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Crises favor the prepared region

Digital transformation in regions during COVID-19 pandemic

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Crises favor the prepared region. Digital transformation in regions during COVID-19 pandemic.

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July 2022

Abstract
The COVID-19 pandemic has accelerated the digital transformation, but with substantial regional differences in the speed of this transformation. In this paper we show that the COVID-19 pandemic favors the prepared region: regions with a high quality entrepreneurial ecosystem seem to be more adaptive in the sense of revealing a more rapid digital transformation during the COVID-19 pandemic. In this paper we analyzed this spatially uneven digital transformation with data on (1) startups (new retail web shops) and (2) established firms (new entrants on the largest e-commerce platform in the Netherlands) in the 40 city regions of the Netherlands.

Keywords: Digital transformation, COVID-19 pandemic, entrepreneurial ecosystems, regional development, online startups, e-commerce platforms

JEL classification: L16, L26, M13, P00, R1, R11, R12

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1. Introduction

Innovation and entrepreneurship are highly spatially uneven phenomena (Audretsch & Feldman 1996; Sternberg, 2009). This is also true for digital innovation and entrepreneurship (Castells 1996; Graham, 1998), key components of the digital transformation of the economy and society. Both the creation and diffusion of innovations take place with different intensities and speeds in regions (Rogers, 1962; Oinas & Malecki, 2002). It is well known that spatial differences in the prevalence of entrepreneurship can to a large extent be explained by the quality of regional entrepreneurial ecosystems (Audretsch & Belitski 2017; Stam & Van de Ven 2021; Leendertse et al 2022).

Crises can substantially affect transformations. First, crises are expected to accelerate transformations, which seems to be particularly true for the COVID-19 pandemic and its effect on digitalization (Schwab & Zahibi, 2020; Bradley et al. 2020; Amankwah-Amoah et al. 2021). This follows an historical pattern where crises seems to accelerate shifts to new technologies (Schumpeter, 1939; Archibugi, 2017; Hershbein & Kahn, 2018). Second, crises are likely to increase inequal economic development over space, due to heterogeneity in regional resilience (Groot et al., 2011). More in particular, regions differ in their resistance to shocks and in their adaptiveness (Simmie & Martin 2010; Martin et al., 2016). In this paper we provide new insights into spatially uneven effects of the COVID-19 pandemic on digital transformation with a new combination of the regional resilience and entrepreneurial ecosystem literatures.

Figure 1
E-commerce traffic growth compared to COVID-19 control measures (Stringency Index) in the Netherlands[1]
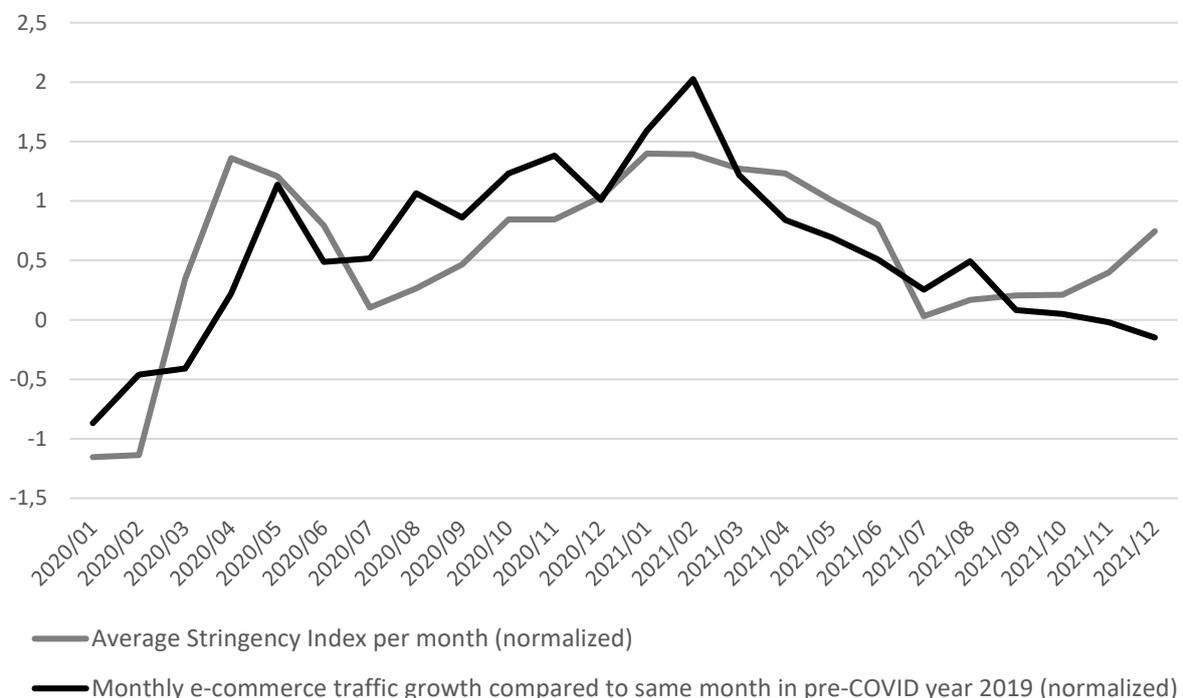
Source: Harboul et al. (2022)

