

GLOBAL STOCKHOLM

PROFILING THE CAPITAL REGION'S INTERNATIONAL
COMPETITIVENESS AND CONNECTIONS



Stockholm Chamber of Commerce



GLOBAL CITIES INITIATIVE

A Joint Project of Brookings and JPMorgan Chase

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SUMMARY

The Stockholm Capital Region operates from a position of global strength. The region's focus on core economic assets—an educated and advanced workforce, highly innovative multinational companies and universities, and modern infrastructure—has positioned it as one of the world's most productive metropolitan economies. Yet Stockholm's enviable position is not guaranteed, especially as globalization, technological change, and demographic forces reset the international landscape. This report, developed as part of the Global Cities Initiative, a joint project of Brookings and JPMorgan Chase, provides a framework for the Stockholm Capital Region to better understand its competitive position in the global economy, offering information and insights to inform regional leaders working to sustain the region's prosperity. Its key findings are:

The Stockholm Capital Region is a wealthy and productive economy that has generated rising living standards for the majority of its population. The Stockholm Capital Region, which includes Stockholm and Uppsala counties and 2.5 million residents, accounts for just over one-quarter of Sweden's population and generates over 30 percent of national economic output. On the core metrics of economic health, the region has performed quite well. Compared to Sweden and eight advanced regional economies in Europe and the United States, the Stockholm Capital Region outperformed on employment and output growth since 2000. These gains have outpaced population and labor force growth, indicating that the region's high labor productivity is translating to rising living standards. That these income gains are more evenly distributed across Stockholm's residents than in global peers indicates that the region is not only growing, but that a wide swath of its population is benefiting. In a composite economic performance index, the capital region placed third among peers.

The Stockholm Capital Region is well-positioned to take advantage of changing market, technology,

and demographic trends, but to do so it must focus on the core drivers and enablers of competitiveness. A competitive region is one in which firms can compete successfully in the global economy while supporting high and rising living standards for local households. Globally competitive traded sectors, innovation ecosystems, and skilled labor are the key drivers of overall productivity, employment creation, and income growth. These drivers are supported by enablers: well-connected, spatially efficient infrastructure and a reliable governance structure and business environment. The Stockholm Capital Region boasts notable strengths and significant opportunities to better deploy these five factors to increase its global competitiveness.




TRADE: The Stockholm Capital Region's tradable sector, anchored by its advantages in technology-intensive industries, is an important growth driver, but is limited by the low participation of small and mid-sized firms in trade. The traded sector accounts for 34 percent and 46 percent of local jobs and output, respectively. Reflecting the region's role as a major trading center, Stockholm accounted for 28.8 percent of Sweden's exports,



42.5 percent of imports, and 35.6 percent of total national goods trade. Three advanced manufacturing industries—electronics and equipment, chemicals, and transportation equipment—generated over half of regional goods exports. But the largest export category was refined petroleum products, a dependence that declining commodity prices could threaten. All of these major export sectors tend to be dominated by large firms. Small and mid-sized companies account for 95 percent of Stockholm's firm base but only 26 percent of exports, suggesting the export pipeline could be expanded. FDI inflows affirm the Capital Region's services strengths in communications, information technology, and finance. In a composite trade index, the capital region placed fifth among peers.

 **INNOVATION: Across several dimensions, the Stockholm Capital Region's innovation assets are strong, but it can take further steps to boost the innovative capacity of its smaller firms.** The region's innovation ecosystem—its collection of technical talent, firms, universities, research institutes, and industry intermediaries—outperforms metropolitan peers on metrics of commercial inventions and university-industry scientific collaborations.

That only five companies account for 53 percent of patents indicates, however, that innovative activities need to be extended to smaller firms. Venture capital investment provides an avenue to boost small-firm innovation, and Stockholm has attracted \$2.5 billion since 2005, a sum that places it in the middle of its peer group. In a composite innovation index, the capital region placed fourth among peers.

 **TALENT: The region's workforce is among the most educated in the world, but demographic shifts suggest looming talent shortages.**

The Stockholm Capital Region benefits from an incredibly well-educated labor pool. Of the 15 and older population, 42 percent have obtained at least a post-secondary education, second highest among peer metro areas. Yet as the region ages, future workforce shortages loom, threatening the competitiveness of talent-driven industries. Foreign migration could help address this coming shortfall if these new entrants are successfully, integrated, educated, and employed. In a composite talent index, the capital region placed fifth among peers.



INFRASTRUCTURE: The Stockholm Capital Region's global infrastructure connections—including freight, aviation, and broadband systems—are world-class, but insufficient housing supply is a challenge.

Firms and workers benefit from some of the best external infrastructure connectivity in the world. Sweden's efficient freight and logistics systems offer cost-effective trade routes for local firms. Aviation passenger flows in the Capital Region totaled 30 million in 2014, and have increased at the second fastest clip among global peers since 2004. Broadband speeds are among the world's fastest. Yet, the region's housing and land use regime could be improved. The built environment is not keeping pace with the significant demand among households to live in Stockholm, raising housing prices and limiting labor mobility. Rent reforms and denser housing development can help ease demand pressures. In a composite infrastructure index, the capital region placed fourth among peers.

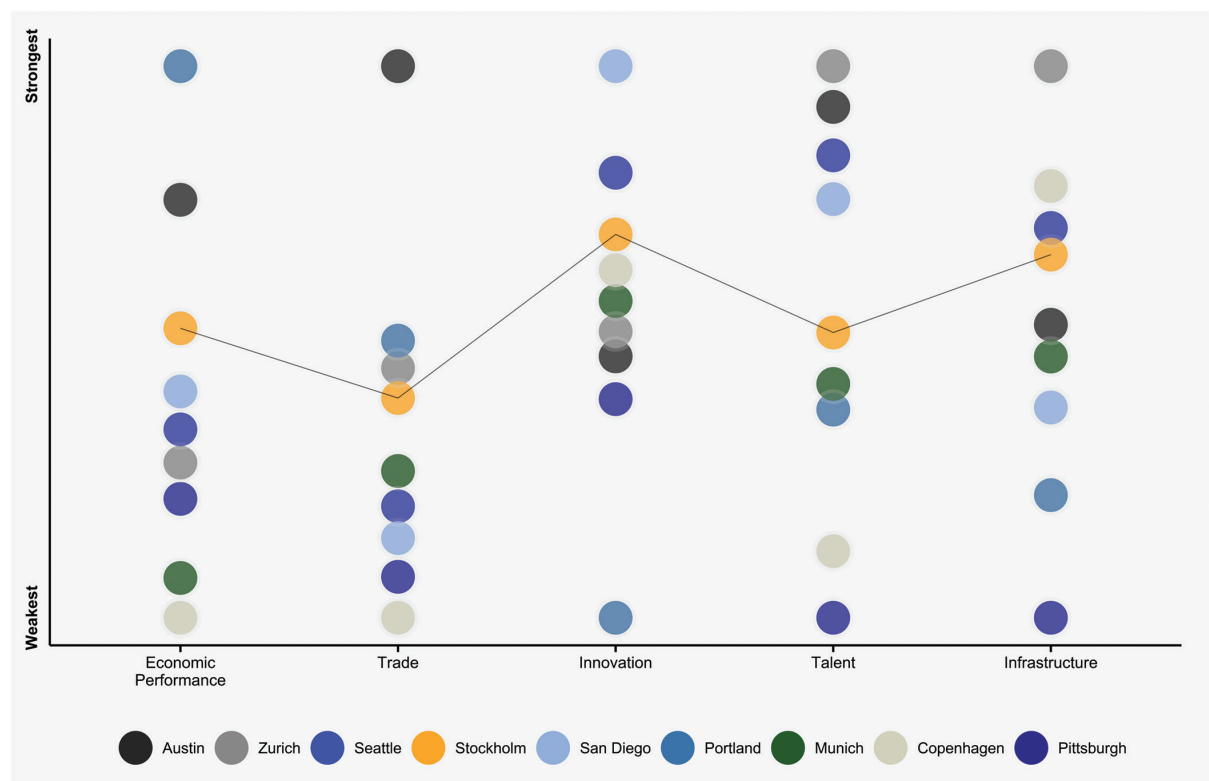


GOVERNANCE: The region's policy and regulatory environment is quite conducive to business success.

Regional governance is strong in the Stockholm Capital Region. While not to the same degree as global peer cities, local governments have fiscal autonomy. Outside of government, there is an emerging network of private and civic institutions working with their public sector colleagues to position the Stockholm Capital Region globally. The policy environment is quite conducive to business, with taxes and the legal and regulatory environment around credit being the major issues for Stockholm firms.

The Stockholm Capital Region has considerable competitive strengths. To better its future, the region can bolster its position by bringing more firms into the export pipeline, expanding its innovation ecosystem to include more small and mid-sized firms, educating and integrating immigrants into the workforce, and addressing the dysfunctional housing market. By taking purposeful action now, Stockholm's public, private, and civic institutions can sustain the region's competitiveness for generations to come.

Summary of the Stockholm Capital Region's performance and competitiveness factors



I. INTRODUCTION

Cities around the world must adapt to a set of global forces that are redefining what it takes to excel in today's global economy.

First, globalization is intensifying. Revolutions in information technology and transportation, the rapid rise of emerging markets, the globalization of finance, and the advent of global value chains has intensified international exchange. Global flows of goods, services, and capital have expanded rapidly over the last two decades, increasing from \$5 trillion in 1990 to \$26 trillion in 2012.²

Second, technology is altering how we communicate, how firms create products and services and deliver them across the globe, and the very nature of work itself.³ The McKinsey Global Institute predicts that 12 emerging technologies will generate an annual economic impact of \$33 trillion by 2025.⁴ Risks accompany these breakthroughs; new technologies are placing 47 percent of U.S. occupations at risk of being automated by 2033.⁵

Third, urbanization and the world's continued shift from rural areas to cities is changing the geography of growth and economic activity in emerging markets, especially in Asia and Africa. The share of global population in metropolitan areas has grown from 29 percent in 1950 to half in 2009, and is predicted to reach 60 percent by 2030.⁶

Cities are on the frontlines of all of these shifts, creating both challenges and opportunities. As more emerging markets have come online—connected by technology and trade—the places where firms and workers can locate have increased, generating new pressures on individual cities to provide a distinct value proposition to the market. This basic premise is not necessarily new; for thousands of years cities have competed to sell their products and services outside of their own borders, using external demand to expand local wealth and prosperity.⁷ But the competition has heightened considerably today, due to the sheer number and size of cities in the network. Of

course, these same dynamics have created abundant market opportunities for cities as well. For those places that can plug-in successfully to the global cities network, the returns are high.⁸ Cities compete, to be sure, but winning the competition also requires collaboration through exchanges of goods, services, talent, capital, and ideas.

Political, business, and civic leaders across the world have thus become increasingly focused on understanding and enhancing their city-regions' economic competitiveness and connections. To help inform their efforts, the Global Cities Initiative—a joint project of Brookings and JPMorgan Chase—will explore the competitiveness of six global city-regions through a two-year series of Global City Profiles. This research draws on the Harvard Business School definition of a competitive region as one in which firms can compete successfully in the global economy while supporting high and rising living standards for local households.⁹

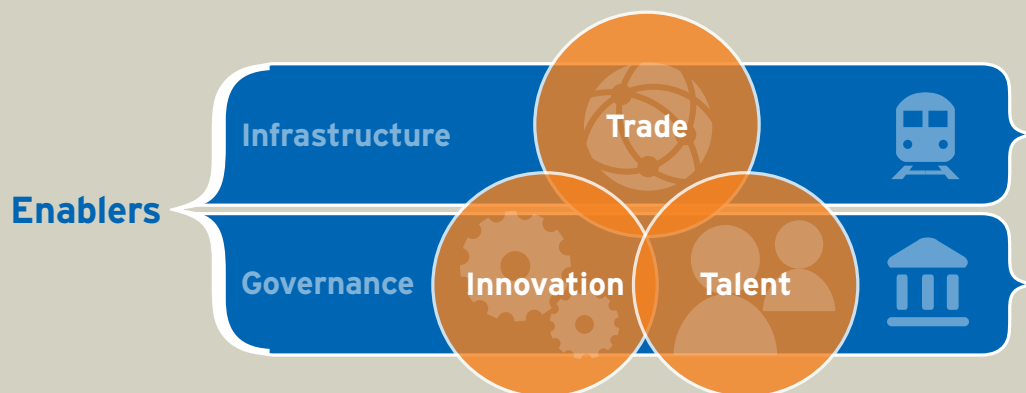
This profile, the first of that series, draws upon a unique dataset of globally comparable performance indicators to offer new insights about the economic competitiveness) of the Stockholm Capital Region. It uses international benchmarking to explore the overall economic performance of the region; its comparative strengths and weaknesses on five key competitiveness factors; and concludes with implications from this assessment, and key topics for the city-region's network of government, business, civic, and community leaders to consider as it positions the Stockholm Capital Region on the global stage in the coming years.

Defining and measuring competitiveness through international benchmarking

Countless definitions of competitiveness exist. This research draws on the Harvard Business School definition of a competitive market as one in which firms can compete successfully in the global economy while supporting high and rising living standards for local households.¹⁰ Competitive regions are, by this definition, supportive environments for both companies and people. Building on an extensive literature review on regional economic development by researchers at George Washington University, this research analyzes competitiveness through a five-factor framework—trade, innovation, talent, infrastructure, and governance.¹¹ Globally competitive traded sectors, innovation ecosystems, and skilled labor are the key drivers of overall productivity, employment creation, and income growth—outcomes that all metro areas care about. These drivers are supported by enablers: well-connected, spatially efficient infrastructure and a reliable governance structure and business environment.¹²

This report utilizes a group of carefully selected metropolitan peers to understand competitiveness beyond a national context.¹³ Stockholm's peer cities were selected through a combination of principal components analysis (PCA), k-means clustering, and agglomerative hierarchical clustering using 22 variables that measure economic size, wealth, productivity, industrial structure, and competitiveness.¹⁴ Eight cities from the United States and Europe were selected because they most closely resemble the economic profile of the Stockholm Capital Region based on this analysis. Table 1 compares the Stockholm Capital Region to its peer metros on five of these variables. Similar to Stockholm, these metro economies are mid-sized economies in terms of output and population and boast high average incomes and productive workforces, partly due to their specializations in higher value-added manufacturing and services industries. Whenever possible, the analysis employs comparable metrics of economic performance and the five competitiveness factors to unveil areas of comparative strength and weakness.¹⁵

A framework for regional competitiveness



Source: Brookings Institution, RW Ventures, and McKinsey and Company.

