productivity insights network

PIN - Productivity Projects Fund

Small Project Report

Entrepreneurial Innovation and the Pandemic: Cities, Competitiveness and Resilience

Report prepared by:
Robert Huggins (Cardiff University) and Piers Thompson (Nottingham Trent University)

www.productivityinsightsnetwork.co.uk

UKRI Economic and Social Research Council

About PIN

The Productivity Insights Network was established in January 2018 and is funded by the Economic and Social Research Council. As a multi-disciplinary network of social science researchers engaged with public, private, and third sector partners, our aim is to change the tone of the productivity debate in theory and practice. It is led by the University of Sheffield, with co-investigators at Cambridge Econometrics, Cardiff University, Durham University, University of Sunderland, SQW, University of Cambridge, University of Essex, University of Glasgow, University of Leeds and University of Stirling. The support of the funder is acknowledged. The views expressed in this report are those of the authors and do not necessarily represent those of the funders.

Table of Contents

Executive Summary

This report examines how entrepreneurial innovation has been affected by the initial stages of the Global Covid-19 Pandemic. This analysis may provide some pointers as to the potential longer-run effects of the Pandemic that will only become fully evident after a number of years. The analysis is based upon data drawn from measures of entrepreneurial innovation as captured through the StartupBlink startup ecosystems rankings and the World Competitiveness Index of Regions (WCIR). It utilises the WCIR and its component elements to understand how these relate to the resilience of innovation in cities as captured by the StartupBlink measures for 2020. In total the combined dataset contains 619 cities across the globe located within 273 regions.

The relationships between regional competitiveness and the innovative startups created at a point when an unprecedented shock in the form of the Pandemic struck confirms that regional competitiveness is a necessary, but not sufficient condition, for achieving high rates of entrepreneurial innovation.

Given the impact of the Global Pandemic, it is no surprise that innovative startup activity has fallen for most cities. However, there is a group of more competitive cities that have actually seen growth in innovative startup activity. This group of seemingly resilient locations that are adapting to the new challenges are global cities from a variety of countries, Beijing (China), Shanghai (China), Boston (US), Los Angeles (US), New York (US) and London (UK). This implies that cities such as these will remain the core source of innovation even with the interruption of social contact and tacit knowledge transfer.

The analysis identifies four clusters of city types as follows:

- Entrepreneurially Innovative Global Leader Cities (Global Cities) - a small group (25 cities) of the most entrepreneurially innovative cities with the greatest entrepreneurial innovative resilience.
- Less Resilient Advanced Entrepreneurially Innovative Cities (Advanced Cities) - a larger group of cities (167 cities) that were also leading centres of entrepreneurially innovative activities in 2020.
- Overachieving Startup Innovation Cities (Overachieving Cities) – a cluster of 115 cities whose entrepreneurial innovation ranking tends to rely on the quantity of innovative startups to a greater extent than their quality.
- Underperforming Startup Innovation Cities (Underperforming Cities) – a group of 311 cities that are relatively less entrepreneurially innovative in 2020 compared to the sample as a whole, but have seen reasonable resilience in terms of resistance to the Pandemic shock.

Overall, the analysis indicates that particular cities have dominated entrepreneurial innovation, and these are the cities that are most likely to have retained their innovative activity when impacted by the shock. They are also the cities that have adapted to engage in Covid Innovation.

The most entrepreneurially innovative cities are Global Cities with balanced economic competitiveness, with both high-technology manufacturing and knowledge intensive services being well represented, as are the knowledge resources required to support them. Those cities located in less competitive regions are very rarely the most entrepreneurially innovative or exhibit high levels of innovative resilience.

The results of the analysis imply the policymakers in developed economies will once again have to consider whether attempts to spatially rebalance economies are practical or even desirable. This may mean ensuring that public R&D activity is located away from the Global Cities, and institutional changes such as subsidies or tax breaks are provided to encourage the (re)location of innovative industries.

It is concluded that further work over time will be required to examine the ongoing resilience of cities across the world. However, the initial patterns exhibited by the current data suggest that the different patterns of innovative resilience mean that further shocks such as the Pandemic will focus resources and innovation within a smaller and smaller number of cities, potentially increasing inequality.

1. Introduction

A potential global phenomenon resulting from the COVID-19 pandemic is that behavioural changes may impact on the spatial configuration of entrepreneurship-driven innovation and subsequently urban and regional development. In particular, some commentators have begun to suggest that the concentration of the COVID-19 disease in densely populated cities may lead to a retreat of both people and economic activity from these urban areas. To address this proposition, this study examines how entrepreneurial innovation has been affected by the initial stages of the Global Covid-19 Pandemic. This analysis may provide some pointers as to the potential longer-run effects of the Pandemic that will only become fully evident after a number of years (Martin, 2012).

The analysis is based upon data drawn from two main sources. Measures of entrepreneurial innovation are captured through the StartupBlink startup ecosystems rankings (StartupBlink, 2020). StartupBlink provides a ranking of cities and countries using three groups of components: Quantity; Quality; and Business environment. Quantity incorporates not just the new businesses that are created, but the entities and activities that are associated with supporting the formation of these startups and nurturing their growth. As such their quantity algorithm draws on: Startups; Coworking spaces; Accelerators; and Startup events.

The quality element helps to provide insight with regard to the innovative behaviour that start-ups are embodying. The focus is on 'How well are these startups driving innovation?' (StartupBlink, 2020, p. 13). This includes accounting for existing businesses that have moved beyond the startup phase, but are both high growth businesses in their own right and also drive growth in their local areas (Pantheon companies), and also high value (US$1billion+) startups (Unicorns). Factors taken into account are: Business activity levels of start-ups; Unicorn start-ups; Pantheon companies; Global coworking brands; Mass startup events; Whether or not startups have reached a critical mass; and the Presence of startup leaders.

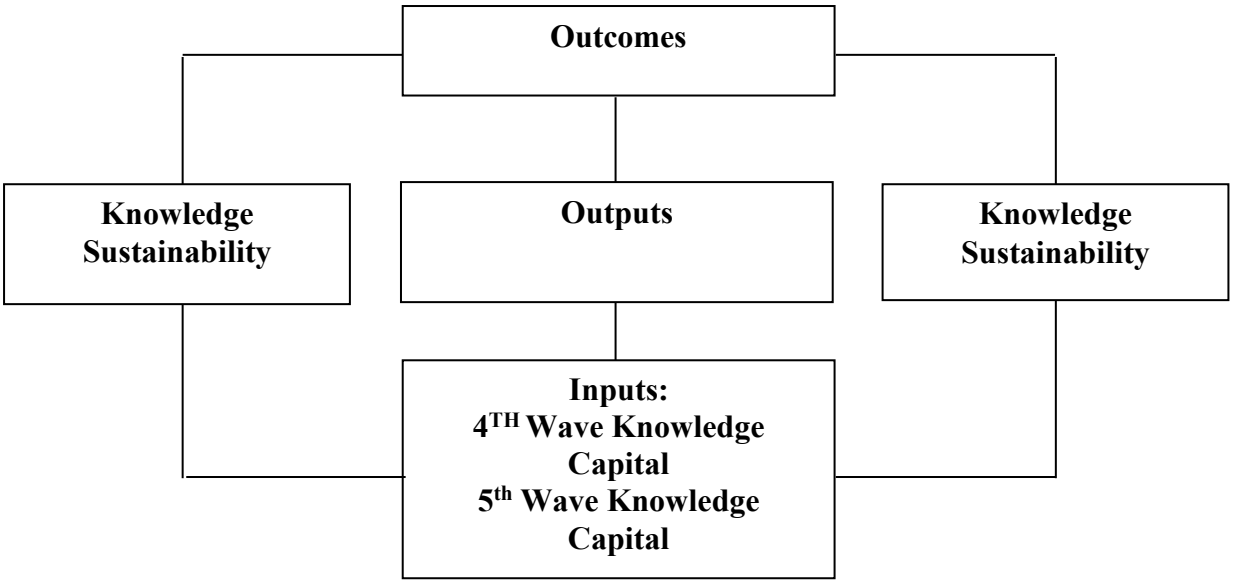
The final business environment element considers the ease of doing business in the city. This mostly reflects national level influences from infrastructure. Adjustments are made where cities are below critical levels of quality and quantity, so that intra-national differences exist. The measure, therefore, includes factors. such as: Ease of doing business; Internet speed; Internet freedom; and R&D investment. As well as the main rankings, StartupBlink also includes rankings by sector, and also of particular pertinence with regard to the adaptability element of resilience, rankings based on innovative projects associated with Covid-19. The innovations considered and ranked are linked to Covid-19 in a wide range of manners including: Prevention of Covid-19; Diagnostics; Treatment; Information; and Life and Business Adaptation.

The second set of data used in this analysis is drawn from the World Competitiveness Index of Regions (WCIR) (Huggins et al., 2014). Competitiveness and resilience are closely associated concepts. Competitiveness is assumed to be related to economies' long-run potential and current performance (Aiginger, 2006; Huggins and Thompson, 2017; Aiginger and Firgo, 2017). Resilience on the other hand is how an economy reacts to a shock (Martin and Sunley, 2011). Greater competitiveness it should be noted is likely to mean greater resilience (Martin and Sunley, 2017).

2. World Competitiveness Index of Regions (WCIR)

The WCIR ranks the competitiveness of regions across the world. It draws on the recognised importance of the knowledge economy for competitiveness and benchmarks regions on their knowledge capacity, capability and sustainability (Huggins et al., 2014). The framework used is depicted below in Figure 1:

Figure 1 Framework Underpinning the World Competitiveness Index of Regions (WCIR)



Source: Huggins et al. (2014)

Inputs are associated with the presence of particular industries that are regarded as more knowledge intensive. This is split into 4th and 5th Wave Knowledge Capital. The items included in the input measures are employment in knowledge intensive sectors as defined by the Eurostat definitions of high-technology manufacturing; medium-high-technology manufacturing sectors; and high-technology service sectors (Hatzichronoglou, 1997; Laafia, 1999). 4th Wave Knowledge Capital relates to those manufacturing industries that dominated the R&D spending and innovative activities in the later 20th century and to a lesser degree in the 21st century (Hall and Preston, 1988). The 5th Wave Knowledge Capital acknowledges the change in the global economy brought by the digital revolution and the Internet. Employment within these sectors is supplemented by data on private equity investment, R&D expenditures, and innovative outputs to capture the other key sources of knowledge generation. The measures considered are outlined below:

4th Wave Knowledge Capital

- Employment in automotive and mechanical engineering per 1000 employees
- Employment in instrumentation and electrical machinery per 1000 employees
- Economic activity rate
- Number of managers per 1000 employees
- Public sector R&D expenditure per capita
- Business R&D expenditure per capita
- Patents registered per 1 million inhabitants.

5th Wave Knowledge Capital

- Employment in IT and computer manufacturing per 1000 employees
- Employment in biotechnology and chemicals per 1000 employees
- Employment in high-tech services per 1000 employees
- Per capita private equity investment.

These measures are closely associated with measures of 'process competitiveness' whereby the focus is on the capability of a region to compete, rather than outcomes previously achieved (Aiginger, 2006). The WCIR also incorporates measures that reflect the ability of a region to continue to sustain this activity by providing the high skilled labour required by these industries, as well the access the population has to global knowledge sources through the internet:

Knowledge Sustainability

- Public expenditure on primary and secondary education per capita
- Public expenditure on higher education per capita
- Secure servers per 1 million inhabitants
- Internet hosts per 1000 inhabitants
- Broadband access per 1000 inhabitants

Lastly, the WCIR accounts for the outcomes achieved. This relates to outcome competitiveness where the focus is on measuring how well the economy has been able to convert the resources/inputs available into outcomes that help secure an increasing standard of living for its population, which should be the ultimate aim of any competitiveness focused policy (Storper, 1997; Aiginger, 2006; Porter, 2007; Stimson et al., 2009). This component of the WCIR should, however, not be regarded as just a consequence of the other elements, but as higher living standards are important factors in attracting and retaining the high skilled mobile labour necessary for success, it will therefore also have an impact on inputs in the longer run (Florida, 2002; Gertler et al., 2014). Indicators of these outputs/outcomes are:

Outputs/outcomes

- Labour productivity
- Mean gross monthly earnings
- The inverse of the unemployment rate

3. Methodological Approach for this Analysis

This study utilises the WCIR and its component elements to understand how these relate to the resilience of innovation in cities as captured by the StartupBlink measures for 2020. To further analyse the resistance of urban entrepreneurial innovation the change in Startupblink measures between 2019 and 2020 is also examined. A first examination of reorientation is captured by considering the Covid-19 Innovation measure.