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[1] The web site traffic growth data is based on data from SimilarWeb about 30 top e-commerce companies in the Netherlands. The Stringency Index of the University of Oxford measures the government's response to the COVID-19 outbreak. The higher the index, the higher the impact of the COVID-19 containment policies on people and businesses. Both measures have been normalized (Harboul et al., 2022).

The retail industry is one of the sectors most affected by the COVID-19 pandemic. Since the start of the pandemic, there has been a major shift from physical to online shopping. This shift is due to the social distancing behavior of consumers and restrictive measures taken by national governments to fight the pandemic such as store closures and limited opening hours. As a result, store-based retailers were forced to rapidly shift their focus to online channels. Research shows that there is a strong correlation (0.74) between e-commerce traffic growth in the Netherlands and the COVID-19 containment measures taken by the Dutch government in 2020 and 2021 (Figure 1).

The aim of this paper is to understand the spatially uneven effect of the COVID-19 pandemic on digital transformation in the retail sector. Our central research question is: to what extent and how does the quality of regional entrepreneurial ecosystems explain the spatially uneven digital transformation in the retail sector during the COVID-19 pandemic. We study this in the Netherlands, a country with a well-developed digital infrastructure, but with substantially uneven use of digital technologies in the business population (KvK, 2019). Our specific research questions are:

1.   To what extent is there an accelerated digital transformation during the COVID-19 pandemic?
2.   To what extent is there a spatially uneven digital transformation by retail startups and established firms during the COVID-19 pandemic?
3.   To what extent does the quality of the regional entrepreneurial ecosystems affect the spatially uneven digital transformation by retail startups and established firms during the COVID-19 pandemic?

We measure the regional digital transformation during the COVID-19 pandemic, with data on (1) startups (new retail web shops) and (2) established firms (new sellers on the largest e-commerce platform in the Netherlands) in the 40 city regions of the Netherlands. We expect the effect of local conditions, in particular the quality of the entrepreneurial ecosystem, on digital transformation to be stronger for startups than for established firms (Kelley & Helper 1998).

Our analyses show an accelerated digital transformation during the COVID-19 pandemic in all regions in the Netherlands. There are substantial regional differences in the speed of this transformation, and these differences are associated with the quality of the regional entrepreneurial ecosystem preceding the COVID-19 pandemic.

2. Theoretical background

Innovation and transformations

Innovation is a key driver of structural change and long term prosperity (Schumpeter, 1934; 1942; Hall & Rosenberg, 2010). Innovators or entrepreneurs, individuals that identify and pursue opportunities for new value creation (Shane & Venkataraman, 2000), can be found in startups but also in established enterprises (Penrose, 1959; Teece, 2007). Startups and established enterprises play complementary roles in realizing and diffusing innovations and transforming the economy (Nooteboom, 1994). On the one hand, established firms have more resources to invest in the creation of innovation, and complementary assets to develop and introduce them on the market in a profitable way (Teece 1986). On the other hand, startups are better able to develop radically new offerings, given that their new offering does not cannibalize on their existing product-market combinations (Arrow 1962; Christensen 1997).

Geography of innovation and entrepreneurship

Innovation and entrepreneurship are highly spatially uneven phenomena (Audretsch & Feldman 1996; Sternberg, 2009). Both the creation and diffusion of innovations take place with different intensities and speeds in regions (Rogers, 1962; Oinas & Malecki, 2002). This spatial heterogeneity is also true for digital innovation and entrepreneurship (Castells 1996; Graham, 1998), key components of the digital transformation of the economy and society. The prevalence of productive entrepreneurship depends on many actors and factors in the region, ranging from the availability of finance, talent, and knowledge, but also the quality of institutions and physical infrastructure (including digital), and the prevalence of networks and intermediary services (Audretsch & Belitski 2017). These elements are often interdependent, indicating the complex system nature of the economy. Taking these actors and factors that enable productive entrepreneurship together is at the heart of the entrepreneurial ecosystem approach (Stam 2015; Spigel 2017; Stam & Van de Ven 2021; Wurth et al 2022). The entrepreneurial ecosystem approach analyses the economy as a set of actors and factors that are governed in such a way that they enable productive entrepreneurship in a particular territory.