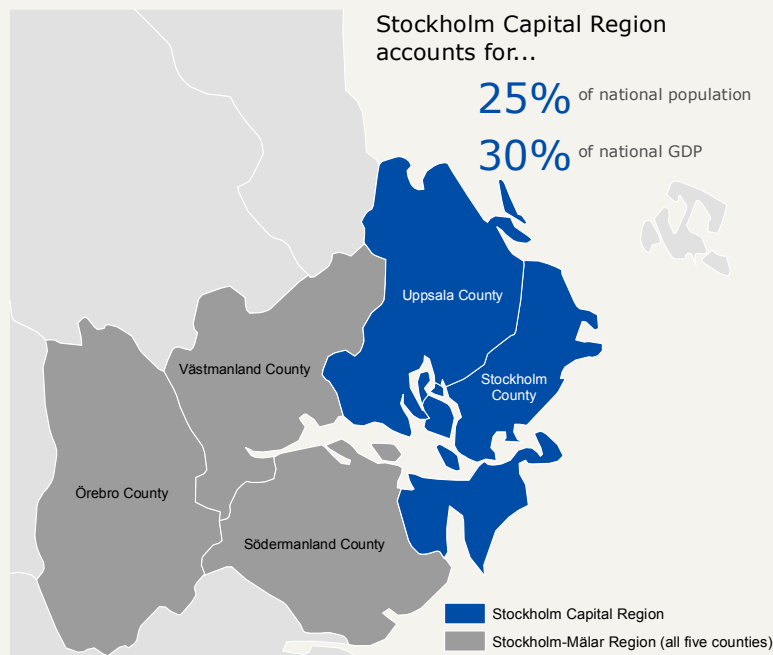
Table 1. Key indicators for the Stockholm Capital Region and global peer metro areas

| Rank | Population | Nominal GDP | Employment | GDP per capita | GDP per worker |
|----------|------------------|------------------|------------------|------------------|------------------|
| 1 | Munich | Seattle | Munich | Seattle | Portland |
| 2 | Seattle | Munich | Seattle | Portland | Zurich |
| 3 | San Diego | San Diego | Copenhagen | Zurich | Seattle |
| 4 | Copenhagen | Portland | San Diego | San Diego | San Diego |
| 5 | Stockholm | Stockholm | Stockholm | Stockholm | Stockholm |
| 6 | Pittsburgh | Copenhagen | Zurich | Munich | Copenhagen |
| 7 | Portland | Pittsburgh | Pittsburgh | Pittsburgh | Austin |
| 8 | Austin | Zurich | Portland | Austin | Pittsburgh |
| 9 | Zurich | Austin | Austin | Copenhagen | Munich |

Source: Brookings analysis of Oxford Economics data.

Defining the Stockholm Region

Several geographic definitions of the Stockholm regional economy exist. This study defines the regional economy as Stockholm County and Uppsala County using the geographic boundaries created by the European Observation Network for Territorial Development and Cohesion (ESPON). We use this definition because it is based on commuting flows of workers (i.e., the regional labor market), which provides the best estimate of the true economic geography of the region. Mentions of the “Stockholm region,” “Stockholm metro area,” “Stockholm Capital Region,” “Capital Region,” and “Stockholm” refer to this two-county geography. This definition differs slightly from several other ways of describing the Stockholm region. The OECD uses Stockholm County in its regional database, and at times in this analysis we utilize that definition to draw on OECD data not available at other geographies. A third classification uses the five-county Stockholm-Mälars Region to define the regional economy, adding the counties of Södermanland, Örebro, and Västmanland. Lack of data prevented us from using this definition.



II. THE STATE OF THE CAPITAL REGION'S ECONOMY

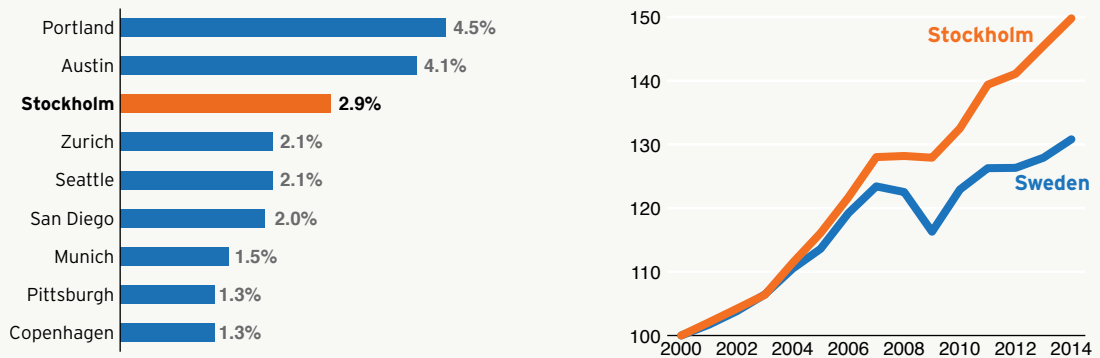
Defined as Stockholm County and Uppsala County, the Capital Region houses 2.5 million residents, just over one-quarter of Sweden's population, and generates over 30 percent of national economic output.¹⁶

A review of top-line trends confirms that the Stockholm regional economy has succeeded in generating economic growth that has raised living standards for much of its population.

Output and employment in the Stockholm Capital Region have grown more quickly than in most global peer cities and in Sweden as a whole. The rate of change in the size of the regional economy can indicate the pace of its progress toward expanding economic opportunity. Real GDP growth in the

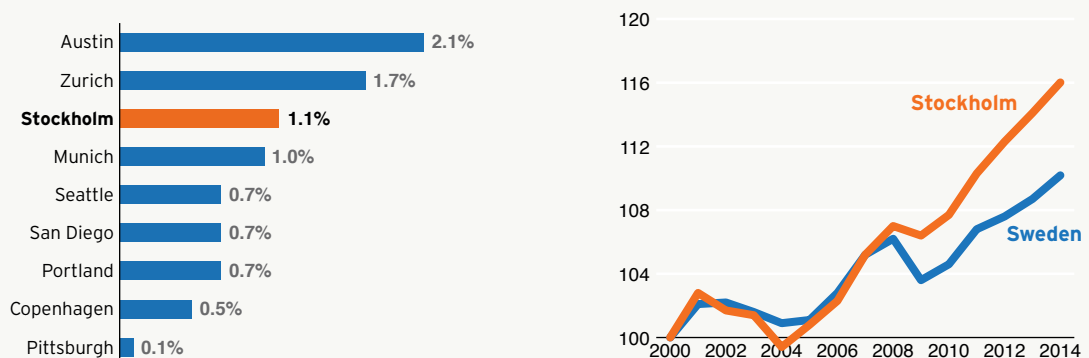
Stockholm region averaged 2.9 percent annually between 2000 and 2014, higher than in all peer cities except Austin and Portland. Employment growth averaged 1.1 percent per year since 2000, placing the region in the top third of global peers. Both growth rates outpace national averages.

Figures 1a and 1b. Real output growth (CAGR and index), 2000-2014



Source: Brookings analysis of Oxford Economics data. CAGR = compound annual growth rate.

Figures 2a and 2b. Employment growth (CAGR and index), 2000-2014

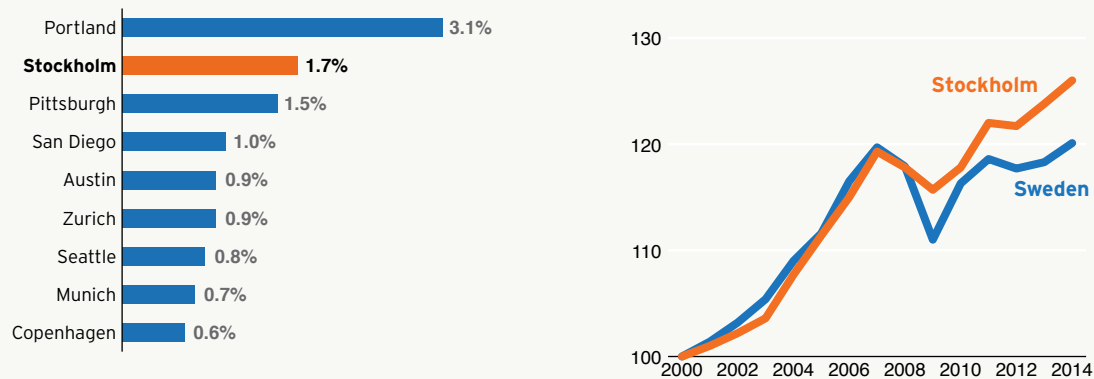


Source: Brookings analysis of Oxford Economics data. CAGR = compound annual growth rate.

Strong productivity gains have increased standards of living in the Stockholm Capital Region, although productivity growth has slowed since 2010. To create lasting prosperity, economic growth must keep pace with population and labor force growth so average standards of living rise. Annual GDP per capita growth, a common metric of standard of living, in the Stockholm region has averaged 1.7 percent since 2000, faster than all of its peer metro economies except Portland.¹⁷ Standards of living increased as a result of strong productivity growth.

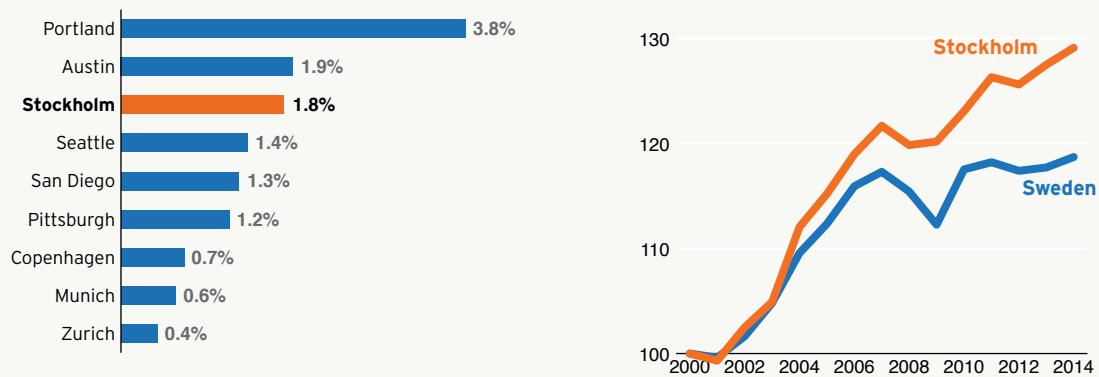
Productivity—measured here as output per worker—captures the ability of firms and workers to transform the factors of production into more valuable products and services. Since 2000, Stockholm's 2.9 percent annual productivity growth has outpaced every global peer city except for Austin and Portland. However, after tremendously fast growth in the 2000s, annual productivity growth has slowed to 1.2 percent since 2010, suggesting that new efforts and investments in competitiveness must be made to sustain these gains into the future.

Figures 3a and 3b. Real GDP per capita growth (CAGR and index), 2000-2014



Source: Brookings analysis of Oxford Economics data. CAGR = compound annual growth rate.

Figure 4a and 4b. Growth of output per worker, CAGR and index, 2000-2014

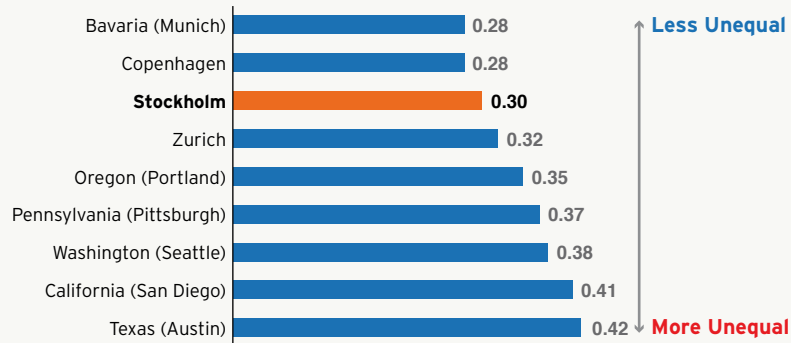


Source: Brookings analysis of Oxford Economics data. CAGR = compound annual growth rate.

Income gains are more broadly shared in Stockholm County than in peer regions. To sustain competitiveness and social cohesion, the gains from growth must be broadly shared. While the global economic trends that contribute to income inequality are beyond the control of any individual city, understanding how income gains are distributed within a regional economy can reveal who among the population is benefitting from local growth. One common way to measure income inequality is the Gini coefficient,

which defines inequality on a scale from zero (perfect equality) to one (perfect inequality). Inequality metrics are not available for the broader Capital Region, but the OECD reports that Stockholm County registered a Gini of 0.30 in 2010, higher than Sweden's Gini (0.27) but lower than in all peers except Bavaria (Munich) and Copenhagen.¹⁸ This suggests that the growth that Stockholm generates is more evenly distributed in the population relative to global peers.

Figure 5. Gini income inequality index, 2010*




Source: Brookings analysis of OECD data.

➤ **BOTTOM LINE:** By almost any metric, the Stockholm Capital Region's economy is healthy. But in a fiercely competitive world, no region can afford to ignore investments in the fundamental drivers of competitiveness and prosperity, especially given that, since 2010, productivity has not grown as quickly as in the 2000s. To maintain its enviable position, the region's networks of public, private, and civic leaders must commit to further investments that position its economy for global success.

III. COMPETIVENESS DRIVERS AND ENABLERS

A. TRADE

 **WHY IT MATTERS:** Trade is a critical driver of competitiveness and prosperity. Firms selling internationally inject new wealth from abroad that, when spent locally, creates a “multiplier effect” in the regional economy, spurring new jobs, growth, and further tax revenue.¹⁹ Participating in global trade also makes metro areas more productive and innovative. Firms that generate revenue from outside their home market must provide goods and services faster, better, and cheaper than global competitors. Local companies that embed themselves in global value chains gain access to high-quality inputs, lower overall costs, and as a result become more globally competitive. This process tends to boost productivity and wages.²⁰ Therefore, the traded economy—as measured

by traded sector growth, trade in goods and services, and by foreign direct investment—is both an important signpost and a critical driver of competitiveness.