Although there is an expectation that more competitive cities will tend to be those that are better able to withstand and adapt to shocks such as the Pandemic (Martin and Sunley, 2017) the speed and depth of the Covid-19 Pandemic shock make it is unique. Therefore, the extent to which pre-existing competitiveness will have built the resilience required for a shock of this kind is uncertain. Similarly, while it is expected that 5th Wave Knowledge Capital and Knowledge Sustainability would provide cities with the greatest potential to adapt to the shock, it is less certain that 'older' forms of knowledge capital, as embodied by the 4th Wave Knowledge Capital measures, will have as positive an impact or whether this may provide a form of the lock-in that is more often associated with older industrial areas (Hassink, 2010).

In our analysis cities in the StartupBlink data are linked to the regions covered by the WCIR. This means that in some cases a number of individual cities are attributed to the same region. This is not necessarily problematic as cities are likely to be able to access similar resources across the wider region. It will also provide a point of interest when considering the extent to which cities have proved more or less successful in retaining their innovation in comparison to other cities in the same region. StartupBlink also combines some urban areas, so that the San Francisco Bay area is not just restricted to the city centre, meaning that for larger cities there will be a close correspondence between city and the wider region.

In total the combined dataset contains 619 cities across the globe located within 273 regions. As noted above, there are a number of regions that include more than one city, with the most being 16 in the Los Angeles-Long Beach-Santa Ana MSA in the US, followed by 15 in the San Francisco-Oakland-Fremont MSA in the US. The region with the most cities outside the US is Ontario in Canada. Given that StartupBlink restrict coverage to the 1000 cities globally that are regarded as the most innovative, this shows the clustering of innovative activity not only within cities, but also cities within regions. For some aspects of the analysis it is necessary to remove the San Francisco Bay Area because it is an extreme outlier and unrepresentative of the other cities within the sample.

The initial analysis is based on correlation analysis examining the relationship between underlying urban and regional competitiveness and entrepreneurial innovation during the early stages of the pandemic. As there are some extreme outliers the data is not normally distributed, but has a positive skew. This means that although the StartupBlink and WCIR data is continuous, preference is shown for the non-parametric Spearman rank correlation.

Cities such as the San Francisco Bay Area and the region of San Jose-Sunnyvale-Santa Clara (Silicon Valley), CA (MSA) may drive any correlations found using the Pearson statistics rather than the pattern reflective of cities as a whole. For illustration, in the StartupBlink data San Francisco obtains a score of 225.310 while the next highest rated city is New York at 65.416. For the WCIR, the most competitive region is San Jose-Sunnyvale-Santa Clara in the US with an index value of 359.98 followed by Région de Bruxelles-Capitale in Belgium with an index value of 328.50. The Spearman rank, by only considering the relative positions of the

cities and regions in the rankings rather than their values, is less strongly influenced by outliers in this manner.

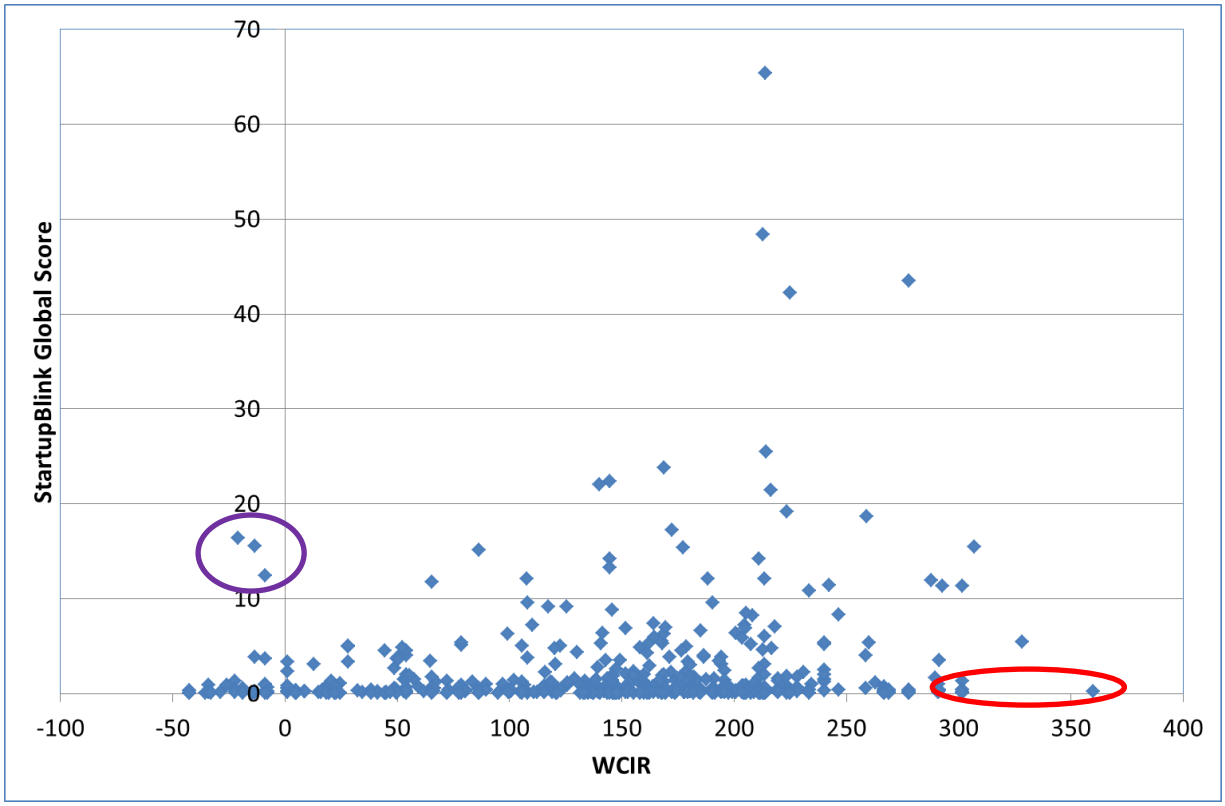
Although it would be theoretically possible to control for physical geography and population, practically this is more problematic. National statistical agencies may define the city limits more or less tightly meaning that population figures are not comparable. At a regional level the WCIR has to utilise the administrative regions available, which can range from Metropolitan Statistical Areas (MSAs) in the US to provinces in China. Hence, this is the reason for scaling indicators to provide them in per capita terms or as a proportion of all employment. In terms of location, it would be interesting to account for spatial spillovers or national level influences in a multi-level approach but this is not possible. Both the StartupBlink and WCIR data are selective in the cities and regions covered respectively. This reflects a focus on the most competitive global regions in the case of WCIR and innovative cities in the case of StartupBlink, where poorer data for those regions and cities not included would mean that any relationships found are likely to be less robust.

To supplement the correlation analysis cluster analysis is also undertaken. This is to understand the groupings of cities in terms of their entrepreneurial innovation activity, and the competitiveness of the regions within which they are located. In order to achieve this, a 2-Step cluster analysis is undertaken with the individual components of the entrepreneurial innovation activity measures and the four elements of the WCIR used. This is to provide a better picture of the nature of the entrepreneurial innovation taking place and the sources of regional competitiveness that may support this. Within the cluster analysis we also include the change in the entrepreneurial innovation activity, so that clusters can be categorised on the basis of not only of their current entrepreneurial innovation, but also the extent to which they display innovative resilience since the onset of the Covid-19 Pandemic shock. Differences in these clusters are considered using relevant t-tests of the averages.

4. Results: Urban Entrepreneurial Innovation and Competitiveness

Figure 2 provides an indication of the distribution of StartupBlink global scores and the WCIR of the corresponding regions, but as the San Fransisco Bay area is such an anomaly it is left out of the chart for the overall pattern to be more clearly seen. It shows that although regional competitiveness, when measured in 2014, varies considerably, higher levels of such competitiveness overall do not necessarily correspond to an environment supporting high levels of innovative startups in 2020. Many of the cities located in competitive regions do not have particularly high levels of entrepreneurial innovation in 2020. However, it is probable that statistically a positive relationship will be found as more innovative cities appear to be located in the more competitive regions. Therefore, competitiveness would appear to be a necessary, but not a sufficient condition on the whole.

Figure 2 – Scatter Chart of StartupBlink Global Score 2020 and WCIR index value



There are exceptions, however, as the three cities circled in purple are those located in less competitive regions that have a higher StartupBlink score. These cities are Bangalore, Mumbai and New Dehli, all of which are located in India. These cities show that although a country and region may lack the resources associated with the knowledge economy, when a city develops beyond a certain scale it can overcome these disadvantages creating its own ecosystem. Bangalore specialises in IT and software exporting, as well as having strengths in the aerospace sector. Mumbai has a long history of commercial and trading activities and is the location for many of India's international firms, and is also an important financial centre. New Dehli as the capital city has developed with a service based economy.

At the other end of the spectrum, and circled in red, Saratoga (CA) in the San Jose-Sunnyvale-Santa Clara MSA region does not rank particularly highly on StartupBlink, which is a

reflection of many of the other cities in this region being subsumed into the San Francisco Bay Area within the StartupBlink figures. Similarly, Sterling and Manassas (both VA) in the Washington-Arlington-Alexandria MSA also do not rank particularly highly, whereas Washington DC itself does. All three of these cities are relatively small with populations of between 27,000 and 38,000 in the 2010 census. The results show that being located in a competitive region does not mean that all cities will necessarily succeed in creating a world class entrepreneurial innovative ecosystem, with nearby alternatives attracting mobile skilled labour through leisure activities, job opportunities and other amenities (Florida, 2002).

Tables 1a and 1b below examines the relationship between the WCIR scores and the StartupBlink scores obtained in 2020 as well as the components of each. This provides some insight as to whether or not cities in the most competitive regions have continued to generate innovative startups since the onset of the Pandemic. Table 1a provides the Pearson correlation coefficients and Table 1b those produced using the Spearman rank. As noted previously the preference is for the latter of these as Figure 2 illustrates that even without the inclusion of the San Francisco Bay area there is a strong positive skew to the StartupBlink figures, and that innovative startup behaviour appears to be heavily concentrated in a small number of cities even on a global basis. These 'giant' locations will tend to drive any relationships found with the correlation coefficients.

Interestingly, the overall WCIR is not significantly related to the overall StartupBlink scores when using the Spearman rank correlations (Table 1b). This is quite different to the case when the Pearson correlation coefficients (Table 1a). The Pearson correlation coefficients find the overall WCIR positively related to the StartupBlink global score at the 5 percent level. Those measures most strongly associated with creating better quality rather than just higher quantity of startups (quality and business conditions) are significantly related at the 5 percent level or better, but the quantity component measure is only weakly related to competitiveness.

The fact that the Spearman rank coefficients do not support these relationships between regional competitiveness and the innovative startups created at a point when an unprecedented shock in the form of the Pandemic has struck confirms that urban and regional competitiveness is a necessary, but not sufficient condition, for achieving high rates of entrepreneurial innovation.