Crises and transformations

Crises can substantially affect transformations. First, crises are expected to accelerate transformations, which seems to be particularly true for the COVID-19 pandemic and its effect on digitalization (Amankway-Amoah et al. 2021). Second, crises are likely to increase inequal economic development over space, due to heterogeneity in regional resilience (Groot et al., 2011). More in particular, regions differ in the resistance to shocks and in adaptiveness (Simmie & Martin 2010; Martin et al., 2016). In this paper we make a new combination between the regional resilience and entrepreneurial ecosystem literatures to better understand the spatially uneven effects of the COVID-19 pandemic on digital transformation.

3. Methodology

3.1. Measuring Digital transformation and the Entrepreneurial Ecosystem Index

We measure the spatially uneven digital transformation during the COVID-19 pandemic, with data on (1) online retail startups and (2) established firms (new sellers on the largest e-commerce platform in the Netherlands) in the 40 city regions of the Netherlands.

Our first measure is the prevalence of online retail startups in a region. An online retail startup is a firm registered at the Chamber of Commerce (KVK) under the category retail web shops ("Detailhandel – webwinkels"). Using data from the Dutch Census (CBS) we observe these online retail startups over a 13 year time period (2008-2021). We count the number of online retail startups in the Netherlands on the NUTS 3 spatial level. The Netherlands has 40 NUTS 3 regions, which have between roughly 46,000 to 1.4 million inhabitants. To compare the regions we divide the number of online retail startups by the number of registered businesses in the same time period.

Our second measure of digital transformation is the entry of firms on the largest Dutch e-commerce platform: bol.com. Bol.com offers business owners and private persons the opportunity to sell their goods through their platform. It currently has 37.000 external sellers. Due to restrictive policy measures by the Dutch government and increased preference of consumers to shop online the third-party sales on the platform increased by 110% in the fourth quarter of 2020 (Ahold Delhaize 2020). By scraping all the sellers present on the platform in the months after the start of the pandemic (April to October 2020) and compare them with the total number of sellers present on the platform we can observe the increase of external sellers on the platform at the start of the pandemic.

Also for this indicator we look at the NUTS 3 regional level. To compare regions we divide the number by total retail businesses in a region.

Table 1
Variables used

Variable	Definition	Unit of measure	Year	Source
Online retail shops	Number of online shops in region per 1000 retail shops	Prevalence	2015-2021	CBS
Firms on bol.com	Registered sellers on bol.com in months after start of the pandemic, divided by total registered sellers on Bol.com in a region	Percentage	2020	Bol.com
EEI	Entrepreneurial Ecosystem Index	Index	2018	Various
Population density	Number of residents per km2	Thousands	2020	CBS
GRP	Gross Regional product	EUR (mln)	2015-2021	CBS
Offline shops	Number of retail shops in region per 1000 businesses	Prevalence	2021	CBS

The strength of the entrepreneurial ecosystem is measured by the Entrepreneurial Ecosystem Index (see also Stam & Van de Ven 2021; Leendertse et al 2022). This Entrepreneurial Ecosystem Index consists of 10 elements, each element is measured by one or multiple indicators. The elements are: formal institutions, entrepreneurship culture, physical infrastructure, demand, networks, leadership, talent, finance, new knowledge and intermediate services (for an overview see table 6 in the appendix). We construct the ecosystem measure on NUTS level 3, the spatial level of city regions. An analysis on NUTS 3 is more spatially fine-grained than Stam & Van de Ven (2021) and Leendertse et al. (2022) who analyze entrepreneurial ecosystems on NUTS level 2. This gives a more reasonable approximation of the causal mechanisms of the entrepreneurial ecosystem (see for example, Groot et al. (2014) who shows the regional wage differences in the Netherlands on NUTS level 3).