A1. TRADED SECTOR STRUCTURE AND GROWTH

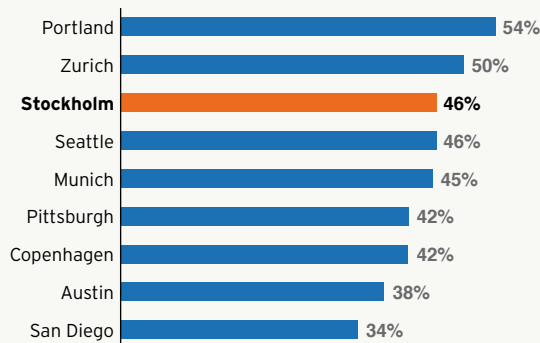
The Stockholm Capital Region’s traded sectors represent one-third of total employment and over 46 percent of total output.²¹ For all the reasons mentioned above, the health of the traded sector is an important indicator of overall competitiveness.²² The share of regional output generated by tradable industries in Stockholm is higher than all metropolitan peers except for Portland and Zurich. Professional services (i.e., legal, accounting, and IT services) accounted for the largest share of traded sector

Table 2. Stockholm Capital Region’s industrial structure, 2014

| Sector | Share of jobs | Share of output |
|---|---------------|-----------------|
| Tradable | 34% | 46% |
| Professional, scientific & technical activities | 9% | 8% |
| Manufacturing | 7% | 16% |
| Information & communication | 7% | 9% |
| Transportation & storage | 6% | 4% |
| Financial & insurance activities | 5% | 9% |
| Agriculture, forestry & fishing | 1% | 0% |
| Mining & Quarrying | 0% | 0% |
| Non-Tradable | 67% | 54% |
| Wholesale & retail trade | 13% | 12% |
| Human health and social work | 13% | 9% |
| Education | 9% | 5% |
| Administrative & support activities | 8% | 4% |
| Construction | 7% | 5% |
| Public administration & defense | 6% | 5% |
| Accommodation & food services | 5% | 2% |
| Real estate activities | 2% | 9% |
| Other services | 2% | 1% |
| Arts, entertainment & recreation | 1% | 1% |
| Electricity, gas & water supply | 1% | 2% |

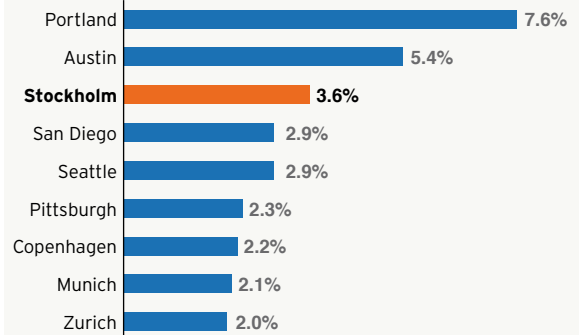
Source: Brookings analysis of Oxford Economics data.

Figure 6. Share of traded sector in total output, 2014



Source: Brookings analysis of Oxford Economics data.

Figure 7. Traded sector output growth, CAGR, 2000-2014



Source: Brookings analysis of Oxford Economics data. CAGR = compound annual growth rate.

employment in 2014, followed by manufacturing, information and communication, transportation and storage, and finance and insurance. Manufacturing generated the largest share of total output (16 percent), followed by information and communication and finance and insurance. The non-tradable portion of the economy continues to absorb the majority of

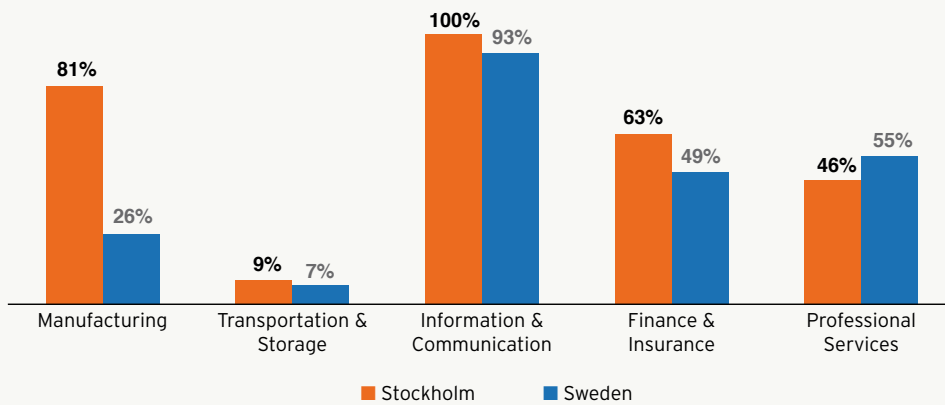
employment and output, including significant concentrations in health, education, and public services, reflecting Stockholm's role as Sweden's political and education center. Tradable industries' technology and capital-intensive structure and high productivity help explain their larger share of regional output (46 percent) than employment (34 percent).

“Participating in global trade makes metro areas more productive and innovative. Local companies that embed themselves in global value chains gain access to high-quality inputs, lower overall costs, and as a result become more globally competitive. This process tends to boost productivity and wages.”

Output has expanded in all of the Stockholm Capital Region's traded sectors since 2000, but employment has contracted in manufacturing and transportation. Overall, output in the Stockholm Capital Region's traded sector has grown 3.6 percent per year since 2000, faster than all peer regions except Portland and Austin. Compared to national trends, output grew faster in all of Stockholm's major

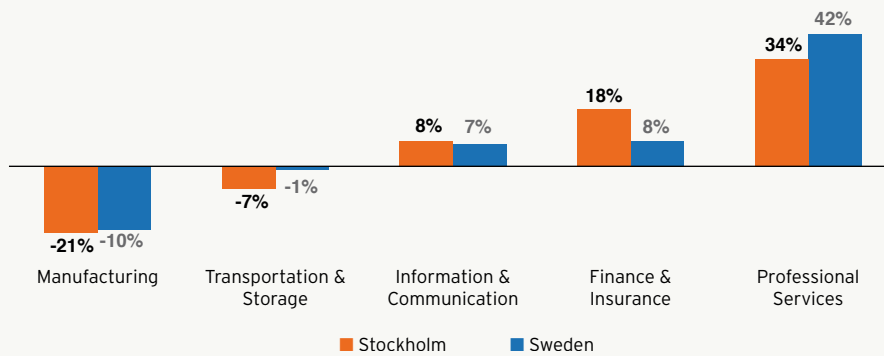
traded sectors except for professional, scientific, and technical services. The region's manufacturing output expanded at triple the national rate. Yet manufacturing lost jobs during this period, similar to many advanced city-regions where labor-saving automation has rapidly expanded productivity in the sector. Employment growth was largest in professional services and finance and insurance.

Figure 8. Output growth in traded sectors, 2000-2014



Source: Brookings analysis of Oxford Economics data.

Figure 9. Employment growth in traded sectors, 2000-2014



Source: Brookings analysis of Oxford Economics data.

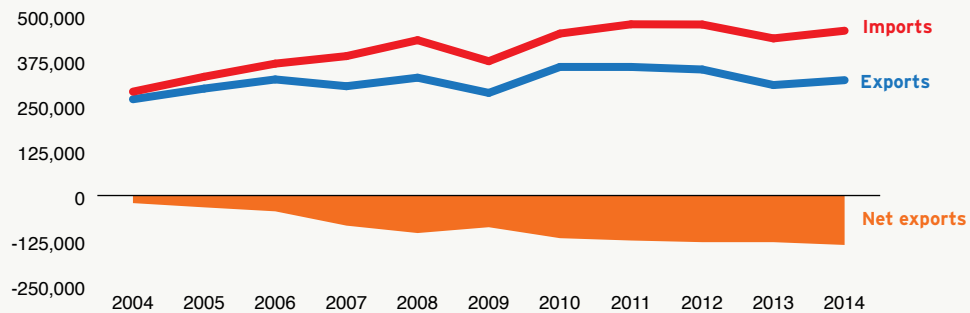
A2. GOODS TRADE

The Stockholm Capital Region is a major driver

of national trade. Sweden registered a goods trade surplus amounting to 1.9 percent of GDP in 2010-2013, while the Stockholm Capital Region's trade deficit was 9 percent of GDP in the same period. Goods trade deficits are common in major metropolitan areas, which import consumables and raw goods to fuel their large

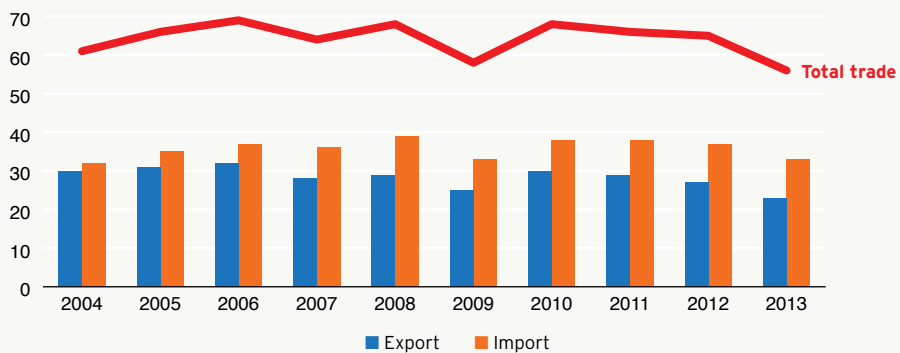
populations and tend to focus on higher-value added services (sidebar 3).²³ Even without services incorporated, the Stockholm Capital Region is a major driver of national trade and national trade growth. In 2014, Stockholm accounted for 28.8 percent of Sweden's exports, 42.5 percent of imports, and 35.6 percent of total national trade. From 2004 to 2014, the region contributed an average of 27 percent and 37 percent of export and import growth, respectively.

Figure 10. Merchandise trade, Stockholm Capital Region, SEK billion



Source: Brookings analysis of Statistics Sweden data.

Figure 11. Stockholm Capital Region's share of contribution to Sweden's trade growth, 2004-2014



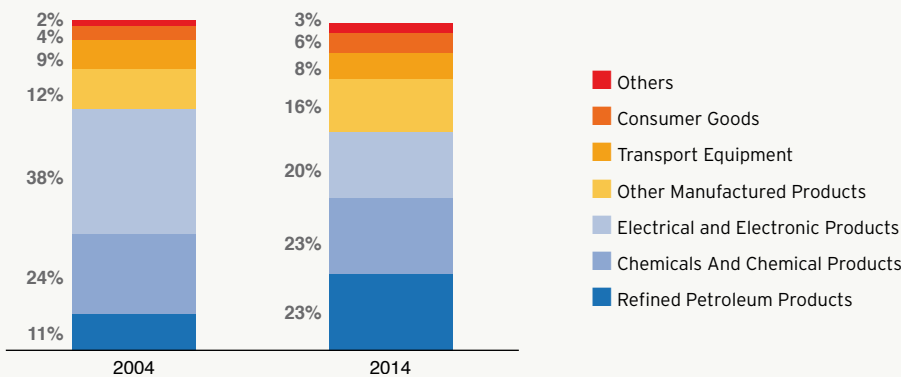
Source: Brookings analysis of Statistics Sweden data.

Stockholm has a well-diversified goods trade base that predominantly relies on destination markets in the European Union.

The Stockholm Capital Region's top ten export markets account for an average of 57 percent of total exports in the last decade, below the national average of 65 percent. More than half of regional exports are bound for Europe. In terms of products, Stockholm's exports are dominated by manufactured goods (74 percent of gross exports in 2014), particularly electronics and chemicals. Export of refined petroleum products has seen a marked increase in recent years, doubling from 11.4 percent in 2004 to 23.4 percent in 2014. This

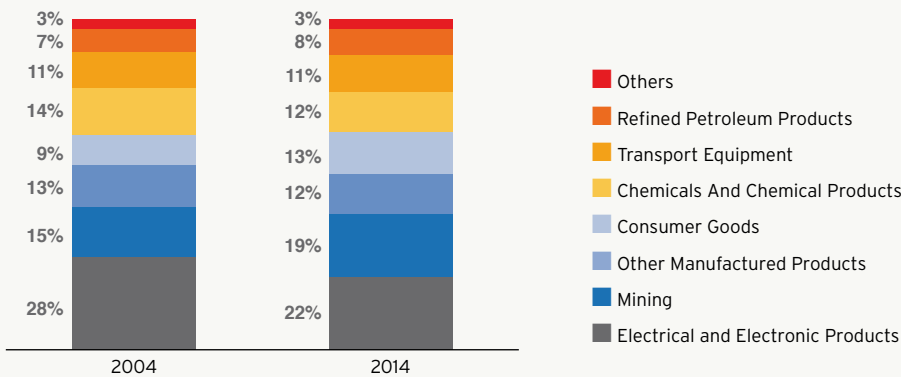
shift was mainly supported by the expansion of Stockholm's role in petroleum storage as well as elevated commodity prices.²⁴ At the same time, the share of gross regional exports in electronics has declined from 37.7 percent in 2004 to 20.4 percent in 2014. Major import products are electronics and electrical goods (23 percent of gross imports), crude petroleum (19 percent), and chemicals and chemicals products (12 percent). Stockholm's import sources are relatively balanced; the top 10 import sources accounted for 51 percent of total imports in 2014, compared to the national average of 70 percent.

Figure 12. Share of gross exports by products in Stockholm Capital Region



Source: Brookings analysis of Statistics Sweden data.

Figure 13. Share of gross imports by products in Stockholm Capital Region



Source: Brookings analysis of Statistics Sweden data.

Sweden's service exports: Stockholm's comparative advantage?

Sweden has been a net services exporter since 2002, due largely to rapidly rising trade in computer and IT services and music royalties and fees. Data measuring services exports do not exist at the sub-national level, but an examination of national services exports trends can lend insights into Stockholm, given that the region contains 38 percent of national services output and ranks 40th out of 525 urban areas in terms of its centrality in global networks of “advanced producer services” firms in accounting, advertising, financial services, law, and management consulting, second most connected among its peer cities after Zurich (Table 3).²⁵

In 2013, Sweden had net services exports of \$17.7 billion, up from a \$1.8 billion services deficit in 1996, largely due to the rapid rise in the export of intellectual property through computer and IT services and royalties and fees (labeled “other services”). The sharp

increase in computer and IT services reflect Sweden's large and internationally competitive pool of software and gaming companies, and the rising demand for these services as they have become more internationally tradable over the past decade.²⁶ At the same time, the growth in receipts for royalties and fees partly reflects continued Swedish success in the global music

and gaming industries.²⁷ The Stockholm Capital Region is the major hub for both sets of services, accounting for 46 percent and 50 percent of national output in professional, scientific, and technical services and arts, entertainment, and recreation, respectively.²⁸

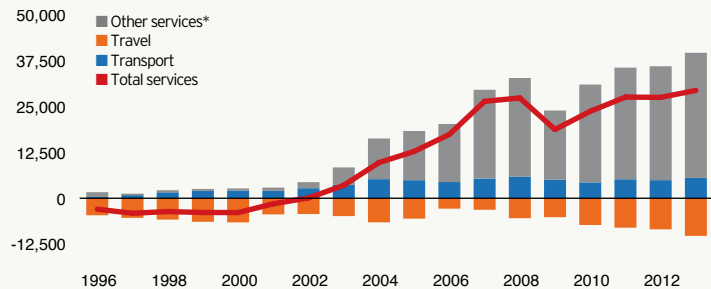
Travel and tourism is another important sector for Stockholm. The travel industry has decelerated since the global financial crisis, with tourism receipts increasingly lagging behind tourism outflows. Tourists to Sweden are mainly headed for Stockholm, and primarily hail from Germany, the United Kingdom, the United States and Norway. Between 2005 and 2010, Stockholm's tourism industry boomed, registering the highest growth among European cities in terms of the number of overnight stays and above-average increase in bed capacity and revenue per available room.²⁹ However, visitors to Stockholm reduced their duration of stay significantly in the aftermath of the global financial crisis.³⁰ The reduction in duration of stay was mainly attributable to tourists from the United Kingdom, Italy, and Spain, countries directly affected by the heightened uncertainty and weak economic recovery in the European Union during this period. Going forward, travel and tourism remains an important traded sector for Stockholm that can be bolstered for effective global brand cultivation and enhanced international connectivity.³¹

Table 3. Advanced services connectivity, 2012

| Global rank | Metro area |
|-------------|------------------|
| 26 | Zurich |
| 40 | Stockholm |
| 43 | Munich |
| 56 | Copenhagen |
| 99 | Seattle |
| 112 | San Diego |
| 173 | Portland |
| 188 | Pittsburgh |
| 191 | Austin |

Source: Brookings analysis of data from the Globalization and World Cities (GaWC) Research Network.

