BENCHMARKING GREATER WASHINGTON'S GLOBAL REACH

THE NATIONAL CAPITAL REGION IN THE WORLD ECONOMY

GLOBAL CITIES INITIATIVE
A Joint Project of Brookings and JPMorgan Chase

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NICK MARCHIO AND ALAN BERUBE

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SUMMARY

Greater Washington is one of the largest and wealthiest regional economies in the world. Much of its current prosperity stems from its status as capital of the world's leading advanced economy. But the region's economic growth has slowed markedly in recent years, and the federal government is becoming a less reliable contributor to Greater Washington's current and future prosperity. Leaders in many other U.S. regions that face similar economic headwinds are taking active steps to understand and enhance their competitive position and connections in a growing global economy. This report, developed as part of the Global Cities Initiative, a joint project of Brookings and JPMorgan Chase, provides a framework for Greater Washington to better understand its performance and position on key indicators of global engagement, offering information and insights to help regional leaders more actively shape the region into a competitive and prosperous global marketplace. Its key findings include:

Greater Washington is a prosperous region, but its economic growth has slowed. The Greater Washington region, which includes 6 million people across three states and the District of Columbia, is one of the largest and wealthiest economies in the United States and worldwide. Its more than $400 billion economic footprint relies heavily on services, particularly the federal government, which through direct employment and other spending accounts for 38 percent of regional output. That reliance on government poses a challenge for growth, however. As the effects of anti-recessionary federal stimulus spending wore off and federal "sequestration" budget cuts kicked in, output growth in the region slowed to well under the national average from 2008 to 2014, and anemic job growth occurred in lower-paying sectors. Increasing pressures on federal domestic discretionary spending mean that failure to diversify the regional economy and build new areas of competitive strength may threaten Greater Washington's long-run prosperity.

Greater Washington's economy could benefit from a more deliberate global orientation. Over the next five years, 86 percent of global economic growth is projected to occur outside the United States. In a growing number of U.S. metropolitan areas, cross-sector groups of leaders are organizing to capture the economic benefits associated with increased global engagement, focusing in particular on boosting local advanced industries, exports, and foreign direct investment (FDI). Efforts among public- and private-sector leaders to reduce Greater Washington's structural dependence on federal spending can explore strategies to re-orient its considerable local assets not only beyond government, but toward opportunities beyond the nation's borders.

Greater Washington has a considerable presence in advanced industries, but those sectors are growing slowly and lack industrial diversity. Compared to nine other peer regions around the United States, Greater Washington ranks third in the share of its jobs in research- and technology-intensive "advanced"

industries that embody the traded core of the economy. However, the region ranked only seventh in the growth rate of advanced industry jobs from 2008 to 2014, and actually saw those jobs shrink in Fairfax County/Falls Church, the metro area's most important advanced industry center. This may reflect two potential weaknesses of advanced industries in Greater Washington. First, they are minimally diversified; just five of the 50 industries identified as "advanced" nationally account for 87 percent of the region's advanced industry jobs. Second, they rely heavily on federal spending, with federal revenues representing 64 percent of all revenues in those sectors in 2014.

Exports make up a relatively small share of Greater Washington's economy. While Greater Washington boasted $27 billion in exports and 220,000 related jobs in 2014, mainly in services, that represented only 6 percent of its total GDP, second-smallest among its peer regions and 95th smallest among the 100 largest U.S. metro areas. The outsized role of the federal government contributes to exports' smaller regional economic footprint, as does the orientation of its exports toward lower-paying sectors such as travel and tourism.

FDI is increasing in Greater Washington, but relatively few of the region's foreign-owned firms operate in advanced industries. Greater Washington is about average in the share of its jobs in foreign-owned establishments (5.4 percent, representing 112,000 jobs), but in contrast to many of its peer regions that share has increased over the past decade, primarily through mergers and acquisitions activity. FDI can boost local trade capacity and job quality, but its benefits may be attenuated in Greater Washington because a below-average share of its foreign firms are in advanced industries. While large numbers of jobs in the region's foreign-owned firms are in advanced sectors such as computer systems design, engineering, and pharmaceuticals, grocery stores employ more local workers in foreign-owned establishments than any other industry.

Greater Washington possesses strong underlying assets to fuel increased trade and investment, but they could be better leveraged toward more purposeful global engagement. Innovation, talent, and infrastructure are the core regional assets that ultimately power trade and investment potential. In each of these areas, Greater Washington possesses

important strengths, but also considerable opportunities to increase the contributions these assets make to the region's global competitiveness and connections.

Despite its overall research emphasis, Greater Washington lags its peers on the production of high-value technology patents. Among peer regions Greater Washington ranked ninth in its per-capita production of tech patents from 2008 to 2012, and saw patenting activity in core sectors such as life sciences and information technology erode from a decade prior. Moreover, the region has few private-sector firms among its top patent creators, suggesting possible limits to the global commercial value of its innovative technologies. Local universities could provide a greater stimulus to private-sector technology innovation, but underperform relative to peers in other regions on measures of scientific impact and industry engagement. Nonetheless, significant recent growth in venture capital investment in the region, particularly in advanced industries, bodes well for Greater Washington's future innovation potential.

Greater Washington's workforce, including foreign-born individuals, is unrivaled in its levels of educational attainment. A higher share of Greater Washington's adults possess a college degree not only relative to peer regions, but also compared to all other major U.S. metro areas. Moreover, the region has more highly educated immigrant adults than its peer regions, conferring a potential advantage in helping the region expand its global networks. Local employers seek highly educated workers for specialized STEM occupations, and exhibit strong demand for highly skilled foreign workers through the H-1B visa program. Still, benchmarks suggest that Greater Washington's colleges and universities could do more to attract and capitalize on the talents and connections of foreign students.

Greater Washington is a major global aviation center, but its residents face long commutes. In 2014, the region's two major airports (Ronald Reagan and Dulles) moved 57 million passengers, second-highest among peer regions. Baltimore/Washington International accounted for another 35 million passengers across the mega-region. Greater Washington also ranked second in the share of those passengers (18 percent) arriving from or traveling to international destinations. However, passengers have grown only 3 percent over the past decade, just eighth-highest among peer regions. And within the region, Greater Washington exhibits the slowest average commute time among its peers. Strengthening infrastructure connections globally while improving connectivity regionally could facilitate increased global trade and investment in Greater Washington.

Although Greater Washington faces unique challenges to its future economic prosperity, many other major city-regions confront similar uncertainties around their growth prospects. This analysis, and the several examples it describes of intentional global strategies other U.S. markets are taking, suggest that now may be the time for Greater Washington's leaders to consider adopting a more coordinated, purposeful, region-scaled stance to identify and seize global opportunities for the local economy.

INTRODUCTION

Greater Washington—including the District of Columbia, together with 17 counties and six independent cities in Virginia, Maryland, and West Virginia—is one of the largest and wealthiest regional economies in the world. It is home to the national capital of the world's premier advanced economy. It has one of the most highly educated and productive workforces in the United States. It boasts renowned universities and research institutions, world-leading professional services firms, unique cultural and natural assets, proximity to critical U.S. markets, and ready connections to leading global regions. Notwithstanding important disparities among its 6 million residents and thousands of individual communities, the overall standard of living and quality of life in Greater Washington is enviably strong.

This prosperity is not guaranteed, however. In fact, recent economic signs for Greater Washington have been less than encouraging. While the region weathered the Great Recession better than most, it has recovered more weakly. Recent job growth has been concentrated in lower-paying sectors of the economy. Federal "sequestration" budget cuts have already affected the region's workforce and federal contractors, and looming discretionary spending pressures are likely to limit the federal government's future contributions to the region's growth as well.

Although Greater Washington faces unique challenges to its future economic prosperity, many other major city-regions confront similar uncertainties around their growth prospects. Their leaders—elected, corporate, and civic—know that local businesses and residents must navigate a fast-changing global economy

marked by expanding trade, relentless technological innovation, and massive demographic shifts that continuously disrupt the path to success. At the same time, they also know that their places contain the assets—skilled workers, advanced technologies, physical infrastructure, capital investment, and cross-sector relationships—that matter most for achieving growth and prosperity.

A growing number of city-regions are thus taking active steps to understand and enhance their competitive position and critical connections in the global marketplace. Several are doing so as part of the Global Cities Initiative (GCI), a joint project of Brookings and JPMorgan Chase. GCI aims to equip metropolitan leaders with the information, policy ideas, and global connections they need to bolster their position within the global economy. Through the initiative, city-regions are developing and executing global engagement strategies focused on connecting local businesses and communities to emerging international sources of growth and opportunity.

This report provides a framework for Greater Washington to better understand its performance and position on key indicators of global engagement, including how it compares to a group of similar U.S. places. It assesses the current state of the Greater Washington economy, examines the regional economy's global reach on core trade and investment indicators, and explores the contributions and limitations of its innovation, talent, and infrastructure assets to global performance. The report also offers examples of strategies other regions are pursuing under GCI to access new global opportunities. It is not a strategy document, but presents Greater Washington's economic strengths and challenges in a new light that hopefully inspires further inquiry and action.

With the federal government waning as a reliable source of future growth, it may be time for Greater Washington's leaders to consider adopting a more coordinated, purposeful, and region-scaled stance with respect to those opportunities. As one observer in a recent GCI case study of the region noted, "D.C. is a global city, but not because somebody set out to make D.C. into a global marketplace." This report aims to offer information and insights to help regional leaders actively shape such a marketplace, and thereby secure future prosperity for Greater Washington's residents.

"This report provides a framework for Greater Washington to better understand its performance and position on key indicators of global engagement."

STATE OF THE ECONOMY

Greater Washington is a large, productive, and prosperous economic center. The District of Columbia and its surrounding jurisdictions in Maryland, Northern Virginia, and West Virginia together constitute the sixth largest metropolitan economy in the United States, and the 14th largest in the world. In 2014, Greater Washington generated more than $400 billion in goods and services, and was home to 3.2 million jobs and 6 million residents.[1]

Industrially, Greater Washington boasts the seventh-largest service economy globally, a robust sector that includes business, finance, research, education, healthcare, and governmental affairs. Greater Washington is also one of the most productive service economies in the world, with the average worker supporting $157,000 dollars of economic activity, ranking it behind only New York and Los Angeles as domestic regions among the world's 10 largest service hubs (Table 1).[2]

Services dominate Greater Washington's economy, accounting for fully 93 percent of its GDP (Figure 1). Goods and commodities represent the remaining 7 percent (which consists of manufacturing, construction, mineral extraction, and agriculture), compared to 33 percent nationally. The largest service components of the regional economy are relatively high-skill sectors in science, consulting, media, real estate and finance (47 percent of GDP; 1.25 times the national average), followed by local, state, and federal government (25 percent; double the national average). These two mega-sectors also pay the highest average per-worker compensation at $94,000 and $83,000 per year, respectively.[3]

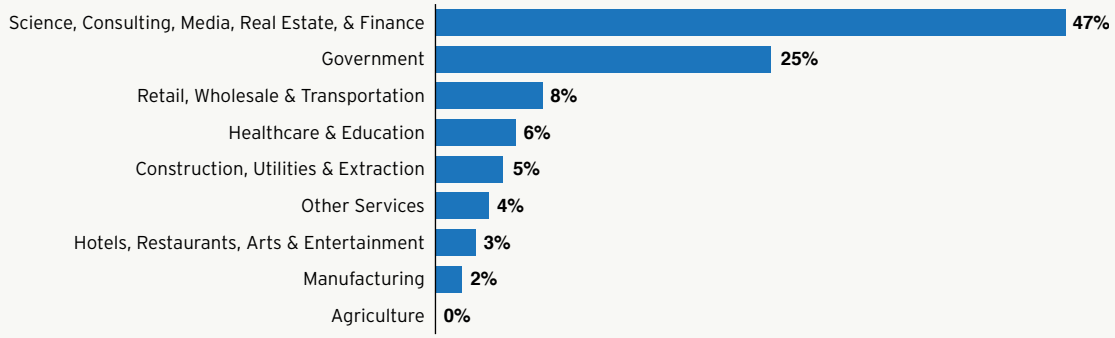
The Greater Washington region's concentrations of high-wage service sectors help explain its relative affluence. Globally, it ranks seventh on per-capita GDP, a common standard-of-living measure. Its typical household earns $91,200, more than 70 percent above the nationwide level. About 8.7 percent of

Table 1. Ten largest global metropolitan economies in business, financial, professional, and local services, 2014

Rank	Metro area	Output (USD billion)	Output per worker (USD)
1	New York	1,071	174,798
2	Tokyo	736	93,227
3	Los Angeles	592	172,284
4	London	500	89,604
5	Paris	484	118,053
6	Seoul-Incheon	370	69,632
7	**Washington**	**367**	**156,957**
8	Chicago	359	133,021
9	Beijing	307	41,424
10	Moscow	301	94,949

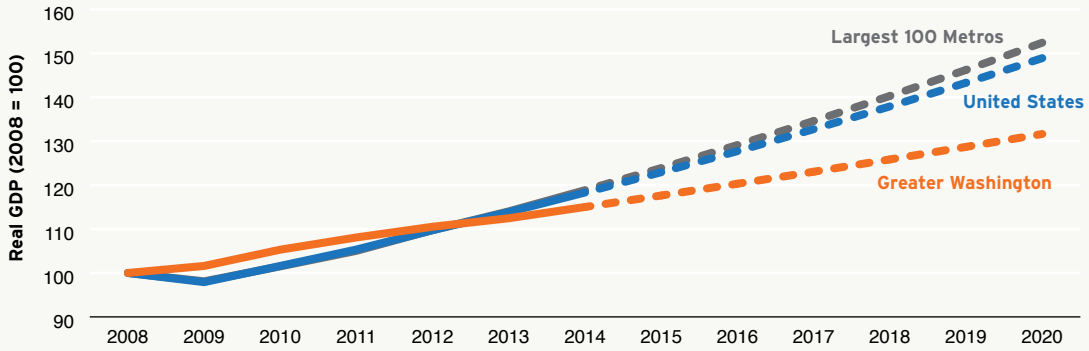
Source: Brookings analysis of data from Oxford Economics and Moody's Analytics.

