019. However, these results suffer from the caveats highlighted in Section 2.2 and relate to the need to impute the input variable to calculate value added. The more modest loss in GDP, compared to VAT sales or value added, is consistent with the sectoral differences between GDP and VAT sales (see Section 2.2 and Table A2). We discuss this in more detail in Section 4.2.

Appendix Table A3 confirms the results of Table 1, but uses only monthly declarations to provide a more disaggregated view across the year. It is worth noting that these larger taxpayers only suffered a total loss of 8% in 2020—compared to 11.4% in Table 1. In comparison, the quarterly declarations data, capturing the performance of smaller firms (as mentioned in Section 2.2), reveals a 35.3% drop year-on-year. These figures provide a first indication that larger taxpayers suffered relatively less than smaller ones, as we show in more detail in Section 4.1.

Furthermore, we test the robustness of our results by checking whether they change if we restrict our data to a balanced panel, as discussed in Section 2.2. To do so, we compute aggregate growth rates again but only based on the yearly or quarterly balanced panel. Again, our results remain largely unchanged, with an overall decline in the yearly balanced panel of 13.1%, compared with 11.4% in Table 1 (see Appendix Table A5). While the loss is higher in the balanced panel, the difference does not suggest a major role of entry and exit in our analysis—consistent with similar results from Honduras (Bachas *et al.*, 2021).

Comparing these results with the available literature, we can highlight two interesting observations. Firstly, the impact magnitude we compute here is very much in line with those found in other studies. The most comparable analysis is by Bachas *et al.* (2021), who found a 40% drop in sales during the lockdown in Honduras and an overall loss of 15% by August 2020, compared to the same period in 2019. These numbers are remarkably in line with our results.[21] The overall impact we find is also in line with projections for Rwandan firms

21 This is particularly the case since our results also include the last quarter of 2020, for which recovery has been stronger. Our result for the first three quarters is even more in line with the Honduras study.

based on historical income tax data: Lees *et al.* (2020) forecast that firms' losses (referring to income less expenses, pre-tax) would increase by 21% in a three month lockdown scenario. In South Africa, Arndt *et al.* (2020) estimate that the full shock would result in a 34% drop in GDP, which, however, improves to a decline of only 5% in a 'quick' recovery scenario that seems consistent with what we observe in Rwanda. Furthermore, Campos-Vazquez & Esquivel (2021) calculate that movement restrictions in Mexico reduced consumption by 23%, while Chetty *et al.* (2020) report that they led to a 30% decrease in small business' revenue in less affluent areas of selected US cities.

Secondly, the Rwandan data shows a very quick rebound to pre-crisis levels as soon as restrictions were lifted. This is in contrast to similar studies from both middle-income countries and HICs, as reported respectively in Bachas *et al.* (2021) and Chetty *et al.* (2020). In those countries, spending remained low even after the lockdown was eased, probably because case numbers remained higher than in Rwanda. With infections still relatively widespread, recovery might have been trumped by health concerns—so that the economic slowdown was only partly linked to the restrictions themselves (Caselli *et al.*, 2020). In contrast, our results confirm the view that, for LICs, where case numbers remained low and governments took decisive and early action, the main economic impact of the crisis is highly associated to the lockdown itself (see Section 1). While it is likely that some firms or individuals did not fully comply with lockdown restrictions, the mobility data suggests that compliance has been good in the case of Rwanda (see Appendix Figure A3).

3.2 Revenue impact

We now turn to how these losses translate into lost tax revenue. This is a highly relevant question for policymakers, as revenue is needed more than ever to fund the crisis response and recovery. Losses in VAT are particularly relevant because this tax is the main source of domestic revenue in Rwanda, as in other LICs (Mascagni *et al.*, 2021). The results presented here follow the same methods as those presented in Section 3.1, but are based on deflated data on net VAT liabilities, as reported in the VAT declarations, instead of sales.[22]

Similar to the results discussed in Section 3.1, losses in terms of net VAT are concentrated around the national lockdown, with a 20.6% decline in the second quarter of 2020 and a 35.9% decline in April alone (see Appendix Figure A4, for monthly taxpayers only), compared to the same periods in 2019. The third quarter saw a smaller but still substantial decline, with the monthly data showing that net VAT rebounded relatively quickly after the lockdown was lifted (also see Appendix Figure A5, based on data for all firms).

Table 1 reports total net VAT for all firms, for each quarter, as well as the year-on-year growth rate in aggregate net VAT by quarter.[23] Similar to sales (see Section 3.1), growth in net VAT has been high and sustained in recent years, reflecting the strong performance of the Rwanda Revenue Authority—as well as the Rwandan economy more broadly. However, the crisis resulted in an aggregate decline of 8.8% in 2020, with the largest net VAT losses in

22 Net VAT liability refers to the tax that firms are liable to pay, after having adjusted for tax paid on inputs, other credits and tax refunds. For more details on the functioning of Rwanda's VAT system, see Mascagni *et al.* (2021).

23 The corresponding monthly figures, calculated only based on monthly declarations, are reported in Appendix Table A6.

Q2. Total VAT due in 2020 was RWF 24.9 billion lower than in 2019 (at constant prices)—roughly equivalent to US$24.4 million at current exchange rates. Inflation was about 8% in Rwanda in 2020,[24] so the year-on-year loss in nominal revenue is more modest—just RWF 5.4 billion. This represents the revenue actually available to the government, and corresponds to a year-on-year loss of 1.8% in nominal terms (to be compared to the real figure reported in Table 1).

The relief measures mentioned in Section 2.1, especially the acceleration of VAT refunds and waivers on penalties, may affect the impact of the crisis on VAT revenue. To account for this possibility, Appendix Table A7 repeats the analysis in Table 1 using VAT payable *before* adjustments for refunds and credit carried forward. It shows a more modest decline of 6.6% in 2020, compared to 8.8% in Table 1, which is consistent with expedited refunds.

Studies on the impact of the crisis on tax revenue are scarcer than those looking at its broader economic impact. The ones that are available report forecasts or simulations, rather than actual impacts as we do here. For example, Lees *et al.* (2020) forecast a loss in Corporate Income Tax revenue of approximately 25% relative to the pre-covid baseline after a three-month lockdown in Rwanda; while Arndt *et al.* (2020) estimate a 32% drop across all tax types in South Africa, with import taxes being the most-affected type.

