

Measuring Digital Intermediation Services: Experimental Estimates of Gross Output for Rideshare, Travel Services, and Food/Grocery Delivery Service Platforms

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Abstract The U.S. Bureau of Economic Analysis (BEA) produces economic statistics through its system of satellite accounts that highlight specialized areas of the economy that are not directly apparent in BEA's official economic statistics published under the North American Industry Classification System (NAICS), such as outdoor recreation and arts and culture. BEA recently developed a Digital Economy Satellite Account (DESA) to better understand this area of the economy as it involves production that spans multiple NAICS industries, ranging from computer manufacturing to internet-based retail trade (e-commerce) to software production. Currently, BEA's digital economy statistics do not fully capture production of digital intermediary services earned from operating a digital platform that facilitates the direct interaction between multiple buyers and multiple sellers for a fee (such as rideshare), resulting in an incomplete picture of the digital economy. In this paper, we discuss options for measuring digital intermediary services across selected industries of interest to other international statistical agencies as well as BEA: rideshare, travel services, and food/grocery delivery services. We also provide experimental estimates of gross output for these services that cover 2018–2021 using two approaches. We find that digital intermediation services for rideshare, travel services, and food/grocery delivery services represented at least \$31 billion in 2021 gross output, or close to 1 percent of the overall value of the digital economy based on the latest DESA statistics.

Keywords Digital Economy, Satellite Account, Digital Intermediation, Digital Platforms

JEL Code E01, O4

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1. Introduction

Digital intermediation services are services that earn revenue from operating a digital platform that facilitates the direct interaction between multiple buyers and multiple sellers for a fee, such as rideshare and food delivery services (Bureau of Economic Analysis 2020). Although the value of digital intermediation services is inherently included in official macroeconomic statistics produced by the U.S. Bureau of Economic Analysis (BEA), these services are spread across multiple industries making their comprehensive value and addition to economic growth unknown. A recent *System of National Accounts (SNA)* guidance note highlighted the importance of identifying where digital intermediation services occur along the supply chain to better understand this relatively new way of intermediating goods and services, including its contribution to value added and productivity statistics (SNA 2021).

BEA produces economic statistics that highlight specialized areas of the economy through its system of satellite accounts, such as the outdoor recreation, arts and culture, and digital economy satellite accounts. Satellite accounts allow for analysis of areas of the economy that are not readily apparent under the standard classification system used to categorize BEA's official economic statistics, the North American Industry Classification System (NAICS). Most BEA satellite accounts highlight areas where economic production spans multiple NAICS industries, including the digital economy satellite account (DESA), which comprises production ranging from computer manufacturing to internet-based retail trade (e-commerce) to software publishing. The current DESA statistics do not include a comprehensive measure of digital intermediation services, providing an incomplete picture of the overall digital economy (Highfill and Surfield 2022). In this paper, we discuss possible strategies for addressing this issue and provide experimental estimates of gross output for three types of digital intermediation services that are of immediate interest to BEA data users and have been the subject of research by other international statistical agencies: rideshare, travel services, and food/grocery delivery services (Wyman, et al. 2023). We use both a top-down approach that relies on government surveys and a bottom-up approach that relies on company financial reporting to develop these estimates. Under the most conservative approach, we find these digital intermediation services represented over \$31 billion in 2021 gross output, or close to 1 percent of the overall value of the digital economy in 2021 based on the latest DESA statistics.

The paper starts with a review of current research related to defining, identifying, and estimating non-financial digital intermediation services across industries, focusing on work done in North America under the NAICS (see Discussion for additional information on measuring financial digital intermediation services). Next, we describe the methodology and results separately for the top-down and bottom-up measurement approaches. We conclude with a comparison of the strengths and weaknesses of each approach, a discussion of other measurement issues, and comments on future research and possible next steps.

2. Background

Official industry classification systems like the NAICS and International Standard Industry Classification (ISIC) currently do not include separate categories for digital intermediation services, making economic measurement a challenge. The use of digital platforms and related digital intermediation services is expected to permeate many areas of the economy into the future, stressing the need to understand the contributions of these services to macroeconomic statistics like gross domestic product (GDP) and gross output (Organisation for Economic Co-operation and Development (OECD) 2020a). To that end, many statistical agencies have attempted to measure these services using a variety of strategies, including conducting or amending business surveys on the topic (Office for National Statistics (ONS) 2023; BEA 2020), focusing only on well-known services and companies, like rideshare and Uber, with readily available data (Highfill and Surfield 2022), and using machine learning and web-scraping to identify digital platforms online (de Boer, de Kruijf, and van Rossum 2021). Each strategy has significant weaknesses, many of which are discussed below, though all provide valuable lessons for improving measures in the future.

Identifying and accurately measuring digital intermediation services is also useful for understanding areas of the economy where digital transformation is occurring and impacting production. A recent paper by Aizcorbe and Chen (2022) showed the introduction of rideshare services in New York City likely introduced a nontrivial bias in official price indexes between 2015 and 2017 as ridesharing gained market share over the years. Another paper stated the drastic increase of self-employed taxi drivers in Census Nonemployer Statistics was attributable to rideshare, also noting new drivers were more likely to be female and not foreign-born (Sandusky 2018). And research by the United Kingdom's ONS on the "sharing economy" highlighted the need for digital intermediation services to make peer-to-peer transactions viable, such as homeshare (2017). A practical reason for identifying where digital intermediation services occur is related to accurately measuring digital trade activities and thus verifying companies conducting business within a country is included in its tax base (Statistics Canada 2022; IMF, et al. 2023).

2.1. Defining Digital Intermediation Services

Various definitions of digital intermediation services are currently used across statistical agencies and private industry reports (table 1). Notwithstanding some differences in wording, there is usually a common theme that digital intermediation services represent a transaction where (1) buyers and sellers are matched for a fee and (2) the product being transacted is not owned by the digital platform (i.e., website or app). Most definitions make explicit that a monetary transaction must occur between parties, thus excluding any value associated with "free" digital platforms like social media (OECD 2020a).

Table 1. Sample of definitions related to “digital intermediation services”

Statistical Report	Definition
BEA's 2019 Benchmark Survey of U.S. Direct Investment Abroad (p.8 2020)	“Digital intermediation services—Services that are earned from operating a digital intermediary platform, which is an online interface that facilitates, for a fee, the direct interaction between multiple buyers and multiple sellers. The platform does not take economic ownership of the goods nor does it provide the services that are being sold.”
RetailNet Group (p.5 2016)	<p>“Digital intermediaries often sit between the consumer and the retailer, brand or marketplace. Digital intermediaries have the following characteristics:</p> <ul style="list-style-type: none"> ▪ Operate a digital consumer engagement platform ▪ Leverage the platform to aggregate and direct demand ▪ Attract and sustain high viewership and audience reach ▪ Have the power to influence consumer’s purchase decisions.”
SNA Digitalisation Task Team (p.1 2021)	“[Digital intermediary platforms] are defined as business that operate online interfaces that facilitate, for a fee, the direct interaction between multiple buyers and multiple sellers, without the platform taking economic ownership of the goods or services that are being sold (intermediated).”
United Nations (p.4 2022)	“Fee-based digitally intermediated platform services are defined as online fee-based intermediation services enabling transactions between multiple buyers and multiple sellers, without the intermediation platform taking economic ownership of the goods or rendering services that are being sold (intermediated).”