Figure 2
Entrepreneurial Ecosystem Index 2018, 40 city regions in the Netherlands
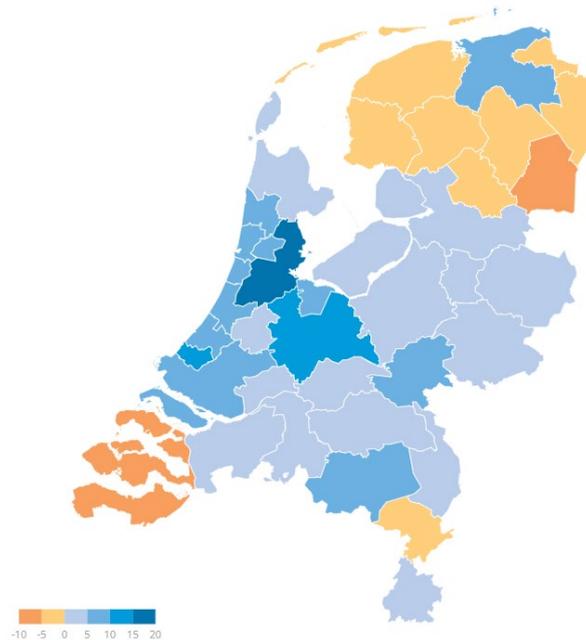
To measure the quality of entrepreneurial ecosystems just before the COVID-19 pandemic we use 2018 data. To make this into a single measure, the Entrepreneurial Ecosystem Index, we standardize the elements values. Next we sum these values up for each region. The region with the highest index value is "Groot-Amsterdam", the Amsterdam metropolitan area, with 16.57 and lowest is "Zuidoost-Drenthe" with -6.37. Figure 2 shows the index values for the 40 city regions in the Netherlands in 2018.

We control for other possible mechanisms explaining the spatial heterogeneity of the digital transformation, and include population density, the number of offline shops (i.e. retail sector minus the web shops) and Gross Regional Product (GRP). All variables we use are shown in table 1.

3.2. Descriptive statistics
Table 2 provides the descriptive statistics of the variables. For our first indicator, "Prevalence online retail shops", we use the data for 8 time periods (2014-2020). The second indicator, "Firms on bol.com", is observed in the first months after the start of the pandemic, March to June 2020. Table 3 shows the correlations of the variables. The number of variables we use is limited as it is hard to find control variables that potentially explain spatial differences in the prevalence of online retail shops but is not highly correlated with our independent variable, the Entrepreneurial Ecosystem Index. The variable offline shops can therefore not be included as a control variable in our model: there is multicollinearity due to its high correlation with both the key dependent and independent variable.

Table 2

Variable	N	Mean	St. Dev	Min	Max
Prevalence online retail shops	320	293.93	70.62	137.056	545.89
Firms on bol.com	40	18.48	3.49	12.13	27.50
EEI	320	2.63	4.98	-6.37	16.57
Offline shops	320	63.16	12.43	37.76	102.54
GRP	320	18493.43	21239.39	1488	127819
Population density	320	706.08	664.86	144	3529

Table 3

Correlations with confidence intervals

Variable	1	2	3	4	5
1. Prevalence online retail shops	1				
2. EEI	.22** [.11, .32]	1			
3. Offline shops	-.71** [-.76, -.65]	-.58** [-.64, -.50]	1		
4. GRP	.16** [.05, .28]	.66** [.59, .72]	-.40** [-.50, -.30]	1	
5. Pop.density	.07 [-.04, .18]	.72** [.66, .77]	-.36** [-.46, -.27]	.43** [.33, .52]	1

Note. * indicates $p < .05$. ** indicates $p < .01$.

4. Results

4.1. Online retail startups

Figure 3 shows the development of the number of offline retail startups and online retail startups in the Netherlands. The number of offline retail startups has declined substantially since 2015, while the number of online retail startups has grown substantially since 2019. The gap widened at the start of the pandemic in the third quarter of 2020 suggesting the pace of digital transformation increased. The number of startups declined at the end of 2021. This could mean a saturation of the market or an anticipation of the market for the end of the lockdown measures (for now) in 2022. We do not have access to regional startup data, but use the amount of registered online shops in a region as an alternative. Figure 4 shows that the number of registered firms shows the same trend as the number of startups. Figure 5 shows the spatial differences of the prevalence of online retail shops over the 40 regions in the Netherlands. In figure 6 we compare the growth of online retail shops in the different regions during and before the pandemic. It shows all regions have a higher growth of web shops during the pandemic, meaning the pace of digital transformation increased in all regions during the COVID-19 pandemic.