4. Disaggregated impact of the crisis

4.1 Distributional impact

Having calculated the aggregate impact of the crisis on sales and tax revenue, we now disaggregate our data further. We start by investigating distributional patterns in our data. The main question we want to answer is whether small firms are more affected than larger ones. To do so, we divide the population of firms into ten deciles, based on total reported sales in 2019.[25] As in other LICs, sales in Rwanda are highly concentrated among the largest firms—those in the 10th decile.[26] As shown in Appendix Figure A6, these large firms accounted for about 88% of total sales and 85% of VAT revenue in 2019. Therefore, naturally, the largest firms also account for almost the entirety of the aggregate losses we discussed in Section 3.1, simply because these firms are larger in absolute terms.[27]

However, in proportional terms the picture is quite different. Table 2 reports growth rates calculated at the firm level based on sales for 2019 and 2020, then averaged across

24 Data from the National Bank of Rwanda shows an average increase in the consumer price index of 7.7% in 2020, compared to 2.4% in 2019 National Bank of Rwanda (2021).

25 Deciles are calculated excluding taxpayers reporting zero sales in 2019.

26 For an example from another context, see Mascagni & Mengistu (2018) on Ethiopia.

27 In aggregate terms, only the top three deciles saw losses in 2020 (both in the unbalanced and balanced panels), therefore the entirety of *aggregate* losses is due to the largest firms. However, as we will show in this section, in proportional terms smaller firms lose more than larger ones. The firm-level versus aggregate growth rates are not fully comparable. One difference (in addition to the discussion in Section 2.2) is that the former is capped at 100% to obtain more meaningful numbers. Uncapped firm-level growth rates would show some very large numbers in the bottom deciles, due to a minority of firms seeing exceptionally large growth—but starting from a very low baseline. Taking the mean across firms is more meaningful when growth rates are capped at 100%, since negative growth rates can be, at most, -100%.

Table 2: Firm-Level Growth Rates by Decile

Decile	Mean growth rates (%)					(6) 100% decline (% of firms)
	(1) Q1	(2) Q2	(3) Q3	(4) Q4	(5) Full year	
1	-54.4	-50.5	-24.5	-14.8	-23.2	39.4
2	-25.8	-45.9	-19.3	-14.4	-19.6	22.4
3	-17.7	-43.6	-22.0	-16.6	-18.8	16.8
4	-8.24	-37.3	-12.9	-11.5	-12.4	11.7
5	-7.22	-37.6	-13.1	-11.3	-14.7	8.1
6	-5.44	-36.0	-10.5	-8.82	-11.9	5.7
7	3.21	-32.3	-10.4	-4.85	-10.0	4.7
8	0.31	-32.5	-6.89	-6.12	-11.4	3.3
9	-1.90	-28.1	-7.69	-6.40	-14.4	4.7
10	-4.81	-23.8	-7.28	-5.60	-14.3	3.9
Average	**-9.13**	**-35.1**	**-12.1**	**-9.17**	**-14.9**	**12.2**

Notes: Growth rates are calculated for the quarterly balanced panel only. That is, a firm must file at least once every quarter, from January 2019 to December 2020. Deciles are calculated according to total annual sales in 2019, excluding nil-filers. Quarterly growth rates are calculated at the firm-level based on quarterly sales in 2019 and 2020. Sales are totalled across the year to calculate the growth rate in column five. Growth rates are capped at 100%.

firms for each quarter (see Section 2.2). Growth rates are capped at 100% to obtain meaningful mean figures across firms and are not directly comparable with the aggregate figures reported in Section 3.1.[28] These calculations include all firms, so sales from monthly declarations are aggregated to the quarterly level before calculating the relevant statistics. Table 2 includes both quarter-on-quarter growth rates (columns one to four) and the growth rates of cumulative sales for the full year (column five)—all disaggregated by decile. These figures show a clear pattern: while, on average, all firms experienced dramatic losses, they have been much larger in the bottom deciles and consistently decrease as firm size increases. While the average smallest firm's sales declined by 23.2% in 2020 (first decile), the average largest firm saw a decline of 'only' 14.3% (top decile). This result is consistent with the finding that sales declined more in quarterly declarations (i.e. smaller firms) than monthly ones (i.e. larger ones), based on the aggregate data analysis of Section 3.1.

Although the mean of firm-level growth rates is negative for all deciles, this mean figure hides a large degree of heterogeneity. Some firms had positive growth rates: although the mean of growth rates across firms is still negative in the third quarter, about 4,800 firms experienced positive growth, up from about 3,000 in the second quarter. Some firms experienced a 100% loss in sales, suggesting a complete stop in their operations. Column six of Table 2 shows that the percentage of firms experiencing a 100% decline in sales (that is, the firm made zero

28 Growth rates are calculated at the firm-level by taking the difference in sales in a quarter of 2019 compared to the same quarter in 2020, as a percentage of sales in the relevant quarter of 2019. Nil-filers in 2019 are excluded and growth rates are capped at 100%. The numbers reported in Table 2 are the mean of these firm-level growth rates, by quarter and by decile. See the previous footnote on the (non-)comparability between firm-level and aggregate growth rates.

sales in 2020 conditional on having some sales in 2019) is correlated with firm size too: it is much larger in the first decile (39.4%) compared to the top decile (3.9%) or even the average of all firms (12.2%). It might well be that larger firms, such as major supermarket chains, were more able to adopt the necessary measures to remain open during the crisis. More detailed summary statistics on firm-level growth rates are available in Appendix Table A8, confirming that the incidence of negative growth is particularly high in the second quarter of 2020—consistently with the aggregate analysis of Section 3.1.

It is worth mentioning two additional robustness checks. Firstly, the distributional differences we document here are not due to a different sectoral composition among deciles. A very similar association between growth rates and firm size is observed within specific sectors, as shown in Appendix Figures A9, A10 and A11 for three of the largest sectors: manufacturing, wholesale and retail trade and knowledge-based services. Secondly, they are not due to the balanced or unbalanced nature of our data.[29]

These results on the distributional impact of the crisis are consistent with those shown by Bachas *et al.* (2021) for Honduras, where the smallest firms also suffered the most from the crisis. They are also in line with simulations showing that in, Sub-Saharan Africa, the crisis is expected to affect mostly the poor (Djiofack *et al.*, 2020). Our analysis shows that, while in absolute terms most of the losses come from the largest firms, in proportional terms the smallest firms bear the greatest burden. This is at odds with similar (but not directly comparable) results from the US showing that higher-income people reduced their spending more than lower-income ones, both in absolute and proportional terms (Chetty *et al.*, 2020).

4.2 Impact by sector

The sectoral information available in the VAT declarations dataset is not fully complete and precise. For example, it does not allow us to split the retail sector into 'essential' and 'non-essential' retail. In addition, since the sectors are broadly defined, such as 'wholesale and retail trade', this information cannot be used to formulate concrete policy recommendations. However, it can still provide an initial indication of the worse-affected sectors in terms of aggregate sales.