2.2. Identification of Digital Intermediation Services Across Industries

This section provides notable examples of efforts by North American statistical agencies to identify and quantify digital intermediation services within NAICS industries. The first two subsections highlight work done in the U.S. and the last section discusses research by Statistics Canada.

2.2.1. BEA Survey of U.S. Multinational Enterprises

BEA’s 2019 Benchmark Survey of U.S. Direct Investment Abroad included a new section on “Digital Economy Activities” that asked from U.S. parents and their foreign affiliates the value of sales for cloud computing services and digital intermediation services (see table 1 for the definition used). To the extent that U.S. multinational firms are major players in this area, the survey results could represent a substantial portion of the overall U.S. totals. However, initial analysis of the survey results indicated that at least a few key companies either did not provide sales values for digital intermediation sales as expected or misinterpreted the question and incorrectly noted positive sales. For this reason, the unedited total sales value from the survey is not a viable option for comprehensively estimating digital intermediation services, though information on relevant industries can still be gleaned from the results.

Table 2 shows the list of NAICS sectors associated with U.S. parent companies that reported positive sales of digital intermediation services on BEA’s survey.² The industries are chosen by the company and reflect sectors where the company had any activity. Since this list covers most NAICS industry sectors, a main takeaway is that these services are provided by companies spread across much of the economy. The survey results also showed that many companies reporting positive digital intermediation services sales classified themselves within the information sector (NAICS 51).

Table 2. Industry sectors associated with companies that reported sales of digital intermediation services in the 2019 BE–10A survey

NAICS description	NAICS code
Utilities	22
Manufacturing	31–33
Wholesale trade	42
Retail trade	44–45
Transportation	48
Information	51
Finance and insurance	52
Real estate, rental, and leasing	53
Professional, scientific, and technical services	54
Management of companies and enterprises	55
Administrative and waste services	56
Health care and social assistance	61
Arts, entertainment, and recreation	71
Accommodation and food services	72
Other services	81

Notes: North American Industry Classification System (NAICS). BE–10A survey covers U.S. parent companies.

² U.S. parents are defined as a person, or entity, resident in the United States, that owns or controls 10 percent or more of the voting securities of an incorporated foreign business enterprise or an equivalent interest in an unincorporated foreign business enterprise. It comprises the domestic operations of a U.S. multinational company (BEA, 2018a).

2.2.2. U.S. Census Bureau

The U.S. Census Bureau (Census) has identified intermediation services, digital or not, within many NAICS industry sectors: 22 (utilities), 23 (construction), 44–45 (retail trade), 48–49 (transportation and warehousing), 51 (information), 52 (finance and insurance), 53 (rental, real estate, and leasing), 54 (professional, scientific, and business services), 56 (administrative services), 61 (educational services), 62 (health care services), and 81 (other services (except public administration)) (Census 2022). As with BEA's 2019 Benchmark Survey of U.S. Direct Investment Abroad, the implication is that intermediation services are produced by many industries. There is considerable overlap between the industries identified by both Census and BEA's survey, though these are still very broad categories to consider.

A complicating factor for identifying digital intermediation services across industries relates to how digital platforms classify themselves and their products. A report from the U.S. Census Bureau noted rideshare drivers are part of NAICS industry 4853 taxi and limousine services (Sandusky 2018), but both Uber and Lyft describe their companies as digital platforms that act as agents between drivers and riders (Uber 2021; Lyft 2021). Uber noted in its 2020 annual Securities and Exchange Commission (SEC) 10-K filing that, "We generate substantially all of our revenue from fees paid by Drivers and Merchants for use of our platform. We have concluded that we are an agent in these arrangements as we arrange for other parties the service to the end-user" (p. 57; Uber 2021). Likewise, Lyft stated in its SEC 10-K filing, "We do not control the transportation service being provided to the rider nor do we have inventory risk related to the transportation services. As a result, we act as an agent in facilitating the ability for a driver to provide a transportation service to a rider" (p.63; Lyft 2021). Given product and industry classifications are self-reported by companies in the U.S., it's possible some digital platforms are categorizing their intermediation services as a data or networking technology, likely within the information sector (NAICS 51). The SNA has recommended that digital intermediation services be classified within the industry of the product they are intermediating (UNSD 2017), making it necessary to also discern where these services are reported by digital platform companies in practice.

2.2.3. Statistics Canada

Statistics Canada has extensive experience measuring many aspects of the digital economy dating back to the 1990s (Mozes and Sciadas 1995). Statistics Canada’s digital supply and use tables show the impact of digitization across the Canadian economy by highlighting relevant production, such as digitally enabling infrastructure (for example, computers) and online retailers (Statistics Canada 2023). A recent paper by Wyman, et al. (2023) on measurement of digital trade in services includes a section related to digital platforms, categorizing these types of services into four distinct groups: accommodation, ride sharing, and food delivery (“margin-oriented platforms”); streaming and services delivery; data- and advertising-driven platforms; and other digital infrastructure platforms. The groups are described in terms of how revenue is accrued; for example, the accommodation, ride sharing, and food delivery group relies on margin-based fees while the streaming and services delivery group tends to rely on subscription fees. These groupings offer an approachable framework for thinking about classification of these services. As noted, we focus on the first group (accommodation, ride sharing, and food delivery) in this paper.

A recent presentation by Statistics Canada researchers highlighted challenges to identifying digital intermediation services within the country’s business register (Statistics Canada 2022). Table 3 shows the industries where researchers have determined digital intermediation services are occurring and, when applicable, the industries of the product being intermediated. For example, digital intermediation services within other travel arrangement and reservation services (NAICS 561590) are associated with products designated within NAICS industries 7113 (promoters of performing arts, sports, and similar events) and 721 (accommodation). To our knowledge, this research provides the finest level of NAICS detail available for identifying digital intermediation services, many at the most detailed six-digit industry level. There are significantly fewer industry sectors identified here compared to the BEA’s 2019 Benchmark Survey of U.S. Direct Investment Abroad and Census industries.