Table 1a – Pearson Correlations of StartupBlink Scores and World Competitiveness Index of Regions (WCIR) scores

	1. StartupBlink Global Total Score 2020	2	3	4	5	6	7	8
2. StartupBlink Global Quantity Score 2020	0.935 (0.000)							
3. StartupBlink Global Quality Score 2020	0.989 (0.000)	0.889 (0.000)						
4. StartupBlink Global Business Score 2020	0.413 (0.000)	0.482 (0.000)	0.285 (0.000)					
5. World Competitiveness Index of Regions (WCIR)	0.100 (0.013)	0.073 (0.070)	0.094 (0.019)	0.110 (0.006)				
6. 5th Wave Knowledge Capital	0.121 (0.003)	0.100 (0.013)	0.113 (0.005)	0.120 (0.003)	0.710 (0.000)			
7. 4th Wave Knowledge Capital	0.054 (0.180)	0.016 (0.690)	0.056 (0.162)	0.050 (0.213)	0.720 (0.000)	0.585 (0.000)		
8. Outputs and Outcome Competitiveness	0.094 (0.020)	0.074 (0.066)	0.089 (0.027)	0.088 (0.029)	0.887 (0.000)	0.429 (0.000)	0.516 (0.000)	
9. Knowledge Sustainability	0.059 (0.143)	0.043 (0.287)	0.052 (0.198)	0.093 (0.020)	0.868 (0.000)	0.412 (0.000)	0.411 (0.000)	0.788 (0.000)

Notes: p-values in parentheses

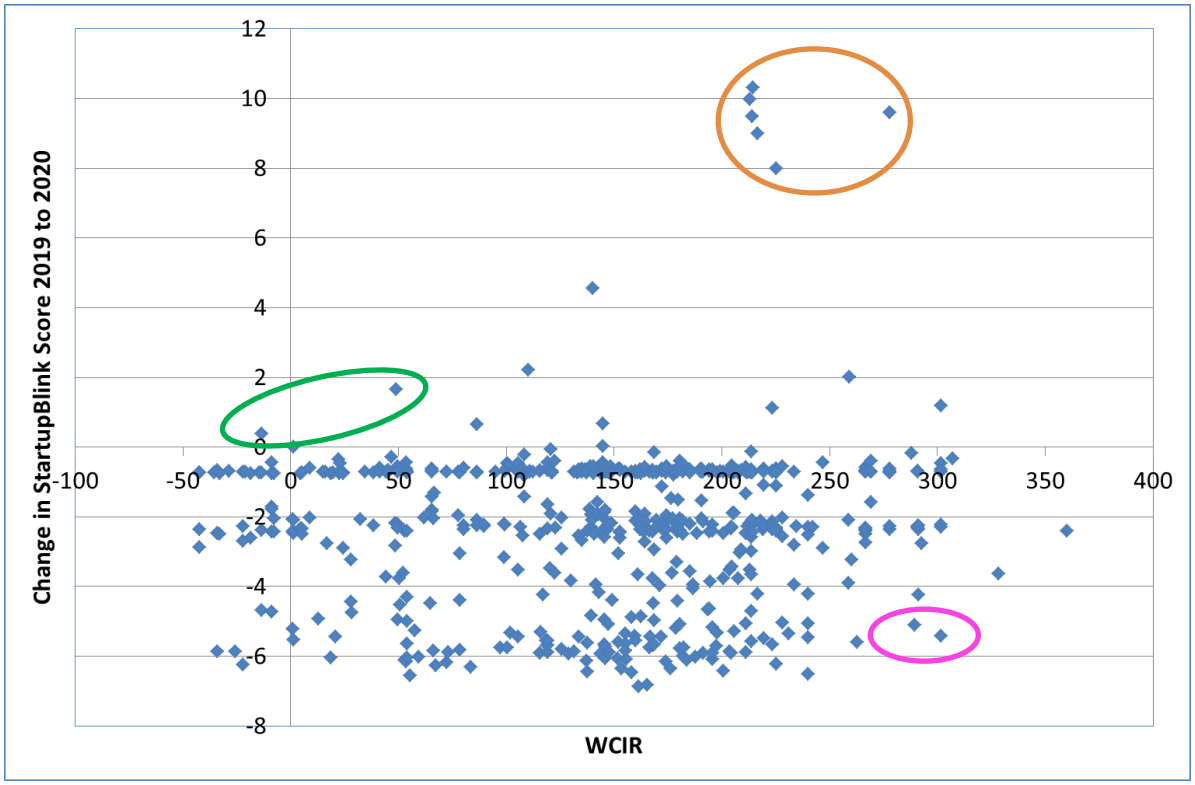
Table 1b – Spearman Rank Correlations of StartupBlink Scores and World Competitiveness Index of Regions (WCIR) scores

	1. StartupBlink Global Total Score 2020	2	3	4	5	6	7	8
2. StartupBlink Global Quantity Score 2020	0.971 (0.000)							
3. StartupBlink Global Quality Score 2020	0.919 (0.000)	0.865 (0.000)						
4. StartupBlink Global Business Score 2020	0.995 (0.000)	0.962 (0.000)	0.912 (0.000)					
5. World Competitiveness Index of Regions (WCIR)	0.036 (0.368)	-0.040 (0.315)	-0.021 (0.596)	0.072 (0.073)				
6. 5th Wave Knowledge Capital	0.045 (0.261)	-0.028 (0.487)	0.029 (0.479)	0.063 (0.119)	0.724 (0.000)			
7. 4th Wave Knowledge Capital	0.026 (0.518)	-0.041 (0.309)	-0.003 (0.943)	0.047 (0.245)	0.715 (0.000)	0.696 (0.000)		
8. Outputs and Outcome Competitiveness	0.036 (0.376)	-0.026 (0.513)	-0.022 (0.591)	0.072 (0.074)	0.832 (0.000)	0.402 (0.000)	0.457 (0.000)	
9. Knowledge Sustainability	0.015 (0.712)	-0.053 (0.185)	-0.048 (0.233)	0.059 (0.140)	0.860 (0.000)	0.422 (0.000)	0.402 (0.000)	0.801 (0.000)

Notes: p-values in parentheses

In terms of resilience, the relationships presented above do not provide insights into whether or not competitive regions have helped the cities within them retain their innovative activities as the Pandemic shock struck. To give some indication of this Figure 3 presents the change in StartupBlink score between 2019 and 2020 graphed against the competitiveness of the region. It should be noted that changes in the methodology used to calculate StartupBlink measures may explain some of the changes, but given the nature of the measures at the centre of the scores and rankings it would not be expected that these would influence these results too greatly. As with Figure 2, the San Francisco Bay Area is left out of the chart, as the high score allows for a much greater variation than other cities and between 2019 and 2020 - although remaining far above any other cities in relative terms, in absolute terms San Francisco Bay Area saw a large decline.

Figure 3 – Scatter Chart of Change in StartupBlink Global Score 2020 and WCIR index value



Given the impact of the Global Pandemic, it is no surprise that innovative startup activity has fallen for most cities that were included in both the 2019 and 2020 rankings. As noted above some of this may reflect changes to the algorithm used to produce the score, but with the focus being on innovative startups the relative pattern of change should provide insights. It is noticeable that none of the least competitive regions contain cities that have seen any sizeable improvement in their StartupBlink score. Highlighted by the green oval, the only city showing any improvement when located in a less competitive region is New Dehli in India, with the next highest climber in terms of moving up the regional competitiveness scale being Xiamen in China. Xiamen's economy may have withstood the shock in part due to a focus on electronic information and financial services which may have resisted better than some sectors.

There is a group of more competitive cities that have actually seen growth innovative startup activity (circled in orange). This group of seemingly resilient locations that are adapting to the new challenges are global cities from a variety of countries, Beijing (China), Shanghai (China),

Boston (US), Los Angeles (US), New York (US) and London (UK). The sheer scale of these cities and the resources that they command has allowed new combinations to be brought together to take advantage of the opportunities that the Pandemic shock has provided. This implies that cities will remain the core source of innovation even with the interruption of social contact and tacit knowledge transfer that is vital for innovation (Ganguly et al., 2019, Huggins and Thompson, 2021; Santamaría et al., 2021).

Outside these global cities, other cities situated in highly competitive regions like the San Francisco Bay area have been less successful in maintaining entrepreneurial innovative startup activities in 2020, although they start from a much lower level of activity. Two examples are circled in pink in Figure 3. This applies to smaller cities within the gravitation pull of larger cities, such as Reston (VA) which is located with the Washington-Arlington-Alexandria MSA, and therefore subordinate to the US capital city. It also seems to be the case for some cities with particular specialisms, such as Luxembourg City in the financial sector that are not of the same global scale as those noted above.

Although Figure 3 shows that location within a competitive region does not guarantee resilience in terms of entrepreneurial innovation for all cities, there is some evidence that a positive relationship may exist driven by the global cities located in competitive regions. For completeness, Table 2a presents the Pearson correlation coefficients for the change in StartupBlink scores and WCIR competitiveness values, but given the influence that changes in cities, such as San Francisco Bay Area, with higher levels of innovative startup activity as outliers will have on these results, it is no surprise that no significant relationship is found between innovative startup activity and the WCIR. Table 2b presents the Spearman rank correlations between the change in StartupBlink scores, which is better able to account for the impact of outliers on the results. Confirming this, removing the San Francisco Bay Area from the sample leads to similar results being produced regardless of whether parametric or non-parametric correlations are used.

The overall StartupBlink Global score is positively associated with the WCIR at the 5 percent level. As the Spearman rank coefficients are less affected by outliers, this does suggest that cities in more competitive regions have on average been able to resist the global shock better than those in less competitive regions. As the correlation is positive, but small, it implies this is far from a universal pattern. For the majority of cities this means, as shown in Figure 3, a smaller decline in these activities rather than an improvement.

Of the individual components, there is no sign that 4th Wave Knowledge Capital has locked-in regions, as this is the one component that is significantly correlated at the 5 percent level with entrepreneurial innovation. Instead, it appears that the innovative inputs in terms of R&D expenditure and outputs in terms of patents promote the resistance to the shock.

5th Wave Knowledge Capital and Outputs/Outcomes components display relationships that are only significant at the 10 percent level. In the case of 5th Wave Knowledge Capital this weaker relationship is a little unexpected as the sectors included are those that could potentially be best placed to take advantage of the opportunities the Pandemic shock brings. However, it is possible that resilience in terms of adaptation and reorientation will only become apparent in the 2021 StartupBlink figures and those afterwards. It will be of value to understand whether this is the case when looking at innovative startup activity more specifically related to the Pandemic.

A similar story may also be true for the Outputs/Outcomes and Knowledge Sustainability components, where these reflect the ability to attract and retain resources, and to generate knowledge on an ongoing basis. The cities in these regions may be best placed to 'recover' quickly as conditions move back towards those present before the Pandemic, but the figures cannot capture this currently. They may also be the key factors along with 5th Wave Knowledge Capital that will enable reorientation. Overall, it is notable that the WCIR is only related to the change in the overall entrepreneurial innovation score and not the individual elements.

Table 2a Pearson Correlations of Change in StartupBlink Ranks and Scores and World Competitiveness Index of Regions (WCIR) scores

	1. StartupBlink Global Score Change 2019 to 2020	2.	3.	4.	5.	6.	7.	8.
2. StartupBlink Global Quantity Score Change 2019 to 2020	0.362 (0.000)							
3. StartupBlink Global Quality Score Change 2019 to 2020	0.694 (0.000)	0.597 (0.000)						
4. StartupBlink Global Business Score 2020	0.630 (0.000)	-0.225 (0.000)	-0.116 (0.004)					
5. World Competitiveness Index of Regions (WCIR)	0.042 (0.292)	-0.064 (0.113)	0.030 (0.457)	0.037 (0.362)				
6. 5th Wave Knowledge Capital	0.057 (0.157)	0.004 (0.926)	0.069 (0.087)	0.009 (0.821)	0.710 (0.000)			
7. 4th Wave Knowledge Capital	0.076 (0.059)	0.000 (0.991)	0.087 (0.031)	0.018 (0.651)	0.720 (0.000)	0.585 (0.000)		
8. Outputs and Outcome Competitiveness	0.023 (0.561)	-0.067 (0.097)	0.000 (0.994)	0.040 (0.316)	0.887 (0.000)	0.429 (0.000)	0.516 (0.000)	
9. Knowledge Sustainability	0.005 (0.895)	-0.106 (0.008)	-0.020 (0.614)	0.041 (0.306)	0.868 (0.000)	0.412 (0.000)	0.411 (0.000)	0.788 (0.000)

Notes: p-values in parentheses

Table 2b – Spearman Rank Correlations of Change in StartupBlink Ranks and Scores and World Competitiveness Index of Regions (WCIR) scores

	1. StartupBlink Global Score Change 2019 to 2020	2.	3.	4.	5.	6.	7.	8.
2. StartupBlink Global Quantity Score Change 2019 to 2020	-0.273 (0.000)							
3. StartupBlink Global Quality Score Change 2019 to 2020	-0.332 (0.000)	0.482 (0.000)						
4. StartupBlink Global Business Score 2020	0.875 (0.000)	-0.403 (0.000)	-0.553 (0.000)					
5. World Competitiveness Index of Regions (WCIR)	0.082 (0.042)	-0.047 (0.245)	-0.023 (0.560)	0.067 (0.098)				
6. 5th Wave Knowledge Capital	0.071 (0.079)	-0.047 (0.239)	-0.015 (0.705)	0.037 (0.361)	0.724 (0.000)			
7. 4th Wave Knowledge Capital	0.092 (0.023)	-0.019 (0.630)	0.005 (0.907)	0.066 (0.100)	0.715 (0.000)	0.696 (0.000)		
8. Outputs and Outcome Competitiveness	0.071 (0.077)	-0.029 (0.465)	-0.017 (0.680)	0.064 (0.114)	0.832 (0.000)	0.402 (0.000)	0.457 (0.000)	
9. Knowledge Sustainability	0.043 (0.288)	-0.064 (0.114)	-0.019 (0.630)	0.076 (0.059)	0.860 (0.000)	0.422 (0.000)	0.402 (0.000)	0.801 (0.000)

Notes: p-values in parentheses

5. Cluster Analysis

Although there is some evidence that more competitive regions are more likely to host cities that have shown a better ability display a resilience in innovative entrepreneurial activities during the Pandemic, it is possible that particular elements of regional competitiveness play a stronger role in generating this resilience. In order to investigate whether this is the case, Two Step Cluster Analysis is used to identify whether there are particular groupings of cities.