The numbers presented in Table 3 are comparable to those reported in Section 3.1 in that they show total sales and growth rates in the aggregate values across quarters. Over the full year, the sectors that suffered the most are, unsurprisingly, accommodation and food service, transportation and storage and wholesale and retail trade. Other sectors, like mining and quarrying, suffered heavily during the lockdown quarter (column five) but recovered quickly after that—registering positive growth over the full year.[30] Similarly, three other sectors stand out with positive aggregate growth rates over the whole year: agriculture, utilities and energy

29 As reported in the table notes for Table 2, the analysis in this section is already based on the quarterly balanced panel, where we require firms to have at least one declaration in each quarter in order to be included.

30 During the lockdown quarter, in column 5, mining and quarrying was among the sectors most affected. This might have been related to large capital outflows from low- and middle-income countries (Goldberg & Reed, 2020), disruptions in imports (Rauschendorfer & Spray, 2020), and limitations to movement and in-person working in non-essential sectors. However, the sector bounced back in Q3 and Q4, registering overall growth over the full year.

Table 3: Impact on Aggregate Sales by Sector

Sector	(1) Sales '19 (RWF bn)	(2) Sales '20 (RWF bn)	(3) Full year (%)	(4) Q1 (%)	(5) Q2 (%)	(6) Q3 (%)	(7) Q4 (%)	(8) N
Agriculture	52.8	55.7	5.5	31.5	-7.2	2.1	2.3	340
Mining and quarrying	43.0	44.6	3.7	-15.4	-42.1	30.1	45.7	182
Manufacturing	716.3	745.1	4.0	7.4	-14.4	12.5	10.3	2,564
Utilities and energy	93.0	98.0	5.4	-2.6	-12.8	34.2	4.0	246
Construction	448.2	405.0	-9.6	-21.2	-18.0	1.6	-0.1	2,085
Wholesale and retail trade	2,919.9	2,621.3	-10.2	-10.0	-35.7	2.6	6.2	10,192
Transportation and storage	352.6	238.3	-32.4	-13.7	-59.2	-45.2	-15.1	786
Accommodation and food service	176.9	107.2	-39.4	-10.9	-57.2	-48.0	-40.2	1,448
Knowledge-based services	991.5	966.3	-2.5	-0.8	-14.5	-2.5	7.4	2,849
Other services	309.4	252.6	-18.4	-9.3	-26.3	-33.9	-5.5	2,181
Miscellaneous	1,254.3	986.7	-21.3	-8.5	-53.3	-4.1	4.7	3,081
Total	**7,357.9**	**6,520.6**	**-11.4**	**-7.6**	**-34.9**	**-3.5**	**3.4**	**25,954**

Notes: Columns 1 and 2 report total sales from January to December for all taxpayers, for 2019 and 2020 respectively. All sales data are given in billions of Rwandan Francs at constant 2017 prices. Columns 3 to 7 show growth rates calculated at the aggregate level, between total sales in the relevant period and the same period in the previous year, by sector (Q = quarter). Column 8 gives the number of firms in each sector in 2019. The miscellaneous category captures firms for which sectoral information is missing in the VAT data.

and manufacturing. This is not surprising, as they can be expected to be less affected by restrictions on mobility, which remained in place beyond the national lockdown, as they are usually considered more essential than others. These results point to substantial heterogeneity in the impact of the crisis across sectors, although all of them suffered severe losses in the lockdown quarter in particular. As mentioned in Section 2.2, VAT sales and GDP are not directly comparable. However, the sector-disaggregated results presented here might shed some light on the larger percentage loss that VAT sales experienced, compared to GDP (see Section 3.1). Sectors that fared relatively well, like agriculture, are under-represented in the VAT dataset; while sectors that were more heavily affected by the crisis, like wholesale and retail trade, are over-represented in the VAT data compared to their contributions to GDP (see Section 2.2).

While the figures above are based on an aggregate analysis, the firm-level growth rates, disaggregated by sector, paint a similar picture. Appendix Table A12 reports these results, which are comparable to those of Section 4.1 as they are computed using the same methods. The most-affected sector by far was accommodation and food service, followed by mining and quarrying. The accommodation and food sector saw over 80% of firms with a negative growth rate in sales in 2020 compared to 2019, and an average firm-level growth rate of -38%. Again, these figures point to substantial heterogeneity within sectors. For example, although wholesale and retail trade is one of the worst-affected sectors on aggregate, nearly

40% of firms continued to grow in 2020, despite the crisis and related containment measures. In addition, the sectoral composition of the economy does not change in any appreciable way during the crisis (see Appendix Figure A7).

4.3 Geographical differences

Similarly to Section 4.2, we now consider the disaggregated impact of the crisis by geographical area. Being a small country, Rwanda has only five provinces, one of which captures the area of the capital, Kigali. Before examining the results, it is worth noting that the geographical location reported in the VAT data refers to the tax centre where the firm is registered, which does not necessarily correspond to the location of the actual business activity. For example, a large company (e.g. a hotel chain) with headquarters in Kigali and several branches throughout the country will appear as being based in Kigali. Therefore, while the results presented here provide a useful indication of geographical differences, they are not accurate enough to offer specific policy advice.

Table 4 shows the level of aggregate sales and their growth rates by province, along the same lines as Tables 3 and 1. Two interesting patterns emerge. Firstly, economic activity is highly concentrated in the capital city, which accounts for approximately 90% of all sales in 2019 and 2020.[31] Secondly, the crisis affected firms in the capital to a much larger extent than anywhere else in the country. Aggregate sales decreased almost everywhere during the lockdown (see column 5), but the decline in Kigali was a lot more marked than anywhere else. Over the full period (column 3), firms outside of the capital managed to recoup their losses and experienced some positive aggregate sales growth. However, firms based in Kigali still saw a decline in aggregate sales of almost 13% over the full period, compared to 2019. This is not related to differences in restrictions, as the lockdown measures were applied equivalently nation-wide.[32] Again, restricting the analysis to the quarterly balanced panel has little impact on the overall picture (see Appendix Table A15). Relatedly, Appendix Table A14 indicates large drops in firm-level growth rates across the whole of Rwanda, although the average firm-level loss remained larger in Kigali. During the lockdown quarter (Q2) again firms in Kigali suffered particularly heavily, but firm-level growth rates have been similarly negative in other provinces during that quarter.

The fact that Kigali was more affected by the crisis might provide some insight on the differential impact of the crisis between relatively higher-income and lower-income households. While we have no information at the household level, trends in aggregate sales might approximate trends in aggregate consumption—although there are important differences in these two measures.[33] If that is the case, and keeping in mind the data caveats mentioned at the beginning of this section, the larger drop in aggregate sales we observe in Kigali might be indicative of larger drops in consumption in the capital compared to other

31 This is a common observation in LICs, also documented in Mascagni & Mengistu (2018) for Ethiopia. It is due in part to the fact that larger firms, in particular, have headquarters in the capital.

32 While restrictions were the same nation-wide, there might have been differences in the stringency of enforcement between Kigali and areas outside of the capital. The lockdown of February 2021 was applied only in Kigali, but it falls out of our data period.

