Brookings export database methodology[1]
Updated May 2015

Purpose of database

The objective of Brookings export database is to provide local economic practitioners with better information on export production in metropolitan goods and services industries. With this information, local practitioners and researchers can better understand export activity and develop strategies to foster export-oriented growth.

Amid numerous export and trade data sources, Brookings export database is unique in several ways.

First and foremost, it estimates U.S. exports by production location, and not origin-of-movement, as is the norm with all the other available export databases. The origin-of-movement is not always the place where the good was produced, especially when the exported goods get consolidated along the shipment route. Origin-of-movement export data are sufficient for a freight study, but they provide a distorted view for regional economic analysis.

Second, this report is unique because it estimates exports at the county level, which allows aggregation at counties, metropolitan and micropolitan areas, states, regions, and national levels. The U.S. Census Bureau produces a state exports series and prepares a metropolitan export series for the International Trade Administration (ITA), but these series reflect origin-of-movement export data.

Finally, Brookings method estimates both goods and services exports at the county level for 91 detailed goods and 40 services industries (For the complete list, see Table A). This is more comprehensive than the Census Bureau's state and metropolitan exports series and the Freight Analysis Framework prepared by Oak Ridge National Laboratory, which cover only goods exports. The U.S. Bureau of Economic Analysis releases service export estimates, but only at the national level.

Overview of methodology

Turning to the methodology, this latest iteration of the data largely follows the methodology developed in the previous editions found in *Export Nation: How U.S. Metros Lead National Export Growth and Boost Competitiveness*, *Export Nation 2012: How U.S. Metropolitan Areas Are Driving National Growth*, and *Export Nation 2013: U.S. Growth Post-Recession*.

Most of the data sources employed in this study are the same with the previous edition: the USA Trade Online (Census) for goods exports, the Bureau of Economic Analysis (BEA) for services exports and price indexes, the Bureau of Labor Statistics (BLS) for jobs multipliers and price indexes, the Internal Revenue Service (IRS) for royalties data, Moody's Analytics production estimates at the county level, and university level foreign students' expenditures from NAFSA. In addition to these sources, this update employs data from the Energy Information Administration (EIA) on petroleum exports from Petroleum Administration for Defense Districts (PADD) regions and proprietary aviation data compiled by Sabre to assess spending by international tourists.

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[1] This document is an updated and revised version of the methodology developed by Emilia Istrate and Nick Marchio in the Brookings report "Export Nation 2012: How U.S. Metropolitan Areas Are Driving National Growth."

As did the earlier edition, the estimation technique allocates U.S. exports for a given industry to each county based on their share of national production in that particular industry. This approach assumes that if Los Angeles County produces 5 percent of the national value-added of computer manufacturing, then this county also exports 5 percent of U.S. computer and electronics. The data is aggregated afterwards at metropolitan, state, region, and national level. Brookings utilizes this technique to allocate goods exports reported by Census and most services exports reported by the BEA.

In an effort to better approximate metropolitan services exports, this study employs a different allocation method for one goods industry and three major service sectors. Those are petroleum and coal products manufacturing and the services industries pertaining to royalties from intellectual property, travel and tourism, and education.

To more precisely allocate petroleum and coal products exports, this update first allocates national petroleum and coal products manufacturing exports to Energy Information Administration's Petroleum Administration for Defense Districts (PADD) based on each districts share of national total crude oil and petroleum products exports. Once allocated to the district level the value is then reallocated to counties based on each county's share of production generated in its petroleum and coal products manufacturing sector. This adjustments helps refine the spatial distribution of oil exports given the prevalence of large scale refineries that primarily serve domestic markets.

For royalties, this study adds a step to the allocation method. It first calculates industry royalties accrued from the use of U.S. copyrights, patents, and trademarks by foreigners for each of the BEA's royalty industry categories and further subdivides those estimates into NAICS industries using the IRS industry receipts from royalties, based on all returns of all active companies. In a second step, this study allocates each NAICS industry's royalties exports to the county level in proportion to each county's share of production generated by that industry.