Figure 3
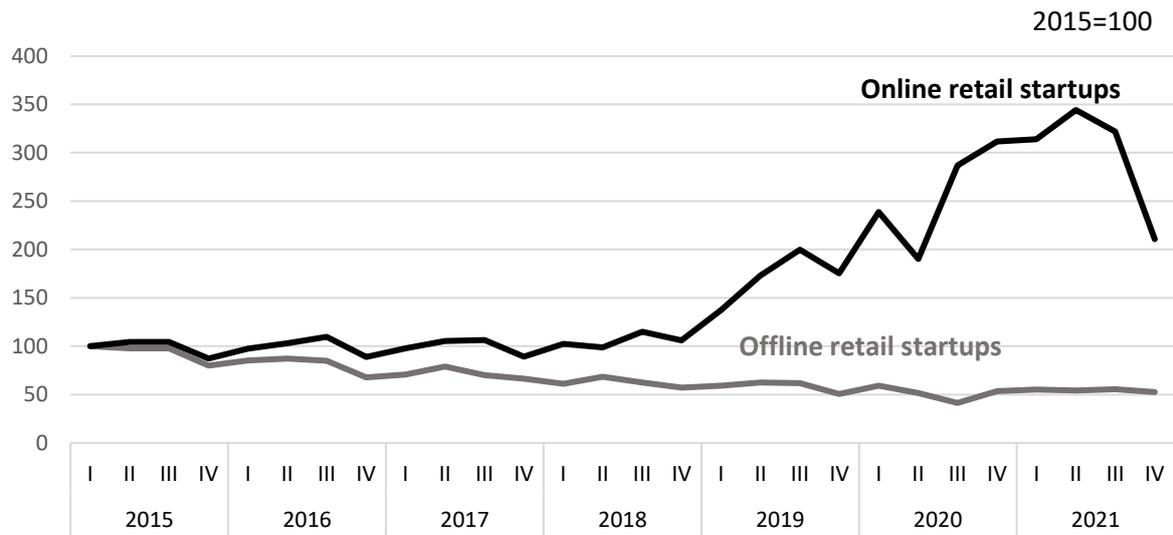Number of offline retail startups and online retail startups, 2015-2021

Figure 4
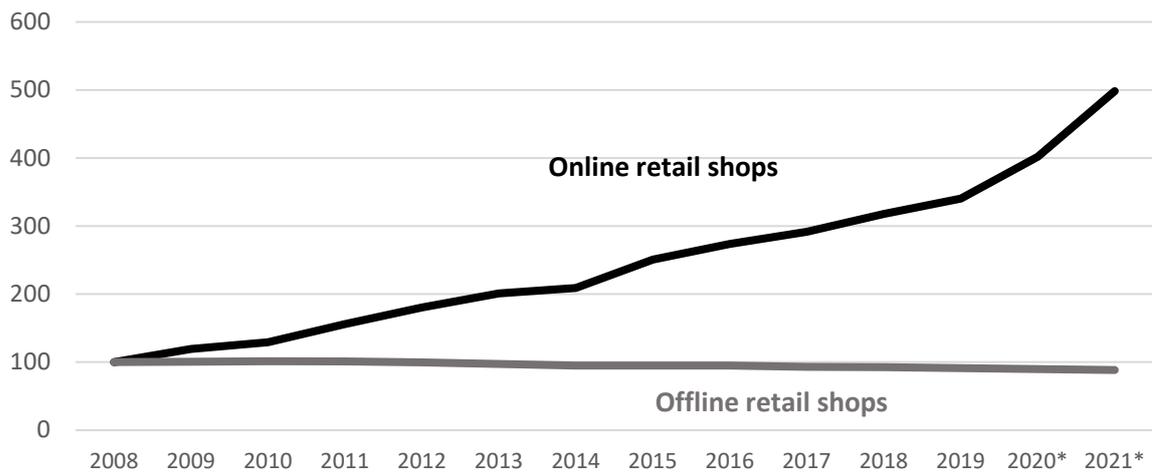Number of offline and online retail shops, 2008-2021