It would be inappropriate to include the overall measure of competitiveness from the WCIR, as the four individual elements could not also be included, and would not allow insights into what helps generate resilience. Although it would be possible to just include the overall measures of entrepreneurial innovation activity from StartupBlink, this would also mask the particular patterns of resilience associated with different forms of competitiveness. As such the four WCIR elements and three components of entrepreneurial innovation are included as well as the change in the three components of entrepreneurial innovation. The inclusion of both the level and change in entrepreneurial innovation will help to establish whether or not groups of more resilient cities tend to be those starting from relatively high positions in the rankings or climbing from a lower starting point. Given the extreme atypical nature of the San Francisco Bay Area it was decided to exclude it from the analysis, as including it was found to skew cluster membership of the cluster it was included within. In reality it might be best considered as a cluster of 1.

The analysis identifies four clusters as shown in Table 3. There are quite different numbers of cities within each of the clusters ranging from 25 to 311. Table 3 shows the overall measures for the WCIR and StartupBlink scores, but this is for comparison and these were excluded from the analysis to identify the clusters. A description of each of the clusters of cities is provided below:

Cluster 1 – Entrepreneurially Innovative Global Leader Cities (Global Cities)

The first cluster includes a small group (25 cities) of the most entrepreneurially innovative cities with the greatest entrepreneurial innovative resilience. These cities are located in more competitive regions, but not necessarily the most competitive regions. For all the component measures of the StartupBlink measures these are the leading cities in 2020. They have also seen the largest average improvement in the StartupBlink quantity and quality measures between 2019 and 2020 suggesting the resilience of innovative activities, at least in the form of resistance, to the Pandemic. However, there has been a decline terms of the business environment, which is likely to reflect the restrictions put in place to control the pandemic, which made doing business harder. The regions hosting these cities are balanced in terms of their competitiveness with higher levels for all four components. These cities, therefore, are often leading cities in the most competitive regions in a variety of countries, rather than a spread of cities from the most competitive countries. As such, examples include: New York, Boston, Los Angeles and Washington DC in the US; London in the UK, Paris in France, Berlin in Germany; but also Moscow in Russia, Bangalore and New Dehli in India; and Beijing and Shanghai in China.

Cluster 2 – Less Resilient Advanced Entrepreneurially Innovative Cities (Advanced Cities)

The second cluster includes a larger group of cities (167 cities) that were also leading centres of entrepreneurially innovative activities in 2020. However, this group of cities have seen a drop in their entrepreneurial innovative activity in 2020 compared to 2019. As with the Global Leader Cities, this largely reflects deteriorating business conditions, but has not been compensated to the same extent through on-going innovative start-up activity either in terms of quantity or quality. In terms of their location, their regions are competitive but more skewed towards Knowledge Sustainability with investments in education and good digital access present, with perhaps a lesser presence from the private sector. Examples of these cities include: Portland and San Diego in the US; Montreal and Vancouver in Canada; Chennai in India; Helsinki in Finland; and Warsaw in Poland.

Cluster 3 – Overachieving Startup Innovation Cities (Overachieving Cities)

The third cluster of 115 cities are those that score less highly on the StartupBlink rankings and tend to rely on the quantity of innovative startups to a greater extent than their quality. The Pandemic has hit these cities primarily through their business environment, but the resistance to the Pandemic shock appears relatively high. The most striking aspect of these cities is that they are located in less competitive regions on average. They are the only group of cities that their average WCIR score is below the sample average (100) for those regions listed in the original full WCIR rankings (Huggins et al., 2014). Symptomatic of being located in less developed or emerging economies these regions score low on Outcome/Output Competitiveness and Knowledge Sustainability. These cities are a mix of those in more peripheral regions of countries such as Spain and Italy, secondary cities in East European countries, and lesser cities outside the most competitive regions of an extended set of BRIC economies as well as countries such as Turkey. This group includes cities such as: Alicante and Santander in Spain; Cagliari and Catania in Italy; Maribor in Slovenia; Varna, Bulgaria; Izmir in Turkey; plus Lucknow, Faridabad and Nagpur in India.

Cluster 4 – Underperforming Startup Innovation Cities (Underperforming Cities)

The final group of cities is the largest with 311 included in the group. These cities are almost identical in terms of their entrepreneurial innovation activity performance as the Overachieving Cities. They are relatively less entrepreneurially innovative in 2020 compared to the sample as a whole, but have seen reasonable resilience in terms of resistance to the Pandemic shock. However, with regard to regional competitiveness, on average, these cities are located in the most competitive regions. This is skewed heavily towards Knowledge Sustainability and Output/Outcome Competitiveness. This may reflect a focus on older establish businesses rather than entrepreneurial innovation. The regions are generally located in advanced economies and globally competitive regions, but not the most competitive, and the cities are generally smaller. This group includes cities such as: Nottingham and Portsmouth in the UK; Greenville and Roswell in the US; Ancona and Genoa in Italy.

Table 3 – Average values for clusters of cities identified

	Cluster 1	Cluster 2	Cluster 3	Cluster 4	Total
N	25	167	115	311	618
StartupBlink Global Total Score 2020	**21.863**	**3.391**	**0.367**	**0.309**	**2.025**
StartupBlink Global Quantity Score 2020	4.185	0.667	0.067	0.046	0.385
StartupBlink Global Quality Score 2020	14.712	0.748	0.047	0.036	0.824
StartupBlink Global Business Score 2020	2.965	1.975	0.253	0.229	0.816
StartupBlink Global Score Change 2019 to 2020	**2.139**	**-4.739**	**-1.546**	**-1.218**	**-2.095**
StartupBlink Global Quantity Score Change 2019 to 2020	0.523	0.143	0.021	0.012	0.070
StartupBlink Global Quality Score Change 2019 to 2020	5.807	0.196	-0.006	0.021	0.297
StartupBlink Global Business Score Change 2019 to 2020	-4.191	-5.079	-1.559	-1.248	-2.460
World Competitiveness Index of Regions (WCIR)	**176.7**	**152.7**	**29.8**	**190.1**	**149.6**
5th Wave Knowledge Capital	0.575	0.233	-0.293	0.366	0.216
4th Wave Knowledge Capital	0.422	0.211	-0.283	0.376	0.210
Outputs and Outcome Competitiveness	0.506	0.323	-0.752	0.683	0.312
Knowledge Sustainability	0.581	0.665	-0.580	1.022	0.610

Notes: Figures in bold were not included in the determination of cluster membership

Table 4 presents paired t-tests to establish if any significant differences in the presence of WCIR elements across the clusters identified. It should be noted that the elements of the WCIR are standardised, so are comparable in the sense of having identical means and standard deviations (Huggins et al., 2014). However, as the elements are capturing different measures using different scales it is not possible to make a direct comparison. For example, higher 4th Wave Knowledge Capital than Knowledge Sustainability does not mean that there are more jobs available than skilled employees to fill them. Instead, it means the measures - when compared to the average from all regions include in WCIR - indicate a relative over representation of the 4th Wave Knowledge Capital compared to Knowledge Sustainability. The implication may be the same; resources will be in a relatively short supply, but cannot be determined in absolute numbers.

Given the relatively small number of Global Cities (Cluster 1), and the relatively even contributions of the four elements, there are no significant differences between the elements. This means that although there are no significant differences between the Global Cities and the other more competitive Advanced (Cluster 2) and Underperforming (Cluster 4) Cities, their better performance may come from the combination of relevant industries providing knowledge spillovers to create innovation through entrepreneurs, as predicted by the knowledge spillover theory of entrepreneurship (Audretsch and Lehmann, 2005; Acs et al., 2013), as well as the resources in terms of skilled workers and access to global knowledge pipelines required (Bathelt et al. 2004).

In the case of the Advanced Cities (Cluster 2) the inputs created through Knowledge Sustainability are not necessarily matched by the 4th and 5th Wave Knowledge Capital present. This may mean that although the resources required for entrepreneurial innovation are present, the opportunities for knowledge spillovers are less. There is also a significant difference between Knowledge Sustainability and Outputs/Outcome Competitiveness. It is possible that these cities are creating more resources for entrepreneurial innovation in the form of young skilled workers than they have capacity to engage them fully either as employees or as entrepreneurs. The significant difference between Knowledge Sustainability and Outputs/Outcome Competitiveness may increase the problem with ambitious entrepreneurial and innovative individuals drawn to opportunities in the Global Cities (Ewers, 2007; Toma and Villares-Varela, 2019).

In the case of the Underperforming Cities (Cluster 4) a similar pattern is present to that observed for the Advanced Cities (Cluster 2). The resources being created seem in excess to the 4th and 5th Wave Knowledge Capital available to capture and put them to use. However, Outputs/Outcome Competitiveness is significantly greater than both 4th and 5th Wave Knowledge Capital, while this was only the case for 4th Wave Knowledge Capital in the Advanced Cities. The relatively higher outcomes achieved suggest that the Underperforming Cities may be employing resources with high rewards, but in sectors that may be less valuable for creating entrepreneurial innovation. Many of these cities are located in advanced economies such as the UK where success was previously based on manufacturing, such as steel in Sheffield, but more recently has seen a transition to service-based, and often retail and hospitality, activities.

The Overachieving Cities (Cluster 3) are likely to experience the opposite problem to the Advanced (Cluster 2) and Underperforming (Cluster 4) Cities. Rather than struggling to productively employ the resources created, these cities are more likely to have significantly higher levels of 4th and 5th Wave Knowledge Capital than Knowledge Sustainability. This

means that these cities will struggle to move into the Advanced Cities group in terms of generating higher levels of entrepreneurial knowledge. They achieve similar levels of performance to the Underperforming Cities by creating a greater quantity of entrepreneurial innovation, but without the necessary resources it is questionable if this can be converted into greater quality. Low levels of Outputs/Outcome Competitiveness also make it less possible to import these resources from other cities. It is worth remembering that this is not a national issue as the Global Cities include Sao Paulo (Brazil) and Mumbai (India).

Table 4 – Pairwise t-tests of differences in presence of WCIR Elements for Clusters