Figure 1. Share of GDP by sector, Greater Washington, 2014



Source: Brookings analysis of Moody's Analytics data

Figure 2. Real GDP and projections, 2008-2020

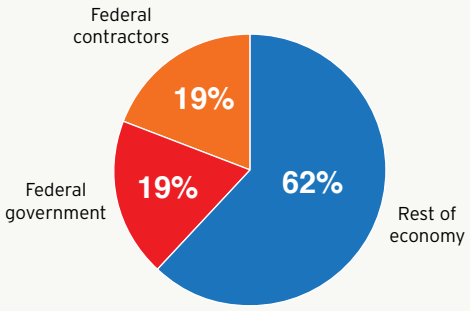


Source: Brookings analysis of Moody's Analytics data

people in Greater Washington live below the federal poverty line, a little more than half the U.S. average. And the median value of owner-occupied housing units is $387,000, more than double the median U.S. value.[4] While these statistics conceal significant variation within the region by place and sub-population, Greater Washington overall is a large and prosperous economy.

Greater Washington's economic growth has slowed. Since the global financial crisis and ensuing deep recession in 2008-09, output growth in the Washington region has been steady, averaging 2.4 percent per year between 2008 and 2014 (Figure 2). This average, however, obscures differences in the region's performance during and after the Great Recession. During the recession, its GDP growth barely slowed thanks to stable federal employment and stimulus spending. Starting in 2010, however, Greater Washington's growth began to lag national and large metropolitan averages as federally induced "recession-proofing" wore off and the effects of federal sequestration cuts began to kick in. Between 2010 and 2014, it ranked 93rd among the 100 largest U.S. metro areas and 249th among the 300 largest globally with 1.5 percent annual GDP growth.[5] Part of its sluggishness owes to the character of recent job growth, which has idled at 0.4 percent per year between 2008 and 2014. Health care, hotels, and food services accounted for 91 percent of net new jobs over that time. On average, occupations in these sectors pay 40 percent below the regional average wage. If

Figure 3. Federal government contribution to Greater Washington GDP, 2014



Source: Brookings analysis of data from Moody's Analytics, GSA, and Fiscal Service at USASpending.gov

current growth rates continue, by 2020 the average U.S. metro economy will be 50 percent larger than its pre-recession peak, but the Greater Washington economy will be only 30 percent larger.[6]

The region's economic structure poses a central challenge to its current and future growth prospects. It is and will remain the epicenter of the U.S. government, itself a source of good jobs and billions of dollars in spending. The federal government directly employs 362,000 workers in Greater Washington (11 percent of the workforce) and accounts for $77 billion in GDP (19 percent of the economy).[7] Yet the role of the federal government in the regional economy extends beyond direct operations to include the commerce that results from business with federal agencies. In 2014 the federal government awarded $75 billion in contracts and grants to firms and organizations operating within the Greater Washington area, amounting to another 19 percent of the regional economy devoted to federally supported activities (Figure 3).[8] Looming increases in federal entitlement costs and attendant budget pressures mean that sequestration cuts may represent only the beginning of a longer-term squeeze on spending that supports more than one-third of Greater Washington's economy. Failure to diversify the regional economy and build new areas of competitive strength may therefore threaten its long-run prosperity.

Greater Washington's economy could benefit from a more deliberate global orientation. In an increasing number of U.S. metropolitan areas, cross-sector groups of leaders are seizing new opportunities for local economic growth in the global marketplace. International trade and investment represent increasingly critical sources of jobs and enhanced competitiveness for U.S. regions, and their workers and firms (see "Why Trade and Investment Matter"). Along these lines, Greater Washington's public, private, and civic leaders can strive to strengthen performance in three key areas that determine and reflect the region's global orientation: the vitality of trade-oriented advanced industries; export volume; and inbound foreign direct investment (FDI) (for more information on each, see Appendix):

- **Advanced industries** are research- and technology-intensive manufacturing and service industries that embody the traded core of the economy. This super-sector is 3.2 times more export-intensive and 2.9 times more FDI-intensive than the U.S. industrial average.[9] It also employs 80 percent of the nation's engineers; performs 90 percent of private-sector R&D; generates approximately 85 percent of all U.S. patents; and accounts for 60 percent of U.S. exports.[10] An industry must satisfy two criteria to earn the "advanced" designation: it must rank among the top 20 percent in per-worker research and development (R&D) spending; and it must employ an above national-average share of workers whose occupations require a high degree of STEM (science, technology, engineering, and math) skills

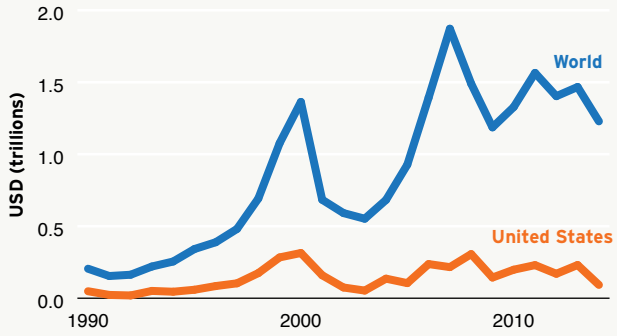
- **Exports** are sales of goods and services to foreign entities (people or companies). Foreign entities include foreign firms located abroad (but no affiliates of foreign companies located in the U.S.), subsidiaries of U.S. firms located abroad, foreign tourists and students in the United States, and foreign passengers on U.S. air carriers[11]

- **Inbound foreign direct investment (FDI)** arises when a foreign entity invests in a business enterprise in the United States. To be considered FDI, the investment must give the foreign entity a majority stake in the management and operations

Why trade and investment matter

Foreign markets represent a large and often overlooked opportunity for local economic growth. While some analysts argue today that the world economy may have reached "peak globalization" (as others did a decade ago), the best projections suggest that the bulk of global economic growth will continue to concentrate in foreign markets.[13] According to estimates derived from International Monetary Fund's *World Economic Outlook*, between 2015 and 2020, 86 percent of global economic growth will occur outside the United States, totaling $13.8 trillion in global economic value.[14] More and more of that value is being generated through trade. In 2012, $26 trillion in goods, services, and capital crossed international borders, equal to 36 percent of global GDP, and the McKinsey Global Institute estimates that share could increase to 38 to 49 percent by 2025.[15] A small but important part of these flows comes in the form of inward FDI, which in 2014 amounted to $1.2 trillion, 93 percent of which flowed to countries other than the United States.[16] The decreasing share of global FDI flowing to the United States points to increasing global competition, and the value of deliberate and focused global engagement strategies that build on local economic strengths.

Figure 4. Net FDI inflows, 1990–2014



Source: Brookings analysis of data from UNCTAD, WTO and ITC, Eurostat, OECD, IMF, UNSD, and other international and national sources.

Trade and investment fuel job creation, diversification, and business survival. Capturing the value associated with exports and FDI has real and direct impacts on the economic well-being of people in local economies. In 2014 U.S. exporters supported 6.2 jobs for every $1 million in export revenue.[17] These include jobs in the industries producing exported goods and services as well as jobs in suppliers of intermediary inputs. Moreover, exports are a major economic pillar, supporting an employment superstructure spanning both traded and non-traded sectors. FDI also drives job creation. Between 1991 and 2011, FDI arriving in the form of new, or greenfield, projects (as opposed to mergers and acquisitions) created 1.4 million jobs in the United States.[18] Greenfield investment is particularly beneficial because it creates new jobs along with stimulating construction and real estate activity involved in the acquisition of new physical locations.

Another benefit of exports and FDI is that exposure to global markets can help insulate firms from local economic shocks. According to one study, business survival is "arguably the most important potential benefit from exporting" with exporters 10 percent more likely to survive.[19] Other studies have found that establishments created or acquired by foreign multinationals fared better on average than local establishments with similar economic characteristics during economic crises.[20] These findings imply that trade and investment supports jobs on two fronts: in directly growing the job base and in mitigating job losses when the local economy faces a downturn.

of the enterprise. Having a majority stake gives the investor a greater incentive to establish a lasting presence in the firm and to transfer technology, best practices, and skills to reduce costs and enhance productivity of firms throughout the supply chain[12]

Harnessing each of these drivers of global orientation is critical. As the next section shows, while Greater Washington possesses strengths in some of these drivers, its performance lags considerably in others. To reduce the regional economy's structural dependence on federal spending, public- and private-sector leaders should explore strategies to re-orient local advanced industries and other high-value service firms not only beyond government, but also toward opportunities beyond the nation's borders.

The next section of the report examines the state of Greater Washington's global orientation through the lens of its performance on these three key areas: advanced industries, exports, and foreign direct investment. It does so by analyzing regional data over time; among individual jurisdictions in the metropolitan area; and most crucially, against similar data for U.S. metropolitan areas identified as peers for Greater Washington based on their size, wealth, and economic structure. Statistical analysis points to the Austin, Baltimore, Boston, Philadelphia, Raleigh, Sacramento, San Diego, San Francisco, and Seattle metropolitan areas being most similar to Greater Washington, especially on signature economic characteristics such as large service sectors and highly productive, high-wage workforces (for more information about peer identification techniques, see Appendix). The subsequent section then digs deeper to understand the global orientation and performance of the region on economic assets that drive and enable trade and investment: innovation, talent, and infrastructure. These sections also provide examples of strategies and initiatives that other U.S. regions are pursuing, and which Greater Washington's leaders might consider, to strengthen global competitiveness and connections in these areas.

"The region's economic structure poses a central challenge to its current and future growth prospects."

GLOBAL TRADE AND INVESTMENT

ADVANCED INDUSTRIES

Advanced industries account for a significant share of Greater Washington's jobs. Advanced industries are characterized as R&D and STEM worker intensive manufacturing and high-tech services industries that represent the core traded sector of the U.S. economy. For Greater Washington these are critical sectors of the economy and represent a major source of high-paying jobs in the region. Jobs in these industries generated $113,000 in compensation per worker on average compared to $64,000 for workers in other industries in the Washington region in 2014. Among 10 peer regions, Greater Washington ranked third in the share of its jobs in advanced industries, behind only Seattle and San Francisco, and sixth overall among the 100 largest U.S. metro areas (Table 2). However, a relatively smaller share of Greater Washington's GDP comes from these sectors—19 percent, ranking the region seventh among its peers.[21]

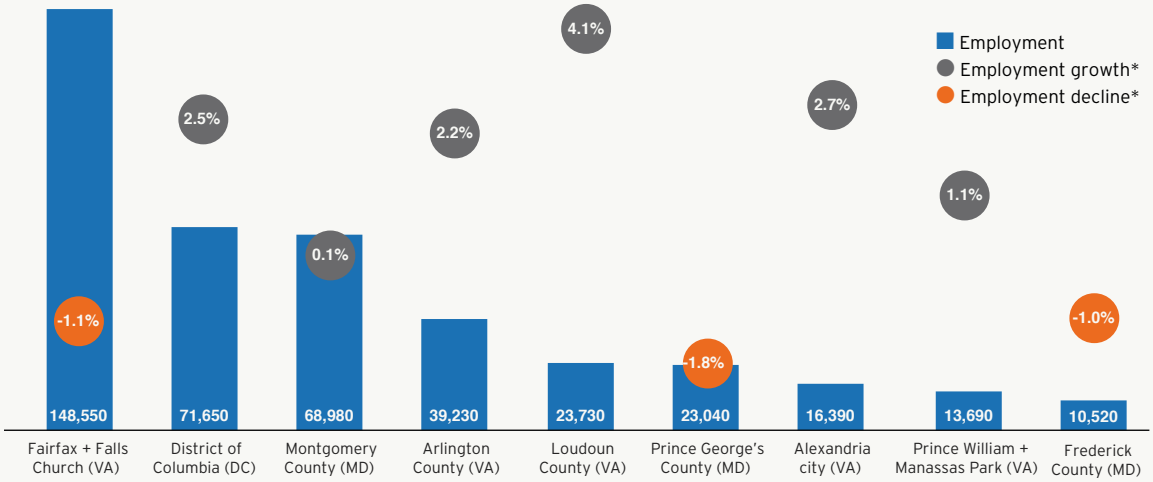
Growth in Greater Washington's advanced industries lags its peers, reflecting variation in performance within the region.[22] Since 1980 advanced industries in Greater Washington experienced strong growth with employment expanding 3.6 percent and real GDP at 8.2 percent each year. Yet between 2008 and 2014, advanced industry job growth slowed to the same sluggish 0.4 percent annual rate as in other industries. That ranked Greater Washington seventh among its peer regions, above only San Diego, Philadelphia, and Sacramento. This aggregate performance reflected significant variation within the region. While Fairfax County and Falls Church account for 34 percent of Greater Washington's advanced industry jobs, employment in their advanced industries shrank at an annualized rate of 1.1 percent from 2008 to 2014 (Figure 5). Losses also occurred in Prince George's and Frederick counties. By contrast, the District of Columbia and Arlington and Loudoun counties posted relatively strong growth in advanced

Table 2. Employment and GDP in advanced industries, Greater Washington and peer regions, 2014

Metro area	Employment in Advanced Industries			GDP of Advanced Industries	
	Share of total workforce	Jobs (thousands)	Annualized job growth rate, 2008-2014	GDP (USD billion)	Share of total GDP
Seattle	15.9%	302	1.8%	82.6	32.6%
San Francisco	14.5%	321	2.8%	81.4	25.3%
Washington	**13.5%**	**432**	**0.4%**	**77.9**	**19.3%**
Boston	13.4%	347	0.8%	77.0	23.0%
Austin	12.8%	119	2.9%	26.7	25.6%
San Diego	12.4%	181	0.3%	40.3	21.2%
Raleigh	12.2%	69	3.2%	14.3	24.2%
Baltimore	9.0%	124	0.8%	24.4	15.3%
Philadelphia	8.7%	245	-1.2%	46.5	14.4%
Sacramento	6.4%	58	-1.7%	12.9	11.8%

Source: Brookings analysis of Moody's Analytics data

Figure 5. Advanced industries employment, 2014, and change in employment, 2008-2014, selected Greater Washington jurisdictions



** Annualized basis, 2008-2014.*

Source: Brookings analysis of Moody's Analytics data

Table 3. Five largest Advanced industries by employment in Greater Washington, 2014

Rank	Advanced Industry	Jobs	Share of regional advanced industry jobs	Annual compensation per worker ($)	Share of revenue from federal government
1	Computer Systems Design	167,800	38.9%	118,999	74%
2	Management and Technical Consulting	98,100	22.7%	103,293	58%
3	Architectural and Engineering	51,230	11.9%	99,369	94%
4	Research and Development Services	46,010	10.7%	132,951	63%
5	Data Processing and Hosting	10,470	2.4%	104,134	45%