Figure 5
Prevalence of online retail shops in 2021
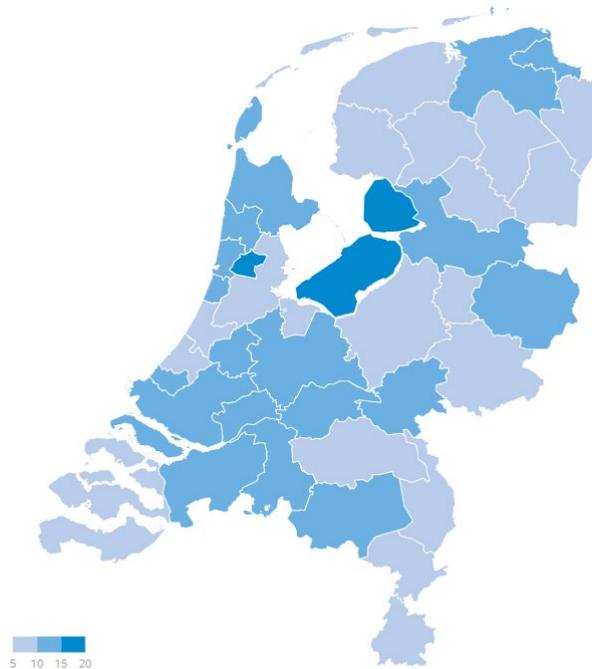
Figure 6
Mean annual growth of number of online retail shops in periods 2015-2019 and 2020-2021
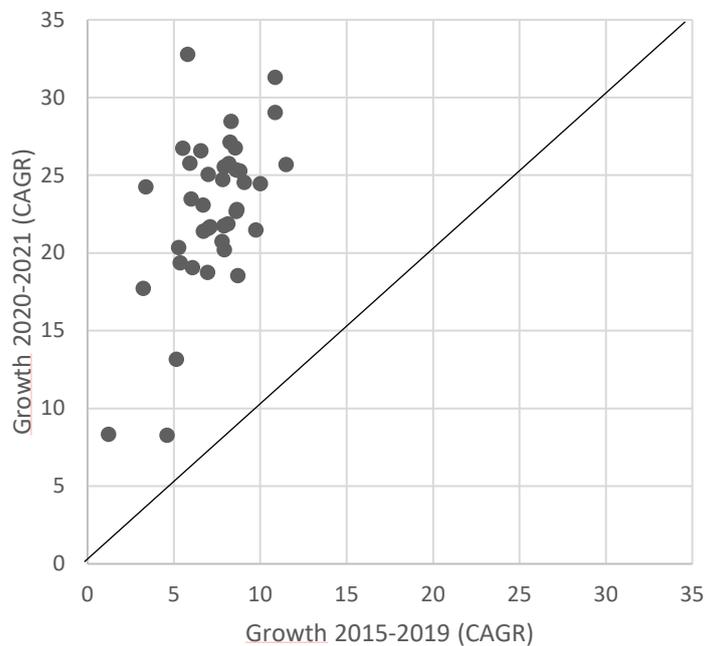
To better understand the spatial differences in the prevalence of retail startups we run a panel regression with year-fixed effects. We use the data from 2014 until 2021. Before 2014 the number of online shops was relatively low, which makes it hard to compare regions. The results are shown in Table 4. These show that the year of the pandemic (model 1) has a larger effect on growth of online retail shops than the previous years, conforming our analysis from Figure 4 that the pandemic accelerated the digital

transformation in all regions. The Entrepreneurial Ecosystem Index, our independent variable of interest, seem to be associated with the prevalence of online retail startups (model 1 and 4). Same is true for GRP (model 2 and 5). Our control variable, population density (model 3), is not related to the prevalence of online retail shops. In other words: more urbanized areas do not have a higher prevalence of online retail startups than less urbanized areas.[2]

Table 4
Regression results online shops

| | Online.shops.prev2 | | | | |
	(1)	(2)	(3)	(4)	(5)
EEI	3.098***			5.213***	
	(0.474)			(0.664)	
log(GRP)		6.680**			6.866**
		(2.910)			(3.213)
Pop.density			0.006	-0.022***	-0.001
			(0.004)	(0.005)	(0.004)
Year_2015	29.993***	29.875***	29.971***	30.070***	29.874***
	(9.430)	(9.674)	(10.014)	(9.162)	(9.691)
Year_2016	46.420***	46.137***	46.378***	46.570***	46.133***
	(9.430)	(9.674)	(10.014)	(9.162)	(9.692)
Year_2017	61.696***	61.148***	61.625***	61.951***	61.139***
	(9.430)	(9.676)	(10.014)	(9.162)	(9.694)
Year_2018	78.553***	77.705***	78.451***	78.919***	77.691***
	(9.430)	(9.681)	(10.014)	(9.162)	(9.699)
Year_2019	94.250***	93.119***	94.068***	94.899***	93.105***
	(9.430)	(9.686)	(10.015)	(9.163)	(9.704)
Year_2020	132.754***	131.677***	132.538***	133.525***	131.668***
	(9.430)	(9.685)	(10.015)	(9.163)	(9.703)
Year_2021	183.508***		183.278***	184.329***	
	(9.430)		(10.015)	(9.163)	
Constant	207.381***	153.329***	211.296***	216.955***	152.005***
	(6.784)	(27.948)	(7.542)	(6.938)	(29.602)
Observations	320	280	320	320	280
R^2	0.652	0.478	0.608	0.673	0.478
Adjusted R^2	0.643	0.465	0.598	0.663	0.463
Residual Std. Error	42.174 (df = 311)	43.261 (df = 272)	44.785 (df = 311)	40.972 (df = 310)	43.339 (df = 271)
F Statistic	72.932*** (df = 8; 311)	35.615*** (df = 7; 272)	60.274*** (df = 8; 311)	70.858*** (df = 9; 310)	31.053*** (df = 8; 271)

*p<0.1; **p<0.05; ***p<0.01

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[2] Same is true for the number of offline shops (i.e. the number of physical retail shops). Regions with more offline shops show a lower prevalence of online shops (Table 3). Hence, different regional entrepreneurial dynamics seem to be in play for offline than online shops. The variable offline shops (the number of physical retail shops in a region) is not included in this model as it is highly (negatively) correlated with the EEI.