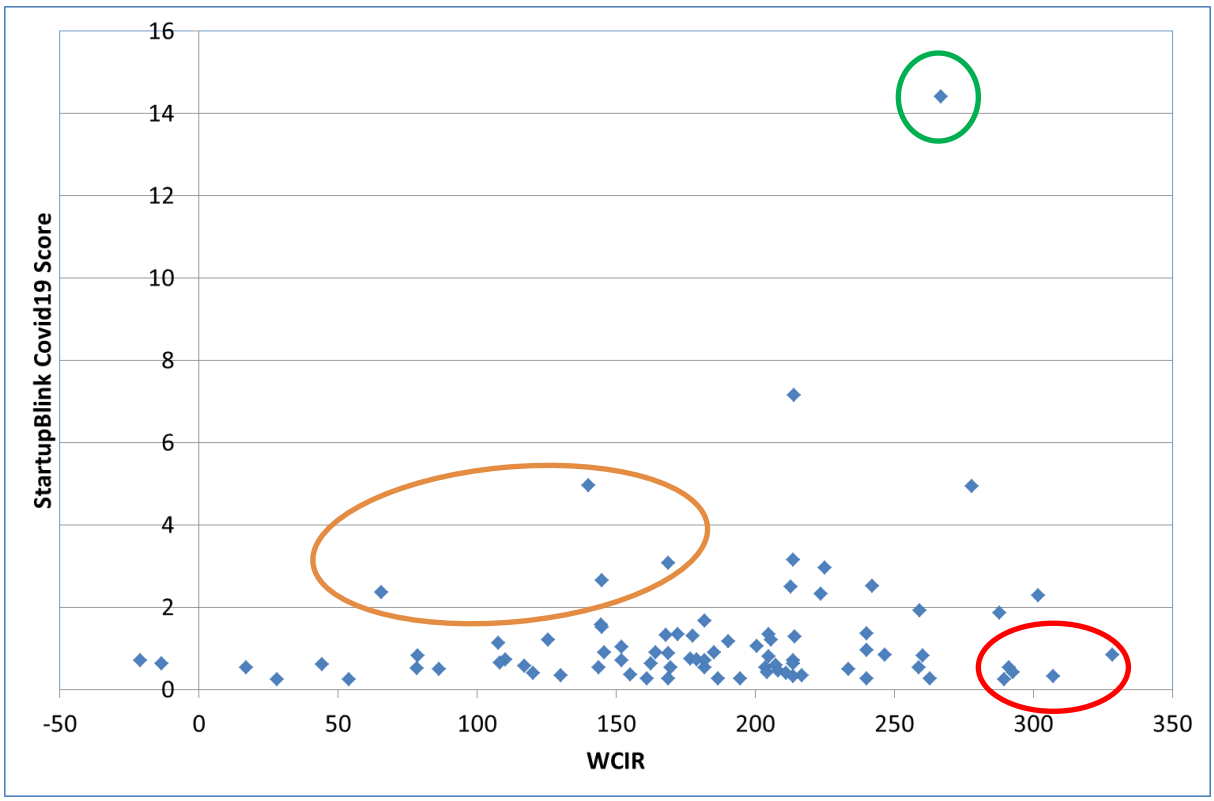
Cluster 1		5th Wave Knowledge Capital	4th Wave Knowledge Capital	Outputs and Outcome Competitiveness
	4th Wave Knowledge Capital			
	Outputs and Outcome Competitiveness			
	Knowledge Sustainability			
Cluster 2		5th Wave Knowledge Capital	4th Wave Knowledge Capital	Outputs and Outcome Competitiveness
	4th Wave Knowledge Capital			
	Outputs and Outcome Competitiveness		+ve	
	Knowledge Sustainability	+ve	+ve	+ve
Cluster 3		5th Wave Knowledge Capital	4th Wave Knowledge Capital	Outputs and Outcome Competitiveness
	4th Wave Knowledge Capital			
	Outputs and Outcome Competitiveness	-ve	-ve	
	Knowledge Sustainability	-ve	-ve	+ve
Cluster 4		5th Wave Knowledge Capital	4th Wave Knowledge Capital	Outputs and Outcome Competitiveness
	4th Wave Knowledge Capital			
	Outputs and Outcome Competitiveness	+ve	+ve	
	Knowledge Sustainability	+ve	+ve	+ve

Notes: t-tests comparing WCIR element in row to WCIR element in column; +ve indicates a positive significant difference at the 5% level or better; -ve indicates a negative significant difference at the 5% level or better

6. Cities and Covid-19 Innovation

As well as the broader measures of entrepreneurial innovation created by StartupBlink, a Covid Innovation Score is also available for a more restricted sample of cities across the globe. There are 83 cities that can be mapped onto WCIR regions in the data. Figure 4 presents the relationship between Covid Innovation Score and WCIR. As with the broader measures of entrepreneurial innovation activities covered previously, it is apparent that a relatively small number of cities account for much of the activity specifically related to Covid-19 innovation. These tend to be based in more competitive regions, but there are exceptions and there are many more cities in competitive regions that do not perform strongly in this regard.

Figure 4 – Scatter Chart of Covid-19 Innovation Score and WCIR



Circled in red are cities in competitive regions that 'underperform' with regard to Covid-19 innovation. These include a number of European capital cities: Brussels (Belgium); Stockholm (Sweden); Oslo (Norway) and Luxembourg City (Luxembourg). In addition, Tokyo in Japan also features as a city within a competitive region that has not shown the initial adaptation or re-orientation associated with the treatment of the virus. However, as noted previously, the data will only capture the initial adjustments to the Pandemic shock, and longer term changes to social and consumption patterns may emerge in the next few years.

There are some cities (circled in orange) that are based in moderately competitive regions with higher levels of Covid-19 innovation. These are cities that have been successful in innovating both in creating new products, but also in terms of policies trying to minimise the impact of Covid-19. HIEx by UNAIDS and StartupBlink's (2020) Covid-19 report provides examples such as Moscow (Russia) in terms of development of vaccines (Gamaleya Research Institute)

and genetic testing (Genetico) and health monitoring and diagnostics with artificial intelligence (Care Mentor AI and Botkin AI), and Seoul (South Korea) with highly effective track and trace technologies and approaches to limiting the spread of the virus (CoronaBoard, Gencurix Inc., and 1drop), as well as distance learning tools (Classum). Tel Aviv in Israel is associated with the success in vaccinating the population, but it has also developed diagnostic robots (Temi Robots). These are joined by Barcelona in Spain with innovations such as disinfection robots (PAL Robotics), crisis communication apps (Mocaplatform), and tests for Covid-19 (Grifols).

These examples show that cities that have adapted to the requirements of the Pandemic with innovative outputs are not necessarily based in the most competitive regions. It also shows that it is not necessarily those countries most strongly affected by Covid-19 that have undertaken the innovations to reduce the impact of the Pandemic. Table 5 presents the correlation coefficients of Covid-19 Innovation and the WCIR. Although the Pearson correlation coefficients suggest that overall regional competitiveness is associated with Covid-19 Innovation, this disappears in the Spearman Rank correlations, indicating that this is likely to be driven by the outliers.

With a sample of only 83 cities it is worth considering the relationships significant at the 10 percent level. In this case, there is some evidence that 4th Wave Knowledge Capital and Outputs/Outcome Competitiveness are associated with Covid-19 Innovation. Outputs/Outcome Competitiveness is likely to relate to the financial resources committed by public bodies in the city.

Table 5 – Pearson and Spearman Rank Correlation Coefficients of Covid-19 Innovation and WCIR

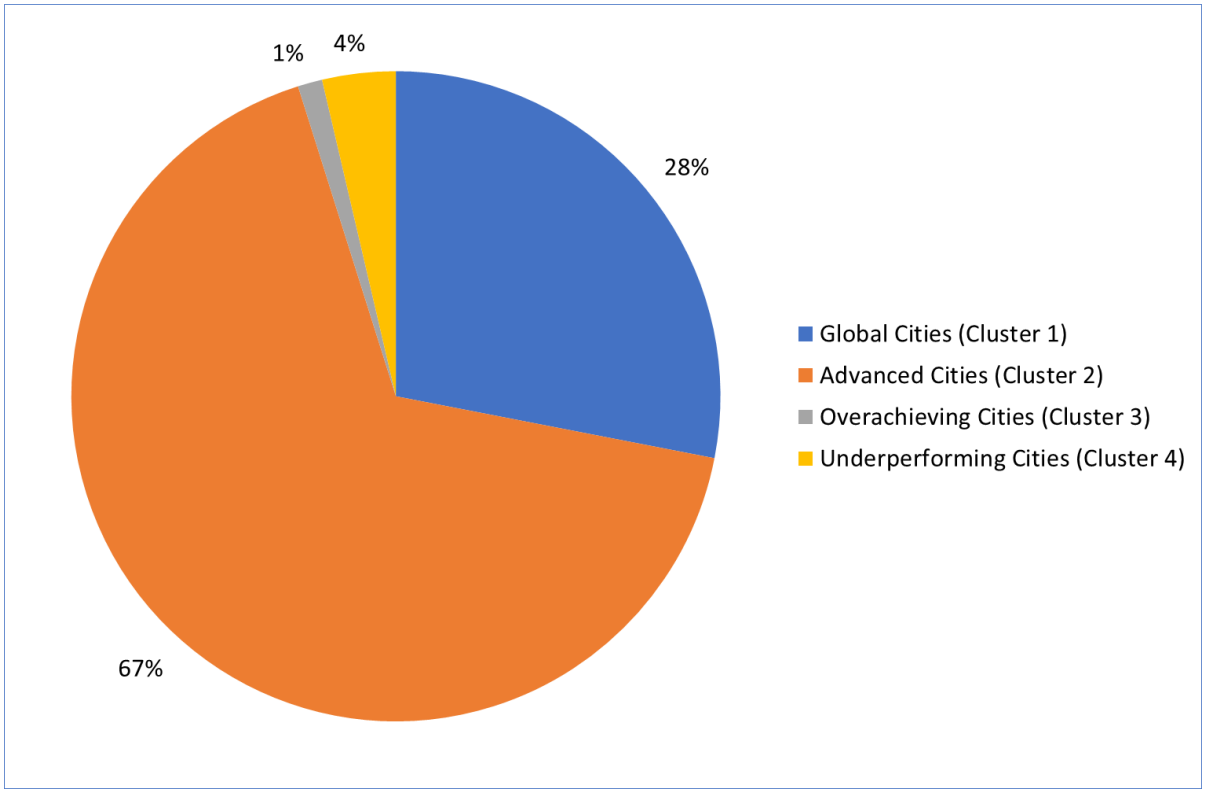
	Pearson	Spearman
World Competitiveness Index of Regions (WCIR)	0.193 (0.080)	0.126 (0.257)
5th Wave Knowledge Capital	0.110 (0.324)	0.101 (0.363)
4th Wave Knowledge Capital	0.080 (0.474)	0.189 (0.087)
Outputs and Outcome Competitiveness	0.253 (0.021)	0.199 (0.071)
Knowledge Sustainability	0.111 (0.320)	0.057 (0.612)

Notes: p-values in parentheses; $N = 83$

Given the relatively small number of cities in the Covid-19 Innovation rankings it is inappropriate to undertake any statistical examination of which of the clusters of cities identified earlier Covid-19 innovation is taking place within. However, it is of interest to see how this Covid-19 Innovation is spread across the clusters. At the same time it must be remembered that, as with the broader entrepreneurial innovation rankings, the outlier of the San Francisco Bay Area can also be regarded as a Global City (Cluster 1), although not included in the analysis.

Figure 5 presents the distribution of the cities across the clusters. Over two thirds of cities ranked by StartupBlink with regard to Covid-19 innovation are Advanced Cities (Cluster 2). The next largest group are the Global Cities (Cluster 1). Only Recife in Brazil appears from the Overachieving Cities (Cluster 3). From the Underperforming Cities (Cluster 4), the two Belgian cities of Leuven and Antwerp are joined by Hangzhou in China.

Figure 5 – Percentage of Covid-19 Innovation cities in each cluster



7. Conclusions

This report has examined the resilience of entrepreneurial innovation in the light of the Pandemic shock. It is shown that particular cities have dominated entrepreneurial innovation, and these are the cities that are most likely to have retained their innovative activity when impacted by the shock. They are also the cities that have adapted to engage in Covid Innovation.

The analysis shows that no straightforward positive relationship exists between entrepreneurial innovation with regional competitiveness. Closer investigation reveals that the most entrepreneurially innovative cities are Global Cities with balanced economic competitiveness, with both high-technology manufacturing and knowledge intensive services being well represented, as are the knowledge resources required to support them.

Underperforming Cities located in competitive regions displaying lower levels of entrepreneurial innovation appear to be somewhat 'subservient' to nearby Global Cities, sometimes in their own region, country or even neighbouring countries. Their competitiveness is more heavily skewed to Outputs/Outcome Competitiveness and Knowledge Sustainability, but with a lower presence of the knowledge intensive industries to employ these resources.

Although being located in a competitive region does not preclude lower entrepreneurial innovation, the opposite is rarely the case. Those cities located in less competitive regions are very rarely the most entrepreneurially innovative or exhibit high levels of innovative resilience. The minority that are tend to reflect those Global Cities located in the relatively most competitive regions of emerging economies, but where national competitiveness is lower.

The results of the analysis imply the policymakers in developed economies will once again have to consider whether attempts to spatially rebalance economies are practical or even desirable. This may mean ensuring that public R&D activity is located away from the Global Cities, and institutional changes such as subsidies or tax breaks are provided to encourage the (re)location of industries associated with 4th and 5th Wave Knowledge Capital. The second point relating to desirability reflects the fact that while the group of Global Cities identified in this study are largely situated in developed economies, some are also present in the BRIC economies, and success of a nation may rest on its small number of Global Cities.

For policymakers in emerging and developing economies, if they were to expand the education system this runs the risk of creating a similar 'brain drain' situation to that has been faced by more developed economies, whereby innovative young people are drawn to a small number of Global Cities, which again generates greater inequality within the country (Zhou et al., 2018). However, the failure to make such investments is likely to see a constant flow of the most important knowledge assets to Global Cities in other countries as the prestige of institutions and research facilities attracts key researchers from other countries.