33 Importantly, VAT sales includes business-to-business transactions that speak to production processes more than final consumption.

Table 4: Impact on Aggregate Sales by Province

Province	(1) Sales '19 (RWF bn)	(2) Sales '20 (RWF bn)	(3) Full year (%)	(4) Q1 (%)	(5) Q2 (%)	(6) Q3 (%)	(7) Q4 (%)	(8) N
Kigali	6,653.5	5,796.0	-12.9	-8.6	-36.7	-4.9	2.1	18,248
East	127.8	144.4	13.0	13.5	-14.9	21.8	32.9	1,715
South	185.6	191.4	3.1	-6.4	-8.1	8.3	16.5	1,881
West	224.7	231.4	3.0	4.5	-18.6	8.5	16.1	1,993
North	141.0	143.4	1.7	8.8	-15.8	7.4	5.7	1,219
No province	25.3	14.0	-44.6	-39.9	-45.3	-41.8	-53.4	898
Total	**7,357.9**	**6,520.6**	**-11.4**	**-7.6**	**-34.9**	**-3.5**	**3.4**	**25,954**

Notes: Columns 1 and 2 report total sales from January to December for all taxpayers, for 2019 and 2020 respectively. All sales data are given in billions of Rwandan Francs at constant 2017 prices. Columns 3 to 7 show growth rates calculated at the aggregate level, between total sales in the relevant period and the same period in the previous year, by province (Q = quarter). Column 8 gives the number of firms in each province in 2019.

areas of the country. This would be consistent with similar findings from Uganda (Mahmud & Riley, 2020) and the US (Chetty *et al.*, 2020), showing a larger impact of the crisis on consumption among higher-income households—possibly because they are more able and better prepared to comply with lockdowns, as well as having a larger margin to cut non-essential consumption.

However, it is important to note that, while formal consumption might have declined less in poorer areas in proportional terms, that does not necessarily mean these areas have been less severely affected in broader terms. In fact, there is evidence suggesting otherwise—that the poorest are expected to be hit the hardest by lockdowns (Barnett-Howell, Watson & Mobarak, 2021; Djiofack *et al.*, 2020; Teachout & Zipfel, 2020; Younger *et al.*, 2020). More research is needed to shed light on the full extent of the crisis' impact at the household-level.

5. Conclusions

Our analysis provides new insight on the impact of the pandemic in a LIC, Rwanda. As discussed in Section 1, there were substantial differences in the spread of the pandemic and the policy response to it between HICs and LICs in 2020. It is therefore important to produce evidence that is context-specific, as results and recommendations available for HICs might not be applicable to lower-income contexts.

In particular, our results speak to the trade-off between containing the spread of the virus with early and strict restrictions (the approach adopted in many LICs) and the economic cost associated with such an approach. Our analysis allows us to quantify this economic cost. We show that the impact of the crisis in Rwanda amounts to an 11.4% decline in VAT sales (Section 3.1). This loss is mostly associated with the lockdown, while economic activity remained otherwise close to pre-crisis levels once restrictions were lifted. Looking at case numbers (Section 2.1), it looks like lockdowns have indeed been successful in preventing an uncontrolled spread of the virus and the overwhelming of a relatively weak health system. Whether the economic cost is worth the outcome is a question that we cannot directly answer,

and one that is beyond the scope of this paper—whose main aim is to quantify the economic impact.

By using highly disaggregated data, we can also explore distributional patterns in the impact of the crisis. While almost all of the losses in absolute terms come from the largest firms, the smallest firms are the ones that suffered the most in proportional terms (see Section 4.1). Moreover, we disaggregate our results by sector and geographical location. Section 4.2 shows that accommodation and food services, transport and storage and wholesale and retail trade have been particularly affected by the crisis, as one might expect. However, there is substantial heterogeneity both across sectors and within sectors, as some firms were able to weather the crisis better than others. Section 4.3 shows that firms in Kigali have been hit particularly hard on aggregate, possibly indicating larger declines in consumption in the capital compared to other areas. Nonetheless, impacts at the firm-level have been severe throughout the country.

These results can offer useful indications to policymakers, despite the caveats highlighted in Sections 4.2 and 4.3. Perhaps most importantly, they suggest that policymakers should ensure smaller firms can access appropriate relief. While the aggregate losses are mostly generated by large firms in the capital, small firms are more vulnerable to large losses in proportional terms. They might also be the ones that are more likely to employ lower-income people, to have a large share of informal workers and pay lower wages—which are all relevant considerations in responding to the crisis. Since the impact of the crisis appears to be particularly associated with the lockdown, it is especially important to provide such relief in tandem with the adoption of more restrictive containment measures.

Finally, while our analysis contributes to addressing the gap in evidence from LICs, compared to HICs, more research is still needed. Although Rwanda's approach to the pandemic has been in line with many LICs, others have taken different policy decisions, adopting weaker or more short-lived restrictions. Generating comparable evidence on these contexts would be particularly valuable to inform policymakers about appropriate policy responses. Moreover, our analysis cannot speak to the impact on households or on the informal sector, because of the nature of our data. However, these are highly relevant dimensions that warrant additional research.

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Supplementary material

Supplementary material is available at *Journal of African Economies* online.

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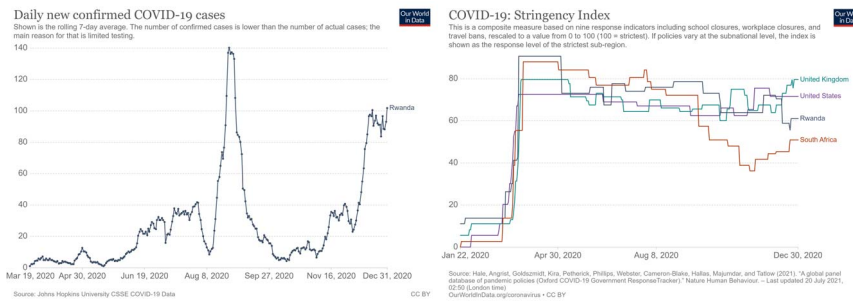
Appendix



(a) COVID-19 spread (b) Stringency of government response

Figure A1: Spread of COVID-19 and Response in Rwanda. Note: Panel (a) shows the daily number of new confirmed cases since March 2020. Panel (b) indicates how the governmental response has changed over time according to the Government Stringency Index, a composite measure of the strictness of policy responses. This includes school and workplace closures, restrictions on public gatherings, transport restrictions, and stay-at-home requirements. A higher score indicates a stricter response (i.e. 100 = strictest response). Source: Ritchie *et al.* (2021).