A related allocation method was used for travel and tourism. This study uses the BEA "Travel and Tourism Account" to derive estimates of export revenues that accrue to industries that sells goods and services to foreign tourists. Once distributed by industry, the detailed categories are summed into "passenger fares" and "all other tourism-related spending" aggregates, which are then allocated to metros based on their share of round-trip international flights originating abroad. Passenger fares were allocated by the combined pass-through and destination flights into metropolitan areas to include the airport providing layover service, whereas all other tourism-related spending was allocated only by the destination flight. The aviation data spans two periods in 2003 and 2011, which were then interpolated into a time-series to cover the entire span of the data series. The resulting metropolitan tourism and travel-related expenditures were then allocated to counties by each county's share of value-added in the corresponding NAICS industry. This edition improves the NAICS identification of travel and tourism industries, based on a BEA provided correspondence table between the Travel and Tourism Account and NAICS codes.

Finally, in the case of education, this study uses the county share of the expenditures of foreign students to allocate education exports. Thanks to the data provided by NAFSA: The Association of International Educators, this method uses the geographical distribution of expenditures of foreign students in the U.S. instead of the number of foreign students in the U.S., which is available through the Institute of International Education's Open Doors survey.

In light of these changes, the previous export estimates and rankings associated with Brookings *Export Nation* reports and this current data series are not comparable. In addition, the Bureau of Economic Analysis (BEA) and Moody's Analytics constantly revise the historical estimates that this study employs, which also make comparisons with previous versions incompatible. Lastly, over the past several years, the

BEA changed its methodology for estimating some service exports, which affects the estimates of service export categories. To enable time-series comparisons, Brookings updates all data going back across the entire series each release.

Export-supported jobs methodology

To estimate the numbers of jobs supported by exports, this update uses annual job multipliers calculated by the U.S. Bureau of Labor Statistics (BLS), adjusted to remove the employment effect of imports.

Along these lines, the database provides two sets of export jobs data. The first type, direct export-production jobs, are jobs supported by exports in the industries producing the exported good or service. Total export-supported jobs, by contrast, reflect the broader employment impact of exports including direct export-production jobs; jobs with the suppliers of intermediate inputs to exporting industries; and, in the case of goods exports, associated jobs in the transportation and wholesale trade industries across the U.S. Some of the direct and indirect jobs may lie outside of the metro area that produces the exported good or service.

For direct export-production jobs, the report employs the BLS job multipliers that show the number of direct jobs, full-time or part-time, supported by $1 million worth of sales (valued in production prices) of the products of an industry. For total export-supported jobs, it employs the BLS job multipliers that show the number of direct and indirect jobs, full-time or part-time, supported by $1 million worth of sales (valued in production prices) of the products of an industry. For example, $1 million worth of sales (in production prices) of medical devices supported an average of 3.78 direct jobs in the U.S. 2013—these are jobs in the medical device industry itself. The same amount of medical device production supports on average 6.18 direct and indirect jobs in the U.S. in 2013— these are jobs in the medical device industry and in any U.S. industry that provided inputs into the production of those products.

The only export for which this study does not use BLS multipliers is travel and tourism, which represents the combined expenditures of foreign tourists with the value of the passenger fares paid by foreign residents to U.S. air carriers for their flight to the U.S. along with the local industries they encounter during their trip to the U.S.

Instead of BLS multipliers, this report uses for direct export-production jobs the ratio of the BEA direct tourism employment over the direct output of U.S. travel and tourism (domestic and international). For total export-supported jobs, takes the difference between the BEA direct and total tourism employment and divides it by the difference between direct and total output of U.S. travel and tourism. The quotient is then then added to the direct export-supported jobs multiplier to create total export-supported jobs. This method was adopted because travel and tourism is a heterogeneous industry for which BLS does not have a unique job multiplier.

Industry coverage

This edition presents the industry analysis of exports for 91 detailed goods export industries and 40 detailed services export industries.

In the case of goods exports, it employs a four-digit North American Industry Classification System (NAICS) industry aggregation, instead of commodity, because the estimation method is based on allocating U.S. exports by the geographical distribution of production of the exporting industry. This study uses U.S. estimates of domestic goods exports by U.S. industries, provided by Census USA Trade Online data

platform. It does not include waste, used merchandise, goods returned to Canada, special classification provisions, scrap, and re-exports, because they are not firsthand production nor identifiable by industry.