Source: Brookings analysis of Moody's Analytics and USA Spending data

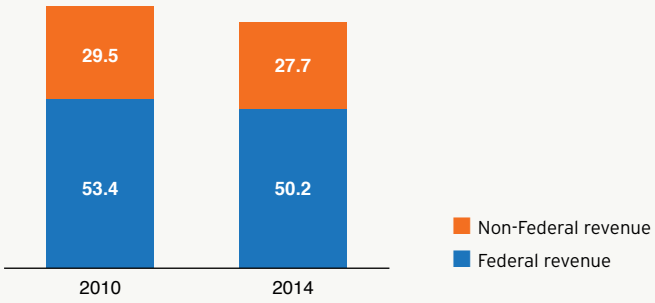
industries during that period, though each started from a considerably smaller base than Fairfax/ Falls Church.[23]

Advanced industries in Greater Washington are minimally diversified and rely heavily on federal spending. In Greater Washington, just five of the 50 industries Brookings identifies as advanced sectors of the U.S. economy account for 87 percent of the region's advanced industry jobs and 80 percent of GDP (Table 3). Based on a common measure of industry concentration, advanced industries in Greater Washington are much less diversified than in most peer regions, where nine to 14 industries account for a similar share of jobs and output.[24] Among Greater Washington's five most significant advanced sectors, computer systems design leads the way followed by management and technical consulting, constituting 39 percent and 23 of advanced industry jobs, respectively. All five sectors post average compensation per worker of $100,000 or more.[25]

Another distinguishing characteristic of Greater Washington's advanced industries is the degree to

which they rely on federal spending. U.S. Treasury Fiscal Service data reveal that in 2014 advanced industries in Greater Washington received $50 billion in federal government contracts and grants, down from $53 billion in 2010. Accordingly, federal sources accounted for 64 percent of all advanced industry revenues in the region in 2014 (Figure 6).[26] While the ability of these advanced industry firms to win federal contracts and grants is a telling measure of their competitive strength, their considerable dependence on federal revenue poses risks in an era of increasingly constrained federal spending. Greater Washington's leaders might consider the example of San Diego, a region that has actively enabled the growth of advanced industries that helped the economy diversify away from dependence on federal spending (see sidebar, "Networks, clusters, and talent further advanced industries in San Diego").

Figure 6. Advanced industry revenue by source, USD billion, Greater Washington, 2010 and 2014



Source: Brookings analysis of data from Moody's Analytics, GSA and Fiscal Service data available at USASpending.gov, and Bureau of Economic Analysis Industry Price Indexes

"Advanced industry firms' considerable dependence on federal revenue poses risks in an era of increasingly constrained federal spending."

Networks, clusters, and talent further advanced industries in San Diego

As Greater Washington aims to diversify its economy, San Diego shows one way a metro area can leverage its regional resources to catalyze advanced industry clusters. Over the past 40 years, San Diego has transformed from a defense, real estate development, and tourism-dependent economy to a world-leading hub of biotechnology and information and communication technology companies. Its economic transformation can be explained by three critical elements that helped the metro area leverage its regional resources effectively: a dense network of institutions and universities that perform cutting-edge research; the existence of organizations that aid the creation of technology-oriented companies; and a steady supply of highly qualified technical workers.[27]

First, a dense network of research institutions, including six universities and more than 80 research institutes, provide the scientific knowledge and resources to San Diego companies to develop new products. The San Diego innovation network promotes joint research projects that diffuse relevant knowledge across firms, a critical process in the formation of high-tech clusters, and fosters the development of a network of entrepreneurs and researchers.[28]

Second, San Diego's advanced industries have also benefited from cluster organizations like CONNECT. Focused on life science and technology products, CONNECT helps organize entrepreneurs, scientists, business services providers, and venture capitalists. Firms are able to tap into the ideas, managerial expertise, capital, and business services necessary for their early growth. Membership fees sustain CONNECT's $3.7 million budget. CONNECT has generated $2 billion in investment capital for more than 3,000 companies in the region.[29]

Third, a constant supply of qualified workers has allowed San Diego to sustain and expand innovative products. Universities such as UC-San Diego, the University of San Diego, and San Diego State University, and research institutions like the Salk Institute for Biological Studies and the Scripps Research Institute, are the main suppliers of technically-trained workers. These researchers and the industry clusters to which they belong have higher average wages compared to other industries both in San Diego and nationally, and have registered higher growth in wages than other industries.[30]

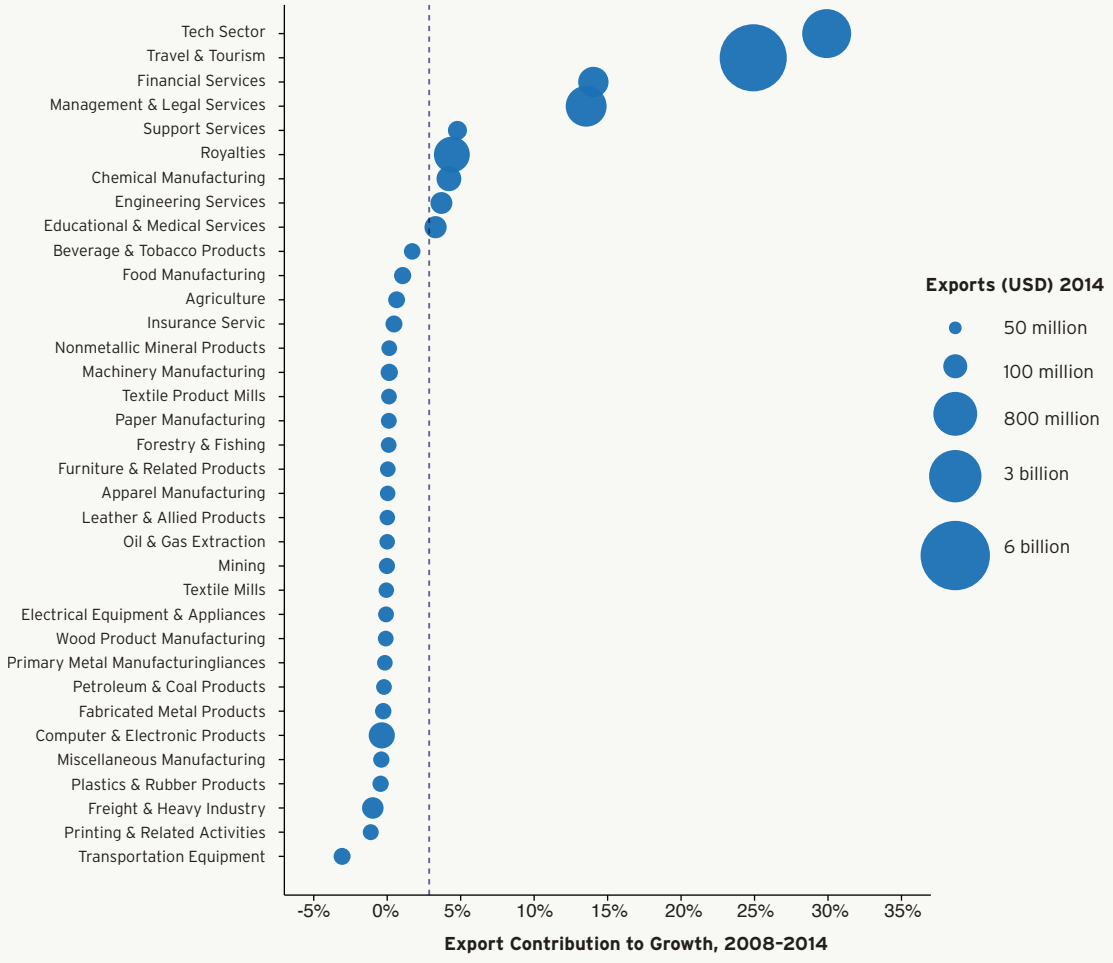
Finally, and importantly for Greater Washington, San Diego has developed into a high-tech cluster by making effective use of government resources. As in Greater Washington, federal funding to universities and other research institutions was critical for the development of the underlying science behind many of the firms located in San Diego. Furthermore, the existence of a research network is a necessary condition for the emergence of innovation but not a sufficient one. The active involvement of different stakeholders through organizations like CONNECT and the provision of the right incentives to promote joint research and collaborative networks are equally important ingredients for a successful base of advanced industries.

For more information: **www.connect.org**

EXPORTS

Greater Washington's services industries generate exports that support significant employment in the region. Given the region's relatively small manufacturing base, exports in Greater Washington are heavily services-oriented, with services industries accounting for 84 percent of export value compared to an average of 34 percent nationally. Tourism and technology represent the largest export sectors in the regional economy, accounting for $6.8 billion and $4.4 billion, respectively, in 2014 export value (Figure 7). They encompass several sub-sectors including R&D services ($2.4 billion), computer services ($1.3 billion), and telecommunication ($600 million) for technology; and restaurants and retailers ($2.9 billion), hotels ($2.0 billion), and air and ground transportation ($1.2 billion) for tourism. Technology and tourism were also the largest contributors to regional export growth from 2008 to 2014, generating an additional $2.3 billion and accounting for more than half of total export growth during that time. Greater Washington's financial, legal, and managerial services also constitute an important export strength, collectively exporting $5.3 billion in 2014. Royalties represent the other significant export sector for the regional economy, generating $2.5 billion in export value in 2014. Through direct employment related to these exports and the additional spending those jobs create (the so-called multiplier effect), Greater Washington's $27 billion in exports supported an estimated 220,000 jobs in 2014.[31] The region's service sectors thus constitute an important platform from which to bolster international trade and investment (see sidebar, "Three benefits of service exports").

Figure 7. Greater Washington exports by sector, 2014, and contribution to export growth, 2008-2014

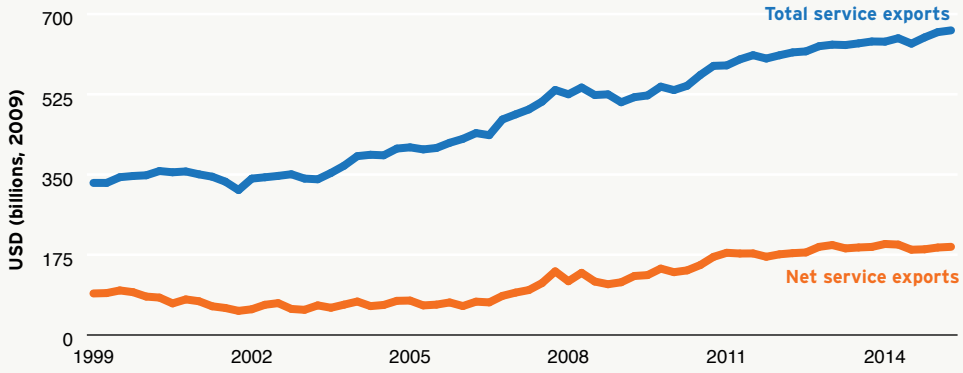


Source: Brookings analysis of Moody's Analytics data

Three benefits of service exports

Because Greater Washington is a highly services-driven economy, it exhibits a negative goods trade balance with other regions (as is true of most large U.S. metro areas). A recent Brookings study found that in 2010 Greater Washington imported $86 billion more in goods than it exported. Across all commodities, Washington held a trade surplus in only garbage and waste products (at half a billion dollars).[32]

Figure 8. U.S. service exports, 1999-2015



Source: Brookings analysis of Bureau of Economic Analysis data

While the lack of significant production capacity in the region might seem like an insurmountable obstacle to increased trade and investment, there are three significant upsides to pursuing service exports. First, U.S. service exports have increased 188 percent over the past decade rising from $364 billion in 2003 to $686 billion in 2014 (Figure 8).[33] Second, unlike in goods, the United States maintains a trade surplus in services that reached $192 billion in 2015.[34] Third, more of the value of service exports is supported domestically than is true for goods exports, which translates into more local jobs and growth. According to OECD-WTO data, the domestic value-added share of gross U.S. service exports in 2011 was 94 percent, compared to 78 percent for goods exports.[35]

Greater Washington is a much less export-intensive region than its peers. A common measure of a region's export orientation is its export "intensity," or the share of total GDP that exports represent. On this count, Greater Washington's $27 billion in exports in 2014 represented just 6.1 percent of total GDP, the second-smallest share among its peer regions (Table 4). Washington also lagged most of its peers, including Seattle, San Francisco, San Diego, Raleigh, and Philadelphia, in boosting its export intensity between 2003 and 2014.

Since 2008, however, exports in Greater Washington have experienced somewhat faster growth and have made an outsized contribution to otherwise sluggish GDP growth.[36] As a result, between 2003 and 2014 export revenues created 85,000 additional jobs in the region, or 29 percent of all jobs created during that time.[37] While Washington ranks ninth among its peers in export share of GDP, it ranks seventh in the share of its jobs supported by exports, at 6.9 percent. This indicates that exports in Greater Washington produce relatively larger job impacts for each dollar exported, reflecting in part the large share of the region's exports in lower-paying travel and tourism sectors.[38] Along these lines, Greater Washington might look to other regions that are developing and implementing deliberate strategies to grow exports as a means for increasing jobs and competitiveness (see sidebar, "Promoting growth through trade in Greater Portland").