Table A1: Descriptive statistics for VAT-registered firms

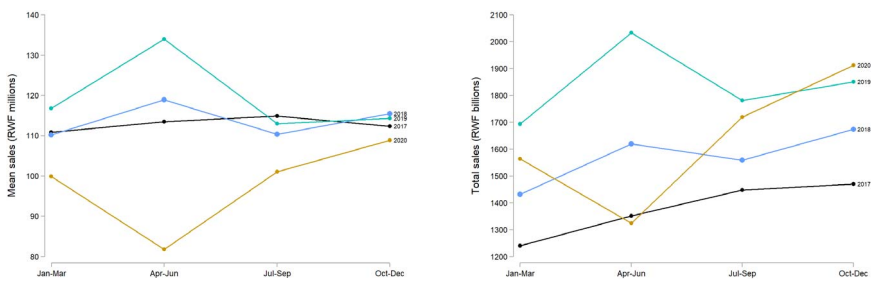
	2017	2018	2019	2020
Total number of firms	**20,585**	**23,356**	**25,954**	**27,789**
Monthly taxpayers	34.2%	32.0%	27.3%	27.2%
Nil-filers[2]	36.1%	37.5%	37.5%	36.6%
Firms in Kigali	68.7%	69.3%	70.3%	71.2%
Average annual sales[3] (RWF mil)				
Monthly taxpayers	1,043	1,128	1,239	1,088
Quarterly taxpayers	61.8	63.4	81.6	47.9
% of total VAT revenue from monthly taxpayers	91.1%	91.2%	91.3%	92.1%

Notes: [1]A firm is defined as a nil-filer if their total annual sales are recorded as zero. [2]Sales data are deflated using 2017 as the base year. Average sales are calculated excluding nil-filers, which represent about a third of all declarations (this is consistent with Almunia *et al.* (2021), Mascagni *et al.* (2020), Santoro & Mdluli (2019)).

Table A2: Sectoral GDP growth, 2019-2020

Sector	GDP 2019 (RWF bn)	GDP 2020 (RWF bn)	Growth (%)	Share of GDP (%, 2019)	Share of VAT sales (%, 2019)
Agriculture	2,259	2,278	0.8	24.7	1.3
Mining and quarrying	170	117	-31.2	1.9	0.7
Manufacturing	746	762	2.1	8.2	9.9
Utilities and energy	131	134	2.3	1.4	1.0
Construction	638	602	-5.6	7.0	8.0
Wholesale and retail trade	862	834	-3.2	9.4	39.3
Transport services	477	364	-23.7	5.2	3.0
Accommodation and food service	165	98	-40.6	1.8	5.6
Knowledge-based services[1]	592	633	6.9	6.5	11.0
Other services[2]	1,782	1,693	-5.0	19.5	8.4
Total GDP	**9,145**	**8,838**	**-3.4**		

Notes: All GDP figures are reported in 2017 constant prices. [1]Includes information and communication services, finance and insurance services, and professional, scientific and technical services (NACE Rev 2 codes J, K, and M). [2]Includes real estate, administrative and support services, education, human health and social work services, and arts, entertainment and recreation (NACE Rev 2 codes L, N, P, Q, R, and S). GDP and VAT sales figures are not directly comparable as they refer respectively to value added and output. Source for GDP data: Rwanda Statistical Yearbook (2020)



(a) Mean sales by quarter (b) Total sales by quarter

Figure A2: Aggregate Impact on Sales for All Taxpayers. Note: These graphs show quarterly trends in mean and total sales for all firms filing VAT in 2017, 2018, 2019 and 2020 (monthly and quarterly taxpayers). Firms that report no sales across the relevant year (nil-filers) are excluded from the mean calculations. Here, sales is taken as the total value of supplies, including VAT-exempted and zero-rated sales.

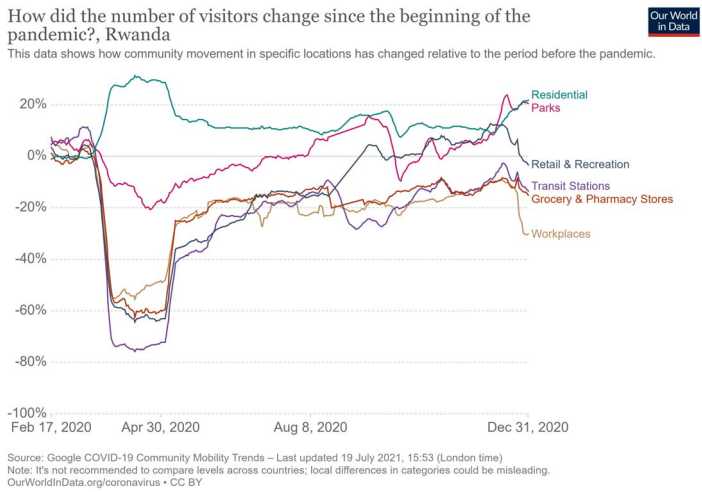


Figure A3: Mobility in Rwanda During Lockdown. Notes: This figure is based on mobility data from Google. The underlying data comes from Google's 'Community Mobility Reports', which are created with aggregated sets of data from users who have turned on location history settings on Google products. This is likely an unrepresentative sample of the wider population of Rwanda. Internet penetration is under 50 per cent in Rwanda, with smartphone usage even less common. So this mobility data might provide only a snapshot of the movements of a wealthier segment of society. The change in total visitors (or duration of time spent at home for the 'Residential' category) is measured relative to a baseline period between 3 January and 6 February 2020. Source: Ritchie *et al.* (2021)

Table A3: Impact of COVID-19 on aggregate sales by month

	2017 (RWF bn)	2018 (RWF bn)	Growth (%)	2019 (RWF bn)	Growth (%)	2020 (RWF bn)	Growth (%)
January	373.2	421.2	12.9	555.8	31.9	471.1	-15.2
February	370.5	471.8	27.3	484.5	2.7	500.6	3.3
March	390.6	447.4	14.5	532.6	19.0	468.1	-12.1
April	341.3	431.7	26.5	505.0	17.0	316.5	-37.3
May	458.2	488.1	6.5	578.2	18.5	442.2	-23.5
June	428.1	460.7	7.6	513.2	11.4	478.1	-6.8
July	478.0	475.3	-0.6	540.7	13.8	506.9	-6.3
August	434.9	507.1	16.6	537.7	6.0	533.8	-0.7
September	400.6	449.0	12.1	539.2	20.1	524.9	-2.6
October	409.8	497.5	21.4	543.3	9.2	545.2	0.3
November	428.2	496.3	15.9	540.5	8.9	526.9	-2.5
December	479.9	533.1	11.1	585.7	9.9	623.9	6.5
Full year	**4,993.3**	**5,679.1**	**13.7**	**6,456.3**	**13.7**	**5,938.1**	**-8.0**

Notes: Total sales, in billions of Rwandan Francs (RWF) reported by monthly taxpayers only, at constant 2017 prices. Growth rates are calculated year-on-year for each month.