For services, this report uses U.S. Bureau of Economic Analysis (BEA) private services estimates, which the federal agency compiles from a number of surveys targeted at certain service industries. In order to allocate services exports by production, this study constructs a match–up table between the BEA services export categories to NAICS codes (see Table B). It does not include U.S. government miscellaneous services and transfers under U.S. military agency sales contracts.

The U.S. exports in this database are a sum of Census goods domestic exports and BEA private services exports, without waste, scrap, and re-exports, U.S. government miscellaneous services, transfers under U.S. military agency sales contracts. This subset of U.S. exports constitutes 85.9 percent of the total U.S. exports (on a balance-of-payments basis) in 2014, reported by BEA.

As a further note on service industries, Travel and tourism industries originate from "Travel and Tourism Account"; detailed business, professional, and technical services originate from the BEA in International Service Statistics;[2] and industries receiving royalties' receipts originate from the IRS in returns of active corporations.

Geographic coverage

The database estimates exports of goods and services for each of the 3113 counties in the 50 states plus the District of Columbia, which allows the simultaneous calculation of exports at the metropolitan level and at the state level. This report uses the U.S. Bureau of Analysis definition of a county, which in comparison with the U.S. Census Bureau definition, combines Maui and Kalawao County in Hawaii and the small independent cities of Virginia—generally those with fewer than 100,000 residents—in their adjacent counties.

This study assesses export trends across the top 100 metropolitan areas in 2013, using metropolitan statistical areas (MSAs) as defined by the Office of Management and Budget (OMB) in 2013. There were 381 metropolitan areas in 2013 and this report focuses on the largest 100 metro areas, with at least 500,000 residents in 2013. This report concentrates on this group, because they collectively contain two-thirds of the nation's jobs and generate three-quarters of GDP. The country's 381 metropolitan areas are home to 85.4 percent of its population and generate nearly 91 percent of national GDP.

Inflation adjustments

This study estimates exports at county level (and through aggregation at metro and state level) between 2003 and 2014. Any growth rates of the export sales are in real terms, with the previous years adjusted for inflation to 2014. The exports are inflation-adjusted by export category. To adjust for inflation to 2014 dollars, the analysis uses the BLS Producer Price Indexes (PPI) for each detailed goods export category (four-digit NAICS industries). This study uses the BLS (PPI) for goods exports, due to insufficient industry

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[2] BEA export data is unavailable for the industries composing "Other Business, Professional, and Technical Services" during the years 2003, 2004, and 2005. Available data on each industry's unaffiliated exports (transfers between companies without stakes in one another) and their aggregate "Other Business, Professional, and Technical Services" exports make the limited application of time series extrapolation possible. This is so because: 1) unaffiliated exports provide a lower bound with which to couch a forecast and serve as a trend predictor because they are highly correlated with overall exports, 2) the availability of the aggregated value of "Other Business, Professional, and Technical Services" provides an upper bound for the estimation of its subcomponents. To reduce error, this study sets the autoregressive integrated moving average (ARIMA) specifications according to the models that best follow the industry share trends during the known years. Total gross output served as the predictor of mining service exports due to the lack of unaffiliated export data during the missing years.

detail and time series availability for the BLS export prices indexes. The BLS PPI indexes were available for all goods except agricultural production. For agriculture, this study uses the BEA exports price index for agricultural goods. For service exports, it employs the BEA service export price indexes by service export category.

Methodological precedents, robustness, and validation:

The method used here is similar to previous efforts to estimate sub-national export data based on location of production. Testa, Klier, and Zelenev[3] from the Federal Reserve Bank of Chicago employed the same method, using metropolitan industry employment shares. Brooks,[4] with the U.S. Department of Agriculture, used the state level agricultural production data to allocate U.S. exports of agricultural goods to the states of production. In addition, the Bureau of Economic Analysis (BEA) uses an allocation method to estimate the Gross Metropolitan Product from the state output.[5] For more on the accuracy of this methods' estimates, please see the Appendix in the first edition of "Export Nation."

One drawback of this methodology is that it does not fully take into account different export propensities of metropolitan industries, but rather gives an approximation of export potential based on the national average for a given industry. For instance, some metros might be especially good at exporting due to hard to quantify factors not captured by production—such as a product mix that better matches international demand. As a result, it is best to say that for a given industry their export level signals its export potential if it performs at the national average for that industry. While not the optimal method to estimate metropolitan exports, this estimation technique is the best available process to provide reasonably accurate estimates of metropolitan exports, especially in comparison to the series available from the Census-International Trade Administration's *TradeStats Express*.