Table 4. Exports, GDP, and jobs, Greater Washington and peer regions

Metro area	Gross exports (USD billion), 2014	Export share of GDP, 2014	Change in export share of GDP, 2003-2014	Annualized export growth, 2008-2014	Annualized GDP growth, 2008-2014
Seattle	51.9	19.1%	7.9%	6.3%	2.0%
San Francisco	38.8	11.4%	3.7%	2.0%	1.1%
Boston	38.9	10.8%	1.4%	1.9%	1.7%
Raleigh	6.5	10.1%	2.5%	2.4%	2.0%
San Diego	20.7	10.0%	3.2%	3.5%	1.2%
Austin	10.0	9.2%	-0.7%	2.6%	3.7%
Philadelphia	31.7	9.1%	2.3%	0.1%	0.6%
Baltimore	12.0	6.9%	1.8%	2.7%	1.8%
Washington	**26.7**	**6.1%**	**2.1%**	**2.9%**	**0.9%**
Sacramento	6.9	5.7%	2.0%	1.8%	0.0%

Metro area	Export jobs, 2014	Share of total jobs supported by exports, 2014	Change in export jobs, 2003-2014	Share of jobs created from exports, 2003-2014	Jobs created by exports of $1 billion
Seattle	317,226	16.7%	144,558	57.5%	6,110
San Francisco	271,533	12.4%	85,835	48.3%	6,993
Boston	276,509	10.6%	43,777	21.8%	7,110
San Diego	131,605	9.0%	35,694	42.6%	6,365
Raleigh	42,593	7.5%	14,825	12.1%	6,581
Philadelphia	200,707	7.2%	38,245	78.4%	6,337
Washington	**219,771**	**6.9%**	**85,223**	**28.7%**	**8,218**
Austin	62,113	6.8%	10,956	4.3%	6,182
Baltimore	79,653	5.8%	19,593	20.4%	6,657
Sacramento	47,232	5.2%	12,939	41.3%	6,822

Source: Brookings analysis of data from Census, BEA, Moody's analytics, BLS, NAFSA, IRS, EIA, and Sabre.

Promoting growth through trade in Greater Portland[39]

Metropolitan economies rely upon trade—both imports and exports—to achieve 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, Oregon was one of the first metro areas to embrace exports as a vehicle for post-recession recovery. 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 planning 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 to leverage strengths and address weaknesses:

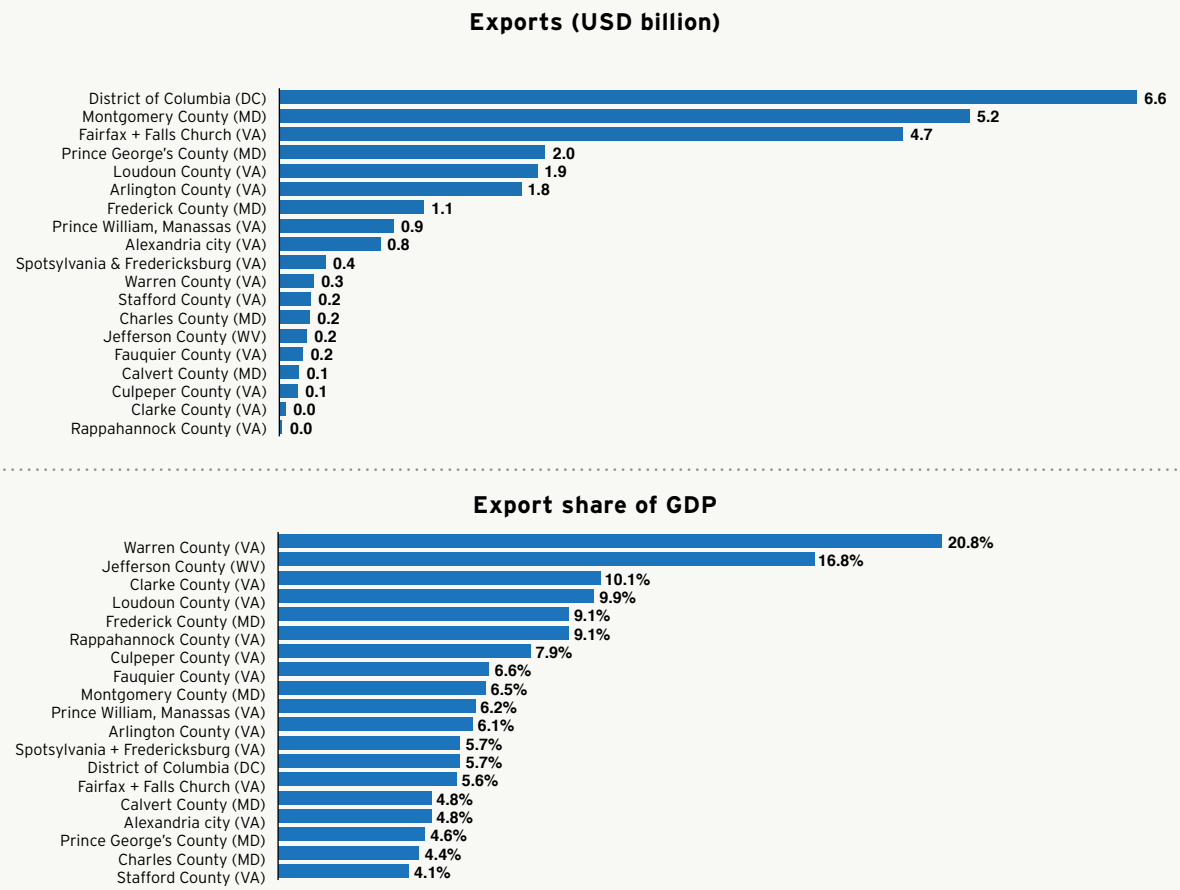
❶ Leverage primary exporters in computer and electronics like Intel and TriQuint;
❷ Catalyze under-exporters in manufacturing;
❸ Improve the export pipeline for small business; and
❹ Build on Greater Portland's global edge in sustainability by launching a "We Build Green Cities" brand

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.[40] 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: "Greater Portland Global Trade and Investment Plan" **www.greaterportlandinc.com**

Greater Washington's largest exporting jurisdictions nevertheless exhibit below-average export intensity. In 2014, five jurisdictions accounted for 76 percent of Greater Washington's exports: District of Columbia, Montgomery, Fairfax/Falls Church, Prince George's, and Loudoun (Figure 9). Nonetheless, each punches below its weight on export intensity, falling below the U.S. average of 11.6 percent in 2014. More rural areas of the region, which are more specialized in agriculture and goods production, tend to exhibit considerably higher export intensity.[41]

Figure 9. Exports and export share of GDP by jurisdiction, Greater Washington, 2014



Source: Brookings analysis of data from Census, BEA, Moody's analytics, BLS, NAFSA, IRS, EIA, and Sabre

FOREIGN DIRECT INVESTMENT

Foreign direct investment accounts for a slightly higher share of jobs in Greater Washington than in the United States overall. In 2011, the number of jobs in foreign-owned establishments (FOEs) in Greater Washington totaled 126,000 (5.4 percent of jobs), up from 112,000 in 2001 (5.2 percent of jobs) and 51,000 in 1991 (3.1 percent of jobs). This steady increase suggests that the regional economy may be increasingly attractive to global firms. Greater Washington was among only four of its peer regions to see an increase in FDI job intensity from 2001 to 2011 (Table 5). Still, it ranked just fifth among its peers in the share of its jobs in FOEs in 2011, behind Boston, Raleigh, Philadelphia, and San Francisco.[42]

As is true with exports, regional averages on FDI intensity mask considerable variation among Greater Washington's jurisdictions. Fairfax/Falls Church and Frederick County had more than 6 percent of their private-sector jobs in FOEs in 2011, while percentages in the District of Columbia (2.9 percent) and Prince George's (3.5 percent) and Arlington (2.6 percent) counties were much lower. A collection of advanced services firms primarily account for the bulk of FDI jobs in Fairfax/Falls Church, such as the technology firm SI International Inc. (headquartered in England as part of Serco Plc), the tech consulting firm Accenture (headquartered in Ireland, and formerly in Bermuda), and computer systems design firm BAE Systems (headquartered in England). Not surprisingly, all of these firms happen to be major federal contractors.[43] In Loudoun, the top firm is Invensys Process Systems

Table 5. Jobs in foreign-owned establishments (FOEs), Greater Washington and peer regions, and Greater Washington jurisdictions, 2011

Metro area	Jobs in FOEs	Share of jobs in FOEs	Change in share of jobs in FOEs, 2001-2011
Boston	142,815	6.7%	-0.8%
Raleigh	24,864	5.9%	-2.4%
Philadelphia	137,037	5.8%	0.7%
San Francisco	89,383	5.5%	-0.6%
Washington	**126,211**	**5.4%**	**0.2%**
San Diego	48,730	4.8%	-0.4%
Austin	29,180	4.6%	0.9%
Seattle	65,045	4.6%	0.3%
Baltimore	48,051	4.5%	-1.0%
Sacramento	15,244	2.6%	0.0%

Greater Washington jurisdiction	Jobs in FOEs	Share of metro area's jobs in FOEs	Share of jurisdiction's jobs in FOEs
Fairfax, Falls Church (VA)	37,221	29.5%	6.0%
District of Columbia (DC)	21,610	17.1%	2.9%
Montgomery County (MD)	20,832	16.5%	4.3%
Prince George's County (MD)	11,724	9.3%	3.5%
Loudoun County (VA)	8,009	6.3%	5.2%
Frederick County (MD)	6,209	4.9%	6.2%
Arlington County (VA)	5,024	4.0%	2.6%
Prince William, Manassas (VA)	4,588	3.6%	3.5%
Alexandria city (VA)	3,048	2.4%	2.9%
Spotsylvania, Fredericksburg (VA)	2,054	1.6%	3.4%
Stafford County (VA)	1,666	1.3%	3.8%
Charles County (MD)	1,052	0.8%	2.3%
Warren County (VA)	917	0.7%	7.1%
Clarke County (VA)	767	0.6%	16.8%
Calvert County (MD)	572	0.5%	2.4%
Fauquier County (VA)	493	0.4%	2.0%
Jefferson County (WV)	426	0.3%	2.5%

Source: Brookings analysis of D&B / NETS, BEA, and Moody's Analytics data

(headquartered in England) specializing in automation and controls. In Frederick, the top employer is currently the pharmaceutical firm MedImmune, which is owned by AstraZeneca (headquartered in England).[44]

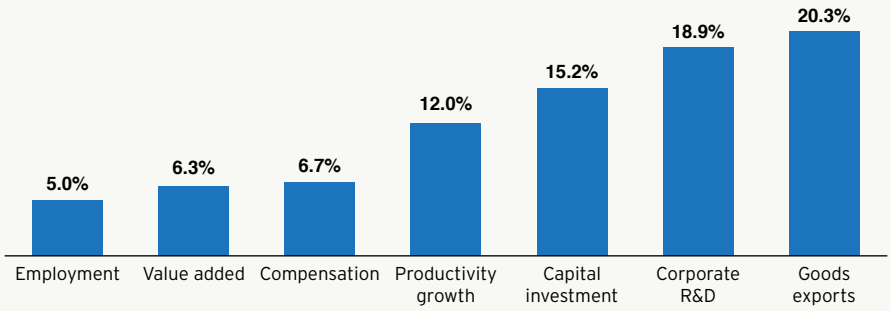
Research demonstrates that the presence of these sorts of globally engaged firms generates several positive effects on the regional economy (see sidebar, "Local spillover effects of globally engaged firms").

Local spillover effects of globally engaged firms

Multinational firms, which account for the vast majority of services export and FDI activity, generate many spillover benefits throughout the economy. Highly competitive, globally engaged multinational firms drive the majority of services exports and FDI in the United States. One report finds that multinational corporations (MNCs) sold $249 billion (82 percent) of the $302 billion in U.S. services exports in 2008. Generally, U.S. services exports are sold either to foreign affiliates of U.S. parent companies or to foreign buyers, with each group representing $106 billion.[45] Although many firms engage in services trade, large multinational parent companies in the United States generate the lion's share of value.

Research points to several economic benefits associated with MNC activity. Intra-firm exports between U.S. parent firms and their overseas affiliates often create jobs. In a 2011 USITC study, researchers estimated that MNC services exports supported over 700,000 jobs in their U.S.-based parents' headquarters and supply chains.[46] MNCs also tend to pay better; workers at MNCs earn hourly wages on average 26 percent higher than in the same occupations in establishments that only operate domestically.[47]

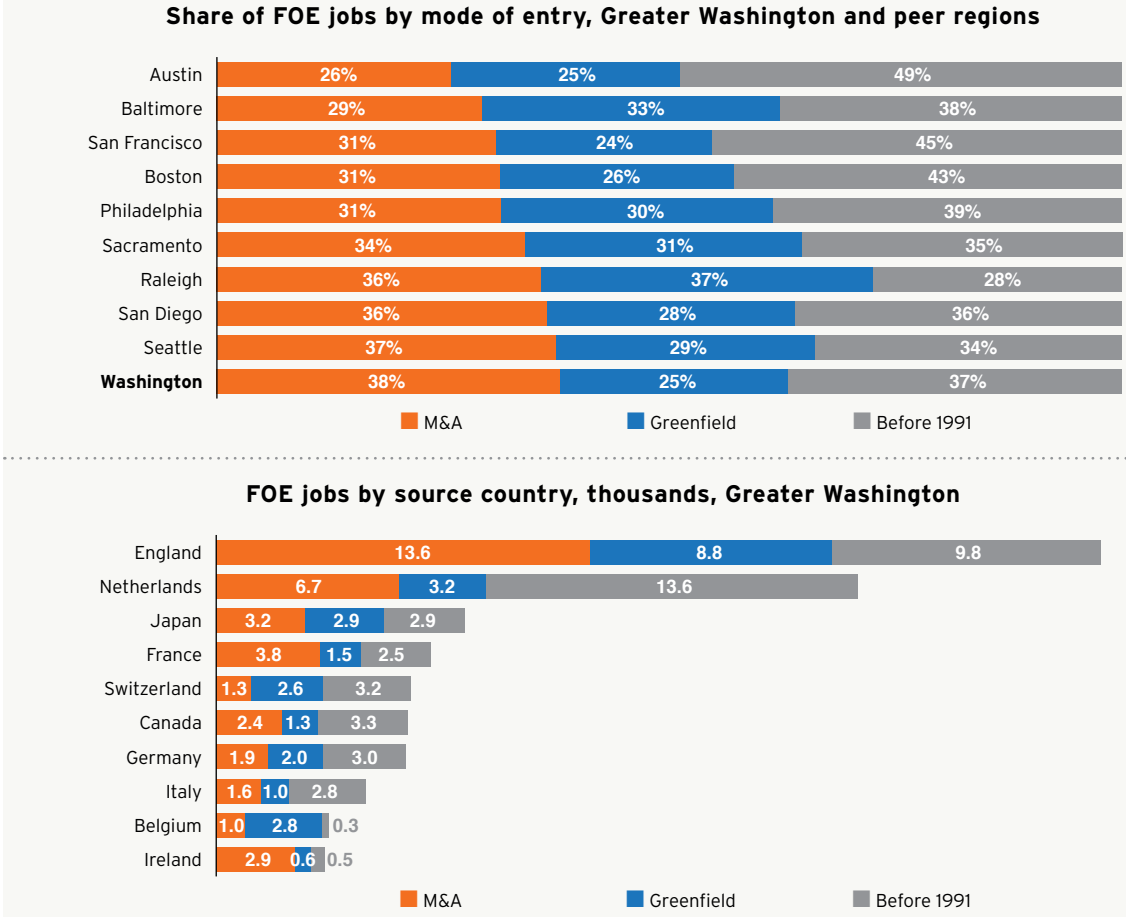
Figure 10. Foreign-owned establishment share of private sector activity, United States, 2011



Source: Brookings analysis of Bureau of Economic Analysis data

Foreign investment is also important because it concentrates in advanced industry sectors that promote innovation and competitiveness. Foreign-owned firms account for 26 percent of advanced industry employment, even though those industries employ only 9 percent of the U.S. workforce. Relative to their share of overall employment, foreign-owned establishments also produce an outsized share of U.S. value-added output, compensation, productivity growth, capital investment, corporate R&D, and goods exports (Figure 10).[48] FDI is a critical piece of a global-engagement strategy because it can give local firms the opportunity to integrate into a multinational network of trading firms that create opportunities to export, innovate, and expand.