Further work over time will be required to examine the ongoing resilience of cities across the world, as reorientation rather than resistance becomes more important. However, the initial patterns exhibited by the current data suggest that the different patterns of innovative resilience mean further shocks such as the Pandemic will focus resources and innovation within a smaller and smaller number of cities, potentially increasing inequality. In general, this means there must be a concern for all citizens not located in the Global Cities, as each shock appear to lead to a further slipping behind and less capability to recover.

References

Acs, Z. J. Audretsch, D. B. and Lehmann, E. E. (2013) 'The knowledge spillover theory of entrepreneurship', *Small Business Economics*, 41 (4), 757-774.

Aiginger, K. (2006) 'Competitiveness: from a dangerous obsession to a welfare creating ability with positive externalities', *Journal of Industry, Competition and Trade*, 6 (2), 161-171.

Aiginger, K. and Firgo, M. (2017) 'Regional competitiveness: connecting an old concept with new goals', in R. Huggins and P. Thompson (eds.), *Handbook of Regions and Competitiveness: Contemporary Theories and Perspectives on Economic Development*, Cheltenham: Edward Elgar, pp. 155-191.

Bathelt, H. Malmberg, A. and Maskell, P. (2004) 'Clusters and knowledge: local buzz, global pipelines and the process of knowledge creation', *Progress in Human Geography*, 28 (1), 31-56.

Ewers, M. C. (2007) 'Migrants, markets and multinationals: competition among world cities for the highly skilled', *GeoJournal*, 68, 119-130.

Florida, R. (2002) *The Rise of the Creative Class*, New York, NY: Basic Books.

Ganguly, A. Talukdar, A. and Chatterjee, D. (2019) 'Evaluating the role of social capital, tacit knowledge sharing, knowledge quality and reciprocity in determining innovation capability of an organization', *Journal of Knowledge Management*, 23 (6), 1105-1135.

Gertler, M. S. Geddie, K. Hatch, C. and Rekers, J. V. (2014) 'Attracting and retaining talent: evidence from Canada's city-regions', in J. Grant (ed.) *Seeking Talent for Creative Cities: The Social Dynamics of Innovation*, Toronto: University of Toronto Press, pp. 3-30.

Hall, P. and Preston, P. (1988) *The Carrier Wave: New Information Technology and the Geography of Innovation 1846-2003*, London: Unwin Hyman.

Hassink, R. (2010) 'Locked in decline? On the role of regional lock-ins in old industrial areas', In R. Boschma and R. Martin (eds.), *Handbook of Evolutionary Economic Geography*, Cheltenham: Edward Elgar, pp. 450-468.

Hatzichronoglou, T. (1997) 'Revision of the high-technology sector and product classification, *STI Working Papers*, 2, Paris: OECD.

HIEx by UNAIDS and StartupBlink (2020) *Covid-19 Innovation Report*, Tel Aviv: StartupBlink.

Huggins, R. Izushi, H. Prokop, D. and Thompson, P. (2014) *The Global Competitiveness of Regions*, Abingdon: Routledge.

Huggins, R. and Thompson, P. (2017) 'Introducing regional competitiveness and development: contemporary theories and perspectives', in R. Huggins and P. Thompson (eds.), *Handbook of Regions and Competitiveness: Contemporary Theories and Perspectives on Economic Development*, Cheltenham: Edward Elgar, pp. 1-31.

Huggins, R. and Thompson, P. (2021) 'Cities, onnovation and behavioural change: how the machine is evolving', in P. McCann and T. Vorley (eds.), *Productivity and the Pandemic: Challenges and Insights from COVID-19*, Cheltenham: Edward Elgar, pp. 173-190.

Laafia, I. (1999) 'Regional employment in high technology', *Statistics in Focus, Research and Development Theme*, 9 (1), Luxembourg: Eurostat.

Martin, R. (2012) 'Regional economic resilience, hysteresis and recessionary shocks', *Journal of Economic Geography*, 12 (1), 1-32.

Martin, R. and Sunley, P. (2011) 'Regional competitiveness: clusters or dynamic comparative advantage', in R. Huggins and H. Izushi (eds.), *Competition, Competitive Advantage and Clusters: The Ideas of Michael Porter*, Oxford: Oxford University Press, pp. 211-238.

Martin, R. and Sunley, P. (2017) 'Competitiveness and regional economic resilience', in R. Huggins and P. Thompson (eds.), *Handbook of Regions and Competitiveness: Contemporary Theories and Perspectives on Economic Development*, Cheltenham: Edward Elgar, pp.287-307.

Porter, M. E. (2007) 'Competitiveness implications for central Europe and the Czech Republic', Paper presented in Prague, 22 October.

Santamaría, L. Nieto, M. J. and Rodríguez, A. (2021) 'Failed and successful innovations: the role of geographical proximity and international diversity of partners in technological collaboration', *Technological Forecasting and Social Change*, 166, #120575.

StartupBlink (2020) *StartupBlink Startup Ecosystem Rankings 2020*, Tel Aviv: StartupBlink.

Stimson, R. Stough, R. R. and Salazar, W. (2009) *Leadership and Institutions in Regional Endogenous Development*, Cheltenham: Edward Elgar.

Storper, M. (1997) *The Regional World: Territorial Development in a Global Economy*, London: Guilford.

Toma, S. and Villares-Varela, M. (2018) 'The role of migration policies in the attraction and retention of international talent: the case of Indian researchers', *Sociology*, 53 (1), 52-68.

Zhou, Y. Guo, Y. and Liu, Y. (2018) 'High-level talent flow and its influence on regional unbalanced development in China', *Applied Geography*, 91, 89-98.

Appendix – List of Cities and Regions arranged by Country

Country	City	Region
Australia	Adelaide	South Australia
Australia	Brisbane	Queensland
Australia	Canberra	Australian Capital Territory
Australia	Darwin	Northern Territory
Australia	Gold Coast	Queensland
Australia	Hobart	Tasmania
Australia	Melbourne	Victoria
Australia	Perth	Western Australia
Australia	Sydney	New South Wales
Australia	Tamworth	New South Wales
Australia	Wollongong	New South Wales
Austria	Graz	Südösterreich
Austria	Innsbruck	Westösterreich
Austria	Klagenfurt am Wörthersee	Südösterreich
Austria	Linz	Westösterreich
Austria	Salzburg	Westösterreich
Austria	Vienna	Ostösterreich
Belgium	Antwerp	Vlaams Gewest
Belgium	Brussels	Région de Bruxelles-Capitale / Brussels Hoofdstedelijk Gewest
Belgium	Ghent	Vlaams Gewest
Belgium	Hasselt	Vlaams Gewest
Belgium	Leuven	Vlaams Gewest
Belgium	Liege	Région wallonne
Belgium	Mechelen	Vlaams Gewest
Belgium	Waterloo	Région wallonne
Brazil	Bauru	Sao Paulo
Brazil	Belo Horizonte	Minas Gerais
Brazil	Campinas	Sao Paulo
Brazil	Curitiba	Paraná
Brazil	Florianopolis	Santa Catarina
Brazil	Itajubá	Minas Gerais
Brazil	Joao Pessoa	Paraíba
Brazil	Joinville	Santa Catarina
Brazil	Juiz de Fora	Minas Gerais
Brazil	Londrina	Paraná
Brazil	Maceio	Alagoas
Brazil	Maringá	Paraná
Brazil	Natal	Rio Grande do Norte
Brazil	Porto Alegre	Rio Grande do Sul
Brazil	Recife	Pernambuco
Brazil	Ribeirao Preto	Sao Paulo

Appendix – Continued

Country	City	Region
Brazil	Rio de Janeiro	Rio de Janeiro
Brazil	Salvador	Bahia
Brazil	Santos	Sao Paulo
Brazil	Sao Paulo	Sao Paulo
Brazil	Sorocaba	Sao Paulo
Brazil	Uberlandia	Minas Gerais
Brazil	Vitoria	Holy Spirit
Bulgaria	Burgas	Severna i iztochna
Bulgaria	Plovdiv	Yugozapadna i yuzhna tsentralna
Bulgaria	Sofia	Yugozapadna i yuzhna tsentralna
Bulgaria	Varna	Severna i iztochna
Canada	Barrie	Ontario
Canada	Brantford	Ontario
Canada	Calgary	Alberta
Canada	Edmonton	Alberta
Canada	Fredericton	New Brunswick
Canada	Halifax	Nova Scotia
Canada	Hamilton	Ontario
Canada	Kelowna	British Columbia
Canada	Kingston	Ontario
Canada	Kitchener Waterloo	Ontario
Canada	Lloydminster	Saskatchewan
Canada	Milton	Ontario
Canada	Mississauga	Ontario
Canada	Moncton	New Brunswick
Canada	Montreal	Quebec
Canada	Ottawa	Ontario
Canada	Peterborough	Ontario
Canada	Quebec City	Quebec
Canada	Regina	Saskatchewan
Canada	Saint John	New Brunswick
Canada	Saskatoon	Saskatchewan
Canada	Sherbrooke	Quebec
Canada	Thunder Bay	Ontario
Canada	Toronto	Ontario
Canada	Vancouver	British Columbia
Canada	Victoria	British Columbia
Canada	Windsor	Ontario
Canada	Winnipeg	Manitoba
China	Beijing	Beijing
China	Guangzhou	Guangdong
China	Hangzhou	Zhejiang
China	Hong Kong	Hong Kong

Appendix – Continued

Country	City	Region
China	Shanghai	Shanghai
China	Shenzhen	Guangdong
China	Wuhan	Hubei
China	Xiamen	Fujian
China	Zhuhai	Guangdong
Colombia	Barranquilla	Atlántico
Colombia	Bogota	Bogotá, D.C.
Colombia	Medellin	Antioquia
Cyprus	Limassol	Cyprus
Cyprus	Nicosia	Cyprus
Cyprus	Paphos	Cyprus
Czechia	Brno	Střední Morava
Czechia	Ostrava	Moravskoslezsko
Czechia	Prague	Praha
Denmark	Aalborg	Nordjylland
Denmark	Aarhus	Midtjylland
Denmark	Copenhagen	Hovedstaden
Denmark	Hirtshals	Nordjylland
Denmark	Kolding	Syddanmark
Denmark	Odense	Syddanmark
Estonia	Tallinn	Estonia
Estonia	Tartu	Estonia
Finland	Helsinki	Etelä-Suomi
Finland	Jyvaskyla	Länsi-Suomi
Finland	Oulu	Pohjois-Suomi
Finland	Tampere	Länsi-Suomi
Finland	Turku	Etelä-Suomi
France	Aix-en-Provence	Méditerranée
France	Annecy	Centre-Est
France	Bordeaux	Sud-Ouest
France	Brest	Ouest
France	Grenoble	Centre-Est
France	Le Bourget-du-Lac	Centre-Est
France	Lille	Nord - Pas-de-Calais
France	Lyon	Centre-Est
France	Marseille	Méditerranée
France	Montpellier	Méditerranée
France	Nantes	Ouest
France	Nice	Méditerranée
France	Paris	Île de France
France	Rennes	Ouest
France	Strasbourg	Est
France	Toulouse	Sud-Ouest

Appendix – Continued

Country	City	Region
France	Tours	Bassin Parisien
France	Valbonne	Méditerranée
Germany	Aachen	Nordrhein-Westfalen
Germany	Augsburg	Bayern
Germany	Berlin	Berlin
Germany	Bonn	Nordrhein-Westfalen
Germany	Bremen	Bremen
Germany	Chemnitz	Sachsen
Germany	Cologne	Nordrhein-Westfalen
Germany	Darmstadt	Hessen
Germany	Dortmund	Nordrhein-Westfalen
Germany	Dresden	Sachsen
Germany	Dusseldorf	Nordrhein-Westfalen
Germany	Essen	Nordrhein-Westfalen
Germany	Frankfurt	Hessen
Germany	Hamburg	Hamburg
Germany	Hanover	Niedersachsen
Germany	Heidelberg	Baden-Württemberg
Germany	Jena	Thüringen
Germany	Karlsruhe	Baden-Württemberg
Germany	Kassel	Hessen
Germany	Kiel	Schleswig-Holstein
Germany	Leipzig	Sachsen
Germany	Mannheim	Baden-Württemberg
Germany	Munich	Bayern
Germany	Munster	Nordrhein-Westfalen
Germany	Nuremberg	Bayern
Germany	Oldenburg	Niedersachsen
Germany	Stuttgart	Baden-Württemberg
Germany	Wiesbaden	Hessen
Germany	Wurzburg	Bayern
Greece	Athens	Attiki
Greece	Ioannina	Voreia Ellada
Greece	Thessaloniki	Voreia Ellada
Hungary	Budapest	Közép-Magyarország
Hungary	Debrecen	Alföld és Észak
Hungary	Szeged	Alföld és Észak
Iceland	Reykjavik	Iceland
India	Ahmedabad	Gujarat
India	Allahabad	Uttar Pradesh
India	Bangalore	Karnataka
India	Bari	Rajasthan
India	Bhopal	Madhya Pradesh