Table 3. Industries related to digital intermediation services as identified by Statistics Canada

Digital intermediation services industry		Product provider industry, when different from intermediary	
NAICS description	NAICS code	NAICS description	NAICS code
Taxi service	48531		
Local messengers and local delivery	49221		
Data processing, hosting, and related services	51821	Consumer goods rental; General rental centres	5322 532310
Data processing, hosting, and related services; Other financial transactions processing and clearing house activities	518210 52232	Retail trade	44–45
Web search portals and all other information services	51929		
Other financial transactions processing and clearing house activities	52232		
Passenger car rental	532111		
Truck, utility trailer and recreational vehicle (RV) rental and leasing	532120		
Employment placement agencies and executive search services	561310	Used household and office goods moving; Local messengers and local delivery; Janitorial services (except window cleaning); Landscaping services; All other services to buildings and dwellings; All other personal services	484210 492210 561722 561730 561799 812990
Other travel arrangement and reservation services	561590	Live theatres and other performing arts presenters with facilities; Sports stadiums and other presenters with facilities; Other traveler accommodation	711311 711319 72119

Notes: North American Industry Classification System (NAICS). Industry names taken from Statistics Canada's website.

2.3. Towards a Comprehensive Measure of Digital Intermediation Services

BEA's digital economy statistics are dominated by a few sectors, namely information (NAICS 51), wholesale trade (NAICS 42), and retail trade (NAICS 44–45) (Highfill and Surfield 2022). Given the existing research, it seems likely that BEA's digital economy statistics already include production of digital intermediation services within many industries, notably retail trade e-commerce (NAICS 44–45) and specific digital services found in sector NAICS 51. The retail trade e-commerce values in the DESA are derived from the Census Retail Trade Surveys which define e-commerce sales as, "sales of goods and services where the buyer places an order, or the price and terms of the sale are negotiated over an Internet, mobile device (M-commerce), extranet, Electronic Data Interchange (EDI) network, electronic mail, or other comparable online system" (Census 2023a). To the extent that online retailers also act as intermediaries, such as sellers using the Amazon and Etsy platforms to sell their products, the value of those digital intermediation services should already be captured in the e-commerce statistics. Likewise, the data processing, hosting, and related services industry (NAICS 518210) is fully accounted for in the DESA statistics, and this industry includes streaming services (Census 2023b). If BEA was to attempt to create a fully comprehensive estimate of digital intermediation services, the digital intermediation services that are already captured in the DESA estimates would also need to be identified and quantified.

While the research done by BEA, Census, and Statistics Canada offer a good starting point for identifying digital intermediation services across industries, a consistent and comprehensive measure will likely require an update to the NAICS. In the meantime, we focus on areas we believe are currently missing from the DESA estimates and that align with the fee-based platform category as described by Statistics Canada: rideshare, travel services, and food/grocery delivery services.

3. Top-down Approach to Estimating Digital Intermediation Services

3.1. Methodology

In this section, we describe one possibility for measuring digital intermediation services for rideshare and travel services using data on revenue from electronic sources from the U.S. Census Bureau's Services Annual Survey (SAS) (Census 2022a). The food/grocery delivery services industry is not currently published in the SAS, so we are unable to attempt the top-down approach for this type of digital intermediation services. Census defines revenues from electronic sources as,

“revenues from customers entering orders directly on a firm’s Web site or mobile application, revenues from customers entering orders directly on third party Web sites or mobile applications, and revenues from customers entering orders via any other electronic system (such as private networks, dedicated lines, kiosks, etc.).”

The Census Bureau is the primary source of data for BEA’s supply and use tables (SUTs) and digital economy statistics, making the SAS electronic revenue data an ideal candidate for estimating output for digital platforms given its compatibility.³ The idea is to start with the overall electronic revenue total for an industry and then adjust down, where needed, to isolate just digital intermediation services revenue, hence the term “top-down” approach.

3.1.1. Rideshare

In general, revenue from electronic sources can originate in various ways. For taxi services, revenue from electronic sources can be delineated into three distinct streams:

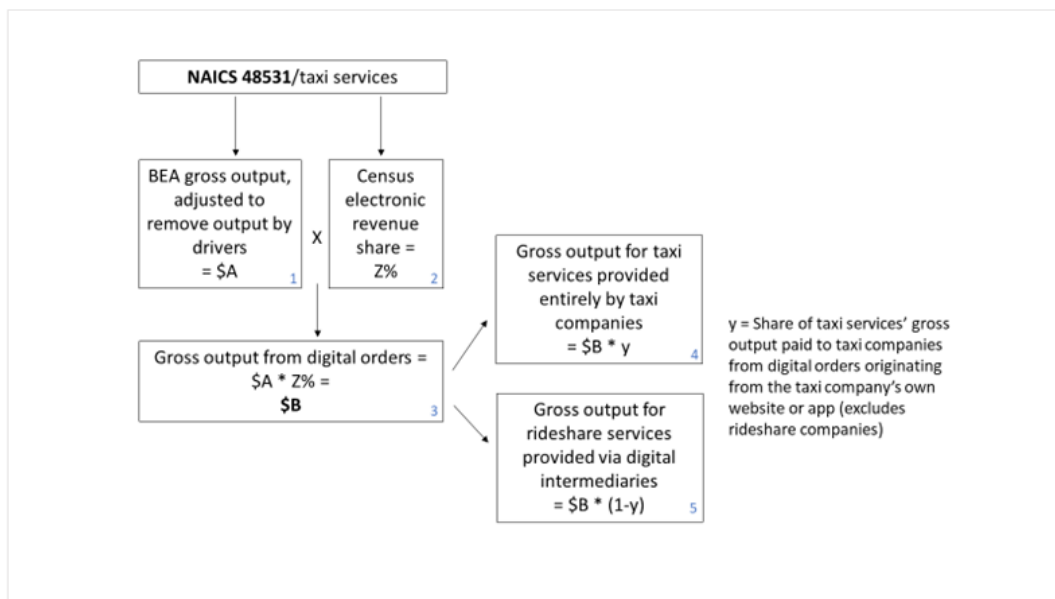
1. Revenue to a taxi company from a digital order originating from their website or app.
2. Revenue to a digital intermediary provider for facilitating a ride.
3. Revenue to a driver whose services are facilitated via a digital intermediary provider.

The third stream of revenue from electronic sources can be disregarded when using the Census SAS data because the survey sample only includes employer firms and rideshare drivers are considered nonemployers.

³ See Highfill and Surfield (2022) for details on BEA’s digital economy satellite account methodology.

Figure 1 shows the steps needed to measure gross output for rideshare digital intermediation services using the SAS electronic revenue data. The general idea is to start with overall gross output for the entire taxi services industry (NAICS 48531), remove the amount attributable to drivers (nonemployers), isolate the portion of that output attributable to electronic sources (i.e., digital orders), and then separate output from digital orders originating from a taxi company's website or app from output originating from a digital platform (i.e., the digital intermediation service).

Figure 1 . A top-down approach to estimating gross output for digital intermediation services for rideshare using U.S. Census Bureau data on revenue from electronic sources



In practice, data availability issues introduce complications in all stages of the calculation. The details of each step outlined in figure 1 are described below.