Table A4: Impact of COVID-19 on value added (output minus input)

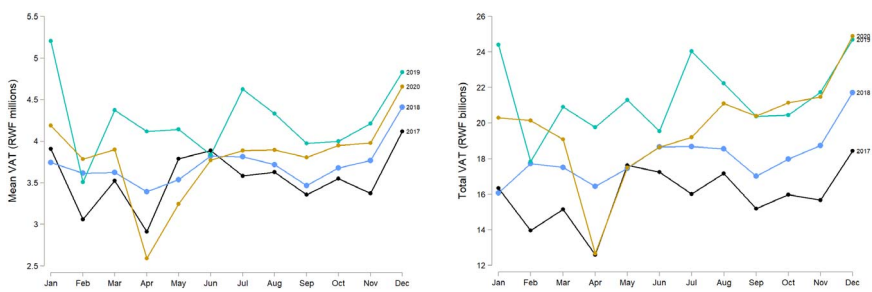
	(1) 2017 (RWF bn)	(2) 2018 (RWF bn)	(3) Growth (%)	(4) 2019 (RWF bn)	(5) Growth (%)	(6) 2020 (RWF bn)	(7) Growth (%)
Jan–Mar	298.2	314.5	5.4	361.2	14.9	353.5	-2.1
Apr–Jun	331.6	345.4	4.2	396.8	14.9	299.7	-24.5
Jul–Sep	313.7	337.1	7.4	379.0	12.4	378.1	-0.3
Oct–Dec	313.6	359.3	14.6	397.3	10.6	407.0	2.5
Total	**1,257.2**	**1,356.3**	**7.9**	**1,534.4**	**13.1**	**1,438.3**	**-6.3**

Notes: Value added can be thought of as the difference between the total value of outputs and the total value of inputs. We calculate this by subtracting VAT-charged inputs from total taxable sales (that is, excluding sales of exports, zero-rated, or exempted items). In our data, we only observe total VAT paid on inputs, so we impute the value of inputs using the standard VAT rate of 18 per cent. All figures are reported in billions of Rwandan Francs (RWF) at constant 2017 prices. These figures are calculated for all taxpayers, both quarterly and monthly, aggregated at the quarterly level. Columns 3, 5 and 7 report year-on-year growth rates, calculated based on the difference between the relevant quarter in year t and (t-1).

Table A5: Impact of COVID-19 on aggregate sales: Balanced panels

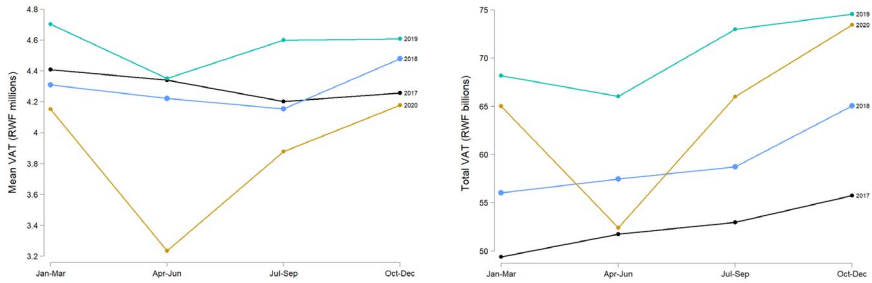
	Yearly balanced			Quarterly balanced		
	(1) Sales '19 (RWF bn)	(2) Sales '20 (RWF bn)	(3) Growth (%)	(4) Sales '19 (RWF bn)	(5) Sales '20 (RWF bn)	(6) Growth (%)
Jan–Mar (Q1)	1,684.6	1,555.6	-7.7	1,681.6	1,497.7	-10.9
Apr–Jun (Q2)	2,018.7	1,307.5	-35.2	2,009.3	1,263.2	-37.1
Jul–Sep (Q3)	1,777.0	1,677.7	-5.6	1,751.6	1,612.6	-7.9
Oct–Dec (Q4)	1,847.3	1,826.2	-1.1	1,799.0	1,762.5	-2.0
Full year	**7,327.5**	**6,367.2**	**-13.1**	**7,241.0**	**6,136.1**	**-15.3**

Notes: Total sales are reported in billions of Rwandan Francs (RWF) in constant 2017 prices. These figures include sales reported by all taxpayers, both those who file quarterly and those who file monthly. Columns 3 and 6 report year-on-year growth rates, comparing the relevant quarter to its counterpart in the previous year.



(a) Mean VAT revenue by month (b) Total VAT revenue by month

Figure A4: Aggregate Impact on Mean and Total VAT Revenue. Note: These graphs show mean and total VAT reported for monthly taxpaying firms only in 2017, 2018, 2019 and 2020. Firms which report no sales across the relevant year are excluded from the mean calculations. This reflects net VAT due on sales, after adjusting for total VAT paid on inputs and other credits.



(a) Mean VAT revenue by quarter (b) Total VAT revenue by quarter

Figure A5: Aggregate Impact on VAT Revenue for All Taxpayers. Notes: These graphs show quarterly trends in mean and total VAT reported for all taxpaying firms in 2017, 2018, 2019 and 2020. Firms that report no sales across the relevant year (nil-filers) are excluded from the mean calculations. This reflects final VAT due on sales, after adjusting for total VAT paid on inputs, other credits and VAT refunds.

Table A6: Impact of COVID-19 on aggregate VAT revenue by month

	2017 (RWF bn)	2018 (RWF bn)	Growth (%)	2019 (RWF bn)	Growth (%)	2020 (RWF bn)	Growth (%)
January	16.3	16.1	-1.7	24.4	52.0	20.3	-16.8
February	14.0	17.7	27.0	17.8	0.6	20.1	12.9
March	15.1	17.5	15.6	20.9	19.4	19.1	-8.7
April	12.6	16.4	30.6	19.8	20.2	12.7	-35.9
May	17.6	17.5	-1.0	21.3	22.0	17.5	-17.9
June	17.2	18.7	8.3	19.6	4.7	18.6	-4.7
July	16.0	18.7	16.6	24.0	28.7	19.2	-20.1
August	17.2	18.6	8.1	22.2	19.9	21.1	-5.1
September	15.2	17.0	12.0	20.4	19.7	20.4	0.2
October	16.0	18.0	12.6	20.5	13.8	21.1	3.3
November	15.7	18.7	19.6	21.7	16.0	21.5	-1.2
December	18.4	21.7	17.7	24.7	13.8	24.9	0.8
Full year	**191.3**	**216.5**	**13.2**	**257.3**	**18.8**	**236.6**	**-8.1**

Notes: Total nominal VAT revenue reported by monthly taxpayers only.