Appendix – Continued

Country	City	Region
India	Bhubaneswar	Orissa
India	Chandigarh	Punjab
India	Chennai	Tamil Nadu
India	Coimbatore	Tamil Nadu
India	Dehradun	Uttarakhand
India	Faridabad	Haryana
India	Ghaziabad	Uttar Pradesh
India	Goa	Goa
India	Hyderabad	Andhra Pradesh
India	Jaipur	Rajasthan
India	Jalalabad	Punjab
India	Jodhpur	Rajasthan
India	Kanpur	Uttar Pradesh
India	Kochi	Kerala
India	Kolkata	West Bengal
India	Kozhikode	Kerala
India	Lucknow	Uttar Pradesh
India	Madurai	Tamil Nadu
India	Mumbai	Maharashtra
India	Nagpur	Maharashtra
India	Nashik	Maharashtra
India	New Delhi	Haryana
India	Nizamabad	Andhra Pradesh
India	Pune	Maharashtra
India	Puri	Orissa
India	Rajkot	Gujarat
India	Shikarpur	Uttar Pradesh
India	Shimla	Himachal Pradesh
India	Surat	Gujarat
India	Thiruvananthapuram	Kerala
India	Udaipur	Rajasthan
India	Vadodara	Gujarat
Ireland	Cork	Southern and Eastern
Ireland	Dublin	Southern and Eastern
Ireland	Dundalk	Border, Midland and Western
Ireland	Galway	Border, Midland and Western
Ireland	Limerick	Southern and Eastern
Ireland	Waterford	Southern and Eastern
Israel	Beer Sheva	Israel
Israel	Haifa	Israel
Israel	Jerusalem	Israel
Israel	Tel Aviv Area	Israel
Italy	Ancona	Marche

Appendix – Continued

Country	City	Region
Italy	Bergamo	Lombardia
Italy	Bologna	Emilia-Romagna
Italy	Bolzano	Provincia Autonoma Trento
Italy	Brescia	Lombardia
Italy	Cagliari	Sardegna
Italy	Catania	Sicilia
Italy	Cesena	Emilia-Romagna
Italy	Fermo	Marche
Italy	Florence	Toscana
Italy	Genoa	Liguria
Italy	Mantua	Lombardia
Italy	Milan	Lombardia
Italy	Modena	Emilia-Romagna
Italy	Naples	Campania
Italy	Palermo	Sicilia
Italy	Pavia	Lombardia
Italy	Perugia	Umbria
Italy	Pescara	Abruzzo
Italy	Pisa	Toscana
Italy	Rome	Lazio
Italy	Rovereto	Provincia Autonoma Trento
Italy	Siena	Toscana
Italy	Trento	Provincia Autonoma Trento
Italy	Treviso	Veneto
Italy	Turin	Piemonte
Italy	Udine	Friuli-Venezia Giulia
Italy	Venice	Veneto
Italy	Verona	Veneto
Japan	Kyoto	Kyoto
Japan	Osaka	Osaka
Japan	Tokyo	Tokyo
Kazakhstan	Almaty	Almaty
Kazakhstan	Astana	Akmola
Latvia	Riga	Latvia
Lithuania	Kaunas	Lithuania
Lithuania	Vilnius	Lithuania
Luxembourg	Luxembourg City	Luxembourg
Malta	Valletta	Malta
Netherlands	Amersfoort	West-Nederland
Netherlands	Amsterdam	West-Nederland
Netherlands	Arnhem	Oost-Nederland
Netherlands	Breda	Zuid-Nederland
Netherlands	Delft	West-Nederland

Appendix – Continued

Country	City	Region
Netherlands	Dordrecht	West-Nederland
Netherlands	Ede	Oost-Nederland
Netherlands	Eindhoven	Zuid-Nederland
Netherlands	Enschede	Oost-Nederland
Netherlands	Groningen	Noord-Nederland
Netherlands	Haarlem	West-Nederland
Netherlands	Heerlen	Zuid-Nederland
Netherlands	Hilversum	West-Nederland
Netherlands	IJsselstein	West-Nederland
Netherlands	Maastricht	Zuid-Nederland
Netherlands	Nijmegen	Oost-Nederland
Netherlands	Rotterdam	West-Nederland
Netherlands	The Hague	West-Nederland
Netherlands	Tilburg	Zuid-Nederland
Netherlands	Utrecht	West-Nederland
Netherlands	Zwolle	Oost-Nederland
New Zealand	Auckland	New Zealand
New Zealand	Christchurch	New Zealand
New Zealand	Wellington	New Zealand
Norway	Oslo	Norway
Norway	Stavanger	Norway
Norway	Trondheim	Norway
Poland	Gdańsk	Region Północny
Poland	Gdynia	Region Północny
Poland	Katowice	Region Poludniowy
Poland	Krakow	Region Poludniowy
Poland	Lodz	Region Centralny
Poland	Poznan	Region Północno-Zachodni
Poland	Rzeszow	Region Wschodni
Poland	Szczecin	Region Północno-Zachodni
Poland	Warsaw	Region Centralny
Poland	Wrocław	Region Poludniowo-Zachodni
Portugal	Braga	Continente
Portugal	Coimbra	Continente
Portugal	Funchal	Região Autónoma da Madeira
Portugal	Guimaraes	Continente
Portugal	Leiria	Continente
Portugal	Lisbon	Continente
Portugal	Porto	Continente
Qatar	Doha	Qatar
Romania	Brasov	Macroregiunea unu
Romania	Bucharest	Macroregiunea trei
Romania	Cluj-Napoca	Macroregiunea unu

Appendix – Continued

Country	City	Region
Romania	Constanta	Macroregiunea doi
Romania	Craiova	Macroregiunea patru
Romania	Iași	Macroregiunea doi
Romania	Sibiu	Macroregiunea unu
Romania	Timisoara	Macroregiunea patru
Russia	Chelyabinsk	Chelyabinsk Oblast
Russia	Kazan	Tatarstan, Republic of
Russia	Moscow	Moscow
Russia	Novosibirsk	Novosibirsk Oblast
Russia	Saint Petersburg	Leningrad Oblast
Russia	Ufa	Bashkortostan, Republic of
Russia	Yekaterinburg	Sverdlovsk Oblast
Saudi Arabia	Riyadh	Al-Riyadh
Singapore	Singapore City	Singapore
Slovakia	Bratislava	Bratislavský kraj
Slovakia	Kosice	Východné Slovensko
Slovenia	Ljubljana	Zahodna Slovenija
Slovenia	Maribor	Vzhodna Slovenija
Slovenia	Novo mesto	Vzhodna Slovenija
South Korea	Seoul	Seoul
Spain	A Coruna	Noroeste
Spain	Alicante	Este
Spain	Barcelona	Este
Spain	Bilbao	Noreste
Spain	Las Palmas de Gran Canaria	Canarias
Spain	Madrid	Comunidad de Madrid
Spain	Malaga	Sur
Spain	Marbella	Sur
Spain	Murcia	Sur
Spain	Oviedo	Noroeste
Spain	Palma de Mallorca	Este
Spain	Pamplona	Noreste
Spain	Santa Cruz de Tenerife	Canarias
Spain	Santander	Noroeste
Spain	Seville	Sur
Spain	Tarragona	Este
Spain	Valencia	Este
Spain	Zaragoza	Noreste
Sweden	Gothenburg	Västsverige
Sweden	Helsingborg	Sydsverige
Sweden	Jonkoping	Småland med öarna

Appendix – Continued

Country	City	Region
Sweden	Karlskrona	Sydsverige
Sweden	Linkoping	Östra Mellansverige
Sweden	Lund	Sydsverige
Sweden	Malmö	Sydsverige
Sweden	Stockholm	Stockholm
Sweden	Uppsala	Östra Mellansverige
Sweden	Vasteras	Östra Mellansverige
Switzerland	Basel	Switzerland
Switzerland	Bern	Switzerland
Switzerland	Geneva	Switzerland
Switzerland	Lausanne	Switzerland
Switzerland	Lugano	Switzerland
Switzerland	Zug	Switzerland
Switzerland	Zurich	Switzerland
Turkey	Ankara	Central Anatolia
Turkey	Istanbul	East Marmara
Turkey	Izmir	Aegean
United Arab Emirates	Abu Dhabi	Abu Dhabi
United Arab Emirates	Dubai	Dubai
United Kingdom	Andover	South East
United Kingdom	Bath	South West
United Kingdom	Belfast	Northern Ireland
United Kingdom	Blackpool	North West
United Kingdom	Bournemouth	South West
United Kingdom	Bradford	Yorkshire and The Humber
United Kingdom	Brighton	South East
United Kingdom	Bristol	South West
United Kingdom	Cambridge	East of England
United Kingdom	Cardiff	Wales
United Kingdom	Corby	East Midlands
United Kingdom	Coventry	West Midlands
United Kingdom	Croydon	London
United Kingdom	Derby	East Midlands
United Kingdom	Edinburgh	Scotland
United Kingdom	Elgin	Scotland
United Kingdom	Exeter	South West
United Kingdom	Glasgow	Scotland
United Kingdom	Gloucester	South West
United Kingdom	Guildford	South East
United Kingdom	Huddersfield	Yorkshire and The Humber
United Kingdom	Lancaster	North West

Appendix – Continued

Country	City	Region
United Kingdom	Leeds	Yorkshire and The Humber
United Kingdom	Leicester	East Midlands
United Kingdom	Lichfield	West Midlands
United Kingdom	Liverpool	North West
United Kingdom	London	London
United Kingdom	Luton	East of England
United Kingdom	Manchester	North West
United Kingdom	Middlesbrough	North East
United Kingdom	Milton Keynes	South East
United Kingdom	Newcastle upon Tyne	North East
United Kingdom	Northampton	East Midlands
United Kingdom	Norwich	East of England
United Kingdom	Nottingham	East Midlands
United Kingdom	Oxford	South East
United Kingdom	Portsmouth	South East
United Kingdom	Sheffield	Yorkshire and The Humber
United Kingdom	Slough	South East
United Kingdom	Southampton	South East
United Kingdom	Swansea	Wales
United Kingdom	Watford	East of England
United Kingdom	Wokingham	South East
United Kingdom	Woodbridge	East of England
United Kingdom	Woolsington	North East
United Kingdom	Worcester	West Midlands
United States	Akron	Akron, OH MSA
United States	Alabaster	Birmingham-Hoover, AL MSA
United States	Alameda	San Francisco-Oakland-Fremont, CA MSA
United States	Albany	Albany-Schenectady-Troy, NY MSA
United States	Albuquerque	Albuquerque, NM MSA
United States	Aliso Viejo	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Allentown	Allentown-Bethlehem-Easton, PA-NJ MSA
United States	Anderson	Greenville-Mauldin-Easley, SC MSA
United States	Annapolis	Baltimore-Towson, MD MSA
United States	Antioch	San Francisco-Oakland-Fremont, CA MSA
United States	Arkansas	Little Rock-North Little Rock-Conway, AR MSA
United States	Atlanta	Atlanta-Sandy Springs-Marietta, GA MSA
United States	Aurora	Denver-Aurora-Broomfield, CO MSA
United States	Austin	Austin-Round Rock-San Marcos, TX MSA
United States	Bakersfield	Bakersfield-Delano, CA MSA
United States	Baltimore	Baltimore-Towson, MD MSA
United States	Baton Rouge	Baton Rouge, LA MSA
United States	Bellevue	Seattle-Tacoma-Bellevue, WA MSA