- Box 1: BEA's gross output⁴ value for taxi services (NAICS 48531) is adjusted to exclude output from nonemployers (i.e., taxi and rideshare drivers). This is done because the SAS electronic revenue data only cover employer firms, so this adjustment makes the populations equivalent. Additionally, we are only interested in measuring the revenue earned by the digital platform, not the drivers, so the nonemployer value is not needed.
 - Census data provide two options for adjusting gross output to remove nonemployers. The SAS data provide revenue separately for employers and nonemployers annually, but the data are only available at an aggregated level for all transit and ground passenger transportation (NAICS 485). This aggregated industry includes various other services including school bus transportation and urban transit systems. The other option is to use revenue data from the Nonemployer Statistics (NES) and Statistics of U.S. Businesses (SUSB) which contain more industry detail, specifically, taxi and limousine service (NAICS 4853) (Census 2021a; Census 2021b). However, the SUSB data are only available every 5 years, with 2017 being the most current year available. The 2017 SUSB and NES data show that the share of revenue for taxi and limousine services generated by employer firms was 45 percent in 2017. The SAS data show the share of revenue attributable to employer firms did not change substantially between 2017 and 2021. Because the SUSB and NES data are more detailed and there is reason to believe revenue shares between employers and nonemployers did not change substantially over the period, we chose to use the 2017 SUSB and NES data to adjust gross output.
- Box 2: Census Bureau's SAS data are used to estimate the share of taxi services revenue that comes from electronic sources.
 - Since the SAS data are only available for total transit and ground passenger transportation (NAICS 485), we must assume the electronic revenue shares for taxi services are the same as other services in this industry, such as bus transportation.
 - The values for revenue from electronic sources are currently suppressed for all available years in the SAS data. However, values at the aggregated transportation and warehousing level (NAICS 48) are available. We interpolate the suppressed data by first subtracting the unsuppressed industry values from the overall industry total which gives us the total suppressed value. The suppressed value is allocated to the suppressed cells

⁴ Gross output is principally a measure of sales or revenue from production for most industries (BEA, 2018b).

based on their relative share of total revenue. Our estimates find that the share of revenue attributable to electronic sources averaged 49 percent over the 2017–2021 period, ranging from 45–56 percent.

- Box 3: The share of taxi services revenue attributable to electronic sources ($Z\%$ in box 2) is applied to BEA’s adjusted gross output for taxi services ($\$A$ in box 1) to find total gross output for taxi services originating from digital orders, labelled as $\$B$.
- Box 4: Gross output from digital orders is estimated for taxi services originating from a taxi company’s own website or app (excluding rideshare companies).
 - Information on the amount of taxi services that are ordered via a taxi company’s website or app is not readily available. We assume most traditional taxis are hailed in person or ordered via the phone, so we attribute only 5 percent of digital orders to this category (labelled as y).
- Box 5: Gross output from digital orders is estimated for taxi services originating from a digital intermediary platform. Since we assumed 5 percent of digital orders for taxi services are attributable to a taxi company’s website or app, the remaining 95 percent are assumed to be digital orders that originate from a digital platform.

3.1.2. Travel Services

The method for estimating digital intermediation services for travel services is more straightforward than for rideshare since the travel agencies industry is already recognized as playing the role of intermediary. Census defines the travel agencies industry (NAICS 56151) as “establishments primarily engaged in acting as agents in selling travel, tour, and accommodation services to the general public and commercial clients” (2023b). Since travel agencies coordinate the purchase of tickets or reservations across multiple buyers and sellers but do not own the service being provided, their services inherently align with the two defining characteristics of intermediation services. If we consider all electronic revenue earned in this industry to be a digital intermediation service, then only the calculations in boxes 1–3 need to be performed to estimate gross output since digital orders do not need to be delineated like with rideshare (boxes 4 and 5). Since the Census data are only published at an aggregated NAICS industry 5615 (travel arrangement and reservation services) level, as with rideshare, we must also assume that digital orders for travel services is similar to the other services in this industry, which includes tour operators and convention and tourism bureaus. The SAS data show that the share of revenue attributable to electronic sources for industry 5615 averaged 46 percent over the 2017–2021 period, ranging from 42 to 52 percent.

Statistics Canada identified NAICS industry 56159 (other travel arrangement and reservation services) as the relevant industry to find production of digital intermediation services for travel services, not travel agencies (NAICS 56151). When we compared total gross output values for both industries between 2017 and 2021, we found that travel agencies experienced growth over the period that corresponded with expected growth in digital intermediation services, whereas growth was mostly flat in the other travel arrangement and reservation services industry. More importantly, the total value of gross output for the other travel arrangement and reservation services industry was too small to realistically include the value of digital intermediation services as well as all other reservation services, which is why we used industry 56151 in our calculations.

3.2. Estimates of Gross Output for Digital Intermediation Services Using the Top-Down Approach

Using Census SAS data on revenue from electronic sources, we estimate digital intermediation services for rideshare and travel services contributed \$27.1 billion to gross output in 2021 (table 4). This top-down method found rideshare digital intermediation services generated \$4.6 billion of gross output in 2021, down from \$6.3 billion in 2017. Gross output for travel services digital intermediation services was \$22.5 billion in 2021, up from \$15.7 billion in 2017. While the data show both rideshare and travel services digital intermediation services experienced a contraction in 2020 gross output by almost half, travel services recovered entirely in 2021, growing 124 percent, whereas rideshare only grew by 22 percent. Growth in rideshare digital intermediation services was relatively slower even before the COVID-19 pandemic, growing only 2 percent in 2019 versus 11 percent for travel services.

Table 4. Estimated digital intermediation services gross output for rideshare and travel services using top-down approach (dollars in millions)

	2017	2018	2019	2020	2021
Rideshare	\$6,333	\$6,942	\$7,089	\$3,777	\$4,605
<i>change</i>		10%	2%	-47%	22%
Travel services	\$15,685	\$16,498	\$18,378	\$10,044	\$22,451
<i>change</i>		5%	11%	-45%	124%
Total	\$22,018	\$23,440	\$25,467	\$13,821	\$27,056
<i>change</i>		6%	9%	-46%	96%

4. Bottom-up Approach to Estimating Digital Intermediation Services

In contrast to the top-down approach, the bottom-up approach estimates revenue at specific companies and then aggregates to the industry-level.

4.1. Methodology

Given this approach's focus on specific companies, the first step is to identify a list of companies in each industry. One feature that simplifies this step is that in many consumer settings, activity tends to be concentrated in a small number of digital intermediary platforms (Lamoreaux 2019). To find the list for each sector, we conduct general research drawing on sources such as SEC annual 10-K filings (which list competitors), web resources (for example, Wikipedia), and publicly available market reports.