Table A7: Impact of COVID-19 on VAT payable

	2017 (RWF bn)	2018 (RWF bn)	Growth (%)	2019 (RWF bn)	Growth (%)	2020 (RWF bn)	Growth (%)
Jan–Mar (Q1)	55.1	58.2	5.5	66.6	14.5	65.1	-2.2
Apr–Jun (Q2)	61.0	64.0	4.9	73.2	14.4	56.1	-23.4
Jul–Sep (Q3)	57.7	62.0	7.4	70.7	14.0	69.2	-2.1
Oct–Dec (Q4)	58.6	67.2	14.8	74.1	10.2	75.4	1.8
Full year	232.4	251.4	8.1	284.6	13.2	265.8	-6.6

Notes: VAT payable is calculated before refunds and credits (in contrast to VAT due, which takes these into account).

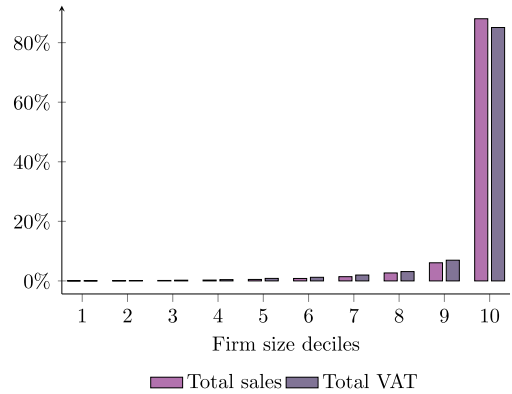


Figure A6: Proportion of Annual Sales and VAT Revenue by Decile. Note: Deciles are calculated for firms with non-zero total sales from January to December 2019.

Table A8: Detailed summary statistics of firm-level growth rates: Quarterly-balanced panel

	Mean	Std. Dev.	25%	50%	75%	95%	Max.	N
Jan–Mar (Q1)	-9.13	68.8	-69.0	-15.8	43.0	100	100	12,355
Apr–Jun (Q2)	-35.1	62.9	-90.9	-50.9	-3.64	100	100	12,457
Jul–Sep (Q3)	-12.1	70.3	-77.5	-20.0	42.4	100	100	12,184
Oct–Dec (Q4)	-9.17	69.9	-71.7	-16.2	47.8	100	100	12,070
Full year	-14.9	65.8	-70.9	-23.5	29.7	100	100	10,568

Table A9: Firm-level growth rates by decile: Manufacturing

Decile	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Full year
1	-58.6	-63.1	-22.5	-27.2	-26.1
2	-33.4	-46.7	-27.6	-13.8	-32.7
3	-26.5	-35.7	-19.3	-2.91	-21.8
4	0.83	-36.6	-21.3	-12.8	-6.74
5	-4.46	-28.8	-9.86	-13.1	-15.5
6	-10.1	-27.8	-7.52	-11.9	-15.0
7	12.4	-23.6	-4.72	4.22	-4.48
8	2.59	-30.2	-11.5	-4.82	-15.5
9	2.23	-18.9	-4.27	-13.0	-10.5
10	-2.74	-25.6	-11.7	-9.80	-23.0
Average	**-9.27**	**-31.8**	**-13.0**	**-9.61**	**-17.0**

Notes: Firm-level growth rates are calculated for the quarterly-balanced panel (that is, firms must file at least once per quarter between January 2019 and December 2020). Deciles calculated according to total sales in 2019, excluding inactive firms, for the manufacturing sector only. Growth rates are capped at 100 per cent.

Table A10: Firm-level growth rates by decile: Wholesale & retail trade

Decile	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Full year
1	-43.4	-45.3	-15.6	-6.02	-25.5
2	-16.7	-34.3	-7.76	-1.62	-13.8
3	-3.77	-32.4	-7.74	-1.76	-10.2
4	-9.98	-36.2	-7.02	-6.81	-11.3
5	-2.90	-37.0	-6.19	3.06	-9.6
6	2.87	-29.7	-1.66	2.19	-4.28
7	6.07	-27.5	-1.18	5.15	-7.65
8	0.35	-29.9	-1.88	1.87	-7.86
9	3.37	-28.0	2.76	2.96	-6.90
10	0.62	-23.3	-0.94	-2.52	-10.2
Average	**-5.31**	**-31.8**	**-4.16**	**-0.049**	**-10.8**

Notes: Deciles calculated according to total sales in 2019, excluding inactive firms, for the wholesale and retail trade sector only. Growth rates are capped at 100 per cent.

Table A11: Firm-level growth rates by decile: Knowledge-based services

Decile	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Full year
1	-22.2	-23.9	-8.97	-11.0	-1.94
2	-39.9	-37.9	-40.7	-41.3	-20.1
3	-22.1	-35.7	-32.8	-15.5	-17.4
4	-15.3	-43.0	-10.4	-20.2	-16.3
5	-11.4	-44.5	-13.5	-12.5	-13.4
6	-15.8	-43.9	-16.9	-24.2	-19.9
7	-3.30	-33.0	-8.40	-4.18	-10.7
8	14.6	-28.7	-7.06	-11.9	-14.2
9	10.5	-32.0	-12.7	-11.3	-16.3
10	-0.86	-13.6	-9.65	-5.95	-16.6
Average	**-8.55**	**-33.4**	-15.0	-14.9	-14.9

Notes: Deciles calculated according to total sales in 2019, excluding inactive firms, for the knowledge-based services sector only. Growth rates are capped at 100 per cent.

Table A12: Firm-level growth rates by sector

Sector	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Full year (%)	100% decline (% of firms)
Agriculture, forestry and fishing	-13.1	-28.3	-16.7	-3.26	-18.8	21.6
Mining and quarrying	-30.6	-50.6	-22.4	-10.7	-30.3	28.3
Manufacturing	-9.27	-31.8	-13.0	-9.61	-17.1	15.4
Utilities and energy	-24.2	-33.4	2.19	-17.8	-16.4	18.1
Construction	-21.7	-38.6	-11.9	-16.7	-14.1	20.3
Wholesale and retail trade	-5.31	-31.8	-4.16	-0.05	-10.8	10.3
Transportation and storage	-10.1	-34.6	-13.3	-12.2	-16.3	10.9
Accommodation and food services	-15.7	-64.8	-48.6	-39.4	-38.0	9.2
Knowledge-based services	-8.55	-33.4	-15.0	-14.9	-14.9	12.1
Other services	-12.0	-37.3	-18.5	-19.1	-18.8	11.9
Miscellaneous	-11.2	-31.2	-14.2	-10.8	-13.3	12.6
Average	-9.13	-35.1	-12.1	-9.17	-14.9	12.2

Notes: Growth rates in the first four columns are calculated year-on-year for each quarter at the firm level. Growth rates in column five are calculated by comparing the total sales from January to December in 2019 against the same period in 2020. These rates are capped at 100 per cent. 'Knowledge-based services' include information and communication services, finance and insurance services, and professional, scientific and technical services (NACE Rev 2 codes J, K, and M). 'Other services' include real estate, administrative and support services, education, human health and social work, and arts, entertainment and recreation (NACE Rev 2 codes L, N, P, Q, R, and S). 'Utilities and energy' combines the electricity, gas, steam, and air conditioning sector with the water supply, sewage and waste management sector (NACE Rev 2 codes D and E). The 'miscellaneous' category covers firms for which no sector is observed in the VAT returns data.