For example, based on Census-ITA exports data, the McAllen, TX metro area sold abroad $2.147 billion worth of computer and electronics in 2013, which was 100 times larger than what the U.S. Bureau of Economic Analysis reported for the production of McAllen's computer and electronics industry in the same year. This study estimates $11.85 million worth of computer and electronics originating from McAllen, in line with the production of this metro industry.

To further evaluate the robustness of the database, Brookings utilized the Bureau of Transportation Statistics *Commodity Flows Survey* from the Department of Transportation to calculate the share of goods that are sent outside the metro for 59 of the 100 largest metropolitan areas for the year 2007. This export orientation measure was positively and significantly correlated with the Brookings export orientation measure, but it was negatively correlated with the Census-ITA measure. Further, the Brookings goods exports data were strongly correlated with manufacturing employment, but the ITA data had no significant correlation with manufacturing. Given the outsized importance of manufacturing to exports, this result also favors using the Brookings data over the ITA data. Using multi-variable regression analysis, the sources of the discrepancies between Census-ITA and Brookings estimates were analyzed. The metropolitan areas with the highest export to GMP ratios in the Census-ITA were in states that bordered Mexico or Canada; metros in these bordering states were allocated an average of 54 extra percentage points to their exports to

[3] William Testa, Thomas Klier, and Alexei Zelenev. "Estimating U.S. Metropolitan Areas Export and Import Competition," Economic Perspective (Federal Reserve Bank of Chicago, 2003).

[4] Nora Brooks. "U.S. Agricultural Trade Update—State Exports," Economic Research Service Outlook Report (U.S. Department of Agriculture, 2005).

[5] Carlos Gutierrez, J. Steven Landefeld, Rosemary Marcus. "Gross Domestic Product by State Estimation Methodology." (Bureau of Economic Analysis, 2006).

GMP ratio; this represented an extra seven billion dollars in exports, most of which is probably erroneous if interpreted as the origin of production. Likewise, metropolitan areas with ports were allocated an extra 3.5 billion in exports on average.

As an additional robustness check, Brookings tested its goods export estimates and the Census-ITA against a novel one-off database constructed by Brookings in partnership with the Economic Development Research Group from a 2010 sampling of the Oak Ridge National Laboratory's *Freight Analysis Framework (FAF)* which compiles subnational export flows from a number of government surveys. This Brookings-modified FAF database identifies commodity flows with greater domestic and international precision using data from the World Institute for Strategic Economic Research (WISER), in addition to industry data from IMPLAN, Moody's Analytics, and various adjustments to discrepancies inherent in FAF.[6] Using these exacting estimates of aggregate goods export flows from metropolitan areas, this export database had a much lower relative and standard error compared to the Census-ITA estimates. See Table C for these results.

Table C
Adjusted-FAF Estimates of Metropolitan Goods Exports
compared to Brookings and Census-ITA Export Series

	Average Standard Error (millions)	Average Relative Standard Error	R-Squared
Brookings	597.3	29.0%	89.5%
Census-ITA	1083.3	72.8%	84.8%

Observations: 269 metropolitan areas

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[6] For more information see Appendix A of Adie Tomer, Robert Puentes, and Joseph Kane. "Metro-to-Metro: Global and Domestic Goods Trade in Metropolitan Areas." (Brooking, 2013).