Figure 14. Net services exports in Sweden, USD billion at current prices

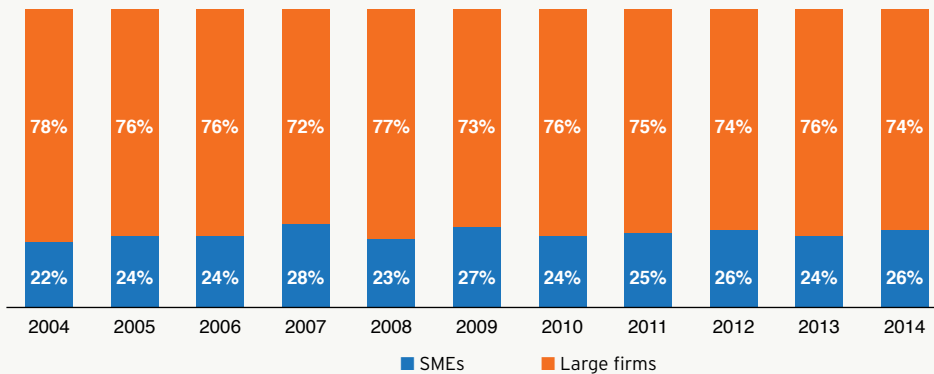


*Includes exports and imports for professional services, computer and information services, and royalties and fees.

Source: Brookings analysis of Statistics Sweden data.

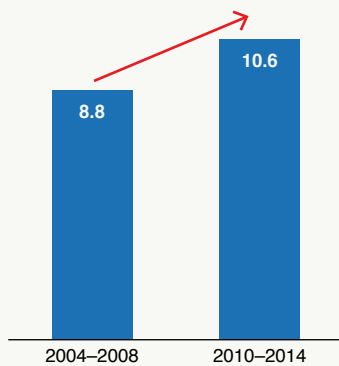
Small and medium-sized enterprises (SMEs) account for 95 percent of companies in Stockholm, but only contribute 26 percent of exports.³² While SMEs dominate the firm base in the Capital Region, they are underrepresented in their share of exports, although export revenues per SME have been increasing over time. Building the pipeline of SME exporters can be a significant growth spur for the region. Internationalized SMEs have been found to be three times more innovative and experience two times faster employment creation than SMEs that are not engaged in trade.³³

Figure 15. Share of Stockholm Capital Region exports by firm size



Source: Brookings analysis of Statistics Sweden data.

Figure 16. Average export revenue per SME in Stockholm Capital Region, SEK billion



Source: Brookings analysis of Statistics Sweden data.

“Internationalized SMEs are three times more innovative and experience two times faster employment growth than SMEs that are not engaged in trade.”

A3. FOREIGN DIRECT INVESTMENT

The Stockholm Capital Region has attracted \$4.3 billion in new greenfield foreign direct investment since 2009, which translated into 8,200 new jobs, placing it in the middle of its peer group.

Greenfield investments—the process by which companies open a new establishment in a foreign market—help reveal the extent to which multinational firms find the Stockholm region an attractive operational

environment vis-à-vis other global regions.³⁴

Stockholm ranked fourth among global peers in terms of total FDI inflows between 2009 and 2014. These investments created 8,200 new jobs, fifth among global peer cities, which represented 7.0 percent of total new employment generated during that period.³⁵ Copenhagen's notably high share of FDI-generated employment stems from its very low overall job creation rate during this period.

Table 4. Greenfield FDI flows, jobs, and share of net new employment, 2010-2014

| Metro area | Total FDI flows (USD million) | Total FDI jobs | Share of net new employment |
|------------|-------------------------------|----------------|-----------------------------|
| Austin | 10,161 | 10,007 | 6.8% |
| Zurich | 4,800 | 8,280 | 9.3% |
| Munich | 4,316 | 12,719 | 6.9% |
| Stockholm | 4,257 | 8,156 | 7.0% |
| Copenhagen | 4,110 | 9,375 | 35.6% |
| San Diego | 2,039 | 4,931 | 5.4% |
| Portland | 1,886 | 5,509 | 5.7% |
| Seattle | 1,294 | 5,305 | 3.5% |
| Pittsburgh | 437 | 1,443 | 3.7% |

Source: Brookings analysis of fDi Intelligence data.

Stockholm's foreign direct investment concentrates in a group of technology-intensive industries. Between 2009 and 2014, 51 percent of new FDI occurred among firms in R&D and STEM-intensive advanced industries, led by communications and software and information technology.³⁶ The steady influx of resources has allowed Sweden to consolidate itself as a top destination for technology investment. Yet, Stockholm faces stiff competition from peer cities that are also attracting large investments in advanced industries. In fact, as compared to global peers, its share of FDI in advanced industries trails places like Austin, Zurich, and Seattle.

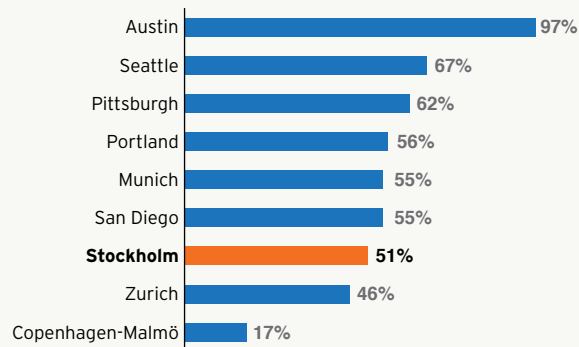
Table 5. Greenfield FDI by industry

| Industry | Total FDI (USD million) |
|------------------------|-------------------------|
| Financial Services | 812.5 |
| Communications | 757.0 |
| Software & IT services | 693.5 |
| Real Estate | 393.0 |
| Textiles | 334.8 |
| Consumer Products | 255.2 |
| Business Services | 214.1 |
| Transportation | 201.6 |
| Pharmaceuticals | 170.3 |
| Biotechnology | 62.5 |

Source: Brookings analysis of fDi Intelligence data.

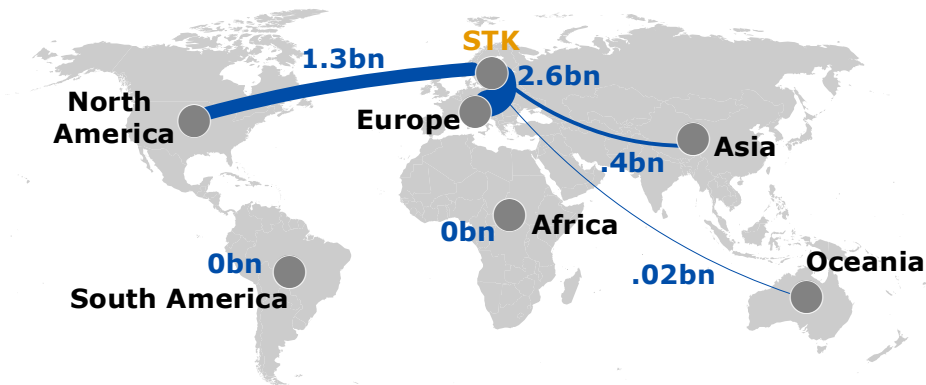
Europe and the United States accounted for 87 percent of all greenfield FDI flows into the Stockholm Capital Region between 2009 and 2014. With \$1.0 billion in total investment between 2009 and 2014, the United States accounted for approximately one-third of total FDI into Stockholm, led by major investments in the region's IT and software cluster.³⁷ Four major European countries—the United Kingdom, Germany, France, and the Netherlands—accounted for another one-third of investment into Stockholm.

Figure 17. Share of total FDI in tech-intensive sectors, 2010-2014



Source: Brookings analysis of Statistics Sweden data.

Greenfield foreign direct investment, Stockholm Capital Region, USD billions, 2009-2014



Source: Brookings analysis of fDi Intelligence data.

► **BOTTOM LINE:** Stockholm's traded sector is diversified and composed of high-value products and services, and the region has attracted new foreign investments into these productive sectors of the economy. However, declining commodity prices could expose the region's growing reliance on refined petroleum exports and the participation of SMEs in international trade remains low. FDI inflows reveal the Capital Region's comparative advantages in technology-intensive sectors, but come from a relatively small set of markets in Europe and the United States. Stockholm could improve its trade position by bolstering trade flows in sectors where it enjoys strong competitive advantages, such as software and biotech, while promoting more participation from small and medium-sized firms. FDI attraction efforts focused beyond the United States and Europe could help diversify regional sources.

B. INNOVATION



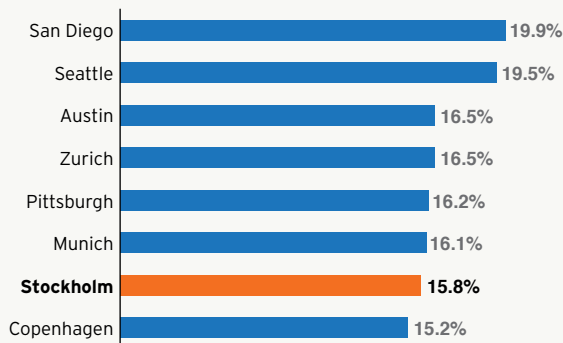
WHY IT MATTERS: A region's innovative capacity and levels of entrepreneurship both have implications for its ability to develop and deploy commercial applications, start new businesses, and maintain industrial competitiveness in the face of disruptive technological change.³⁸ Innovation takes many forms and can be hard to measure, especially innovations that improve processes, management techniques, or occur in the informal economy. Yet, the most productive and technologically-advanced metropolitan economies in the world tend to combine a common set of institutions and assets into a rich collaborative innovation ecosystem that can commercialize research and development into new products and services for the market.³⁹ In the case of Stockholm innovation has been a centerpiece of its economic growth and development strategy for much of the past century.

Stockholm County accounts for one-third of Sweden's research and development expenditures, but R&D expenditures as a share of GDP has been declining over time. Research and development (R&D) is an important measure of the resources invested in the discovery and commercialization

of new products, processes, and technologies.⁴⁰ Compared to the rest of the world, firms, universities, and government in Sweden and Stockholm invest significantly in R&D as a share of the overall economy. R&D expenditure stands at 3.8 percent of GDP in the Stockholm region, higher than the national average of 3.4 percent. However, the region has not returned to pre-crisis R&D expenditure levels, when Stockholm spent 4.3 percent of GDP in R&D.⁴¹ Even with these declines, Stockholm County is more R&D-intensive than all peers except California (San Diego), Copenhagen, and Washington (Seattle).⁴²

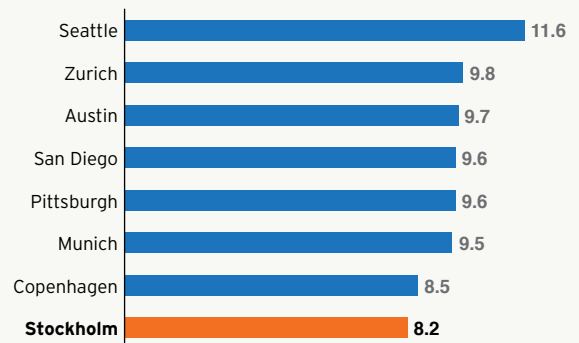
A strong network of research universities support R&D and drive innovation in the Stockholm Capital Region. Research universities play a major role in driving innovation by providing basic research that underlies scientific discovery and understanding, facilitating the translation of research results into consumable goods and services, and attracting and supporting the growth of other research-intensive industries.⁴³ To measure the scientific impact of universities, the Centre for Science and Technology Studies (CWTS) and Leiden University have compiled metrics for 750 major universities worldwide. Five universities in the Capital Region (Karolinska Institute, KTH Royal Institute of Technology, Stockholm

Figure 18. Share of total publications in top 10 percent most cited papers in all fields, 2010-2013



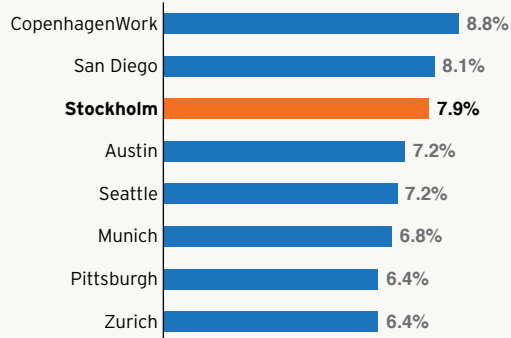
Source: Brookings analysis of Centre for Science and Technology Studies (CWTS) and Leiden University data.

Figure 19. Mean citation score for all fields, 2010-2013



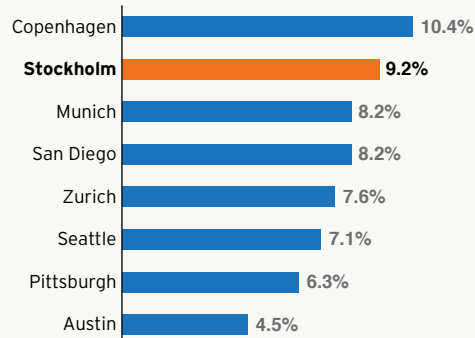
Source: Brookings analysis of Centre for Science and Technology Studies (CWTS) and Leiden University data.

Figure 20. Share of total publications done with industry, 2010-2013



Source: Brookings analysis of Centre for Science and Technology Studies (CWTS) and Leiden University data.

Figure 21. Share of total publications done in collaboration with industry (biomedical and health sciences), 2010-2013



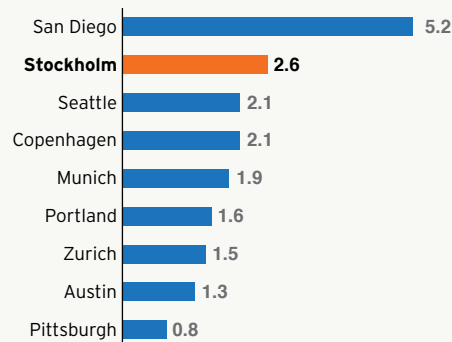
Source: Brookings analysis of Centre for Science and Technology Studies (CWTS) and Leiden University data.

University, Swedish University of Agricultural Sciences, and Uppsala University) are ranked within the top 750 research universities, more than any of Stockholm's peer regions.⁴⁴ Notwithstanding the acknowledged high academic quality of the Stockholm Capital Region's universities, compared to global peers a relatively low share of the regional system's total scientific publications fall in the 10 percent of most highly cited papers.⁴⁵ Importantly, however, Stockholm's universities collaborate well with industry partners, a key element for the successful translation of knowledge into new ventures.⁴⁶ Between 2010 and 2013, the five universities in Stockholm produced 7.9 percent of scientific papers in collaboration with industry partners, much higher than the global metro average of 5.2 percent. When compared to similar peers, Stockholm ranks third in industry collaboration, and second when examining key regional sectors such as biomedical and health sciences.

