Existing Data Sources That Can Be Used in Conjunction With the Vehicle Inventory and Use Survey (VIUS)

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Title
Existing Data Sources That Can Be Used in Conjunction With the Vehicle Inventory and Use Survey (VIUS)

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Abstract
The 2021 Vehicle Inventory and Use Survey (VIUS) provides the most comprehensive data on the physical and operational characteristics of the trucks being driven on U.S. roadways. The dataset is a rich resource that can be used to inform decisions regarding investments in transportation infrastructure, vehicle technologies and parts, safety, energy consumption, and more. This report summarizes exploratory research on where and how the value of VIUS could be strengthened through being used in conjunction with other national data sources. The research investigates which data sources are viable candidates for strengthening VIUS, what each dataset's suitability is for being used in conjunction with VIUS, and what research questions could be answered with the tandem data that result from such effort.

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Introduction

The Bureau of Transportation Statistics (BTS), within the U.S. Department of Transportation (DOT), is an objective supplier of statistically sound baseline, contextual, and trend information used to shape transportation policy and investment decisions across the United States. BTS is responsible for providing timely, accurate, and reliable information on U.S. passenger and freight transportation systems and their impacts on the economy, society, and the environment.

As part of its transportation statistics and analysis programs and activities, BTS conducts the Vehicle Inventory and Use Survey (VIUS) as a joint effort with the U.S. Census Bureau. VIUS collects data on the physical and operational characteristics of the truck population in the United States. The latest iteration of VIUS was conducted in 2021[1] and surveyed owners of vehicles with gross vehicle weight rating (GVWR) classes 1–8 that were classified by manufacturers as pickup trucks, straight trucks, truck tractors, minivans, light vans, or sport utility vehicles (SUVs).[2] For the 2021 VIUS, a total of 150,000 vehicles were sampled, and almost 68,000 completed surveys were returned. Prior to 2021, the last VIUS was conducted in 2002. Additional details regarding the VIUS program can be found at https://www.bts.gov/vius [BTS 2024a].

The 2021 VIUS provides the most comprehensive data on the physical and operational characteristics of the trucks being driven on U.S. roadways. The dataset is a rich resource that can be used to inform decisions regarding investments in transportation infrastructure, vehicle technologies and parts, safety, energy consumption, and more. With a wealth of information on the registered truck fleet in the U.S., VIUS can provide a bridge to many other national data sources, thereby enhancing the value of information provided by the data.

The purpose of this report is to summarize exploratory research on one aspect of potential VIUS usage: where and how other national data sources might be leveraged to strengthen the value of VIUS data. Three specific questions were considered and are addressed in the following chapters:

- Chapter 1—Which data sources are considered, in this research, as viable candidates for strengthening VIUS through linking?
- Chapter 2—What is each dataset's suitability for linking to VIUS?
- Chapter 3—What research questions could be answered with such enhanced (linked) VIUS data?

It should be noted that matching data at a VIUS record level (i.e., vehicle to vehicle) is not possible within the scope of this report. Therefore, throughout this report variations of the word "link" (e.g., linking, linkage) have been used to refer to "being used in conjunction with" (e.g., mapping data at an aggregate level). For instance, "linking a particular dataset to VIUS" in this report means "the dataset being used in conjunction with the VIUS data" (and not linking the dataset to VIUS at the VIUS record-level).

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[1] The 2021 VIUS was a joint product by BTS and U.S. Census Bureau with financial support from U.S. DOT's Federal Highway Administration and the U.S. Department of Energy.

[2] Refer to https://www.census.gov/programs-surveys/vius/technical-documentation/methodology.html for more details about the GVWR classification scheme used in the 2021 VIUS.

The research process included identifying potential data sources, assessing the publicly available methodology and documentation for suitability, and exploring the possibilities and limitations of using the identified data sources in conjunction with VIUS data. Through this process, the following national data sources were identified and assessed:

- Federal Highway Administration's (FHWA's) Highway Statistics Series (HSS)
- BTS' freight data from the Freight Analysis Framework (FAF) and Commodity Flow Survey (CFS)
- FHWA's National Household Travel Survey (NHTS)
- National Highway Traffic Safety Administration's (NHTSA's) Fatality Analysis Reporting System (FARS)

The results suggest the following:

- The notion of strengthening VIUS through linking it to other national datasets (i.e., using the datasets in conjunction with the VIUS data such as mapping the data at an aggregate level) is a general possibility. This research identified several viable applications that have the potential to increase the value of VIUS by both linking other data to VIUS and linking VIUS data to other datasets.
  This potential is somewhat limited due to the vehicle model year and body type variables being the only publicly available fields for linkage between the datasets. In most cases, the resulting applications would be stronger if the vehicle make and model variables were available in the VIUS Public Use File (PUF). Note that a Title 13 (T13) dataset of the 2021 VIUS data is available for researchers to request through the Federal Statistical Research Data Center. For more information, researchers should visit https://www.census.gov/about/adrm/fsrdc.html.
- Due to respondent and reporting burden, BTS requesting data elements be added to the other data sources is unlikely. BTS might consider partnering by allowing a few carefully selected and highly relevant questions that are important to stakeholders to be added to VIUS.
- VIUS has a 5-year data-collection cycle, which makes it challenging to link, on a temporal basis, with other sources being released more regularly. However, possibilities exist within the temporal differences when cycles do eventually line up. In addition, complementary data sources could be used to statistically impute interim VIUS metrics.
- The 2002 VIUS has been linked with some data sources and tools in prior years, illustrating suitability and strengthening partnership opportunities. However, this circumstance could raise future challenges when linking new releases of those same data sources, creating instances of circular referencing if data vintages differ.