With the list of companies selected, we then collect financial sources. For companies listed on U.S. stock exchanges, we can use their annual 10-K filings and their S/1, which details financial information prior to their IPO. For other countries, we can sometimes rely on annual financial reports. For companies with no such available information, we can sometimes use public market reports that report the relative sizes of the missing companies.

Financial reports often helpfully classify revenue as the final payment to the platform, net of payments to the service providers. It is common, however, that they do not report it at the U.S.-industry level, especially when there are multiple lines of business in multiple countries. In these cases, we estimate the company statistic from a combination of reported data, as shown in the industry calculation tables below.

4.2. Estimates

We next present estimates for our three digital intermediation services: rideshare, travel services, and food/grocery delivery services.

4.2.1. Rideshare

For rideshare, our research found two main U.S.-based companies: Lyft and Uber. Both companies have public SEC filings with information on revenue and neither indicate rival rideshare companies in the U.S. For Uber, we use their "Mobility" revenue since the company also provides other services, such as food/grocery delivery. However, "Mobility" revenue is only available for Uber's worldwide sales. U.S. revenue shares are shown for Uber's overall revenue total, so we apply that share to estimate the U.S. portion of the "Mobility" revenue. Our estimates using this bottom-up method show that rideshare digital intermediation services was \$5.1 billion in 2017, peaked at \$10.6 billion in 2019, and ended at \$7.2 billion in 2021 (table 5).

Table 5. Estimated digital intermediation services revenue for rideshare using bottom-up approach (dollars in millions)

Company	Element	2017	2018	2019	2020	2021
Lyft	U.S. revenue	\$1,060	\$2,157	\$3,616	\$2,365	\$3,208
Uber	“Mobility” revenue	\$7,278	\$9,288	\$10,707	\$6,089	\$6,953
	U.S. share	55%	60%	65%	59%	58%
	U.S. mobility estimate	\$4,007	\$5,543	\$6,972	\$3,614	\$4,021
Total		\$5,067	\$7,699	\$10,588	\$5,979	\$7,229
	change		52%	38%	-44%	21%

4.2.2. Travel Services

To determine the main companies for travel services we utilized a market research list (Grand View Research 2023). Estimates were produced for the following companies:

- Booking Holdings (Kayak, Booking.com): Data were collected from the company’s annual 10–K filings (Bookings Holdings, Inc. 2019; 2021). These explicitly list their U.S. revenue, which is defined as net of payments to travel services providers.
- Expedia Group (VRBO, Expedia.com, Travelocity): Data were collected from the company’s annual 10–K filings (Expedia Group Inc. 2019; 2020; 2021). Global revenue for the company is broken out by business model and we include the Merchant and Agency models and exclude the Advertising model. For 2017, the advertising share of VRBO is not excluded and so we adjust this using the advertising share of VRBO for 2018 (determined by reconciling the 2019 and 2020 reports). We then adjust the non-advertising global revenue by the U.S. share of total global revenue.
- Airbnb: Data were collected from the company’s initial prospectus statement and its annual 10–K filing (Airbnb 2020; 2021). We start with revenue for North America (U.S. and Canada). For 2019–2021, this was explicitly listed. For 2017–2018, we estimate this from global revenue for those years and the 2019 North American share of total revenue for 2019 (the earliest year where this share is available). To estimate the U.S.-specific amount, we multiply the North American revenue by the share of North America’s gross output attributable to the U.S. for the broader 561 sector (BEA 2023; Statistics Canada 2023b) using contemporaneous exchange rates (Internal Revenue Service 2022). This data is only available through 2019, so later years use the 2019 value.

- TripAdvisor: Data were collected from the company’s annual 10–K filings (Tripadvisor, Inc. 2019; 2021). These list their U.S. revenue. Much of the revenue is advertisement based, so we only focus on the Experiences and Dining segment, which explicitly is fee-based intermediation. We adjust U.S. revenue by the ratio of Experience and Dining revenue to total revenue. This ratio is unreported in 2017, so we use the 2018 value.

We show revenue estimates in table 6.

Table 6. Estimated digital intermediation services revenue for travel services using bottom-up approach (dollars in millions)

Company	Element	2017	2018	2019	2020	2021
Booking Holdings	U.S. Revenue	\$1,620	\$1,536	\$1,537	\$783	\$1,434
Expedia Group	Revenue (Non-advertising)	\$8,987	\$9,826	\$10,645	\$4,528	\$7,844
	Estimated missing VRBO	\$236				
	U.S. Share across all segments	0.551	0.553	0.569	0.675	0.764
	Company Estimate	\$4,821	\$5,430	\$6,060	\$3,058	\$5,993
Airbnb	North America Revenue	\$1,050	\$1,497	\$1,970	\$1,773	\$3,201
	U.S. Share of (U.S.+Canada) Gross output for 561	0.940	0.940	0.943	0.943	0.943
	Company Estimate	\$988	\$1,407	\$1,857	\$1,671	\$3,018
TripAdvisor	U.S. Revenue	\$802	\$835	\$821	\$302	\$526
	E&D ratio	0.23	0.23	0.29	0.31	0.34
	Company Estimate	\$185	\$192	\$240	\$93	\$179
Total		\$7,613	\$8,566	\$9,694	\$5,605	\$10,624
	<i>change</i>		13%	13%	-42%	90%

One gap in the bottom-up approach is that our process for identifying travel companies mainly resulted in companies serving the household market. While our sample includes Expedia, which does have an enterprise division, that division’s contribution is small as it accounted for only 17 percent of Expedia’s revenue in 2021. Business travelers are undoubtedly using digital intermediary platforms, possibly a larger number of smaller companies. It is difficult to estimate the missing amount as digital intermediary platforms are not used for all travel services, but business travel is estimated to make up 26 percent of total travel spending (Fortunly 2023) and 60 percent of airline spending (Industry Tap 2022). Our levels may then be off by 35 percent to 150 percent, though the effect on growth rates is unknown.

4.2.3. Food/Grocery Delivery

To determine the main companies for food/grocery delivery and to estimate the amount that may be missing from our analysis (such as Instacart) we use a market report (McKinsey 2021) with data through April 2021. Data prior to 2018 is poor (Postmates, Uber, and DoorDash were private and issued no annual reports).