The Stockholm Capital Region concentrates 43 percent of Sweden's overall patenting activity and 44 percent of all technology-related patents. Patents provide a reliable and comparable, if imperfect, measure of new inventions that spur economic development.⁴⁷ The Stockholm region has been able to increase its patenting output thanks to a healthy innovation ecosystem, a well-educated labor force,

and strong public-private collaboration on R&D.⁴⁸ In the 2008 to 2012 period, Stockholm produced 2.6 patents per thousand inhabitants, a 31 percent increase from the 2003-2007 period. At the same time, Stockholm's share of national patents increased from 37 percent to 43 percent during that same period. The region's invention rate ranked second among global peers, after San Diego, and ahead of other global innovation hubs such as Seattle, Copenhagen, and Munich.

Figure 22. Patents per 1,000 inhabitants, 2008-2012



Source: Brookings analysis of OECD REGPAT data.

Table 6. Top inventors by firm, 2008-2012

| Firm | Industry | Patents invented | Share of total patents |
|-------------------------------|------------------------|------------------|------------------------|
| Ericsson | Digital communication | 2,339 | 38.9% |
| Scania Cv Ab | Motor vehicles | 490 | 8.1% |
| Ge Healthcare Bio Sciences Ab | Measurement | 143 | 2.4% |
| Huawei Co Ltd | Digital communication | 90 | 1.5% |
| Delaval Ab | Other special machines | 102 | 1.7% |

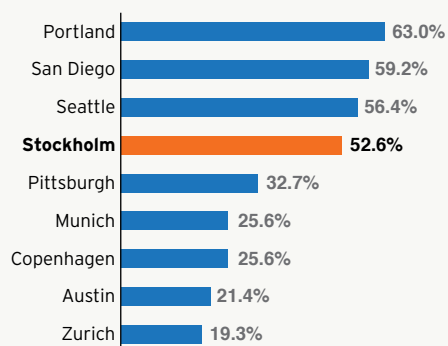
Source: Brookings analysis of OECD REGPAT data.

Patenting activity concentrates in technology-intensive clusters where Stockholm enjoys comparative advantages. Three-quarters of inventions between 2008 and 2012 concentrated in just three industries: information technology (49 percent), life sciences (14 percent), and advanced manufacturing (13 percent). Within these sectors, digital communication, telecommunications, medical technology, and computer technology accounted for almost half of all patenting activity. Large firms dominate the innovation ecosystem in Stockholm. Between 2008 and 2012, only five companies generated 53 percent of all patents, and one company, Ericsson, produced 39 percent of all patents. Regional peers with major, research-intensive multinational firms experience a similar pattern; Boeing produces 45 percent of Seattle's patents while Intel accounted for 44 percent of all patents in Portland.

Stockholm is one of the most successful entrepreneurial environments in Europe, receiving \$2.5 billion in venture capital investments since 2005.

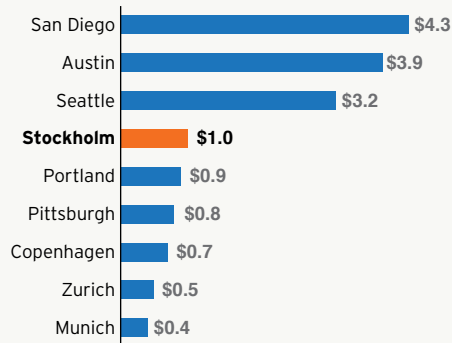
Venture capital (VC) provides funds for innovative enterprises positioned for high growth and the potential to create and capture entire new markets.⁴⁹ Firms that receive venture capital can be particularly important stimulants to regional economies; VC recipients are three to four times more patent-intensive than other firms, and are much more likely to translate their R&D activities into high-growth ventures.⁵⁰ Stockholm's concentration of IT firms as well as the highly educated labor force has propelled it to be one of the most internationalized venture capital markets in Europe.⁵¹ Compared to other metro peers, Stockholm ranks first in share of venture capital funds from international investors, with 75 percent of the total. Yet, it still trails U.S. cities such as San Diego, Austin, and Seattle in terms of total venture capital received, indicating further efforts to bolster entrepreneurship and cultivate domestic sources of venture capital are needed.⁵² Five industries account for almost three quarters of all venture capital investments into Stockholm: software (36 percent), other financial services (13 percent), pharmaceuticals and biotechnology (12 percent), communications and networking (6 percent), and semiconductors (6 percent). The rise of Stockholm's software cluster has dramatically reshaped its venture capital structure. In 2005, less than 3 percent of venture capital into the region was allocated to software companies while more than a third of all venture capital funds in Stockholm went to software firms in 2014.

Figure 23. Share of patents generated by five largest inventors, 2008-2012



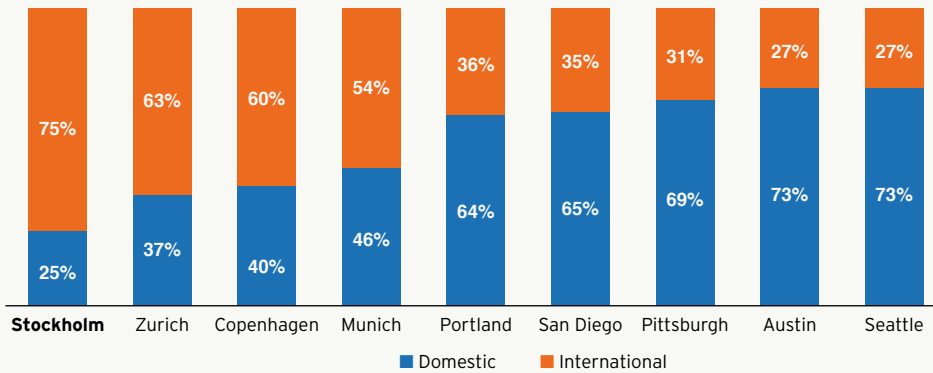
Source: Brookings analysis of OECD REGPAT data.

Figure 24. Total venture capital investments, USD millions per 1,000 inhabitants, 2005-2014



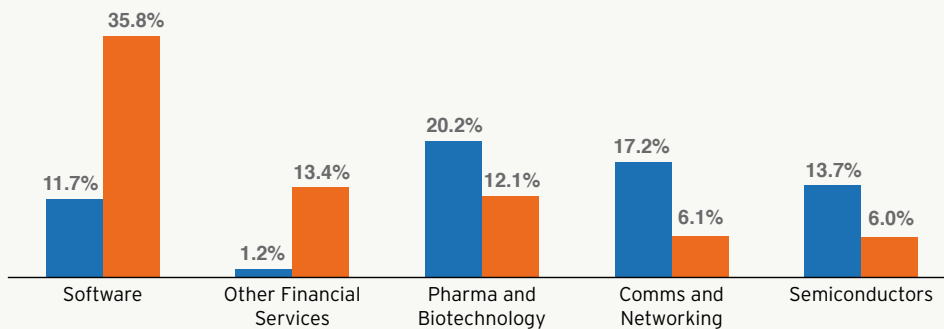
Source: Brookings analysis of Pitchbook data.

Figure 25. Share of venture capital investment by source, 2005-2014



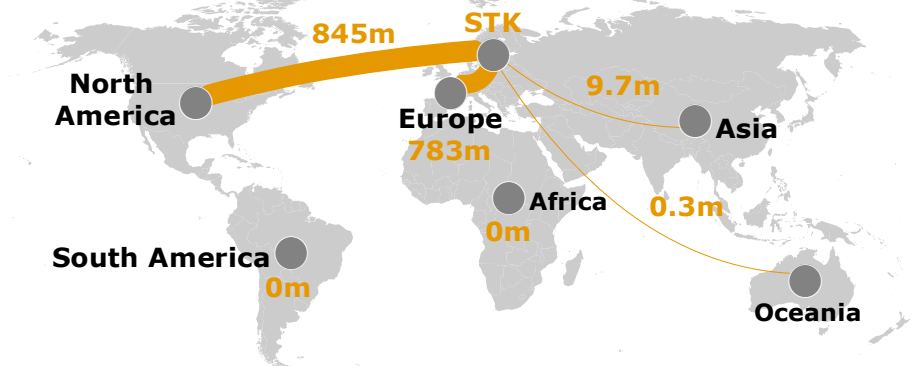
Source: Brookings analysis of Pitchbook data.

Figure 26. Stock of venture capital in Stockholm Capital Region, by industry, 2008 and 2014



Source: Brookings analysis of Pitchbook data.

International venture capital investment, Stockholm Capital Region, USD millions, 2005-2014



Source: Brookings analysis of Pitchbook data.

► **BOTTOM LINE:** Across several dimensions, the Stockholm Capital Region’s innovation assets are strong. Rates of new commercial inventions are high. Universities collaborate well with firms on joint research and development. Venture capital markets find the region’s firms attractive investments. Yet challenges still remain: investment in R&D as share of GDP has been steadily declining, patenting activity is dominated by a small number of large firms, and venture capital still lags several U.S. cities, due in part to the nascence of Sweden’s local venture capital scene. Stockholm is well-positioned, but must maintain investments in its world-class research institutions and its burgeoning venture capital markets to keep its edge in key advanced industries.

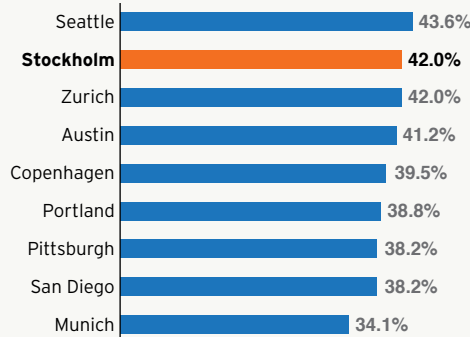
C. TALENT

WHY IT MATTERS: Human capital, the stock of knowledge, skills, expertise, and capacities embedded in the labor force, is of critical importance to enhancing productivity, raising incomes, and driving economic growth.⁵³ Producing, attracting, and retaining educated workers; creating jobs for those workers; and connecting those workers to employment through efficient labor markets all matter for regional competitiveness and ensuring broad-based economic opportunity.⁵⁴

Stockholm’s workforce is among the most educated in the world. The Stockholm Capital Region benefits from an incredibly well-educated labor pool. Of the 15 and older population, 42 percent have obtained at least a tertiary education, second highest among peer metro areas.⁵⁵ Importantly, Stockholm’s labor pool has acquired technical skills that are required to invent and complement technology, which are a critical input to maintain the region’s innovation

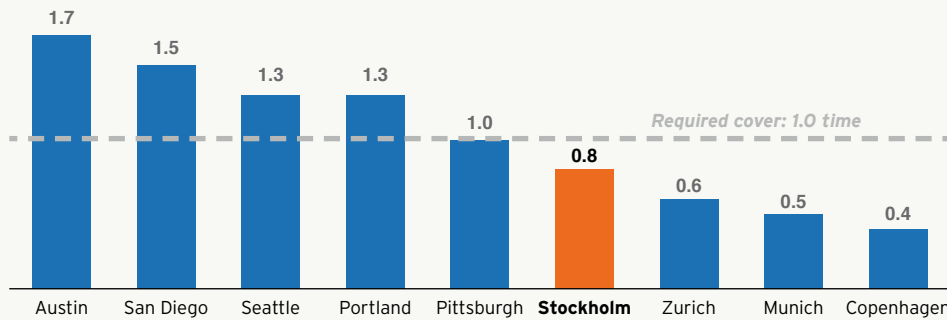
advantages mentioned above. According to the OECD, about one-third of employees with tertiary education in Stockholm County are trained in a science and technology field, placing it in the top 10 percent of European regions.⁵⁶

Figure 27. Share of population above 15 years old with tertiary education, 2013



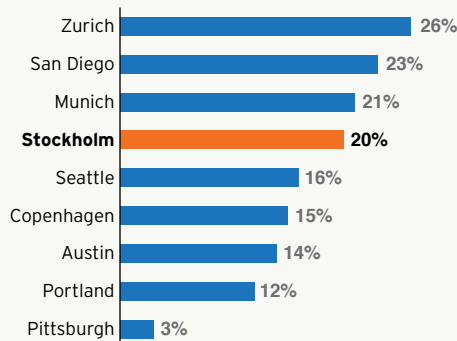
Source: Brookings analysis of Oxford Economics data.

Figure 28. Workforce replacement rate coverage in 2034



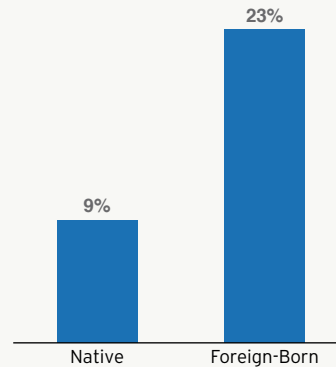
Source: Brookings analysis of Oxford Economics data.

Figure 29. Foreign-born share of total population, 2011



Source: Brookings analysis of Oxford Economics data.

Figure 30. Share of students failing to qualify for upper secondary school in Sweden by place of birth, 2009



Source: Swedish Ministry of Education and Research

While population growth has been strong, Stockholm’s current demographic profile suggests looming workforce shortages in the coming decades. The Stockholm Capital Region’s population has been growing quickly in recent years, as workers and families gravitate towards good jobs and a high quality of life. Yet, even with recent growth, in 20 years more people may be leaving the workforce than entering it.⁵⁷ Simply put, Stockholm needs to continue to attract young workers and families to maintain its labor supply. Copenhagen, Munich, and Zurich also face these challenges. U.S. peer cities, by comparison, are well-positioned demographically due to their younger populations and higher shares of foreign-born individuals.

Successfully integrating foreign-born workers can help address workforce shortages, but disparities in skill development and employment between native-born Swedes and immigrants must be addressed. Immigration can help counteract Stockholm’s demographic transition in the coming decades. Foreign-born individuals currently account for one-fifth of the region’s population, up from 17 percent in 2001.⁵⁸ Only Copenhagen has experienced more growth in its foreign-born population during that period. As immigration has increased, however, disparities in educational and labor market outcomes between foreign-born and native-born youth have emerged. While only 9 percent of Swedish-born students do not qualify for entry into upper secondary

school, fully 23 percent of foreign-born students fail to qualify.⁵⁹ Similarly, the share of youth aged 15-24 that are not in the education system or employed (NEETs) is much higher for immigrants (10.0 percent)

than for native Swedes (6.8 percent).⁶⁰ Addressing these disparities will be imperative for Stockholm to maintain a skilled workforce.

► **BOTTOM LINE:** The Stockholm Capital Region's high levels of human capital remain a critical asset. Workers with science and technology training are needed complements to the capital and technologies deployed in Stockholm's innovation ecosystem, and serve as the key ingredient to the Capital Region's key advanced industries. Yet, as the region and country age, future workforce shortages loom, threatening the competitiveness of these sectors. Foreign migration provides one avenue to address this coming shortfall, and immigration has grown in the Capital Region. Key for the region's future competitiveness will be to successfully integrate, educate, and employ these new entrants.