Appendix – Continued

Country	City	Region
United States	Bethlehem	Allentown-Bethlehem-Easton, PA-NJ MSA
United States	Birmingham	Birmingham-Hoover, AL MSA
United States	Bloomfield	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	Boise	Boise City-Nampa, ID MSA
United States	Boston Area	Boston-Cambridge-Quincy, MA-NH MSA
United States	Brentwood	San Francisco-Oakland-Fremont, CA MSA
United States	Bridgeport	Bridgeport-Stamford-Norwalk, CT MSA
United States	Brookhaven	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	Brookline	Boston-Cambridge-Quincy, MA-NH MSA
United States	Broomfield	Denver-Aurora-Broomfield, CO MSA
United States	Buffalo	Buffalo-Niagara Falls, NY MSA
United States	Buffalo Grove	Chicago-Joliet-Naperville, IL-IN-WI MSA
United States	Calabasas	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Camarillo	Oxnard-Thousand Oaks-Ventura, CA MSA
United States	Cape Coral	Cape Coral-Fort Myers, FL MSA
United States	Centennial	Denver-Aurora-Broomfield, CO MSA
United States	Chantilly	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
United States	Charleston	Charleston-North Charleston-Summerville, SC MSA
United States	Charlotte	Charlotte-Gastonia-Rock Hill, NC-SC MSA
United States	Chattanooga	Chattanooga, TN-GA MSA
United States	Cheshire	New Haven-Milford, CT MSA
United States	Chicago	Chicago-Joliet-Naperville, IL-IN-WI MSA
United States	Cincinnati	Cincinnati-Middletown, OH-KY-IN MSA
United States	Cleveland	Cleveland-Elyria-Mentor, OH MSA
United States	Colorado Springs	Colorado Springs, CO MSA
United States	Columbia	Columbia, SC MSA
United States	Columbus	Columbus, OH MSA
United States	Concord	Boston-Cambridge-Quincy, MA-NH MSA
United States	Conroe	Houston-Sugar Land-Baytown, TX MSA
United States	Cuyahoga Falls	Akron, OH MSA
United States	Dallas-Fort Worth	Dallas-Fort Worth-Arlington, TX MSA
United States	Danbury	Bridgeport-Stamford-Norwalk, CT MSA
United States	Danville	San Francisco-Oakland-Fremont, CA MSA
United States	Davis	Sacramento--Arden-Arcade--Roseville, CA MSA
United States	Dayton	Dayton, OH MSA
United States	Denver	Denver-Aurora-Broomfield, CO MSA
United States	Des Moines	Des Moines-West Des Moines, IA MSA
United States	Detroit	Detroit-Warren-Livonia, MI MSA
United States	Draper	Salt Lake City, UT Metropolitan Statistical Area, US

Appendix – Continued

Country	City	Region
United States	Easton	Allentown-Bethlehem-Easton, PA-NJ MSA
United States	Edison	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	Edmond	Oklahoma City, OK MSA
United States	El Paso	El Paso, TX MSA
United States	Elk Grove	Sacramento--Arden-Arcade--Roseville, CA MSA
United States	Emeryville	San Francisco-Oakland-Fremont, CA MSA
United States	Englewood	Denver-Aurora-Broomfield, CO MSA
United States	Folsom	Sacramento--Arden-Arcade--Roseville MSA
United States	Fort Myers	Cape Coral-Fort Myers, FL MSA
United States	Franklin	Nashville-Davidson--Murfreesboro--Franklin, TN MSA
United States	Frederick	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
United States	Garden City	Detroit-Warren-Livonia, MI MSA
United States	Grand Rapids	Grand Rapids-Wyoming, MI MSA
United States	Great Neck	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	Greensboro	Greensboro-High Point, NC MSA
United States	Greenville	Greenville-Mauldin-Easley, SC MSA
United States	Harrisburg	Harrisburg-Carlisle, PA MSA
United States	Hartford	Hartford-West Hartford-East Hartford, CT MSA
United States	Hayward	San Francisco-Oakland-Fremont, CA MSA
United States	Henderson	Las Vegas-Paradise, NV MSA
United States	Herndon	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
United States	Honolulu	Honolulu, HI MSA
United States	Horsham	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA
United States	Houston	Houston-Sugar Land-Baytown, TX MSA
United States	Indianapolis	Indianapolis-Carmel, IN MSA
United States	Issaquah	Seattle-Tacoma-Bellevue, WA MSA
United States	Jacksonville	Jacksonville, FL MSA
United States	Jupiter	Miami-Fort Lauderdale-Pompano Beach, FL MSA
United States	Kansas City	Kansas City, MO-KS MSA
United States	Kent	Seattle-Tacoma-Bellevue, WA MSA
United States	King of Prussia	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA
United States	Kirkland	Seattle-Tacoma-Bellevue, WA MSA
United States	Knoxville	Knoxville, TN MSA
United States	Laguna Beach	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Laguna Hills	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Laguna Niguel	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Lake Forest	Los Angeles-Long Beach-Santa Ana, CA MSA

Appendix – Continued

Country	City	Region
United States	Lake Oswego	Portland-Vancouver-Hillsboro, OR-WA MSA
United States	Lancaster	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Larkspur	San Francisco-Oakland-Fremont, CA MSA
United States	Las Vegas	Las Vegas-Paradise, NV MSA
United States	Lawrenceville	Atlanta-Sandy Springs-Marietta, GA MSA
United States	Leesburg	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
United States	Lisle	Chicago-Joliet-Naperville, IL-IN-WI MSA
United States	Little Rock	Little Rock-North Little Rock-Conway, AR MSA
United States	Littleton	Denver-Aurora-Broomfield, CO MSA
United States	Livermore	San Francisco-Oakland-Fremont, CA MSA
United States	Livingston	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	Los Angeles Area	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Louisville	Louisville/Jefferson County, KY-IN MSA
United States	Madison	Madison, WI MSA
United States	Malibu	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Manassas	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
United States	Marietta	Atlanta-Sandy Springs-Marietta, GA MSA
United States	Marlborough	Boston-Cambridge-Quincy, MA-NH MSA
United States	Memphis	Memphis, TN-MS-AR MSA
United States	Miami Area	Miami-Fort Lauderdale-Pompano Beach, FL MSA
United States	Middletown	Cincinnati-Middletown, OH-KY-IN MSA
United States	Midvale	Salt Lake City, UT MSA
United States	Millbrae	San Francisco-Oakland-Fremont, CA MSA
United States	Milwaukee	Milwaukee-Waukesha-West Allis, WI MSA
United States	Minneapolis	Minneapolis-St. Paul-Bloomington, MN-WI MSA
United States	Mission Viejo	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Montclair	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	Mooresville	Charlotte-Gastonia-Rock Hill, NC-SC MSA
United States	Morristown	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	Nashville	Nashville-Davidson--Murfreesboro--Franklin, TN MSA
United States	Needham	Boston-Cambridge-Quincy, MA-NH MSA
United States	New Brunswick	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	New Haven	New Haven-Milford, CT MSA
United States	New Orleans	New Orleans-Metairie-Kenner, LA MSA
United States	New York	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA

Appendix – Continued

Country	City	Region
United States	Newport News	Virginia Beach-Norfolk-Newport News, VA-NC MSA
United States	Norcross	Atlanta-Sandy Springs-Marietta, GA MSA
United States	Norfolk	Virginia Beach-Norfolk-Newport News, VA-NC MSA
United States	Northbrook	Chicago-Joliet-Naperville, IL-IN-WI MSA
United States	Norwalk	Bridgeport-Stamford-Norwalk, CT MSA
United States	Novato	San Francisco-Oakland-Fremont, CA MSA
United States	Novi	Detroit-Warren-Livonia, MI MSA
United States	Oklahoma City	Oklahoma City, OK MSA
United States	Omaha	Omaha-Council Bluffs, NE-IA MSA
United States	Oregon City	Portland-Vancouver-Hillsboro, OR-WA MSA
United States	Orlando	Orlando-Kissimmee-Sanford, FL MSA
United States	Oxnard	Oxnard-Thousand Oaks-Ventura, CA MSA
United States	Philadelphia	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA
United States	Phoenix	Phoenix-Mesa-Glendale, AZ MSA
United States	Pittsburgh	Pittsburgh, PA MSA
United States	Portland	Portland-Vancouver-Hillsboro, OR-WA MSA
United States	Prairie Village	Kansas City, MO-KS MSA
United States	Providence	Providence-New Bedford-Fall River, RI-MA MSA
United States	Raleigh Durham	Raleigh-Cary, NC MSA
United States	Rancho Cordova	Sacramento--Arden-Arcade--Roseville, CA MSA
United States	Rancho Santa Margarita	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Redmond	Seattle-Tacoma-Bellevue, WA MSA
United States	Renton	Seattle-Tacoma-Bellevue, WA MSA
United States	Reston	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
United States	Richmond	Richmond, VA MSA
United States	Rochester	Rochester, NY MSA
United States	Rocklin	Sacramento--Arden-Arcade--Roseville, CA MSA
United States	Roswell	Atlanta-Sandy Springs-Marietta, GA MSA
United States	Sacramento	Sacramento--Arden-Arcade--Roseville, CA MSA
United States	Salem	Boston-Cambridge-Quincy, MA-NH MSA
United States	Salt Lake City	Salt Lake City, UT MSA
United States	San Anselmo	San Francisco-Oakland-Fremont, CA MSA
United States	San Antonio	San Antonio-New Braunfels, TX MSA
United States	San Bruno	San Francisco-Oakland-Fremont, CA MSA
United States	San Clemente	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	San Diego	San Diego-Carlsbad-San Marcos, CA MSA
United States	San Francisco Bay	San Francisco-Oakland-Fremont, CA MSA
United States	San Juan Capistrano	Los Angeles-Long Beach-Santa Ana, CA MSA

Appendix – Continued

Country	City	Region
United States	San Rafael	San Francisco-Oakland-Fremont, CA MSA
United States	San Ramon	San Francisco-Oakland-Fremont, CA MSA
United States	Santa Clarita	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Sarasota	North Port-Bradenton-Sarasota, FL MSA
United States	Saratoga	San Jose-Sunnyvale-Santa Clara, CA MSA
United States	Saratoga Springs	Albany-Schenectady-Troy, NY MSA
United States	Schenectady	Albany-Schenectady-Troy, NY MSA
United States	Scranton	Scranton--Wilkes-Barre, PA MSA
United States	Seattle	Seattle-Tacoma-Bellevue, WA MSA
United States	Shelton	Bridgeport-Stamford-Norwalk, CT MSA
United States	Simi Valley	Oxnard-Thousand Oaks-Ventura, CA MSA
United States	South Jordan	Salt Lake City, UT MSA
United States	South Lake Tahoe	Sacramento--Arden-Arcade--Roseville, CA MSA
United States	St Charles	St. Louis, MO-IL MSA
United States	St. Louis	St. Louis, MO-IL MSA
United States	Stamford	Bridgeport-Stamford-Norwalk, CT MSA
United States	Sterling	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
United States	Sterling Heights	Detroit-Warren-Livonia, MI MSA
United States	Stillwater	Minneapolis-St. Paul-Bloomington, MN-WI MSA
United States	Stony Brook	New York-Northern New Jersey-Long Island, NY-NJ-PA MSA
United States	Sudbury	Boston-Cambridge-Quincy, MA-NH MSA
United States	Suwanee	Atlanta-Sandy Springs-Marietta, GA MSA
United States	Syracuse	Syracuse, NY MSA
United States	Tacoma	Seattle-Tacoma-Bellevue, WA MSA
United States	Tampa Bay Area	Tampa-St. Petersburg-Clearwater, FL MSA
United States	Texas City	Houston-Sugar Land-Baytown, TX MSA
United States	The Woodlands	Houston-Sugar Land-Baytown, TX MSA
United States	Thousand Oaks	Oxnard-Thousand Oaks-Ventura, CA MSA
United States	Toledo	Toledo, OH MSA
United States	Troy	Detroit-Warren-Livonia, MI MSA
United States	Tulsa	Tulsa, OK MSA
United States	Tustin	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Ventura	Oxnard-Thousand Oaks-Ventura, CA MSA
United States	Virginia Beach	Virginia Beach-Norfolk-Newport News, VA-NC MSA
United States	Washington DC Area	Washington-Arlington-Alexandria, DC-VA-MD-WV MSA
United States	Wellesley	Boston-Cambridge-Quincy, MA-NH MSA
United States	West Des Moines	Des Moines-West Des Moines, IA MSA
United States	West Valley City	Salt Lake City, UT MSA
United States	Westborough	Worcester, MA MSA

Appendix – Continued

Country	City	Region
United States	Westlake Village	Los Angeles-Long Beach-Santa Ana, CA MSA
United States	Westminster	Denver-Aurora-Broomfield, CO MSA
United States	Westport	Bridgeport-Stamford-Norwalk, CT MSA
United States	Wichita	Wichita, KS MSA
United States	Wilkes Barre	Scranton--Wilkes-Barre, PA MSA
United States	Williamsburg	Virginia Beach-Norfolk-Newport News, VA-NC MSA
United States	Wilsonville	Portland-Vancouver-Hillsboro, OR-WA MSA
United States	Worcester	Worcester, MA MSA

Notes: MSA – Metropolitan Statistical Area