We collect data on the following companies:

- Uber: We collect data from the company's annual 10-K filings (Uber Technologies, Inc. 2020; 2021). These include revenue data from UberEats as well as Postmates, which was acquired in 2020. From these reports, we collect the delivery segment revenue. To estimate North American delivery revenue, we adjust by the North American share of total revenue. To estimate U.S. delivery revenue, we then adjust by the share of U.S. production in North America for the greater industry, "other transportation and support services," published as 487OS⁵ (BEA 2023; Statistics Canada 2023b). The data for this latter adjustment is only available until 2019 and so later years use the 2019 value.
- DoorDash: We collect data from the company's annual 10-K filings (Doordash, Inc. 2020; 2021). These include revenue data from the DoorDash brand as well as Caviar, which was acquired from Square in 2019. While Doordash does have international operations, their revenue is small and the reports do not break out revenue by geography. We therefore attribute all revenue to the U.S.
- GrubHub: We collect data from GrubHub's annual 10-K filing (Grubhub Inc. 2020) and Just Eat Takeaway.com's annual report (Just Eat Takeaway.com 2021), as they acquired Grubhub in 2021. For 2021, Just Eat Takeaway.com reports the North American revenue in Euros. We adjust this by the contemporaneous exchange rate and then by the share of U.S. production in North American for the broader 487OS industry.

⁵ This combines NAICS 487, 488, and 492.

Revenue estimates are shown in table 7.

Table 7. Estimated digital intermediation services revenue for food/grocery delivery using bottom-up approach (currency in millions)

Company	Element	2018	2019	2020	2021
Uber	Delivery Revenue	\$772	\$1,401	\$3,904	\$8,362
	U.S. + Canada Total Revenue share	0.597	0.651	0.594	0.578
	U.S. share of (U.S.+Canada) gross output for 4870S	0.956	0.956	0.956	0.956
	Company Estimate	\$441	\$872	\$2,216	\$4,624
DoorDash	Revenue	\$291	\$885	\$2,886	\$4,888
	Estimated share from U.S. (author est.)	100%	100%	100%	100%
	Company Estimate	\$291	\$885	\$2,886	\$4,888
GrubHub	U.S. + Canada Revenue (euros)				€2,470
	U.S. + Canada Revenue (dollars)				\$2,920
	U.S. share of (U.S.+Canada) gross output for 4870S				0.956
	Company Estimate	\$1,007	\$1,312	\$1,820	\$2,792
Other companies	Share of market	13%	9%	6%	4%
Total		\$1,989	\$3,388	\$7,851	\$12,844
	<i>change</i>		70%	132%	64%

4.2.4. Total Digital Intermediation Services

We present totals for the bottom-up approach in table 8. For 2018, the first year where we have estimates for all three industries, the total is \$19.0 billion and it grows to \$31.0 billion in 2021. There was only a slight decline during 2020 of 19 percent as even though both rideshare and travel services contracted by over 40 percent, food/grocery delivery expanded by 132 percent.

Table 8. Estimated digital intermediation services revenue using bottom-up approach (dollars in millions)

	2017	2018	2019	2020	2021
Rideshare	\$5,067	\$7,699	\$10,588	\$5,979	\$7,229
<i>change</i>		52%	38%	-44%	21%
Travel services	\$7,613	\$8,566	\$9,694	\$5,605	\$10,624
<i>change</i>		13%	13%	-42%	90%
Food/grocery delivery	NA	\$1,989	\$3,388	\$7,851	\$12,844
<i>change</i>			70%	132%	64%
Total	NA	\$18,896	\$24,251	\$19,644	\$31,044
<i>change</i>			28%	-19%	58%

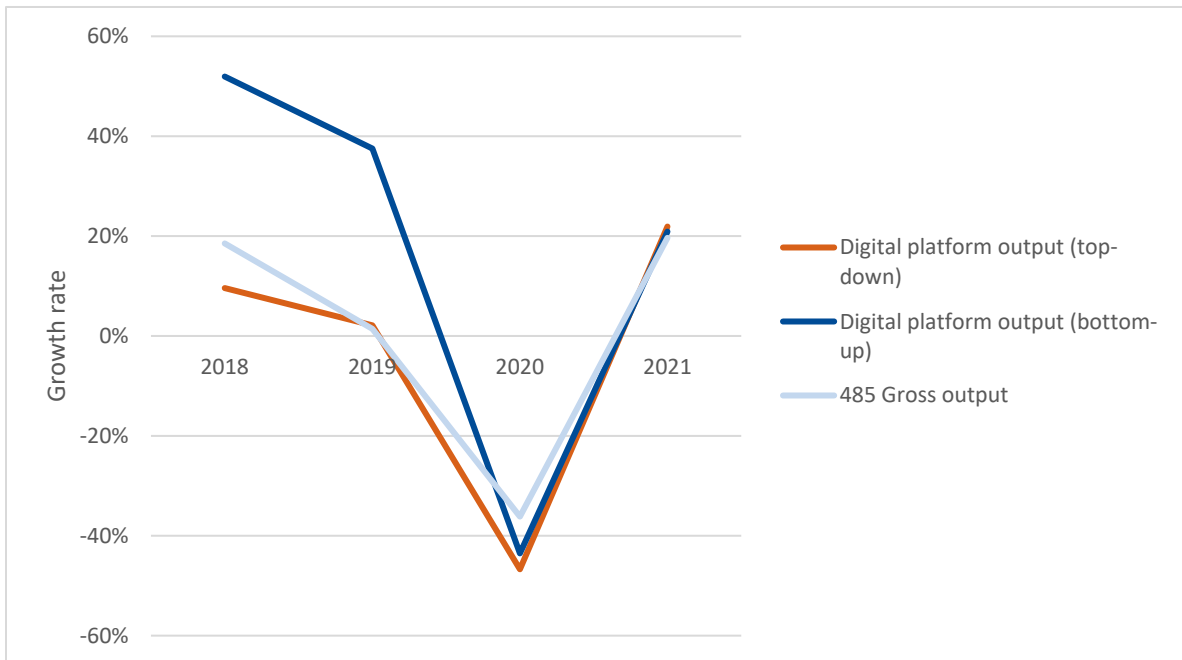
5. Discussion

5.1. Comparison of the Two Approaches

In this section, we compare the overall estimates of digital intermediation services' gross output for each approach and type of service (tables 4 and 8). While we expect that the absolute levels may differ between the approaches given some of the necessary assumptions made, a good check of their performance is if their growth rates are similar, so we also compare those values.