D. INFRASTRUCTURE



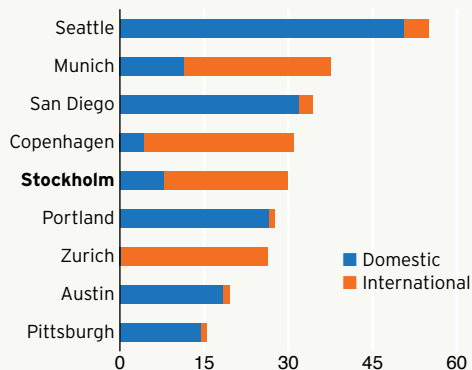
WHY IT MATTERS: Infrastructure and the spatial layout of a metropolitan area matter for competitiveness in two ways. First, firms rely upon global access points like airports and ports and digital infrastructure to bring their products and services to markets outside the region in the most cost-effective manner possible.⁶¹ Second, the competitiveness of a regional economy also hinges on its ability to effectively connect its people and physical assets to their best use within the region—what planners and economic developers call “spatial efficiency.”⁶²

Stockholm benefits from a leading national trade and logistics infrastructure. Metropolitan areas rely on the exchange of goods to allow for economic specialization and, ultimately, long-term growth and prosperity. Freight transportation networks are critical to forging these economic connections, and the Stockholm region's ability to deliver goods to the global marketplace depends on infrastructure countrywide.⁶³ According to the World Bank, Sweden's transportation and logistics system is one of the most well-developed in the world, ranking sixth out of 160 countries in 2014.⁶⁴ Partly due to the efficiency of its freight infrastructure, it costs less to export a shipping container to trading partners from Stockholm (\$725) than from European peer cities of Copenhagen (\$795) or Zurich (\$1,660).⁶⁵

Stockholm's prominence in international aviation networks is growing, but still lags several global peers. In addition to goods, metropolitan economies must efficiently move people. Airports serve as key exchange points in the domestic and international flow of people and ideas, and in doing so help stimulate regional employment and GDP per capita growth.⁶⁶ In 2014, nearly 30 million passengers moved through the airports in the Stockholm region, the 57th highest total of any metropolitan area in the world and fifth most among global peer regions.⁶⁷ Since 2004, Stockholm's two-way passenger flows have increased by 5.1 percent annually, second highest among its peers, just behind Copenhagen.

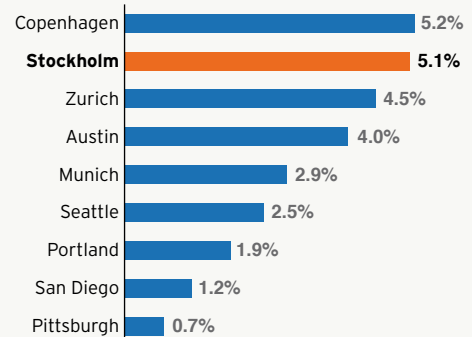
“In 2014, nearly 30 million passengers moved through the airports in the Stockholm region, the 57th highest total of any metropolitan area in the world and fifth most among global peer regions.”

Figure 31. Total aviation passengers by origin, million of passengers, 2014



Source: Brookings analysis of Sabre data.

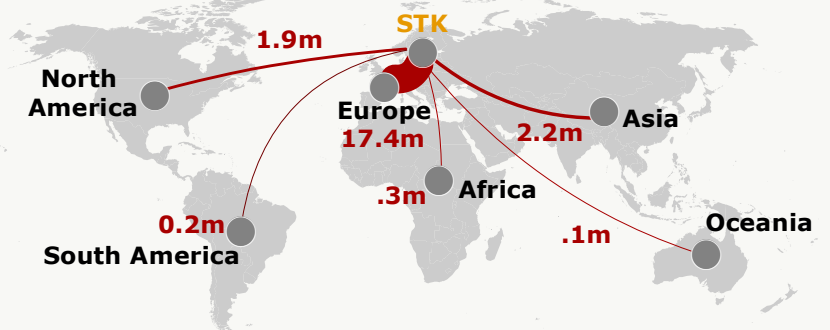
Figure 32. Aviation passenger growth, CAGR, 2004-2014



Source: Brookings analysis of Sabre data.

Stockholm's global aviation linkages

Europe remains Stockholm's most common aviation market, but Asia has been its fastest-growing over the past 10 years. In 2014, approximately 17.4 million passengers traveled to and from European airports outside of Sweden.⁶⁸ The most common final origins and destinations in Europe were Copenhagen, London, Gothenburg, Oslo, and Paris.



Source: Brookings analysis of Sabre data.

Table 7. Largest metropolitan corridors (final origin/destination), 2014

| Rank | Metro area | Total passengers | Share of Stockholm's total passengers |
|------|---------------------|------------------|---------------------------------------|
| 1 | Copenhagen | 4,897,856 | 16.4% |
| 2 | London | 2,513,536 | 8.4% |
| 3 | Gothenburg | 1,166,169 | 3.9% |
| 4 | Oslo | 1,019,651 | 3.4% |
| 5 | Paris | 907,150 | 3.0% |
| 6 | Rotterdam-Amsterdam | 771,031 | 2.6% |
| 7 | Helsinki | 698,003 | 2.3% |
| 8 | Berlin | 673,663 | 2.2% |
| 9 | Barcelona | 658,712 | 2.2% |
| 10 | New York | 583,894 | 1.9% |

Source: Brookings analysis of Sabre data.

→ CONTINUED FROM PREVIOUS PAGE.

Since 2004, Stockholm's fastest growing routes have been between the region and cities in Asia (8.8 percent annually) and Africa (6.6 percent), reflecting the rapid rise of commerce and travel in those markets. Emerging cities in Turkey (Izmir and Istanbul) and the Middle East (Dubai and Tel Aviv) were some of the fastest-growing metro-to-metro aviation connections between 2004 and 2014.⁶⁹

Table 8. Fastest growing metropolitan corridors (final origin/destination), 2004-2014

| Rank | Metro area | Total passengers, 2014 | Annual growth in passengers |
|------|------------------|------------------------|-----------------------------|
| 1 | Izmir | 21,692 | 25.3% |
| 2 | Dubai | 122,922 | 20.0% |
| 3 | Berlin | 673,663 | 16.6% |
| 4 | Istanbul | 304,796 | 15.6% |
| 5 | Bucharest | 39,592 | 12.6% |
| 6 | Katowice-Ostrava | 31,676 | 12.4% |
| 7 | Barcelona | 658,712 | 11.4% |
| 8 | Tel Aviv | 123,116 | 10.4% |
| 9 | Miami | 208,375 | 10.4% |
| 10 | Warsaw | 279,702 | 10.4% |

Source: Brookings analysis of Sabre data.

The Stockholm region relies on yet another set of metropolitan economies as “connection points” to global destinations. These 10 metropolitan areas—led by Frankfurt, Copenhagen, London, and Rotterdam-Amsterdam—are where passengers “pass-through” on their way to and from Stockholm. In this sense, these metropolitan hubs act as critical gateways that connect Stockholm to the rest of the world.

Table 9. Top metropolitan gateways, 2014

| Rank | Metro area | Total passengers |
|------|---------------------|------------------|
| 1 | Frankfurt | 548,769 |
| 2 | Copenhagen | 502,018 |
| 3 | London | 467,235 |
| 4 | Rotterdam-Amsterdam | 351,580 |
| 5 | Istanbul | 311,229 |
| 6 | Munich | 306,185 |
| 7 | Helsinki | 266,583 |
| 8 | Oslo | 238,588 |
| 9 | New York | 228,465 |
| 10 | Berlin | 226,835 |

Source: Brookings analysis of Sabre data.

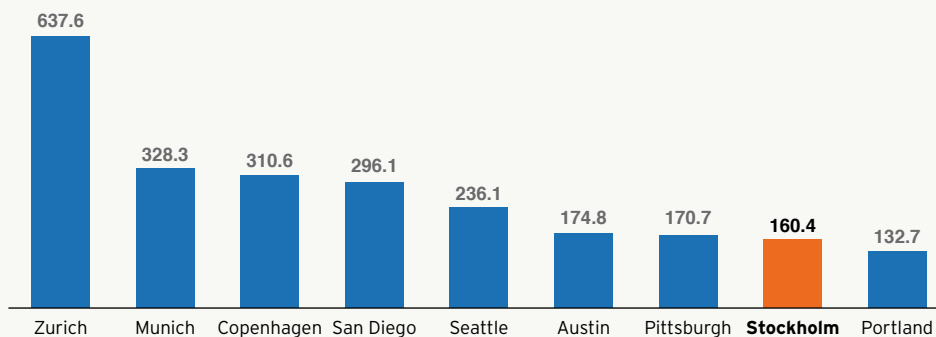
Access to high-speed broadband provides Stockholm's firms and workers a competitive edge over global peers.

The internet and mobile technologies have revolutionized communication across the globe. Research has shown that the quality of internet infrastructure does indeed matter for regional economic development.⁷⁰ Faster broadband speed has implications for productivity in its ability to ease communication and the processing large amounts of information. Accessing the breadth and depth of information available online can empower learning for all members of society, enhancing human capital. One common way to measure broadband quality is the speed at which data can be transferred through the network. By this metric, the average download speeds reported by internet users in the Stockholm region were the second fastest, after Austin.⁷¹

The regional housing supply in Stockholm is struggling to keep pace with the demands of population growth. Workers and families across Sweden and

increasingly the rest of the world want to partake in the successes of the Stockholm regional economy. Yet, according to a recent OECD report, housing development is not keeping pace with the demands of current and new entrants to the region.⁷² There are early signs that the shortage is affecting talent retention, with start-up companies in particular noting the lack of housing and its high cost as a barrier.⁷³ Comparisons to global peers suggest that the Stockholm Capital Region could grow denser to allow for greater housing development.⁷⁴ Doing so in a way that maintains the region's green space and enhances its approach to transit-oriented development can preserve Stockholm's distinct quality of life offering, a key asset for its economic development.⁷⁵ Housing market reforms that ease rent controls, land use rigidities, and incentivize new development could also help address supply challenges.⁷⁶ Failure to address housing shortages could hinder growth in the long-term if Stockholm is unable to attract and retain the talent its industries require to remain globally competitive.

Figure 33. Population density (persons per square kilometre), 2014



Source: Brookings analysis of Oxford Economics data.

► **BOTTOM LINE:** Undersupplied housing is the region's main challenge, which requires housing reforms that allow for greater supply and more dense development. In terms of external connectivity, cross-country studies reveal that the transportation and logistics systems in Sweden are world-class. While not yet at the same volume as larger airports in Seattle, Munich, and San Diego, international passenger flows through Stockholm's Arlanda Airport are growing quickly, especially with Asia. Further investments in Arlanda, including the institution of preclearance programs, can help connect the region's firms and workers to market opportunities worldwide.

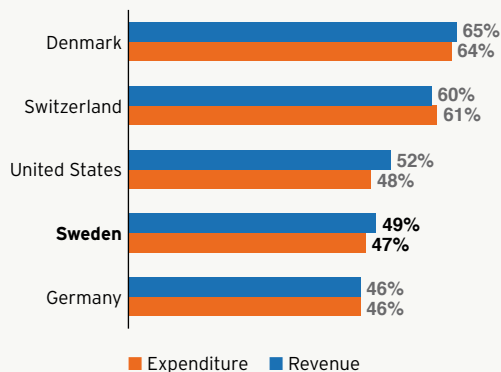
E. GOVERNANCE



WHY IT MATTERS: Broadway and Shah define governance as “the formulation and execution of collective action at the local level,” and thus implicate public, private, educational, and civic institutions.⁷⁷ For our purposes, governance includes formal government structures as well as the quality and capacity of public, private, and civic institutions to positively influence competitiveness.⁷⁸ Governance matters for competitiveness because proactive government, public, and civic groups can marshal investment from a wide variety of domestic and international sources to enable new growth strategies. Federal, state, and local governments also have unique and complementary roles to play in enabling firms and metro areas to succeed in global markets.⁷⁹

While Stockholm enjoys much more local power than most global city-regions, sub-national fiscal autonomy is actually lower in Sweden than in the countries of its peer cities. The OECD provides several useful metrics of sub-national autonomy, including the share of sub-national government expenditures and the share of sub-national tax collections. On average, sub-national governments in the OECD accounted for 40.0 percent and 42.6 percent of total public sector expenditures and revenues, respectively, in 2013. Compared to the OECD, Swedish local and regional governments are quite autonomous, but less so when compared to Denmark, Switzerland, and the United States, the nations in which several peer city-regions are located.

Figure 34. Sub-national share of total government expenditures and revenues, 2013

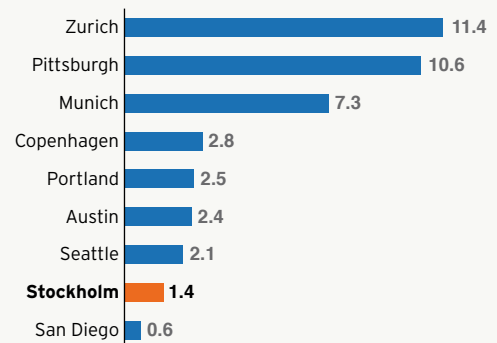


Source: Brookings analysis of OECD data.

The Stockholm Capital Region has less territorial fragmentation than global peers, but could be better integrated with the central government.

Horizontal fragmentation refers to multiple governments within one broader regional economy.⁸¹ The OECD uses territorial fragmentation—the number of local governments in comparison to the total population of the metropolitan area—as a proxy for horizontal fragmentation. By this metric, the Stockholm metropolitan region is less fragmented than all its global peers except San Diego. A recent case study indicated that, through structures such as the Council for the Stockholm-Malar Region, the Stockholm region has become better coordinated across individual municipalities.⁸² And this government structure and coordination matters for competitiveness; the OECD finds that, all else equal, more fragmented metropolitan economies are less productive.⁸³ Earlier studies by the OECD reveal, however, that the Stockholm metropolitan region could be better integrated with the central government, particularly on issues of transportation, housing, and economic development policy.⁸⁴

Figure 35. Number of local governments per 100,000 inhabitants, 2012



Source: Brookings analysis of OECD data.

The Stockholm Capital Region's business and regulatory environment is conducive to starting new businesses and accessing international markets, but lags on the strength of its credit systems and bankruptcy laws. The business environment experienced by firms in a given locality is partly based on factors outside the remit of local officials (e.g. property rights, national taxes, quality of financial markets, distance to other markets, etc.) as well as those squarely within their control (e.g. local tax rates, permitting processes, other regulatory structures, corruption, etc.). Both sets of factors influence the desirability of the business environment, which is oft-cited by firms as a key determinant of where they locate operations.⁸⁵ The World Bank's Doing Business

project, which collects measures of business environment, assembles analysis from the perspective of a firm located in the largest city in the country (including Stockholm for Sweden). Sweden performs well overall (11th of 189 countries) in terms of the overall ease of doing business, behind Denmark and the United States but ahead of Germany and Switzerland. Firms in Stockholm find it easy to trade internationally, get electricity, obtain permits, and register property. Yet, the strength of credit reporting systems and the effectiveness of collateral and bankruptcy laws in facilitating lending are lagging comparable economies. Sweden's next lowest ranking involves the time, total tax rate, and number of payments necessary for a local medium-size company to pay all taxes.⁸⁶

Figure 36. Rank in World Bank Doing Business 2015 Report (out of 189 countries)



Collaboration around economic development has been improving in the Greater Stockholm Region.