4.2 Entry of firms on the largest Dutch e-commerce platform

Our second indicator for regional digital transformation uses the number of companies that are registered on the platform Bol.com. These data are not temporal. However, since we have the registration date of each seller, we can analyze differences among regions in the number of new sellers on bol.com since the start of the pandemic (April to October 2020) as share of the total number of sellers on the platform. The share of new entrants since the start of the pandemic is lightly correlated (0.16) with the number of online retail shops per region. The latter reflects more of the startup dynamism, while entry at bol.com more likely involves dynamics of incumbents. In Figure 7 we show for each region the number of retail sellers that registered in the months April to October 2020 as a percentage of total retail sellers. Table 5 shows the regression results. Running multiple models, the Entrepreneurial Ecosystem Index seems to be the only variable to show significant results. The effect of the Entrepreneurial Ecosystem Index becomes stronger in model 5 if we control for the size of the offline shops in the retail sector.

Figure 7
Percentage of external sellers on Bol.com that registered in April – October 2020
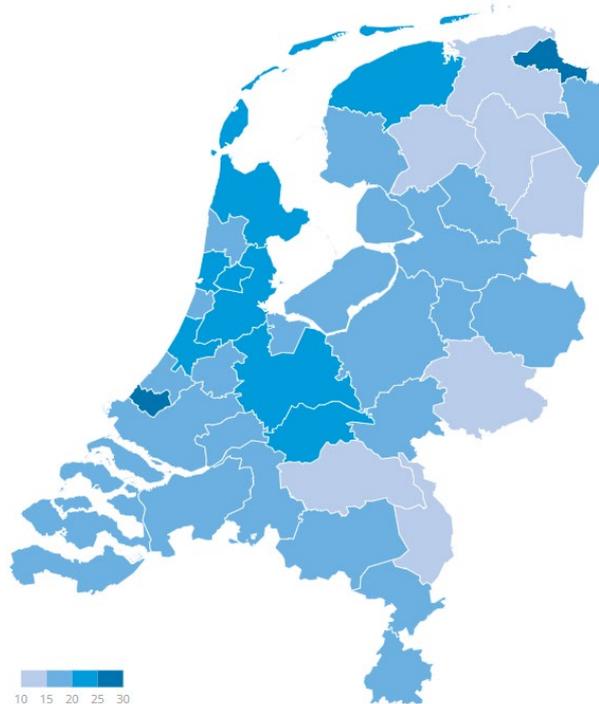
Table 5

Regression results bol.com

	Bol.com				
	(1)	(2)	(3)	(4)	(5)
EEI	0.216*				0.281**
	(0.107)				(0.138)
BRP		0.0001			
		(0.0001)			
Offline shops			0.0002		-0.0003
			(0.0003)		(0.0004)
Pop.density				0.002**	
				(0.001)	
Constant	17.868***	16.136***	17.976***	17.302***	18.365***
	(0.602)	(2.263)	(0.910)	(0.771)	(0.895)
Observations	40	40	40	40	40
R^2	0.097	0.028	0.011	0.098	0.111
Adjusted R^2	0.073	0.003	-0.015	0.074	0.062
Residual Std. Error	3.363 (df = 38)	3.489 (df = 38)	3.520 (df = 38)	3.361 (df = 38)	3.383 (df = 37)
F Statistic	4.078* (df = 1; 38)	1.098 (df = 1; 38)	0.410 (df = 1; 38)	4.127** (df = 1; 38)	2.299 (df = 2; 37)

Note: $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$

5. Conclusions

The COVID-19 pandemic has led to severe global health and economic effects, and has been a shock to most economies. However, the shock has been very different to different national and regional economies.It not only revealed to be heterogeneous in its initial shock effect, but also in the degree to which it triggered and accelerated the already ongoing digital transformation in the retail sector.

The aim of this paper was to understand the spatially uneven effect of the COVID-19 pandemic on digital transformation in the retail sector. Our central research question was: to what extent and how does the quality of regional entrepreneurial ecosystems explain the spatially uneven digital transformation of the retail sector during the COVID-19 pandemic. We studied this in the Netherlands, a country with a well-developed digital infrastructure, but with substantially uneven use of digital technologies in the business population.