Figure 11. Share of FOE jobs by mode of entry and jobs by source country, 1991-2011



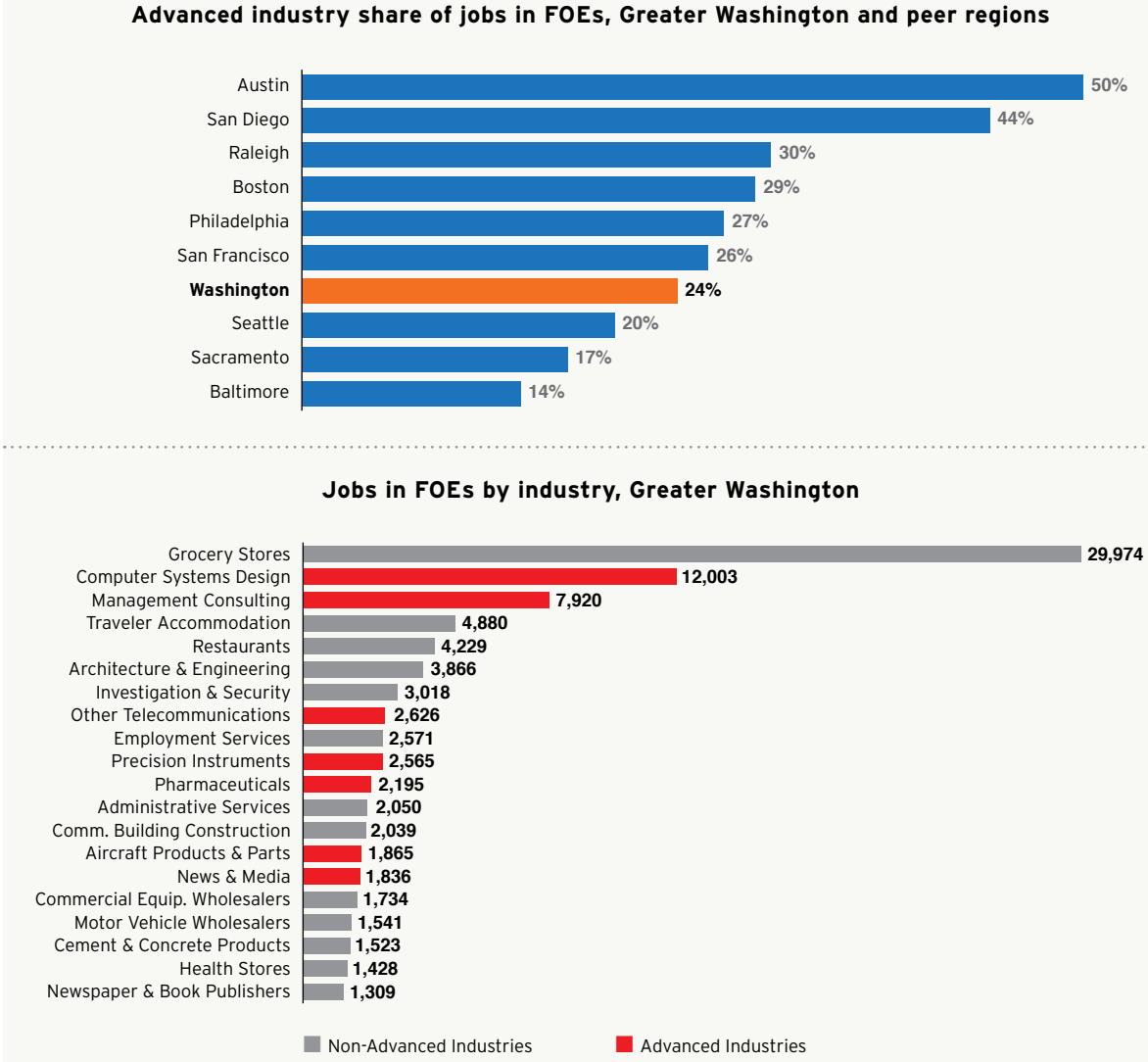
Source: Brookings analysis of D&B / NETS, BEA, and Moody's Analytics data

A large share of Greater Washington's FDI came about through mergers and acquisitions (M&A). Data that track each firm's corporate ownership structure from 1991 to 2011 show that 38 percent of Greater Washington's jobs in FOEs (48,000 total) emerged through M&A, a higher share than in any of its peer regions (Figure 11). Notably, 37 percent of Greater Washington's jobs in FOEs arrived before 1991 (during which the data do not record mode of entry).[49]

More than half of Greater Washington's jobs in FOEs have global partners in just three countries: England (26 percent), Netherlands (19 percent), and Japan (7 percent). While M&A over the past two decades was the most common mode of entry for FDI from England, most jobs in Netherlands-owned establishments were already present in the region in 1991. Over 80 percent of Dutch investment comes from Royal Ahold, which owns the regional chain Giant Food Stores, and accounts for more than 19,000 jobs in the region.[50]

Relatively few of Greater Washington's jobs in foreign-owned establishments operate in advanced industries. As noted above, jobs in foreign-owned establishments nationwide are nearly three times as likely to be in advanced industries as U.S. jobs overall. In 2011, foreign advanced industry parent firms in the United States employed 1.4 million workers at 98,000 establishments. While 24 percent of jobs in Greater Washington's FOEs are in advanced industries, near the national average of 26 percent, the region ranks only seventh among its peers in this regard (Figure 12).[51]

Figure 12. Jobs in foreign-owned establishments by industry category, 2011



Source: Brookings analysis of D&B / NETS, BEA, and Moody's Analytics data

A large share of Greater Washington's FDI concentrates in lower-value-added service sectors, including grocery stores, hotels, restaurants, security firms, and staffing agencies. Together, these sectors account for nearly one-third of jobs in FOEs in the region. Foreign-owned advanced industries firms in Greater Washington cluster in computer systems design and technical consulting, which together account for another 16 percent of regional jobs in FOEs.

These findings suggest not only that Greater Washington is less FDI-intensive than its peer regions, but also that its FDI may not contribute to the region's innovative capacity and global competitiveness to the degree it does in other places. Foreign investors may be choosing Greater Washington less based on its fundamental competitive assets, and more because it has a large and wealthy consumer base and enjoys greater access to federal spending. To that end, the region's leaders might look to the experience of Columbus, Ohio, where an effort to position that region for greater foreign investment led to new approaches in economic development (see sidebar, "Greater Columbus' evolving approach to FDI").

Greater Columbus' evolving approach to FDI[53]

The Columbus Region has created a joint trade and investment strategy—**Columbus Global Connect**—that aims to position the region centrally in the global economy. While the internationalization of the Columbus economy has been intensifying recently, as in Greater Washington the Columbus Region's FDI share of employment is only at the national average. Opportunities for growth are significant, however, due in no small part to the large presence of Honda and other Japanese-owned firms. Seeing this opportunity, the region's economic development organization—Columbus 2020—has pursued FDI as an important component of its broader regional economic strategy.[54]

Similar to the Portland process, Columbus' FDI assessment involved analytics, firm and other local stakeholder interviews, and strategy-setting. The planning process revealed several insights, but perhaps none more important than discovering that Columbus 2020's traditional approach to business retention and expansion (BRE)—a hallmark service of economic development—needed to evolve to address the core drivers of firms' competitiveness. As our Brookings colleagues Brad McDearman and Ryan Donahue wrote, Columbus 2020 found that "even companies already exposed to global markets—including foreign-owned firms, exporters, and their suppliers—often lacked critical information about global opportunities and local economic development resources, and were too consumed with day-to-day operations to actively seek it out."[55]

Columbus 2020's new FDI strategy thus overhauls its entire BRE effort to focus more on the core topics the organization discussed with foreign-owned companies, such as exports, workforce development, and infrastructure. BRE services will now include more in-depth business intelligence on these issues, drawing on real-time information Columbus 2020 staff can obtain through their deep connections with firms, industry groups, site selectors, and international contacts. Providing more valuable BRE services to foreign-owned firms already located in Columbus can be one important component of Columbus 2020's broader effort to help local business grow.

For more information: "Columbus Global Connect Global Trade and Investment Plan" **http://www.brookings.edu/~/media/Multimedia/Interactives/2013/GCXMedia/TradeAndInvestmentPlans/Columbus.pdf**

"Not only is Greater Washington less FDI-intensive than its peer regions, but also its FDI may not contribute to the region's innovative capacity and global competitiveness to the degree it does in other places."

LEVERAGING GLOBAL ASSETS

City-regions must find ways to adapt and strengthen their economies in order to stay globally competitive. Underpinning this effort are the region's "global assets," which ultimately power its trade and investment potential. This section focuses on three primary global assets in Greater Washington critical for advancing growth and prosperity:

- **Global innovation assets** represent the innovative capacity and the ability of firms to translate ideas into ground-breaking products and services
- **Global talent assets**, also referred to as "human capital," represent the stock of knowledge and skills embodied in the labor force
- **Global infrastructure assets** are the built systems that connect people and industries to places and information

While excellence in any one area is insufficient to guarantee wealth and continued prosperity, together these assets can help a region to thrive and magnify its global engagement efforts. What's more, Greater Washington possesses many of these assets already, but may not have fully exploited their value in the global marketplace. (Please refer to Appendix for methodological information on the various measures of global asset performance.)

"City-regions must find ways to adapt and strengthen their economies in order to stay globally competitive."

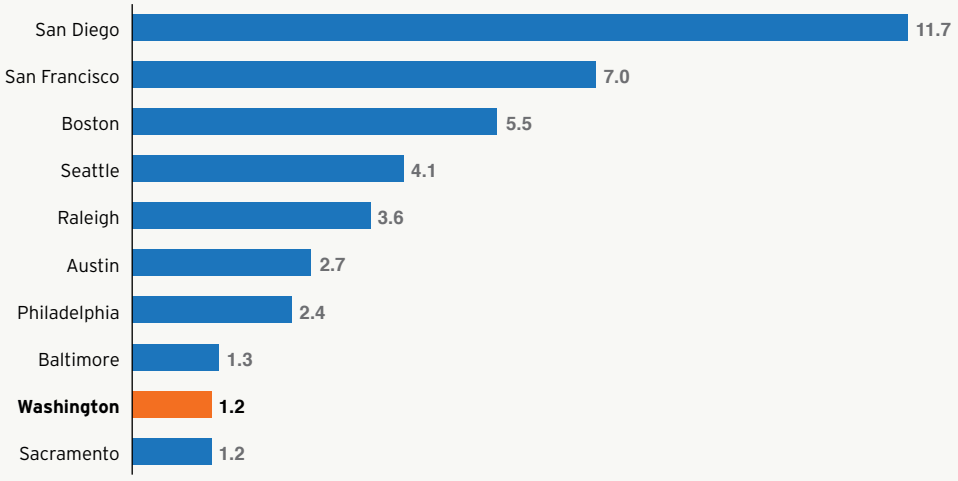
GLOBAL INNOVATION ASSETS

TECHNOLOGY PATENTS

Greater Washington scores well below its peers in the patenting productivity of its workforce. Greater Washington possesses a world-renowned research cluster. In 2014, the region ranked behind only New York and Boston in total employment in scientific research and development (46,000).[56] However, that research prowess may not be translating into valuable technological innovation. Greater Washington ranks far behind its peers at 1.2 technology patents per thousand workers (Figure 13).[57] Some of this underperformance surely owes to the nature of research conducted in the region, such as the large presence of social science researchers whose work would not likely be the subject of a patent, and organizations developing sensitive technology that for national security reasons cannot be patented. Nonetheless, it raises legitimate concerns regarding the region's ability to innovate in technologies with global commercial value.[58]

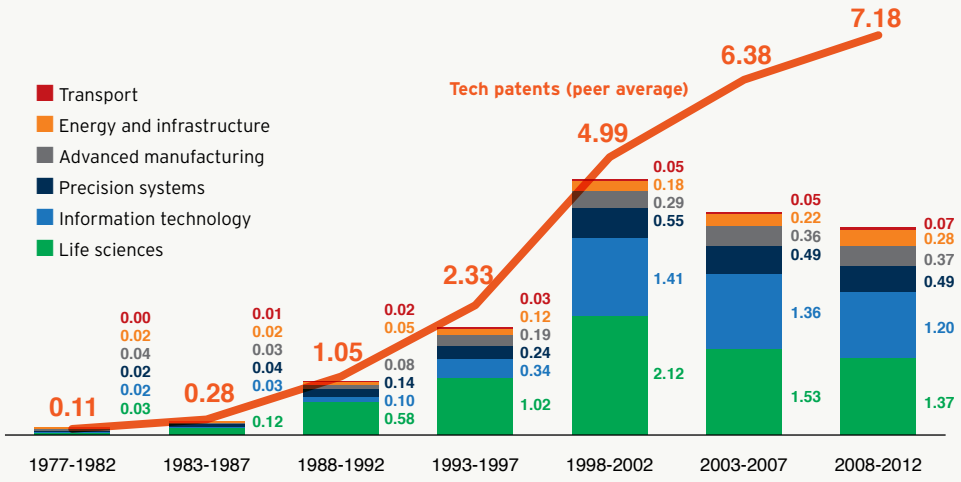
Greater Washington has a strong emphasis on life sciences and information technology patents, but patent stocks are decreasing. Greater Washington's main patent emphases are in life sciences and information technology. A little under one-third of the region's patents from 2008 to 2012 came in life sciences technologies including organic fine chemistry, biotechnology, and medical technology (Figure 14). But the volume of those patents dropped by 36 percent from a decade prior. Another 25 percent of recent patents came in information technologies such as computer technology, digital technology, and IT methods for management. Those patents, too, dropped off by 15 percent over the decade. Advanced manufacturing technology patents have risen from a relatively low base, but the broader trend suggests potential weakening in the capacity of Greater Washington's private sector to develop and commercialize new technologies, especially when set against the upward trend experienced in Greater Washington's peer metro areas.[59]

Figure 13. Technology patents per 1,000 workers, Greater Washington and peer regions, 2008-2012



Source: Brookings analysis of data from OECD REGPAT and Moody's Analytics.