The Stockholm region is home to a robust network of public, private, and civic leaders acting purposefully to maintain and grow the local economy. Clark and colleagues documented in a recent case study that organizations such as the Stockholm Business Region have been able to align individual municipalities around a coherent message and strategy.⁸⁷ In turn, a

more coordinated public sector is better positioned to engage the business community and civic groups on the economic development agenda. This state of play represents a marked improvement from just a decade ago, when a 2006 OECD Territorial Review noted the need to create stronger links between the public and private sectors.⁸⁸

► **BOTTOM LINE:** Regional governance is strong in the Stockholm Capital Region. While not to the same degree as global peer cities, Stockholm has fiscal autonomy. Horizontal fragmentation is relatively low, allowing for more streamlined public service delivery, while vertical coordination between the local and central governments on issues of shared responsibility remains a challenge. For the most part, the policy environment is quite conducive to business, with taxes and the legal and regulatory environment around credit being the major issues for Stockholm firms. Finally, there is an emerging network of public, private, and civic institutions intentionally positioning the Stockholm Capital Region globally.



IV. IMPLICATIONS AND OPPORTUNITIES

The Stockholm Capital Region operates from a position of global strength. It concentrates many of the key ingredients for success in the 21st century economy—advanced industries, a skilled workforce, innovative firms and research institutions, efficient infrastructure, and strong governance. This assessment revealed, however, several areas where the region’s public, private, and civic leaders can focus their efforts to maintain growth and competitiveness in an era of rapid globalization and technological change.

A. PURSUE GROWTH THROUGH TRADE



Trade has always been a critical means to generate wealth and prosperity in the Stockholm Capital Region. From iconic industrial giants like Ericsson to globally known brands like H&M to new entrants like Spotify, Stockholm houses countless successful international companies. The region’s competitive niches in fast-growing, advanced industries like biotechnology and information technology position it well going forward. Yet, by other metrics, the region may not be living up to its trading potential. The Stockholm Capital Region houses thousands of small and mid-sized firms, but most of these companies are not globally connected. Small and mid-sized firms account for 95 percent of the firm base, but only generate 26 percent of exports. Of course not all firms are export-ready. But many SMEs, and particularly mid-sized companies, likely have a globally competitive product to offer but are unable to overcome other barriers to exporting.

National policies can help boost trade, as central governments set the rules for trade, negotiate trade agreements, and provide export promotion and support services. In this realm, Sweden’s involvement in the Transatlantic Trade and Investment Partnership (TTIP) negotiations remains a key avenue to reduce trade barriers, align regulations, and further international business between the United States and Europe.

Similarly, the Ministry for Enterprise and Innovation has invested SEK 800 million (\$98.3 million USD) in a new strategy to connect more firms (particularly SMEs) to export support, increase tourism and foreign direct investment, and attract greater foreign education and research talent.⁸⁹

Notwithstanding the important platform national actors establish for trade, metro areas are uniquely positioned to identify and increase the number of firms ready to export and to make exports a significant part of broader regional economic strategies. Regional chambers of commerce, business groups, and other public-private economic development organizations can be important funnels of export-ready firms to national export services. Indeed, over 30 metropolitan regions across the United States, Canada, and the United Kingdom are undertaking regional export strategies. For example, Portland’s regional government agency and public-private business group together launched the **Greater Portland Metropolitan Export Initiative** (see sidebar). Similar efforts are underway in **London, San Diego, Seattle,** and **Toronto**.

Promoting growth through trade in Greater Portland⁹⁰

Metropolitan economies rely upon trade—both imports and exports—as a means to economic specialization and growth. Recognizing this, dozens of U.S. metropolitan areas and several of their international counterparts are developing and implementing strategies that maximize the local benefits of trade. Portland, Ore. was one of the first metro areas to embrace exports as a vehicle for recovery post-recession. In 2011 Portland Mayor Sam Adams and the Portland Development Commission organized a group of regional stakeholders to launch the **Greater Portland Metropolitan Export Initiative**. Greater Portland's export effort involved three steps: a market assessment, an export plan, and a policy memo. The market assessment headlined an effort to better understand Portland's global comparative advantages by rigorously analyzing Portland's recent economic performance, export strengths and weaknesses, prominent clusters and industries, and key trade partners. Surveys and interviews with local firms and export service providers revealed further market insights. From the data analysis, four export strategies emerged that sought to leverage strengths and correct weaknesses:

- 1 Leverage primary exporters in computer and electronics like Intel and TriQuint;
- 2 Catalyze under-exporters in manufacturing;
- 3 Improve the export pipeline for small business; and
- 4 Build on Greater Portland's global edge in sustainability by launching a "We Build Green Cities" brand.

Through the initiative, Portland has successfully launched a pilot program to help under-exporting companies gain access to new markets through market research and case management assistance; successfully bundled and marketed firms in its sustainability cluster under the "We Build Green Cities" brand; and is on track to reach its goal of doubling exports within five years. The "We Build Green Cities" effort, which recently launched a website, led to a partnership with Mitsui Fudosan, one of Asia's largest developers, and representatives from the city of Kashiwa, Japan to create a community-based master plan for a new district.⁹¹ To ensure region-wide buy-in, the effort is overseen and coordinated by Greater Portland Inc., a public-private economic development organization, which convenes a board of directors made up of representatives across business, academia, government, and civil society. In 2013, *National Journal* named Portland the nation's top innovator in expanding exports, and in 2015 Greater Portland launched a foreign direct investment strategy to complement its work on exports.

For more information: <http://www.greaterportlandinc.com/assets/documents/Resources/GPG%20Trade%20and%20Investment%20Plan.pdf>

B. CONTINUE TO BOLSTER THE INNOVATION ECOSYSTEM



The ability to generate and commercialize innovations is the Stockholm Capital Region's global comparative advantage. The region's innovation ecosystem—meaning its collection of talent, firms, universities, research institutes, and industry intermediaries—outperforms other highly-innovative metropolitan areas on metrics of commercial inventions and university-industry scientific collaborations.

The key for the Stockholm region, given the historic dominance of large firms, is extending its innovation ecosystem to include more small and mid-size companies. Several steps, both national and within the Stockholm Capital Region, can help in this regard. First, small and mid-sized firms struggle to match R&D levels of their larger counterparts, a market failure that limits innovation. Targeted incentives (currently

Sweden does not have an R&D tax credit) and enlarging national innovation support programs aimed at SMEs can help boost R&D.⁹² Second, expanding access to venture capital and other investments can help entrepreneurs bring innovative products and services to market at scale. Organizations that help entrepreneurs connect to resources, investors, and technical assistance can help bridge these connections at the regional scale (see sidebar).⁹³ Finally, while university-industry collaboration is a notable strength in Stockholm, large firms tend to dominate joint research with universities. To incentivize collaboration between SMEs and research institutions, Munich's home state of Bavaria provides innovation vouchers that allow firms to conduct additional research themselves or redeem the voucher at a research institution of their choosing.⁹⁴ The Swedish innovation agency VINNOVA, which has piloted the use of innovation vouchers, could expand their use.

Regional intermediaries anchor the innovation ecosystem

Many of the most successful technology hubs around the world are working purposefully to broaden their innovation ecosystems to a wider range of firms. For instance, San Diego **CONNECT** is a premier technology commercialization initiative that has attracted more than \$2 billion in investment capital for more than 3,000 companies since its founding in the 1980s. More than 50 regions around the world have adopted the CONNECT model, including New York City, Bogotá, and Saudi Arabia. Other efforts exist in **Greater Copenhagen**, **Seattle**, and **Munich**, among others. Local action is underway in Stockholm as well. **Stockholm Innovation and Growth** (STING) offers entrepreneurs access to qualified coaching, a business angel network, a venture capital fund, a recruitment service, and an international network of investors.⁹⁵ Expanding the network of entrepreneurs involved with STING and incubators and accelerators such as SUP46, Epicenter, and THINGS can further develop Stockholm's innovation ecosystem.

C. EMBRACE FOREIGN-BORN TALENT



Stockholm's demographic profile suggests that firms will be contending with workforce shortages in the coming decades. At the same time, foreign immigrants have increased as a share of the Capital Region's total population, attracted by Stockholm's high quality of life and good labor market opportunities. Successfully integrating foreign-born workers can help address labor supply issues, but doing so requires an immigration policy that welcomes new in-migrants and helps connect them to labor market opportunities.

Sweden's 2008 immigration reform created a demand-driven migration policy that the OECD deems Europe's most open.⁹⁶ Under this new regime, the Stockholm Capital Region's firms have greater access to global talent pools, allowing for a more efficient matching of worker skills with labor market demands and ultimately improved firm and industry competitiveness.⁹⁷ Silicon Valley's reliance on foreign-born engineers and computer programmers to maintain its innovation edge is a well-known reflection of this dynamic.⁹⁸ Beyond their contributions to local labor markets, recent evidence indicates that increases in Sweden's foreign-born workforce led to increased trade, suggesting that immigrants can help foster international business linkages.⁹⁹

Yet as noted earlier in this analysis, to maximize the economic benefits of immigration, disparities in employment between native-born Swedes and immigrants must be addressed. A recent review of migrant integration found that several barriers to employment exist—basic skills and language deficiencies, firms' inability to recognize foreign certifications, inadequate employer demand, discrimination, insufficient networks and job search capabilities, complicated school-to-work transitions and labor market rigidities, and coordination among local and national actors.¹⁰⁰

Cities act as crucial gateways for new immigrants to attach to work, education, and social networks. Municipalities in Sweden are responsible for local schools, delivering supportive services, and offering

language training. Community-based organizations supplement these efforts. And local employers ultimately hire and train immigrants. As our Brookings colleague Audrey Singer has documented, an increasing number of cities, regions, and states are investing in immigrant integration as an economic strategy.¹⁰¹ While a sound public sector integration model exists, Stockholm's leadership could consider several examples from peer metro areas that have engaged private and civic actors as well. Through its **Integrated Basic Education Skills Training Program**, which provides language training and adult basic education in high-demand occupations across 34 community and technical colleges, the state of Washington, home of Greater Seattle, is advancing the career prospects of low-skilled immigrants. The Austin city government has launched a **Welcoming City** effort to develop a shared vision for how Austin will welcome international newcomers. In Munich, the **Migrant Entrepreneurs Munich program** supports immigrant entrepreneurs start businesses by providing training and networking events. And cities such as **Seattle, Chicago, San Francisco, Los Angeles**, and **New York City** have launched offices of immigrant affairs to help improve the economic prospects of immigrants, and their regional economies as a result.¹⁰²

D. BOOST HOUSING CONSTRUCTION, LABOR MOBILITY, AND DENSITY



Recent examinations of Sweden's competitiveness point to imbalances in housing supply and demand.¹⁰³ Improperly functioning housing markets can hinder regional economies when they limit labor mobility. The overall potential of the economy diminishes if people are locked in their housing and cannot move to other parts of the region to take a new job in which they would be more productive. If job seekers outside the region are unable to contribute their human capital to Stockholm because they cannot find housing, that also limits growth.

The origin of the housing market challenge is beyond the scope of this report, but a recently convened

group of experts concluded that the crisis cannot be solved without addressing two main challenges. First, policymakers must reform rent-setting policies that are currently “locking in” residents at below-market rates, limiting labor mobility, and leading to sub-optimal housing uses. Second and subsequently, zoning and land use reforms are needed to allow for greater construction and rehabilitation. Increased supply will help keep newly-liberalized rents from skyrocketing.¹⁰⁴ Increasing region-wide density, especially near mass

transit, can be a mechanism for increasing supply without adding to sprawl. While Stockholm’s housing challenges are somewhat unique, other high-demand metropolitan housing markets, such as Seattle, are also working on strategies to increase the quality and affordability of housing (see sidebar). Their process may serve as a useful example for Stockholm, where organizing local stakeholders for action seems to be the main challenge.

Seattle’s compromise approach to affordable housing

In Seattle, Mayor Ed Murray recently led the creation of a city-wide **Housing Affordability and Livability Agenda** that aims to create 50,000 new housing units in 10 years. The mayor tasked a committee of economists, real estate developers, tenant advocates, and social and community leaders with finding a compromise solution on a highly contentious issue.¹⁰⁵ After lengthy deliberations, committee members arrived at what they called a “grand bargain.” Residential developers will be allowed to build more densely in designated rezoned areas but must either build affordable housing units or contribute to a fund for the city to build them. Commercial developers must pay a “linkage fee” to fund additional affordable housing.¹⁰⁶ While these may not be the specific remedies Stockholm’s housing market needs, the Seattle process of convening public, business, and community leaders to forge a compromise solution provides one example for how the region could seek to build consensus for reform.

“Looking forward, the region can bolster its competitiveness by bring more firms into the export pipeline, expanding its innovation ecosystem to include more SMEs, educating and integrating immigrants into the workforce, and addressing housing market challenges.”



V. CONCLUSION

This assessment of the Stockholm Capital Region reveals an economy that has succeeded in generating growth that has raised living standards for much of its population. Even as compared to some of the most productive metropolitan areas in the world, Stockholm stands out for its highly educated population, innovative firms, collaborative universities, and good governance. Looking forward, the region can bolster its competitiveness by bringing more firms into the export pipeline, expanding its innovation ecosystem to include more small and mid-sized firms, educating and integrating immigrants into the workforce, and addressing the dysfunctional housing market. By taking purposeful action now, Stockholm's public, private, and civic institutions can sustain the region's competitiveness for generations to come.

METHODOLOGICAL APPENDIX

Selection of Peers

Global peer cities were selected based on economic characteristics and competitiveness factors. Classifying and identifying peers allows policymakers and stakeholders to better understand the position of their economies in a globalized context as well as to conduct constructive benchmarking.

To select peers we utilized a combination of principal components analysis (PCA), k-means clustering, and agglomerative hierarchical clustering.¹ These commonly used data science techniques allowed us to group metro areas with their closest peers given a set of economic and competitiveness indicators. For this report we selected 14 economic variables: population, nominal GDP, real GDP per capita, productivity (defined as output per worker), total employment, share of the population in the labor force, and industry share of total GDP (8 sectors).² We included seven additional variables that measure one of the four quantitative dimensions of the competitiveness analysis framework used in this report. The variables included are: share of the population with tertiary education (talent), stock of greenfield foreign direct investment (FDI) (trade), number of international passengers in 2014 (infrastructure), number of highly cited papers between 2010 and 2013 (innovation), mean citation score between 2010 and 2013 (innovation), and average internet download speed in 2014 (infrastructure).