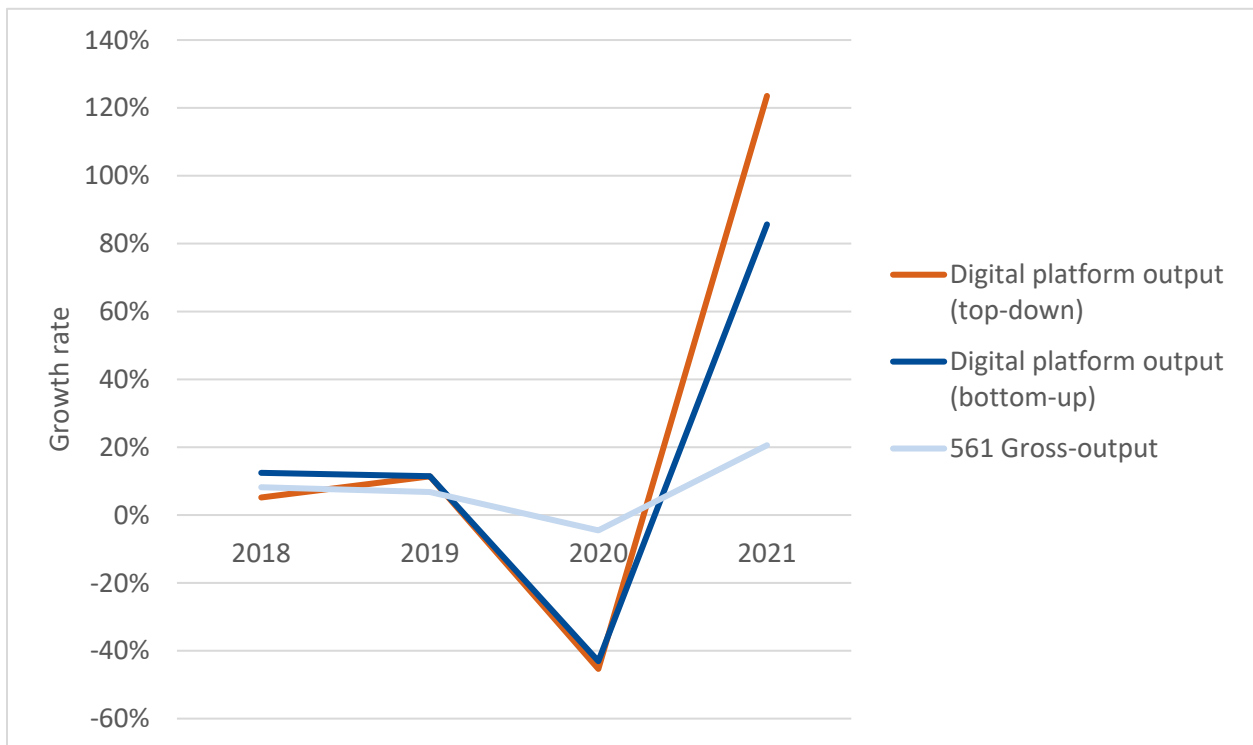
We first compare the statistics for the rideshare industry. Overall, the gross output levels for the bottom-up approach are about 25 percent higher for the years studied. We graph the yearly growth rates alongside the growth rate from the broader transit and ground passenger transportation industry (NAICS 485) in figure 2. All three growth rates are correlated, though the bottom-up approach is much higher for 2018–2019.

Figure 2. Rideshare (NAICS 48531) growth rate estimates



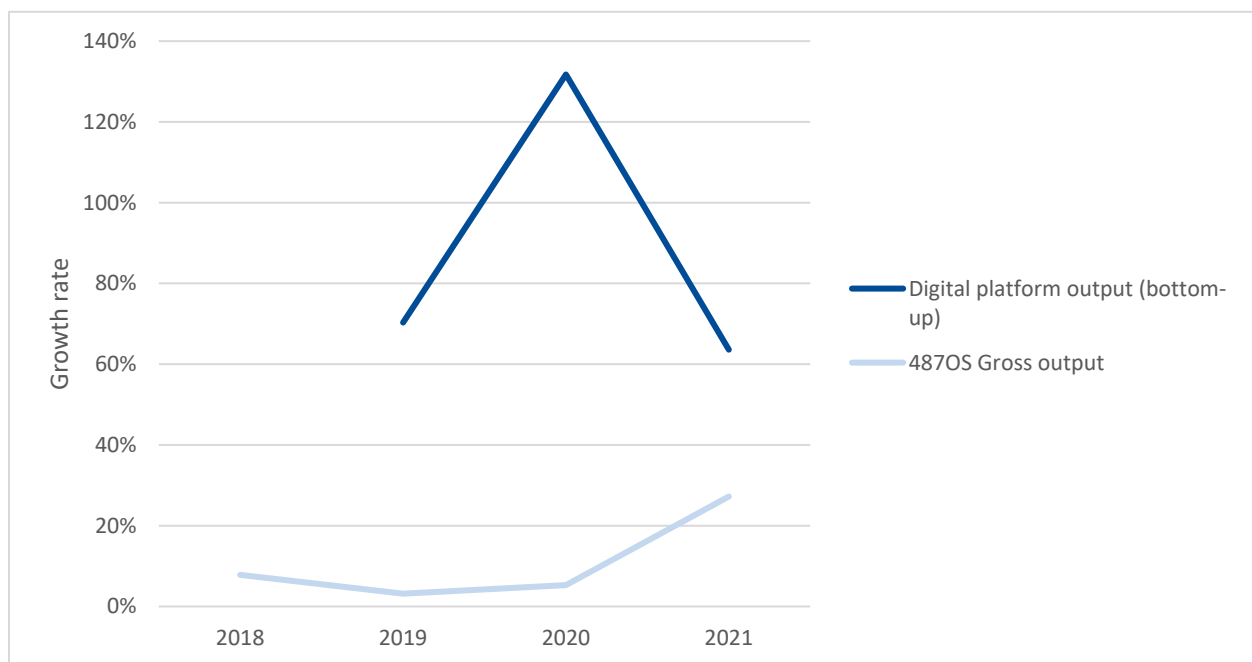
For travel services, the average level for the top-down approach is about 87 percent higher than the bottom-up approach, likely due to the bottom-up approach excluding output for business travelers. In figure 3 we combine the growth rates for travel services digital intermediary services gross output alongside the growth rate for the gross output of the broader administrative and support services industry (NAICS 561). We see that the growth rates for both approaches are quite well correlated and more extreme than for the broader sector.

Figure 3. Travel services (NAICS 56151) growth rate estimates



For food/grocery delivery, there is no top-down approach due to a lack of source data. In figure 4 we combine the growth rates for the bottom-up approach alongside the growth rate for the gross output of the broader NAICS 4870S industry, “other transportation and support services.” While in the previous cases the broader industry was similar to the industry studied, in this case they are likely quite different as 4870S also includes NAICS 487 and 488, scenic and sightseeing transportation and support activities for transportation. We include the broader industry in the graph for consistency, but note that there is no expectation of similar growth rates. Indeed, we see that the growth rate in digital intermediary services is much higher than for the broader industry.

Figure 4. Food/grocery delivery (NAICS 492) growth rate estimates



In practice, the top-down approach using published Census revenue data from electronic sources has weaknesses that prevent it from being the sole data source for estimating digital intermediation services output for rideshare platforms, though it could be useful to inform or validate estimates. The main issue is the level of detail provided in the public estimates—for all years, data on electronic revenue are suppressed for the transit and ground passenger transportation industry (NAICS 485). While it is possible to interpolate the values for the transit and ground passenger transportation industry, that still only leaves us with information on an industry that includes a variety of passenger transportation activities, including urban transit systems and chartered bus, in addition to taxi services. If it were possible for BEA to access the unsuppressed, detailed data on electronic revenue for taxi services, the survey only covers years 2017–2021 and a different methodology would need to be devised to estimate historical values. Even if the

weaknesses of the Census data could be overcome, an estimate must still be made to identify the portion of taxi services' gross output paid to taxi companies from digital orders originating from the taxi company's own website or app. Despite the weaknesses with this method, the results are in the ballpark of those found using the alternative bottom-up approach, including very similar growth rates for many years. This finding also provides support for the industries used to estimate rideshare digital intermediation services (NAICS 48531) and travel services digital intermediation services (NAICS 56159).