Table A

NAICS 2	NAICS 2 Title	NAICS 3	NAICS 3 Title	NAICS 4	NAICS 4 Title
11	Agriculture, Forestry, & Fishing	11FR	Agriculture	11FR	Agriculture
		11FH	Forestry & Fishing	11FH	Forestry & Fishing
21	Mining, Oil, & Gas Extraction	211	Oil & Gas Extraction	2111	Oil & Gas Extraction
		212	Mining	2121	Coal Mining
				2122	Metal Ore Mining
				2123	Nonmetallic Minerals Mining
31-33	Manufacturing	311	Food Manufacturing	3111	Animal Foods
				3112	Grain & Oilseed Products
				3113	Sugar & Confectionery Products
				3114	Frozen & Canned Foods
				3115	Dairy Products
				3116	Meat & Poultry Products
				3117	Seafood Products
				3118	Bakery Products
				3119	Snack, Coffee, & Condiments
		312	Beverage & Tobacco Products	3121	Beverage Products
				3122	Tobacco Products
		313	Textile Mills	3131	Fiber, Yarn, & Thread Products
				3132	Fabrics
				3133	Textile & Fabric Finishings
		314	Textile Product Mills	3141	Household Textile Products
				3149	Misc. Textile Products
		315	Apparel Manufacturing	3151	Knit Apparel Products
				3152	Cut & Sewn Apparel Products
				3159	Apparel Accessories
		316	Leather & Allied Products	3161	Leather Finishing Products
				3162	Footwear Products
				3169	Misc. Leather Products
		321	Wood Product Manufacturing	3211	Sawmill & Treated Wood Products
				3212	Wood Products
				3219	Misc. Wood Products
		322	Paper Manufacturing	3221	Paper Products
				3222	Converted Paper Products
		323	Printing & Related Activities	3231	Printing & Related Activities
		324	Petroleum & Coal Products	3241	Petroleum & Coal Products
		325	Chemical Manufacturing	3251	Basic Chemicals
				3252	Resins & Synthetic Rubbers
				3253	Pesticides & Fertilizers
				3254	Pharmaceuticals
				3255	Paint Products
				3256	Cleaning Products
				3259	Misc. Chemicals
		326	Plastics & Rubber Products	3261	Plastics
				3262	Rubber Products
		327	Nonmetallic Mineral Products	3271	Clay Products
				3272	Glass Products
				3273	Cement & Concrete Products
				3274	Lime & Gypsum Products
				3279	Misc. Nonmetallic Mineral Products
		331	Primary Metal Manufacturing	3311	Iron & Steel Products
				3312	Steel Products
				3313	Aluminum Products
				3314	Nonferrous Metal Products
				3315	Foundry Products
		332	Fabricated Metal Products	3321	Forging & Stamping
				3322	Cutlery & Handtools
				3323	Architectural & Structural Metals
				3324	Tanks & Shipping Containers
				3325	Hardware Products
				3326	Spring & Wire Products
				3327	Screws, Nuts, & Bolts
				3329	Misc. Fabricated Metal Products
		333	Machinery Manufacturing	3331	Agri., Constr., Mining Machinery
				3332	Industrial Machinery
				3333	Commercial & Service Machinery
				3334	HVAC Equipment
				3335	Metalworking Machinery
				3336	Engine & Power Equipment
				3339	Misc. General Purpose Machinery

Table A (continued)

NAICS 2	NAICS 2 Title	NAICS 3	NAICS 3 Title	NAICS 4	NAICS 4 Title
31-33	Manufacturing	334	Computer & Electronic Products	3341	Computer Equipment
				3342	Communications Equipment
				3343	Audio & Video Equipment
				3344	Semiconductors
				3345	Precision Instruments
				3346	Magnetic & Optical Media
		335	Electrical Equipment & Appliances	3351	Electrical Lighting Equipment
				3352	Household Appliances
				3353	Electrical Equipment
				3359	Misc. Electrical Equipment
		336	Transportation Equipment	3361	Motor Vehicles
				3362	Motor Vehicle Body & Trailers
				3363	Motor Vehicle Parts
				3364	Aircraft Products & Parts
				3365	Railroad Rolling Stock
				3366	Ships & Boats
				3369	Misc. Transportation Equipment
		337	Furniture & Related Products	3371	Furniture Products
				3372	Office Furniture Products
				3379	Home Furnishing Products
		339	Miscellaneous Manufacturing	3391	Medical Equipment & Supplies
				3399	Miscellaneous Goods
S1	General Business Services	SVM	Management & Legal Services	14SV	Management & Consulting
				21SV	Legal Services
		SVS	Support Services	16SV	Accounting & Auditing Services
				17SV	Advertising Services
				24SV	Trade-related Services
				26SV	Ancillary Services
S2	Finance & Insurance	SVF	Financial Services	07SV	Investment Banking
				08SV	Financial Management
				09SV	Credit Issuance & Lending
		SVI	Insurance Services	05SV	Insurance Carriers
				06SV	Auxiliary Insurance Activities
S3	Engineering & Heavy Industry	SVE	Engineering Services	01SV	Equipment Installation Services
				18SV	Architectural & Engineering Services
				20SV	Industrial Engineering Services
		SVH	Freight & Heavy Industry	02SV	Freight & Port Services
				15SV	Operational Leasing Services
				19SV	Construction Services
				22SV	Mining Services
S4	Information & Technology	RYX	Royalties	01RY	Chemical Manufacturing Royalties
				02RY	Other Manufacturing Royalties
				03RY	Computer & Electronic Royalties
				04RY	Wholesale & Retail Royalties
				05RY	Information Technology Royalties
				06RY	Scientific & Technical Royalties
				07RY	Other Royalties
				08RY	Film & Music Industry Royalties
		SVT	Tech Sector	10SV	Telecom Services
				11SV	Computer Services
				12SV	Information Services
				13SV	R & D Services
S5	Eds, Meds, & Tourism	SVD	Educational & Medical Services	03SV	Medical Services
				04SV	Educational Services
				25SV	Training Services
		TTX	Travel & Tourism	01TT	Air Transportation Services
				02TT	Ground Transportation Services
				03TT	Accommodation Services
				04TT	Food & Drink Services
				05TT	Entertainment Services
				06TT	Retail Services
				23SV	Sports & Performing Arts