Our analysis proceeded in three steps. First, we applied PCA to reduce the number of dimensions of our data by filtering variables that are highly inter-related while retaining as much variance as possible. PCA generates “components” by applying a linear transformation to all the variables.³ To successfully perform our clustering algorithm we selected the number of components that explain 80 to 90 percent of the variance of a dataset. For this report we selected the first seven components, which accounted for 84 percent of the total variation of the data.⁵ The second stage applied a k-means algorithm to the seven components, a process which calculates the distance of every observation in our dataset to each other, then generates a cluster centroid and assigns each data point to the closest cluster.⁴ K-means repeats this procedure until a local solution is found. This algorithm provides a good segmentation of our data and under most circumstances it is a sufficient method for partitioning data. However k-means sometimes generates clusters with multiple observations, thus obscuring some of the closest economic relationships between metro areas. To improve the results of k-means we implemented a third step, hierarchical clustering, which follows a similar approach to k-means. Hierarchical clustering calculates Euclidean distances to all other observations, but generates a more granular clustering that permits clearer peer-to-peer comparison.

Key variables

| Dimension | Indicator | Source |
|-----------------------------------|--|---|
| Economic Performance | Gross domestic product | Oxford Economics, Moody's Analytics |
| | Employment | Oxford Economics, Moody's Analytics |
| | Gross domestic product per capita | Oxford Economics, Moody's Analytics, U.S. Census Bureau |
| | Output per worker | Oxford Economics, Moody's Analytics |
| | GINI coefficient | OECD |
| Trade | Traded sector output | Oxford Economics, Moody's Analytics |
| | Traded sector employment | Oxford Economics, Moody's Analytics |
| | Exports and imports | Statistics Sweden data |
| | Greenfield foreign direct investment | fDi Intelligence data |
| Innovation | Share of total publications in top 10 percent cited papers | Centre for Science and Technology Studies (CWTS) and Leiden University data |
| | Mean citation score 2010-2013 | |
| | Share of total publications done with industry | REGPAT |
| | Patent output per 1,000 inhabitants | |
| | Venture capital investments, millions of dollars per 1,000 inhabitants | |
| Venture Capital Stock by Industry | Pitchbook | |
| Talent | Share of population 15+ with tertiary education | Oxford Economics, U.S. Census Bureau |
| | Foreign-born share of total population | Unemployment rate |
| Infrastructure | Total aviation passengers | SABRE |
| | Average download speed | Net Index |
| | Population density | Oxford Economics |

DATA SOURCES

Oxford Economics:

Economic indicators as well as selected indicators corresponding to talent for non-U.S. metropolitan areas were provided by Oxford Economics (OE). Economic variable such as GDP, Gross Value Added (GVA), employment, unemployment rates, educational attainment, and industry-level employment and output were collected by OE from national statistics bureaus in each country or from providers such as Haver, ISI Emerging Markets, and Eurostat. Population estimates and the share of the foreign-born population were based on official population projections produced by national statistical agencies and or organizations such as Eurostat, adjusting migration assumptions on a case-by case basis. The study uses gross value added

(GVA) and Gross Domestic Product (GDP) in nominal terms at purchasing power parity rates, and in real terms at 2009 prices and expressed in U.S. dollars. All the indicators were provided at the metropolitan level.

Moody's Analytics:

Economic indicators for U.S. metro areas were provided by Moody's Analytics. Moody's uses data published by the Bureau of Labor Statistics (BLS) and by the Bureau of Economic Analysis (BEA) to generate their estimates of employment and GDP at the county level. We aggregated those estimates to metropolitan areas using the current Census Bureau definition. For real GDP, both total and at the industry level, Moody's provides 2009 chained dollars. For nominal analysis they report their estimates in current dollar.

Census Bureau:

The indicators for talent for U.S. metro areas come from a variety of surveys published by the U.S. Census Bureau. The population estimates were created using intercensal population estimates at the county level and then aggregating those estimates to the metro level using the current definitions of metropolitan areas. For the foreign-born share of the population and unemployment rates, we utilized American Community Surveys at the county levels and aggregated them at the metropolitan level. The educational attainment variables were obtained through the Integrated Public Use Microdata Series platform (IPUMS) from the Minnesota Population Center. Data was built up from PUMA level microdata on the educational attainment and age of residents. These age intervals were utilized to comport with the international education attainment levels.

For more information, see Steven Ruggles, Katie Genadek, Ronald Goeken, Josiah Grover, and Matthew Sobek. *Integrated Public Use Microdata Series: Version 6.0* [Machine-readable database]. Minneapolis: University of Minnesota, 2015.

REGPAT:

The source of the patents data is the OECD's REGPAT database. The OECD manages this database as part of the Patent Cooperation Treaty, which offers patent protection to organizations and individuals planning to do business in multiple countries. A number of research decisions went into the construction of the patent estimates. Patent locations correspond to the inventor's place of residence or workplace. In cases when there are multiple inventors, the patent was fractionally-counted and apportioned in equal shares to each co-inventor. Patents that fall under multiple International Patent Classification (IPC) technology codes were also apportioned in equal shares to each technology class in order to account for the cross-cutting nature of technological development. To mitigate year-to-year fluctuations in invention activity, patents were summed in five-year intervals. The time dimensions represents the "priority year" when the patent was first filed. This year is closest to the actual date of invention and is the most relevant reference date

when assessing an areas technological activity at a specific point in time. Since patent filing is a costly and administratively burdensome process the analysis excludes patents submitted in 2013 and 2014 since patents filed in these years only account for a portion of patents actually invented and may bias places and organizations with better systems for shortening lag time between the date of invention and the application year.

For more information see Maraut, Stephane. Helene Dernis, Colin Webb, Vincenzo Spiezia, and Dominique Guellec. 2008. "The OECD REGPAT Database: A Presentation." June 3, 2008.

<http://www.oecd.org/sti/inno/40794372.pdf>

Leiden:

The source of the university scientific impact data is the Centre for Science and Technology Studies (CWTS) at Leiden University. This publicly available database tracks bibliometric performance data for 750 universities with the largest publication output in internationally recognized journals. The database relies on the Thomson Reuters Web of Science citations indices which researchers cleansed, geocoded, and classified into fields of study. CWTS reports publications based on full-counting methods which gives equal weight to all publications from a university and fractionally-counting methods which apportion shares to each collaborator. Brookings' analysts focused on fully-counted publications and aggregated the raw university-level citations data into metro-level estimates (see geocoding section below). Mean citation scores were aggregated based on the metro average weighted according to university-level publication count. Brookings analysis primarily focused on two measures. First, the mean normalized citation score is the average number of citations of the publications of a university, normalized for field differences and publication year. A value of two for instance means that the publications of a university have been cited twice above world average. Second, the percent of publication in the top ten percent most cited is the proportion of the publications of a university that, compared with other publications in the same field

and in the same year, belong to the top ten percent most frequently cited.

For more information see Waltman, L., Calero-Medina, C., Kosten, J., Noyons, E.C.M., Tijssen, R.J.W., Van Eck, N.J., Van Leeuwen, T.N., Van Raan, A.F.J., Visser, M.S., & Wouters, P. (2012). *The Leiden Ranking 2011/2012: Data collection, indicators, and interpretation. Journal of the American Society for Information Science and Technology*, 63(12), 2419-2432. <http://www.leiden-ranking.com/methodology>

PitchBook:

The source of the venture capital data is PitchBook, a private financial research firm that collects and tracks global private equity activity. Pitchbook analysts deploy web crawlers to perform a daily systematic scan of media reports and public filing information on deals which they then record and validate through a manual review process. In assembling their database they include address level data for both investors and recipient companies, industry, investor details along with the deal value. Brookings' analysts took the data and then assigned the investors and recipients to metropolitan geographies (see geocoding section below). The primary statistic in the analysis is the cumulative stock of venture capital which is the sum total of year-to-year investment flows. Secondary statistics examine the number of investors and companies along with data between different geographies, deal categories, and industries. The advanced industries classification is an approximate grouping based of detailed industry categories matched to Brookings' NAICS-based definition. All value measures were inflation-adjusted to 2014 dollars.

For more information see [PitchBook.com http://blog.pitchbook.com/wp-content/uploads/2014/06/3Q-2014-PE-Breakdown-Methodology.pdf](http://blog.pitchbook.com/wp-content/uploads/2014/06/3Q-2014-PE-Breakdown-Methodology.pdf)

Net Index:

The source of the internet download speed data is Ookla's Net Index (now rebranded as Speedtest Intelligence). Ookla is a web service that offers free internet speed tests to users as part of an internet

intelligence business. The coverage is global in scope because the service relies upon user-submitted tests logged through the speedtest.net website that gauges internet speeds. Ookla reports the raw data at the city-level at the daily frequency which Brookings' aggregated into annual metro-level averages weighted according to the number of tests in each city-day record (see geocoding section below). Since the data is crowd-sourced from users it may be susceptible to bias if users disproportionately share characteristics that diverge from the average internet user in their metro area. One reason to trust the data is that it is unlikely that this bias would systematically vary between metro areas so if there is a "slow" or "fast" bias it would likely affect all places equally. In addition, the vast majority of metro areas display normal distributions and the sample size is quite large with the average largest 100 metro areas by population recording over 30 million tests in 2014.

For more information see [Ookla.com https://www.ookla.com/speedtest-intelligence](https://www.ookla.com/speedtest-intelligence)

Sabre:

The source of the aviation data is Sabre Aviation Solutions' global demand dataset (GDD). The dataset includes a record for every international itinerary entering and leaving the United States or any large global metro area with economies larger than \$100 billion in 2014. Each record includes the origin and destination airports, plus up to three connecting airports with the number of passengers and total revenue generated from that specific itinerary for that year. The GDD is based on a variety of sources including information developed from direct business relations between Sabre and over 400 global airlines. For international itineraries not reflected in their database, Sabre imputes missing flights and passenger levels based on additional market data. The result is a complete dataset of travel into and out of major global aviation centers. Brookings' performs a number of additional value-adds. These include: assigning all airports to global metropolitan areas (see geocoding section below), obtaining latitude and longitude coordinates to derive distance measures, cleansing anomalous records, and aggregating the passenger and

revenue flows to better facilitate regional analysis. All value measures were inflation-adjusted to 2014 dollars.

For more information see Tomer, Adie, Robert Puentes, and Zachary Neal. 2012. "Global Gateways: International Aviation in Metropolitan America." Brookings Institution. October 25, 2012.

<http://www.brookings.edu/~media/research/files/reports/2012/10/25-global-aviation/25-global-aviation.pdf>

FDI Intelligence:

The source of the greenfield FDI data is the Financial Times' fDi Markets database. This database tracks all cross-border investment into new physical projects or expansions of an existing investment, otherwise known as "greenfield" investment. Company announcements form the basis for the database and each submission is manually verified before being published. In cases when the capital investment and job counts are not publicly released, analysts impute the value invested and jobs created using an econometric model. The primary sources of the data are newswires, internal sources, top business journals, industry organizations, investment agencies, and data purchased from private vendors. Brookings' analysts assigned metro areas to the city-level information available in the database and processed the flows between different investor and recipient geographies and industry levels. The preferred metric is the cumulative stock of FDI invested and jobs created over the reference period from 2009 to 2015. All value measures were inflation-adjusted to 2014 dollars.

For more information see fDi Markets.com <http://www.fdimarkets.com/faqs/>

Geocoding Process

An addition layer of data assignment was required for data that was not available at the metropolitan scale. Geographic identifiers were used to process individual data points through the Google Maps Geocoding API to obtain latitude, longitude and other geographic information.⁶ Using the latitude

and longitude information, we assigned an observation to a metropolitan area using defined geographic boundaries through a geo-intersection.⁷ Finally we aggregated observations and created a metropolitan level indicator. We iterated this process several times to ensure data consistency and the adequate allocation of observations to its corresponding geographic boundaries.

APPENDIX ENDNOTES

1. For an overview of the three methods utilized see Trevor Hastie, Robert Tibshirani, and Jerome Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, Springer: New York, 2011.
2. For industry analysis we collected industry-level data and estimates for Real Gross Value Added (GVA). Given the heterogeneity of the industrial classification used among the different metro areas we reclassified all the GVA information into eight major industrial sectors: transportation; utilities; business, financial and professional services; local non market services; construction; trade and tourism; manufacturing; and commodities. To see a complete list of the industries included in these 8 categories see: Parilla and others, *Global Metro Monitor 2014: An uncertain recovery*, Brookings Institution: Washington DC, 2015.
3. See I.T. Jolliffe, *Principal component Analysis: Second Edition*, Springer: New York, 2002.
4. Similar approaches to quantify complexity of data have been implemented at the national level, see: Ricardo Hausmann, César A. Hidalgo, Sebastián Bustos, Michele Coscia, Alexander Simoes, and Muhammed A. Yildirim, *The atlas of economic complexity: mapping paths to prosperity*, MIT press: Boston, 2014.
5. Trevor Hastie, Robert Tibshirani, and Jerome Friedman, *The Elements of Statistical Learning: Data Mining, Inference, and Prediction*, Springer: New York, 2011
6. For more information on the Google Maps Geocoding API see: <https://developers.google.com/maps/documentation/geocoding/intro>
7. Wilpen L. Gorr and Kristen S. Kurland, *GIS Tutorial 1: Basic Workbook*, Esri Press: California, 2013.

ENDNOTES

1. We ranked Stockholm and its peers along the five quantitative dimensions that this report examines. The categories and indicators we used to create indexed scores are as follows: **economic performance** (indicators: 2000-2014 annual growth in output, employment, productivity, and GDP per capita; Gini coefficient, 2010); **trade** (2000-2014 traded sector output growth; total greenfield FDI investment per 1000 workers, 2009-2014; share of greenfield FDI in tech-intensive industries, 2009-2014; and advanced services connectivity as defined by GaWC, 2012); **innovation** (local universities share of total publications in the top 10 percent of cited papers, 2010-2013; local universities mean citation score, 2010-2013; local universities share of total publications done with industry, 2010-2013; patents per 1,000 inhabitants, 2008-2012; venture capital investment per 1,000 inhabitants); **talent** (unemployment rate (latest year available); share of population above 15 with tertiary education, 2013; share of foreign-born population 2011; workforce supply, 2014); **infrastructure** (total aviation passengers, 2014; total aviation passengers growth, 2004-2014; broadband download speed, 2014; and population density, 2014). For every indicator in a given dimension we take the value of every observation minus the median value of that variable, and then we divide that difference by the distance between the values of that variable at the 90th percentile of the distribution minus the value at 10th percentile. We repeat the process for all the indicators in a dimension and then sum the results to obtain a global score. We rank the metropolitan areas based on these scores for all the dimensions. For the graph that we present we scaled the highest value to 100 and adjusted the remaining scores proportionally. For more information on the variables used see the methodological appendix. For information on the methodology see: Joseph Parilla and others, "Global Metro Monitor 2014: An uncertain recovery" (Washington: Brookings Institution, 2015).
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