Figure 14. Patents (1000s) by technology type, Greater Washington, 1977-2012



Source: Brookings analysis of data from OECD REGPAT

Table 6. Organizations with most patents, Greater Washington, 2008-2012

Rank	Organization	Primary technology	Primary research location	Technology patents generated
1	U.S. Government	Biotechnology	Washington	538
2	ExxonMobil Research	Oil and gas	New York	166
3	Georgetown University	Organic fine chemistry	Washington	92
4	AVIcode	Computer technology	Seattle	84
5	Boeing	Aerospace	Chicago	77
6	MedImmune	Biotechnology	Washington	72
7	Verisign	Computer technology	Washington	63
8	Amazon Tech	Computer technology	Reno	51
9	Henry M. Jackson Foundation	Organic fine chemistry	Washington	40
10	Canon U.S. Life Sciences	Biotechnology	Washington	40

Source: Brookings analysis of OECD REGPAT data

The U.S. government powers the bulk of the region's patenting activity. The main patent creator in Greater Washington is the U.S. government, followed by ExxonMobil, Georgetown University, AVIcode, and Boeing (Table 6). Government organizations such as the National Institute for Health in Bethesda and the Naval Research Laboratory in Anacostia account for significant shares of federal government patenting activity.[60] While these research institutions develop important technologies with clear public benefits and deserve strong support for their activities, government dominance indicates that the role of the private sector in technology development is even lower than the top-line figures suggest. Moreover, the region's largest source of private-sector patents, ExxonMobil, decided in 2013 to relocate its Fairfax-based operations, including about 2,100 jobs, to Houston by the end of 2015.[61] Together the patenting statistics strongly suggest that Greater Washington's private sector is not as well positioned as that in peer regions to generate technological innovations that reach new global markets and attract inward investment.

UNIVERSITY RESEARCH

Greater Washington's university system exhibits a relatively weak scientific impact compared to systems in peer regions. Notwithstanding the acknowledged high academic quality of Greater Washington's universities, the regional system underperforms on measures of scientific research impact. Publications from local universities are only 45 percent more likely to be cited than the world average, after normalizing for field differences and publication year, ranking Greater Washington just ninth among its peers. Local universities also trail their peers in publication quality; only 15 percent of their publications fall in the 10 percent most highly cited papers, also ninth in its peer cohort. Only 7 percent of those publications were co-authored with industry researchers, indicating a weaker private sector orientation than universities in regions such as Baltimore and San Diego.[62] University research matters for economic development because evidence links the performance of research universities, measured in terms of citations and its impact, with higher levels of patenting and innovation related activities.[63]

Table 7. Indicators of university scientific research impact, Greater Washington and peer regions, 2010-2013

Metro area	Mean normalized citation score	Publications	Share of publications in top 10 most cited globally	Share of publications coauthored with industry
San Francisco	1.93	44,844	22.5%	7.0%
Boston	1.90	109,244	22.3%	7.1%
Seattle	1.75	28,514	19.5%	7.0%
San Diego	1.68	26,469	19.2%	8.1%
Baltimore	1.65	39,470	18.0%	7.8%
Philadelphia	1.54	44,417	16.8%	6.6%
Austin	1.52	15,245	16.5%	7.2%
Sacramento	1.45	20,505	15.8%	5.6%
Washington	**1.45**	**27,252**	**15.4%**	**7.0%**
Raleigh	1.16	9,767	12.2%	7.2%

Greater Washington university	Mean normalized citation score	Publications	Share of publications in top 10 most cited globally	Share of publications coauthored with industry
University of Maryland, College Park	1.50	13,928	16.5%	7.3%
Georgetown University	1.45	4,470	15.7%	7.5%
George Washington University	1.39	5,398	14.1%	4.6%
George Mason University	1.29	3,456	12.8%	8.4%

Source: Brookings analysis of Centre for Science and Technology Studies, Leiden University and Thomson Reuters Web of Science data

Among local research universities, University of Maryland, College Park produces the most scientific impact and highest quality publications. Between 2010 and 2013 local universities produced 9,100 publications in biomedical and health sciences, followed by 7,300 in physical sciences and engineering, and 5,200 in social sciences and the humanities. Local universities display diverse specializations. The physical science and engineering departments at University of Maryland, College Park accounted for 21 percent of total metro publications, while George Washington University's and Georgetown University's biomedical and health science research centers together accounted for 22 percent of the total. Leading the way in both citation impact and publication quality was the University of Maryland, College Park, with 50 percent more of its publications receiving citations than the world average and 17 percent of its publications ranking among the top 10 percent most cited. In terms of industry collaborations, George Mason University ranked the highest with 8 percent of its publications featuring an industry coauthor.[64] Thus, the region possesses important university research assets from which to extend its global research impact.

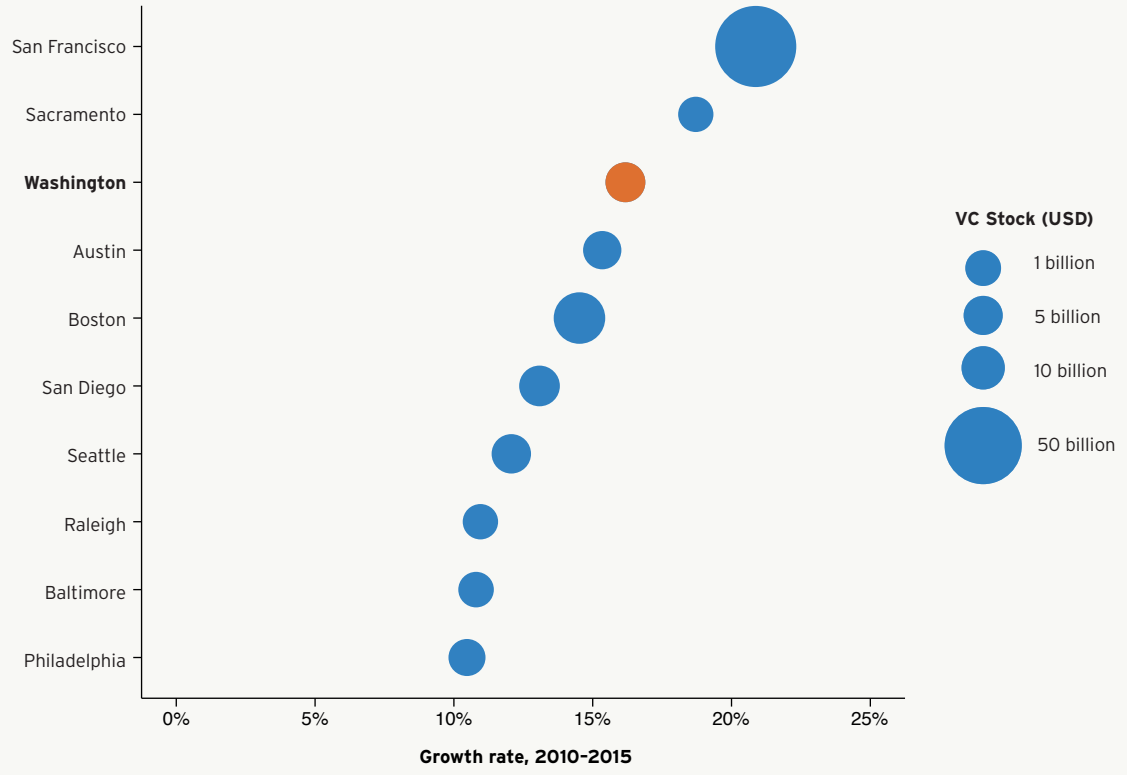
"Notwithstanding the acknowledged high academic quality of Greater Washington's universities, the regional system underperforms on measures of scientific research impact."

VENTURE CAPITAL

Over the past five years Greater Washington received almost $6 billion in venture capital investment. Venture capital (VC) provides funds for innovative enterprises positioned for high growth and the potential to create and capture entire new markets.[65] 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.[66] Despite trailing some of its peers on venture capital received per capita, Greater Washington ranked third on per-capita venture capital growth over the past five years, behind only San Francisco and Sacramento (Figure 15).[67]

The region also ranks second among peers in the share of venture capital invested in advanced industries, with 93 percent of the total, behind only San Diego. Five sectors receive more than 80 percent of all venture capital investments in Greater Washington: software (35 percent), commercial services (22 percent), pharmaceuticals and biotechnology (12 percent), communications and networking (7 percent), and IT services (5 percent). Nevertheless, the share of venture capital invested in the region's advanced industries declined from 98 percent in 2005 to the current level of 93 percent.[68]

Figure 15. Venture capital invested and growth rate, Greater Washington and peer metros, 2010-2015



Source: Brookings analysis of PitchBook data

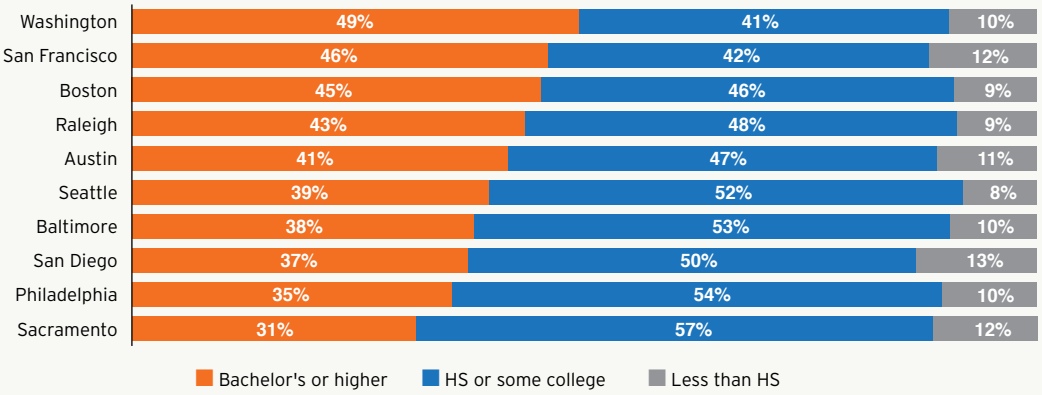
GLOBAL TALENT ASSETS

WORKFORCE SKILLS

Greater Washington's residents are among the most highly educated in the country. One of Greater Washington's signature strengths is the high levels of educational attainment its residents possess. Fully 49 percent of its adults have at least a bachelor's degree, ranking Greater Washington first not only among its peer regions but also among the 100 largest metro areas nationwide (Figure 16).[69] Greater Washington's skills profile directly reflects its human capital assets. In 2014, the region employed 3.4 times the average U.S. share of legal professionals, 2.7 times the average share of computer and math workers, 2.2 times the average share of scientists and researchers, and 2 times the average share of business and financial professionals.[70] This abundance of human capital is a major global asset for enticing foreign investment and enhancing the region's presence in advanced services.

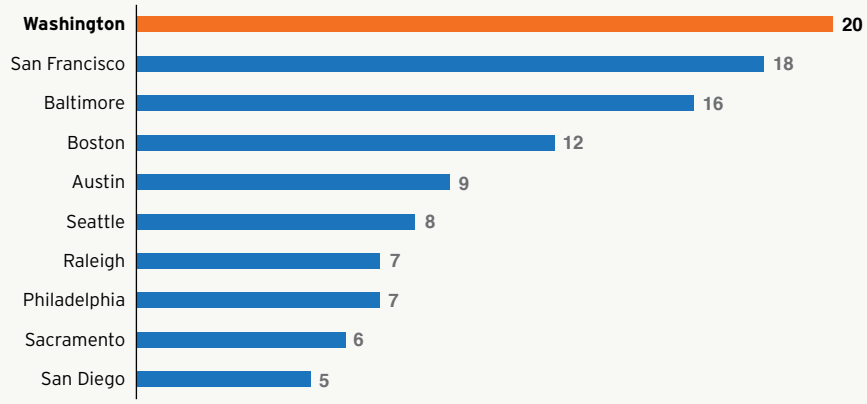
Greater Washington's employers nevertheless face challenges in filling job vacancies, particularly for highly specialized STEM occupations.[71] Greater Washington's advanced services economy demands some of the most valuable skills in the country; as a result, it often takes employers longer to fill vacant positions than elsewhere. Among its peers, Greater Washington's online job postings in 2013 had the longest median duration (20 days) and the second-highest average market value of skills posted (Figure 17). Greater Washington employers also advertised the highest percentage of STEM occupations (55 percent), more than half of which were for computer and mathematical science occupations, and which were typically posted for 27 days.[72] Long search times are not necessarily a critical deficiency in the labor market, but rather a symptom of the highly specialized skills which Greater Washington's advanced services employers seek.