To answer our central question we formulated three specific research questions and answered these with empirical research with data on (1) startups (new retail web shops) and (2) established firms (new entrants on the largest e-commerce platform in the Netherlands) in the 40 city regions of the Netherlands. Our analyses showed an accelerated digital transformation during the COVID-19 pandemic in all regions in the Netherlands, but with substantial regional differences in the speed of this transformation.

The number of online shops seems to be strongly related to the quality of the regional entrepreneurial ecosystem. We also found a – somewhat weaker – positive relation between the quality of the regional entrepreneurial ecosystem and the prevalence of firms on the largest Dutch online shopping platform. We might be hit by surprise when the COVID-19 pandemic emerged and evolved, and its effects on business and the economy have largely been unanticipated. But, our analyses show that such "chance events" like the COVID-19 pandemic favor the prepared region. Regions with a high quality entrepreneurial ecosystem seem to be more adaptive in the sense of revealing a

rapid digital transformation that was very salient, especially for continuing business activity during lockdowns.

The two indicators we used as proxies for digital transformation during COVID-19 may not be useful to proxy digital transformation after COVID-19. The number of online retail shops, our first indicator, will probably drop post pandemic. Consumers will partially shift back to offline consumption when the lockdowns end. Furthermore, the market for online retail startups could become saturated with the surge in new entrants during COVID-19 making it less profitable to start an online retail shop. We already see a decline in online retail startups in year two of the pandemic (figure 3). The same holds for the growth in e-commerce traffic (see example figure 1). The second indicator, incumbents shifting to online platforms, will probably also show lower results post COVID19, even if there is a new pandemic, as a shop cannot make the transformation from offline to online twice.

The results in this paper contribute to the literature of digital transformation by constructing a spatial measure to compare regions in their pace of digital transformation. Future research could examine spatial differences in digital transformation during COVID-19 in other countries. It could also extend the time period of our second indicator of digital transformation, the shift of established firms to online sales, which we were only able to observe in one time period. Further, it is important to note that we do not have data on the number of store-based retailers that increased their online sales activities via other digital channels than platforms such as web shops and social media channels. As such, our data only captures part of the digital transformation that occurred as a result of the pandemic.

The question is whether the acceleration of the digital transformation is here to stay. Consumers have indicated to consume more online and eat out less after the crisis (Hodbod, et al. 2020). It is thus unlikely that the transformation will be countered post-COVID-19 with a decline in the number of online shops and an increase in offline shops. The transformation may slow down, but may still mean the final blow for offline only – "brick and mortar" – shops, and an increased the dominance of multichannel (offline and online) retail shops, or even an increase of online shops at the cost of local brick and mortar shops.

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APPENDIX
Table 6 Empirical measures of entrepreneurial ecosystem elements

Elements	Description	Variable name	Empirical indicators	Data sources
Formal institutions	The rules of the game in society, in particular the quality of government	QUALGOV — quality of government*	Four components: corruption rule of law, government effectiveness and voice & accountability	Quality of government survey
Entrepreneurship culture	The degree to which entrepreneurship is valued in a region	NEWFIRM – new firms	New firms registered per 1000 inhabitants	CBS (Netherlands Census Bureau)
Physical infrastructure	Physical infrastructure and the position of a region	ACCESS – accessibility	Three components: distance to main road, distance to train station, accessibility via airports**	CBS (Netherlands Census Bureau), EU regional Competitiveness Index
Demand	Potential market demand	DEMAND – demand	GDP per capita	CBS (Netherlands Census Bureau)
Networks	The connectedness of business for new value creation	INNOCOL – innovation collaboration*	Percentage of firms in the business population that collaborate for innovation	EU Community Innovation Survey
Leadership	Leadership that provides guidance for and direction of collective action	PROLEAD – project leaders	Measured with the prevalence of innovation project leaders. Project leaders received Dutch or European public subsidies (out of H2020, FP7 or RVO)	RVO, H2020, FP7
Talent	The prevalence of individuals with high levels of human capital	EDU – education	Percentage of higher-educated in the adult population	CBS (Netherlands Census Bureau)
Finance	The amount of venture capital (start-up and growth) invested in the region	VC – venture capital*	Amount of venture capital per 1000 Establishments (3-year lagged average)	National Association of Private Equity
New Knowledge	Investments in new knowledge	RD – R&D*	Percentage of gross domestic product invested in R&D (by public and private organizations)	CBS (Netherlands Census Bureau)
Intermediate services	The supply and accessibility of intermediate business services	BUSSERV – business services*	Percentage of business service firms in the business population	CBS (Netherlands Census Bureau)

* Data not available on NUTS 3 level: NUTS 2 level used
** Data for accessibility airports only available on NUTS 2 level; due to differences in methodology this indicator is being kept constant (2019) in the data set