Table B

NAICS Components	Brookings Code	Export Category Title
111; 112	11FR	Agriculture
113; 114	11FH	Forestry & Fishing
5416; 5611	14SV	Management & Consulting
5411	21SV	Legal Services
5412	16SV	Accounting & Auditing Services
5418	17SV	Advertising Services
4541	24SV	Trade-related Services
5419; 5612; 5613; 5614; 5616; 5617	26SV	Ancillary Services
5231; 5232	07SV	Investment Banking
5239	08SV	Financial Management
5222; 5223	09SV	Credit Issuance & Lending
5241	05SV	Insurance Carriers
5242	06SV	Auxiliary Insurance Activities
8111; 8112; 8113; 8114	01SV	Equipment Installation Services
5413	18SV	Architectural & Engineering Services
5414	20SV	Industrial Engineering Services
481; 482; 483; 484; 488	02SV	Freight & Port Services
5324	15SV	Operational Leasing Services
23	19SV	Construction Services
213	22SV	Mining Services
325	01RY	Chemical Manufacturing Royalties
311; 312; 313; 314; 315; 316; 321; 322; 323; 324; 326; 327; 331; 332; 333; 335; 336; 337; 339	02RY	Other Manufacturing Royalties
334	03RY	Computer & Electronic Royalties
423; 424; 425; 441; 442; 443; 444; 445; 446; 447; 448; 451; 452; 453; 454	04RY	Wholesale & Retail Royalties
511; 517; 519	05RY	Information Technology Royalties
522; 523; 524; 525; 531; 532; 533; 541; 551; 561; 562	06RY	Scientific & Technical Royalties
FR; FH; 212; 221; 236; 237; 238; 481; 482; 483; 484; 485; 486; 487; 488; 493; 611; 621; 622; 623; 624; 711; 712; 713; 721; 722; 811; 812; 81	07RY	Other Royalties
512; 515	08RY	Film & Music Industry Royalties
517; 5151; 5152	10SV	Telecom Services
5415	11SV	Computer Services
5112; 518; 519	12SV	Information Services
5417	13SV	R & D Services
622; 6211; 6214; 6215; 6219	03SV	Medical Services
611	04SV	Educational Services
6114; 6115; 6116	25SV	Training Services
481; 4881	01TT	Air Transportation Services
447; 482; 4882; 483; 4851; 4853; 4859; 487; 4883; 4884; 4852; 4853; 4855; 5321; 8111	02TT	Ground Transportation Services
721	03TT	Accommodation Services
722	04TT	Food & Drink Services
5121; 5615; 7113; 7114; 7115; 7121; 7131; 7132; 71	05TT	Entertainment Services
441; 442; 443; 444; 445; 446; 448; 451; 452; 453; 454; 8129	06TT	Retail Services
7111; 7112	23SV	Sports & Performing Arts