Figure 16. Adult educational attainment, Greater Washington and peer regions, 2014



Source: Brookings analysis of U.S. Census Bureau data

Figure 17. Median duration of STEM job openings (days), Greater Washington and peer regions, 2013



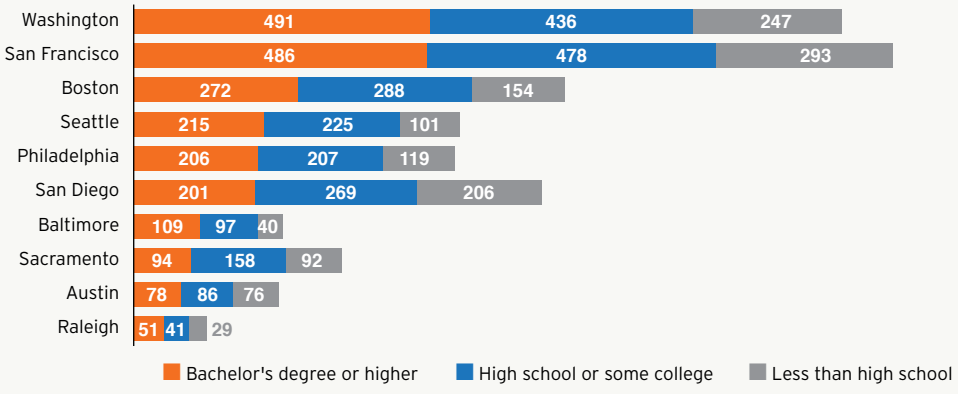
Source: Brookings analysis of Burning Glass data

IMMIGRANTS AND FOREIGN STUDENTS

Nearly one-half million highly educated immigrants call Greater Washington home. Immigrants of all skill levels can further economic growth, but Greater Washington's abundance of highly educated immigrants may confer a special advantage in helping the region expand its global networks.[73] In 2014, 491,000 immigrants (42 percent of the foreign-born population 25 years and older) held at least a bachelor's degree, more than in any peer metro area (Figure 18). Greater Washington also ranked third among its peers in the share of its immigrants with college degrees, behind only Baltimore and Raleigh, which have much smaller foreign-born populations.[74]

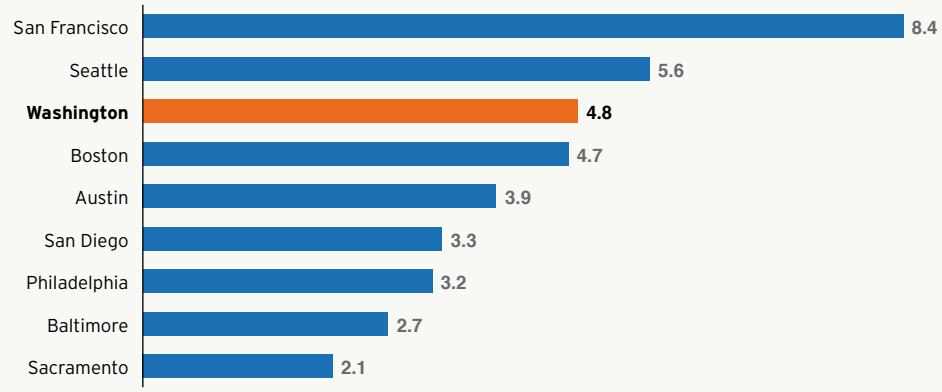
Greater Washington's employers exhibit strong demand for highly skilled foreign workers. Many highly educated immigrants in the region hold H-1B

Figure 18. Foreign-born adult educational attainment, thousands, Greater Washington and peer regions, 2014



Source: Brookings analysis of U.S. Census Bureau data

Figure 19. H-1B guest worker visas requested per 1,000 workers, Greater Washington and peer regions, 2010–2011



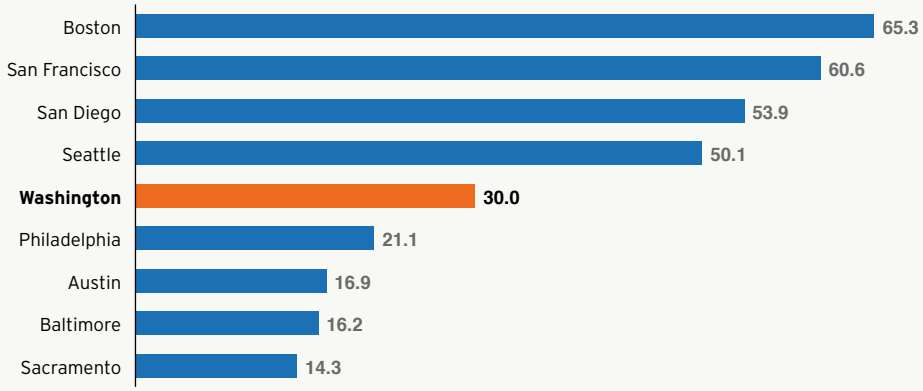
Source: Brookings analysis of U.S. Department of Labor, Labor Condition Application data

visas, a program that allows employers to hire foreign workers for specialty occupations on a temporary basis.[75] Relative to the size of its labor market, Greater Washington ranked third among its peer regions with its employers requesting slightly fewer than five H-1B visas per 1,000 workers in 2010–11, behind only San Francisco and Seattle (Figure 19). Of the nearly 14,600 H-1B visas requested in Greater Washington during that time, 64 percent were for workers in STEM fields.[76]

Greater Washington has fewer foreign students at its colleges and universities than many of its peer regions. Foreign students can enhance a regional economy's global engagement in several ways. Most directly, foreign student expenditures count as exports; in 2014 they brought over $760 million into Greater Washington's economy, supporting an estimated 8,300 jobs.[77] Foreign students can also enrich the workforce given their disproportionate representation in STEM and business fields, their familiarity with their home markets, and their tendency to settle in the same metro area as their university if they stay to work in the United States.[78]

Between 2008 and 2012, about 35,000 foreign students were approved for F1 visas to attend colleges and universities in Greater Washington, or about 30 per 1,000 students in the area over that time (Figure 20). That ranked Greater Washington just fifth among its peers, and well behind Boston, San Francisco, San Diego, and Seattle. Nearly three-quarters of F1 approvals in Greater Washington were for graduate students, highest among peer regions. If strategically harnessed, this concentration of foreign expertise can help local firms enter new markets (see sidebar, "Foreign students in Los Angeles help local firms 'go global'"). These may include the most frequent home countries for Greater Washington's foreign students, such as India (9,400), China (5,400), South Korea (3,500), and Saudi Arabia (1,300).[79] At the same time, these figures also suggest untapped opportunities to expand international representation at the undergraduate level at the region's colleges and universities.

Figure 20. F1 student visas approved per 1,000 higher education students, Greater Washington and peer regions, 2008-2012



Source: Brookings analysis of Immigration and Customs Enforcement data

Foreign students in Los Angeles help local firms 'go global'[80, 81]

Universities—long known for their role as local economic catalysts—are also experimenting with new ways to leverage the networks, knowledge, and language skills of foreign students to connect local firms with global markets. In the Los Angeles region, as part of the Los Angeles Regional Export Council (LAExC), the USC Marshall School of Business and the UCLA Anderson School of Management have created the Export Champions program. Through the program, MBA student teams work on an international business consulting project to help Los Angeles-based companies export to global markets. Firms pay fees that cover the student teams' costs, which include multi-week international trips to interview potential customers and suppliers and to gather information on competitors. The social networks, cultural familiarity, and language prowess developed by students who have lived and traveled abroad are brought to bear in making these connections. The final outputs of the program are proprietary market reports that guide firm decisionmaking. In 2012 and 2013, Small Business Administration (SBA) provided State and Trade and Export Promotion (STEP) grants to a few small- and medium- sized enterprises that wanted to participate in this program but could not afford the full fee.

GLOBAL INFRASTRUCTURE ASSETS

AVIATION

Greater Washington is one of the largest aviation centers in the country, serving over 56 million passengers in 2014. Roughly six in 10 (58 percent) regional passengers traveled through Ronald Reagan National Airport, with the remainder using Dulles International Airport (42 percent). Among peer regions only the San Francisco metropolitan area moved more passengers (88 million) in 2014 (Table 8). Including flows through Baltimore/Washington International Airport, which is located in the Baltimore metropolitan area but services many Greater Washington residents and employers, boosts the mega-region's passenger total to 91 million.

Greater Washington's most common final U.S. origins and destinations are Chicago (3.0 million passengers), Boston (2.9 million), Los Angeles (2.6 million), Miami (2.4 million), and San Francisco (2.1 million).[82]

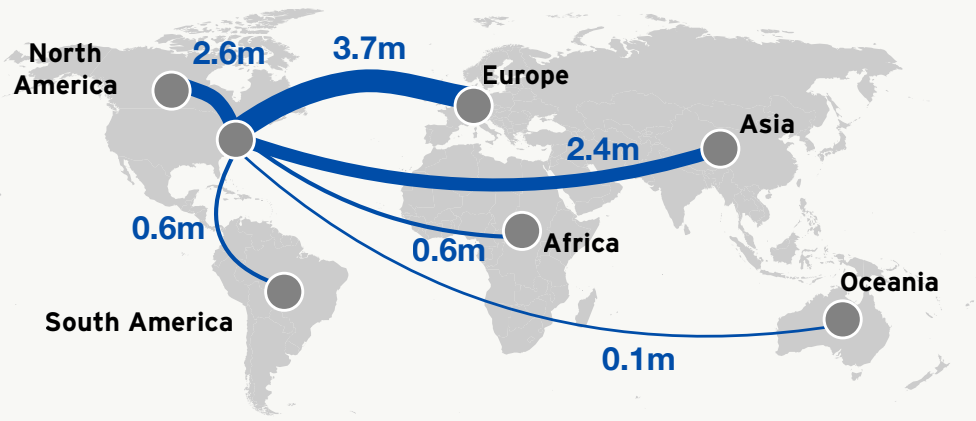
Greater Washington serviced 10 million international passengers in 2014, ranking it among the most internationally-oriented air hubs. Among peer regions, only San Francisco's air passengers travel to/from international destinations more frequently than Greater Washington's. Europe is by far Greater Washington's largest international market (37 percent of total international passengers), followed by the rest of North America (26 percent), Asia (24 percent), and South America (6 percent) (Figure 21).

Table 8. Air passengers, Greater Washington and peer regions, 2014

Metro area	Passengers (millions)	Share of domestic passengers	Share of international passengers	Change in passengers, 2004-2014	Avg. fare per Km
San Francisco	87.8	81.8%	18.2%	28.2%	$0.11
Washington	**56.5**	**82.3%**	**17.7%**	**2.8%**	**$0.14**
Seattle	55.0	91.8%	8.2%	27.7%	$0.10
Boston	54.3	82.5%	17.5%	19.8%	$0.12
Baltimore	34.7	94.5%	5.5%	3.2%	$0.12
San Diego	34.3	92.7%	7.3%	12.5%	$0.10
Philadelphia	33.3	89.0%	11.0%	-3.0%	$0.13
Austin	19.5	93.7%	6.3%	48.0%	$0.12
Raleigh	17.9	91.6%	8.4%	8.0%	$0.14
Sacramento	16.8	96.0%	4.0%	-7.3%	$0.12

Source: Brookings analysis of Sabre global aviation data

Figure 21. International air passengers by continent, Greater Washington, 2014



Source: Brookings analysis of Sabre global aviation data

Origin-destination flows are highest with the following countries (metropolitan destinations with more than 100,000 passengers included): United Kingdom (London), Canada (Toronto and Montreal), Germany (Frankfurt and Munich), France (Paris), Mexico (Mexico City), and China (Beijing). Among routes with more than 100,000 passengers in 2014, flows have grown fastest with Saudi Arabia (22 percent per year), United Arab Emirates (17 percent), Dominican Republic (13 percent), South Africa (11 percent), Turkey (10 percent), and China (10 percent).[83] Several of these major emerging economies represent target markets for expanding local travel and tourism exports.

Adding to Greater Washington's status as a major global aviation center, analysis of the region's top international destinations shows that many of its routes are more direct than the global average. Based on the miles that layovers add to each origin/destination pair, Greater Washington offers flights that are eight times more direct to Istanbul and Tel Aviv, three times more direct to Vienna-Bratislava and London, and two times more direct to Zurich and Munich (Table 9).[84] Compared to its peers, Greater Washington ranks only behind Philadelphia and San Francisco in the average number of layovers for international flights (with 60 percent of international travelers experiencing one layover on average).[85]

"Several major emerging economies represent target markets for expanding local travel and tourism exports."

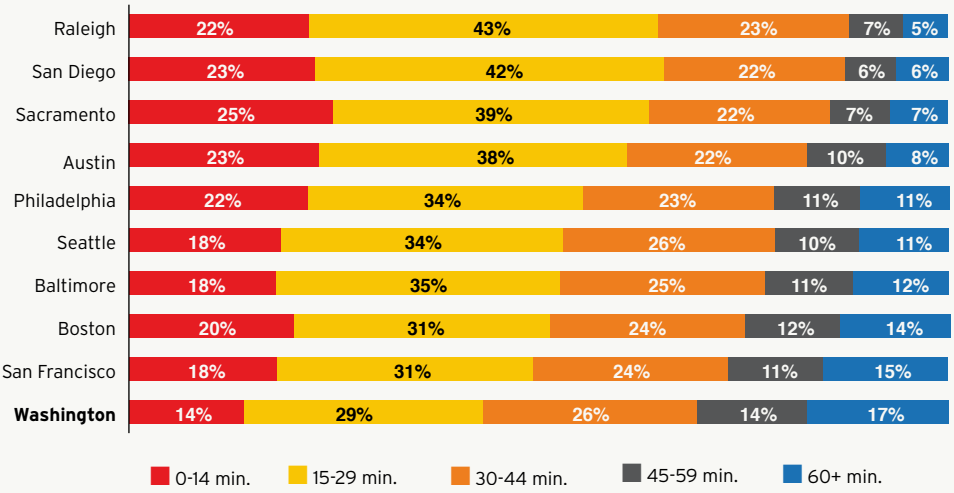
Table 9. Directness of air access to international markets, Greater Washington, 2014

Origin/Destination metro area	Greater Washington passengers	Miles added from layovers (per 100 miles)	Times more direct than global average
Istanbul	127,770	0.26	**8.21**
Tel Aviv	129,639	0.52	**8.12**
Vienna-Bratislava	113,846	1.28	**3.38**
London	933,447	0.87	**2.98**
Brussels	158,693	1.51	**2.44**
Zurich	83,382	1.50	**2.31**
Munich	101,587	1.88	**1.95**
Tokyo	216,497	2.00	**1.81**
Frankfurt am Main	233,300	1.80	**1.75**
Copenhagen-Malmö	90,397	2.77	**1.70**
Rotterdam-Amsterdam	170,680	1.87	**1.66**
Mexico City	200,586	2.06	**1.62**
Paris	402,708	2.41	**1.23**
Rome	173,558	3.45	**1.19**
Sao Paulo	89,486	3.91	**1.08**
Seoul-Incheon	238,800	4.14	**1.05**
East Rand	84,198	7.27	**0.98**
Toronto	508,345	3.89	**0.93**
Beijing	290,050	4.02	**0.78**
Delhi	141,096	8.99	**0.76**
Montreal	141,321	6.50	**0.73**
Lima	94,260	6.58	**0.70**
San Juan	369,232	8.64	**0.69**
Madrid	91,628	11.95	**0.35**
Shanghai	77,072	8.81	**0.32**

Source: Brookings analysis of Sabre global aviation data.