The bottom-up approach has its own strengths and weaknesses. It is likely weakest for travel services, as our method did not capture business travel. Further research could be done to specifically identify and collect information on this customer segment, though this information may be harder to acquire as they are business suppliers and many may be private businesses. One benefit of the bottom-up approach in this sector is we can delineate digital intermediary platforms that connect consumers to traditional businesses (e.g., TripAdvisor and Expedia for flights) from newer companies that are more peer-to-peer based (e.g., Airbnb for homesharing). Additionally, it is an approach that is more flexible. If holes in the existing data are identified, it is potentially easier to acquire new financial data. Finally, this approach of relying on identifiable companies mirrors the method used by Statistics Canada to measure digital intermediation services.

5.2. Other Measurement Issues

Classification of digital intermediation services: This paper focused on measuring gross output attributable to digital intermediation services, but to understand their contribution to other economic statistics like productivity a distinction must be made as to how the flow of these services is treated between service providers, consumers, and the digital platform. An OECD report presents four options for how the revenue from a rideshare trip should be accounted for between all actors (2018). The key is whether we consider the rider as purchasing the trip directly from the driver who then pays the platform a fee or whether we consider the trip as being purchased by the platform and then sold to the rider. For the first option, there was also discussion of whether the fee paid to the platform, the digital intermediation service, should be considered as coming from both the rider and the driver. Ultimately, the OECD recommended that the flow of revenue be treated as starting with the rider, then to the driver, then to the platform such that there is no direct interaction between the rider and platform. The implication of this recommendation is that digital intermediation services are considered intermediate inputs as opposed to a final demand service.⁶ This treatment also aligns with how the financial statements are structured for the digital platforms discussed in this paper.

⁶ Intermediate input commodities are goods and services used up in the production of other products. Final demand products are goods and services purchased or consumed for "final use" and comprise GDP. Final use consists of personal consumption expenditures, gross private fixed investment, change in private inventories, exports of goods and services, imports of goods and services, and government consumption expenditures and gross investment.

Financial digital intermediation: In the OECD's nomenclature for measuring the digital economy, financial digital intermediation services are included in the category "financial services predominately operating digitally" and are inherently separate from all other digital intermediation services (OECD 2020b). Crowd-funding platforms that connect fundraisers and donors for a fee, such as GoFundMe and Kickstarter, are an example of a relatively new type of financial digital intermediation service. Yet, many financial services do not meet the two criteria of digital intermediation services: a transaction where (1) buyers and sellers are matched for a fee and (2) the product being transacted is not owned by the digital platform. For payment service companies like PayPal and Venmo that connect two separate parties, it's unlikely that the buyer found a product and was matched to a seller using PayPal or Venmo, so the companies did not actually facilitate the transaction. Likewise, banks take ownership of deposited funds and therefore they are not considered intermediaries.

The NAICS explicitly includes the following financial intermediation industries:

- 522 credit intermediation and related activities
- 5231 securities and commodity contracts intermediation and brokerage
- 52391 miscellaneous intermediation

The Census SAS data provide estimates of revenue from electronic sources for NAICS 5223, activities related to credit intermediation, and NAICS 5231, securities and commodity contracts intermediation and brokerage, so measuring digital intermediation services output for these industries is notionally feasible using the top-down approach. In 2021, Census SAS data show over 30 percent of revenue for NAICS 5223 came from electronic sources, up from 17 percent in 2017. Given the complexities related to measuring financial services in general, the focus for BEA at this stage is measurement of non-financial digital intermediation services, aligning with the OECD framework.

Potential legal changes: Another potential measurement issue relates to whether rideshare drivers are classified as independent contractors or employees of the rideshare platform. A 2021 legal ruling in California stated that rideshare drivers are not employees of the digital platforms, aligning with the methodology used in this paper (National Public Radio 2023). Were the ruling to proclaim rideshare drivers as employees, this would have changed the concept of rideshare digital platforms from intermediaries to owners, essentially reclassifying the service from a digital intermediation service to a transportation service.

5.3. Next Steps

This paper focused on quantifying key non-financial digital intermediation services that are currently excluded from BEA's DESA statistics. Two methods were used to estimate gross output for these services and despite the similarity of the results, both methods have weaknesses that present measurement challenges. Census data are the ideal data source, in theory, because they come from government collections that should be nationally-representative, comprehensive, and consistent. The Census SAS data on revenue from electronic sources also cover many service industries aside from what is discussed in this paper, opening up the possibility of using the data to measure other types of digital intermediation services. However, the public Census SAS data are aggregated and sometimes suppressed for key industries. Despite this, the Census-based estimates for rideshare and travel services were often in the ballpark the bottom-up method of using financial reports, especially with regard to growth rates for many years, providing some support for the usefulness of the Census data for this type of estimation. A best-case scenario may be for BEA to obtain detailed and unsuppressed SAS data from Census. BEA will consider whether to incorporate some version of these estimates into the DESA statistics to get closer to a comprehensive estimate of the total digital economy, even if the full value is understated and notwithstanding some of the measurement issues. A recent paper showed transportation and delivery services make up most of the gig economy in terms of number of workers (Garin, et al. 2023), so having only these major players may be a reasonable approach for BEA to consider in the short run.

Another next step relates to whether BEA attempts to quantify other digital intermediation services excluded from the DESA statistics. An obvious place to continue work is to look at areas where there is agreement on which industries are involved and where suitable source data exists (including Census SAS data) using research done by Statistics Canada or further exploration of results from BEA's survey of multinational enterprises. Also, if BEA ever seeks to create a fully comprehensive estimate of digital intermediation services, we will need to carve out the digital intermediation services that are already captured in the DESA's e-commerce and priced digital services estimates (as explained in Section 2.3).

There remains no clear way for BEA to determine a comprehensive and consistent measure of digital intermediation services across industries aside from future updates to the official classification systems such as NAICS. However, using a combination of data sources, including government surveys and public financial reports, it may be possible to estimate a reasonable portion of digital intermediation services, giving some sense of the magnitude of these services' contribution to economic output. Identification of new or growing digital intermediation services will continue to be a challenge moving forward, though if these services tend to be small in their inception, then focusing only on the larger players may represent a reasonable estimate of the total value of digital intermediation services.

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