Table A13: Impact on aggregate sales by sector: Quarterly balanced panel

Sector	(1) Sales '19 (RWF bn)	(2) Sales '20 (RWF bn)	(3) Full year (%)	(4) Q1 (%)	(5) Q2 (%)	(6) Q3 (%)	(7) Q4 (%)	(8) N
Agriculture	50.9	51.2	0.6	32.2	-5.2	-2.1	-11.5	237
Mining and quarrying	42.7	42.9	0.6	-18.0	-45.3	26.0	44.1	142
Manufacturing	699.8	709.3	1.4	4.8	-15.7	9.9	6.5	2,032
Utilities and energy	90.0	85.1	-5.4	-10.0	-20.9	12.6	-2.5	190
Construction	436.0	353.9	-18.8	-31.2	-27.3	-8.1	-7.0	1,511
Wholesale and retail trade	2,889.9	2,470.7	-14.5	-12.7	-38.0	-2.5	-0.8	8,289
Transportation and storage	345.0	215.4	-37.6	-19.0	-63.5	-49.7	-21.4	616
Accommodation and food service	175.3	100.2	-42.9	-14.9	-59.6	-51.1	-44.4	1,197
Knowledge-based services	976.4	939.8	-3.7	-2.2	-13.3	-3.0	3.1	2,116
Other services	303.5	236.6	-22.0	-13.0	-29.7	-38.7	-8.2	1,658
Miscellaneous	1,231.6	931.0	-24.4	-11.4	-55.0	-8.9	1.9	1,857
Total	**7,241.0**	**6,136.1**	**-15.3**	**-10.9**	**-37.1**	**-7.9**	**2.0**	**19,845**

Notes: Columns 1 and 2 report total sales from January to December for all taxpayers, for 2019 and 2020 respectively. All sales data are given in billions of Rwandan Francs at constant 2017 prices. Columns 3 to 7 show growth rates calculated at the aggregate level, between total sales in the relevant period and the same period in the previous year, by sector (Q = quarter). Column 8 gives the number of firms in each sector in 2019. The miscellaneous category captures firms for which sectoral information is missing in the VAT data.

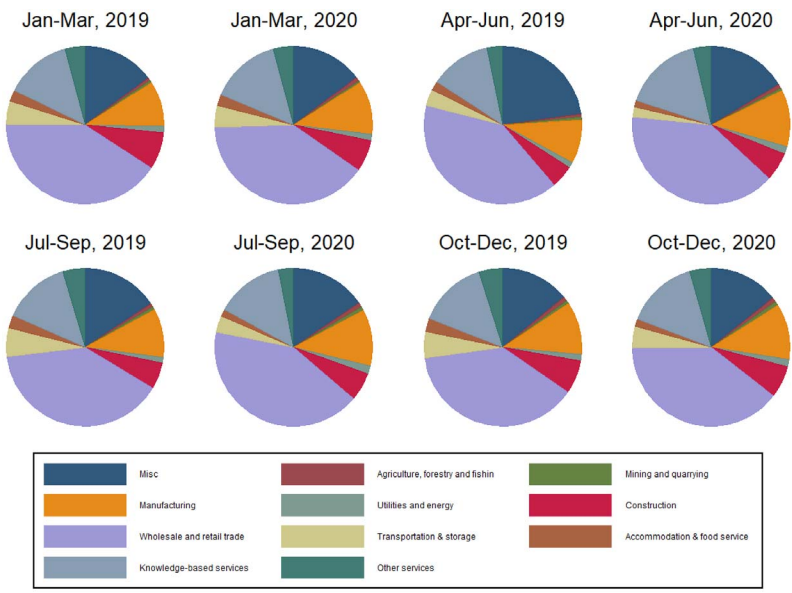


Figure A7: Sectoral Composition by Quarter. Notes: This figure shows the share of total sales coming from each sector, by quarter.

Table A14: Firm-level growth rates by province

Province	Q1 (%)	Q2 (%)	Q3 (%)	Q4 (%)	Full year (%)	100% decline (% of firms)
City of Kigali	-9.85	-36.7	-15.1	-12.3	-17.7	12.6
Eastern province	-1.77	-20.0	6.49	6.98	0.22	10.6
Southern province	-14.5	-31.1	-7.93	-3.91	-11.6	12.5
Western province	-5.48	-36.2	-6.40	-0.41	-9.42	10.8
Northern province	-3.66	-35.6	-8.08	-3.96	-10.0	8.94
No province	-36.0	-54.5	-42.4	-59.5	-54.4	26.9
Average	**-9.13**	**-35.1**	**-12.1**	**-9.17**	**-15.1**	**12.2**

Notes: Growth rates in the first four columns are calculated year-on-year for each quarter at the firm level. Growth rates in column five are calculated by comparing the total sales from January to December in 2019 against the same period in 2020. These growth rates are capped at 100 per cent.

Table A15: Impact on aggregate sales by province: Quarterly balanced panel

Province	(1) Sales '19 (RWF bn)	(2) Sales '20 (RWF bn)	(3) Full year (%)	(4) Growth Q1 (%)	(5) Growth Q2 (%)	(6) Growth Q3 (%)	(7) Growth Q4(%)	(8) N
Kigali	6,561.8	5,482.2	-16.5	-11.6	-38.7	-9.0	-3.0	14,328
East	124.8	131.4	5.3	4.4	-18.4	13.1	23.6	1,281
South	183.6	179.8	-2.1	-10.0	-11.3	2.1	9.2	1,513
West	218.0	199.1	-8.7	-6.9	-27.2	-6.1	5.0	1,598
North	139.1	132.6	-4.7	3.9	-20.9	1.4	-3.0	961
No province	13.6	11.0	-19.4	-33.9	-19.8	-6.7	-19.1	164
Total	**7,241.0**	**6,136.1**	**-15.3**	**-10.9**	**-37.1**	**-7.9**	**-2.0**	**19,845**

Notes: Columns 1 and 2 report total sales from January to December for all taxpayers, for 2019 and 2020 respectively. All sales data are given in billions of Rwandan Francs at constant 2017 prices. Columns 3 to 7 show growth rates calculated at the aggregate level, between total sales in the relevant period and the same period in the previous year, by province (Q = quarter). Column 8 gives the number of firms in each province in 2019.