Greater Washington's passenger growth over the last decade has been slower than that in many peer regions. Aviation passenger totals in Greater Washington grew only 2.8 percent from 2004 to 2014, ranking the region below every other peer region except Philadelphia and Sacramento (Table 8). Peer regions such as San Francisco, Seattle, Boston, Austin, and San Diego all experienced double-digit growth during that time. One contributing factor may be costs to passengers, which on a per-kilometer basis are higher in Greater Washington than in most other markets at an average of 12 cents in 2014. Notably, including Baltimore/Washington International Airport in regional totals would not change Greater Washington's recent air travel growth picture considerably.[86]

Figure 22. One-way commuting times, all workers, Greater Washington and peer regions, 2014



Source: Brookings analysis of U.S. Census Bureau data

SPATIAL EFFICIENCY

Greater Washington's lack of spatial efficiency contributes to slower commutes. The global competitiveness of a region depends on its ability to link people not only to international markets but also to the global assets within the region, a trait researchers term "spatial efficiency."[87] Transportation networks connect firms to global access points like airports and ports, shuttle workers to jobs, and facilitate intra-metro commerce and collaboration. A major obstacle facing Greater Washington's spatial efficiency has been the region's rapid expansion over time. In 1960 the Washington, D.C. metropolitan statistical area (MSA) spanned 1,470 square miles. In the wake of five decades of growth, much of it at the region's periphery, the MSA has more than quadrupled in size to cover 6,244 square miles today.[88] Among other things, this spreading out has led to lengthier commutes for Greater Washington residents.[89] In 2011 the typical resident traveling to work within Greater Washington journeyed 9.1 miles, longer than in any peer region.[90] Predictably, these longer distances lead to slower commutes. In 2014 the average Greater Washington commuter spent 49 minutes traveling to work, and a much higher share (31 percent) traveled at least 45 minutes one-way than in San Francisco, the nearest peer (26 percent) (Figure 22).[91] While an imperfect measure of the region's spatial efficiency, Greater Washington's longer commute times suggest unmet opportunities to connect economic assets within the region to bolster trade, investment, and competitiveness.

"The global competitiveness of a region depends on its ability to link people to the global assets within the region."

CONCLUSION

Like most major U.S. metropolitan areas, Greater Washington does not lack for analyses of its economic strengths, challenges, and priorities. This report, however, provides a different lens through which to view the region's performance, one that explicitly acknowledges the imperative for Greater Washington to engage globally.

Analyzing the region from a global standpoint, particularly compared to many of its U.S. peers, highlights a number of unique assets upon which regional leaders can build to strengthen global engagement: a solid base of advanced industries; an expanding presence of foreign-owned firms; growing venture capital investment; one of the world's most highly educated and international workforces; and high levels of air connectivity to established and emerging markets around the world.

That same viewpoint, however, flags a number of areas in which Greater Washington lags its peers in connecting to global opportunity. It sells relatively little of its economic output abroad, and its foreign firms under-contribute to its exports. Compared to other markets, Greater Washington's companies and research institutions innovate less in commercially valuable technologies, and its major universities exert a smaller scientific impact. Many of these weaknesses can be traced back to the outsized influence of the federal government in the regional economy, which continues to provide good jobs and sponsor world-class research, but whose presence may have held back the private-sector innovation and public-private collaboration that has proven critical to effective global engagement in other regions.

This report is not the first to identify these issues, nor will it be the last. However, looking outward to global economic possibilities may present Greater Washington's public, private, and civic sector leaders with a more unifying, accessible agenda that lends itself to working more easily across economic development stakeholders and jurisdictional lines. It may also point toward discrete topics and initiatives that, as other regions are discovering, enable them to "collaborate to compete" globally, and grow in ways that provide greater opportunities and a higher quality of life for all residents.

APPENDIX

Peer Methodology

Classifying and identifying peers allows policymakers and stakeholders to better understand the position of their economies in a national context as well as to conduct constructive benchmarking. Brookings utilized a combination of principal components analysis (PCA) and agglomerative hierarchical clustering to identify nine peer U.S. metro areas for Greater Washington.[92] Brookings evaluated the metro areas based on a variety of metrics, including total employment, four-digit North American Industrial Classification System (NAICS) employment shares, two-digit NAICS output per worker, and two-digit NAICS compensation per worker in 2014. Using detailed industrial data as classification criteria provides a good foundation for assessing the "industrial DNA" of a given economy and allows for fairer, more relevant comparisons between places with similar economic structures.

Principal components analysis reduced the number of dimensions in the data by dropping redundant and highly interrelated information while retaining as much variance as possible, ultimately generating new variables called components.[93] Next, Brookings selected the number of components (65 in this case) that explained 80 to 90 percent of the variance of the dataset and where the eigenvalue is equal to one. Next, Brookings applied complete-linkage (furthest neighbor) and weighted-group average hierarchical clustering algorithms to the components. Brookings then visualized the results using dendrograms and selected the most industrially similar metropolitan areas within Greater Washington's immediate branch.

Employment, Output, and Compensation

Economic indicators for U.S. metro areas are derived from Moody's Analytics data. Moody's uses data published by the Bureau of Labor Statistics (BLS) and the Bureau of Economic Analysis (BEA) to generate their estimates of employment and GDP at the county level. The estimates were aggregated to metropolitan areas using the current definition of metropolitan areas followed by the Census Bureau. Moody's reports all non-public administration industries (NAICS 92) in terms of their private employment, which reduces the size of industries with higher governmental employment such as health care and education. Since Moody's data are heavily estimated they occasionally diverge from BEA output statistics. For instance, in 2014 BEA reported Greater Washington's output at $472 billion while Moody's reported $404 billion.

Federal Spending

Data sources for federal procurement spending are the General Services Administration and the Treasury Department's Bureau of the Fiscal Service (available at USASpending.gov). Each record in this database contains detailed information about the company or organization receiving federal awards. Brookings' estimates focused exclusively on contracts and grants to non-governmental entities operating in the Washington, D.C. metro area during the 2010 and 2014 fiscal years. The analysis only considered entities that listed their principal place of performance as Washington, D.C. The aggregate federal contract and grant award value represents the amount of federal government's obligation or contingent liability, in dollars, which approximates the scale of revenue flowing to firms from commerce with the federal government. A small share of the contracts were part of multi-year appropriations. As a result, the analysis assumes that the number of multi-year appropriations are relatively constant year-to-year and should not significantly skew the aggregate value in the selected years. To obtain federal contractors' share of GDP, Brookings divided total obligations into total output for the region in current dollars. The statistic measuring the advanced industry share of revenue from federal sources was developed by matching firms to advanced industries using their principal NAICS code and calculating obligations as a share of GDP. 2010 estimates were inflation-adjusted to 2014 dollars using BEA chained indices.

For more information: **www.usaspending.gov/about/Pages/TheData.aspx**

Advanced Industries

NAICS code	Industry	NAICS code	Industry
2111	Oil & Gas Extraction	3351	Electrical Lighting Equipment
2122	Metal Ore Mining	3352	Household Appliances
2211	Power Generation & Supply	3353	Electrical Equipment
3241	Petroleum & Coal Products	3359	Misc. Electrical Equipment
3251	Basic Chemicals	3361	Motor Vehicles
3252	Resins & Synthetic Rubbers	3362	Motor Vehicle Body & Trailers
3253	Pesticides & Fertilizers	3363	Motor Vehicle Parts
3254	Pharmaceuticals	3364	Aircraft Products & Parts
3259	Misc. Chemicals	3365	Railroad Rolling Stock
3271	Clay & Refractory Products	3366	Ships & Boats
3279	Stone & Mineral Products	3369	Misc. Transportation Equipment
3311	Iron & Steel Products	3391	Medical Equipment & Supplies
3313	Aluminum Products	3399	Jewelry, Sporting Goods
3315	Foundries	5112	Software Products
3331	Agri., Constr., Mining Machinery	5152	Cable & Other Programming
3332	Industrial Machinery	5172	Wireless Telecom Carriers
3333	Commercial & Service Machinery	5174	Satellite Telecommunications
3336	Engine & Power Equipment	5179	Other Telecommunications
3339	General Purpose Machinery	5182	Data Processing & Hosting
3341	Computer Equipment	5191	News & Media
3342	Communications Equipment	5413	Architecture & Engineering
3343	Audio & Video Equipment	5415	Computer Systems Design
3344	Semiconductors	5416	Management Consulting
3345	Precision Instruments	5417	R&D Services
3346	Magnetic & Optical Media	6215	Medical & Diagnostic Laboratories

For more info see Brookings "America's Advanced Industries" report

Advanced Industries

Brookings identifies 50 four-digit NAICS industries as "advanced" in the U.S. economy.

For more information: Mark Muro and others, "America's Advanced Industries: What they are, where they are, and why they matter" (Washington: Brookings Institution, 2015).

Exports

Export data are derived from a number of sources including: Census, BEA, Moody's analytics, BLS, NAFSA, IRS, EIA, and Sabre. The estimates include both goods and services and are adjusted to reflect the export value-add at the point of production using the local share of national output to allocate national exports for each industry and county.

For more information: Nick Marchio, "Brookings export database methodology" (Washington: Brookings Institution, 2015).

www.brookings.edu/~/media/research/files/interactives/2015/export-monitor/brookings-export-series-methodology-nm-5715.pdf

Foreign Direct Investment

Jobs in foreign-owned establishments are derived from data from Dun and Bradstreet (D&B), the National Establishment Time Series (NETS), and the Bureau of Economic Analysis (BEA). The estimates include all foreign investment activity into the United States between 1991 and 2011, excluding real estate and EB-5 investment. Brookings utilized Moody's private-sector employment totals to calculate the shares of domestic jobs in foreign-owned establishments.

For more information: Nick Marchio, "Methodological Appendix for FDI in U.S. Metro Areas: The Geography of Jobs in Foreign-Owned Establishments" (Washington: Brookings Institution, 2014).

www.brookings.edu/~/media/research/files/reports/2014/06/20-fdi-us-metro-areas/method-appendix.pdf

Patents

Patents data are derived from 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 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 represent 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 area's 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: Stephane Maraut and others, "The OECD REGPAT Database: A Presentation" (Paris: OECD, 2008). **www.oecd.org/sti/inno/40794372.pdf**

University Research Impact

University scientific impact data come from 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 fractional-counting methods which apportion shares to each collaborator. Brookings focused on fully-counted publications and aggregated the raw university-level citations data into metro-level estimates. 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 means that a university's publications have been cited at twice the rate of the world average. A second measure captures the percentage of a university's publications that, compared with other publications in the same field and same year, are in the top ten percent most frequently cited.

For more information: L. Waltman and others, "The Leiden Ranking 2011/2012: Data collection, indicators, and interpretation." *Journal of the American Society for Information Science and Technology* 63(12), 2419–32. **www.leidenranking.com/methodology**

Venture Capital

Venture capital data are derived from 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 took the data and then assigned the investors and recipients to metropolitan geographies. 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: **http://blog.pitchbook.com/wp-content/uploads/2014/06/3Q-2014-PE-Breakdown-Methodology.pdf**

Aviation

Aviation data are derived from 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 output of at least $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 assigned all airports to global metropolitan areas, obtained latitude and longitude coordinates to derive distance measures, cleaned anomalous records, and aggregated the passenger and revenue flows to better facilitate regional analysis. All value measures were inflation-adjusted to 2014 dollars.

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

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

ENDNOTES

1. Brookings analysis of data from Oxford Economics, Moody's Analytics, and the U.S. Census Bureau. For methodological details, please see: Parilla, Joseph, Jesus Leal Trujillo, and Alan Berube with Tao Ran. 2014. "Global Metro Monitor: An Uncertain Recovery." Brookings Institution. July 2015.
2. Ibid.
3. Brookings analysis of data from Moody's Analytics.
4. Brookings analysis U.S. Census Bureau, 2014 American Community Survey 1-Year Estimates.
5. Brookings analysis of data from Oxford Economics and Moody's Analytics.
6. Brookings analysis of data from Moody's Analytics. Projections derived by author.
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8. Brookings analysis of data from General Service Administration and Department of the Treasury's Bureau of the Fiscal Service available at USASpending.gov and Moody's Analytics data. See Appendix section on federal spending analysis.
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56. Brookings analysis of data from Moody's Analytics.

57. Brookings analysis of OECD REGPAT Patent database and data from Moody's Analytics. See Appendix section on patents.

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84. To assess the "directness" of a region's international flights, Brookings examined the ratio of miles added from layovers to geodesic miles between the origin and destination and normalized it on a 100 mile scale. This measure is unique because it weighs flight paths by passengers traveled. If a metro area only provides direct flights to a small percentage of total passengers to that destination their miles added from layovers statistic will reflect the skew towards more layover-heavy flights.

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87. Sarzynski and Levy define spatial efficiency as the ability to minimize transaction cost and maximize output. Spatial efficiency is of particular importance for cities as the primary appeal of cities is its ability to concentrate ideas, technology and skills. The concentration of these factors allow for fluid exchange of ideas and goods, thereby creating a vibrant environment for businesses and households. The increase in a city's population, however, places greater emphasis on the coordination of land, housing and transportation development to ensure sustained accessibility and optimal use of land. It is further found that regions with special mismatch such as lacking vibrant, desirable neighborhoods may be slow to achieve their growth potential. This was supported by OECD's (2015) finding that in the context of large urban agglomerations, poor land-use and transport planning are among the most significant consequences of failure in policy coordination. Andrea Sarzynski and Alice Levy, "Spatial Efficiency and Regional Prosperity: A Literature Review and Policy Discussion" Working Paper (George Washington Institute of Public Policy, August 2010); Edward Glaeser, "Are Cities Dying?" *Journal of Economic Perspectives* 12(2) (1998): 139-160; OECD, "The Metropolitan Century."

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