1. Data Sources Overview

The 2021 VIUS was administered to owners of pickup trucks, minivans, light vans, straight trucks, truck tractors, and SUVs that were used for personal and commercial purposes. Two survey forms were used, one for light-duty vehicles and another for heavy-duty vehicles. Given the coverage of personal and commercial use spanning light- and heavy-duty vehicles, this research focused on the following national data sources with a potential to be linked with VIUS data:

1. FHWA's HSS
2. BTS' freight data from FAF and CFS
3. FHWA's NHTS
4. NHTSA's FARS

A high-level overview and background for each of these data sources is provided in this section. As noted in the Introduction, this review focuses on the publicly available datasets for all sources considered. The 2021 VIUS has a T13 dataset that can be accessed through special clearance, and the other data sources may have similar datasets as well (researchers should contact the sponsoring agencies for more information regarding the availability of similar T13 datasets).

1.1. HIGHWAY STATISTICS SERIES

HSS is an annual reporting series of highway data curated by FHWA. It contains state-submitted data on motor fuel, motor vehicle registrations, driver licenses, highway-user taxation, highway mileage, travel, and highway finance. These data are available publicly and analyzable at the state and national levels. Data submission is required by federal legislation and is used to inform Congress on the current status of the highway system. The data have been published annually since 1945.

HSS provides overarching data coverage of the Nation's highway system and its users. Some data are publicly available by vehicle classification. Vehicle-related data elements in HSS that are relevant to VIUS include vehicle miles traveled (VMT)[3] by highway functional classification, vehicle registration totals, and motor fuel usage. Further details can be found at the HSS homepage: https://www.fhwa.dot.gov/policyinformation/statistics.cfm [FHWA 2024].

[3] FHWA calculates VMT as the state-submitted annual average daily traffic divided by the mileage of the functional classification as defined by the Highway Performance Monitoring System. Please refer to https://www.fhwa.dot.gov/policyinformation/hpms/2010/ch2.cfm for more information.

1.2. FREIGHT DATA

This report explores the linkages between VIUS and FAF and between VIUS and CFS. In broad terms, FAF provides a comprehensive view of flows, while CFS collects shipment data by many variables, including industry, commodity, mode of transportation, hazardous material status, and temperature-control status.[4] CFS is one of several data sources used to create the FAF database.

1.2.1. Freight Analysis Framework

The FAF database is a national-level model of freight flows produced by BTS with support from FHWA. Data can be analyzed at the national, state, and metropolitan-area levels by mode of transportation and commodity type. Flows are represented as tonnage, value (U.S. dollars), and activity (ton-miles).

The current version, FAF5, is the focus of this report. FAF5 has a base year of 2017, and annual estimates and forecasts are available through 2050. Although FAF provides freight flows for several mode types and combinations, this report focuses on the truck mode only, which is where a linkage to VIUS could be made. The next version of the FAF, FAF6, will be produced with a 2022 base year. Further details can be found at the FAF homepage: https://www.bts.gov/faf [USDOT, BTS, FHWA 2017].

1.2.2. Commodity Flow Survey

The purpose of CFS is to provide a complete picture of multimodal national- and state-level freight flows for selected industries. It is the only publicly available source of data for highway freight flow and, as such, serves as a main input for FAF. The data are used to assess the current movement of goods and forecast that movement into future years, mapping commodity and vehicle flows and guiding infrastructure management and investment decisions.

This survey is a BTS product that is fielded by Census. The establishments surveyed are sampled from the mining, manufacturing, wholesale trade, and auxiliaries (i.e., warehouses and distribution centers) industries as well as select retail and service trade industries that ship commodities. Questions focus on types of commodities moved, their origins and destinations, values, weights, and modes of transportation. Variables, such as distance and ton-miles, are derived from responses to the survey questions. Details about CFS are available on the survey's homepage: https://www.bts.gov/cfs [BTS 2024b]. For guidance on whether CFS or FAF is a better fit for an application, refer to https://rosap.ntl.bts.gov/view/dot/62743 [BTS 2022].

1.3. NATIONAL HOUSEHOLD TRAVEL SURVEY

NHTS is the authoritative source on noncommercial household travel behavior data in the United States. It is managed by FHWA and, starting with the 2022 edition, fielded biennially. Data captured include household, person, household vehicle, and daily trip characteristics. The survey is a stratified random sample of the noninstitutionalized population of the United States

[4] For more information about the differences between FAF and CFS, refer to https://rosap.ntl.bts.gov/view/dot/62743.

using an addressed-based sample approach. The most recent surveys support analyses at the national, census region, and census division levels.

While NHTS focuses on personal, noncommercial travel, the inclusion of the household vehicle roster allows for the potential to append vehicle and travel characteristics of personal light-duty vehicles to a subset of VIUS vehicles (those reported for personal use). Further details can be found on the NHTS homepage: https://nhts.ornl.gov/ [FHWA 2025].

1.4. FATALITY ANALYSIS REPORTING SYSTEM

FARS provides a census of fatal motor-vehicle traffic crashes in the United States and Puerto Rico. It is managed by NHTSA and includes crashes that involve a motor vehicle traveling on a public roadway and result in the death of a vehicle occupant or nonoccupant within 30 days of the crash.

FARS is compiled by trained state employees who gather their states' data from existing documents, such as police crash reports, state vehicle registration files, death certificates, emergency medical service reports, and state roadway classification data. These employees code more than 170 data elements as they translate the data to a standard format and transmit it into FARS. Vehicle data are stored in a vehicle file, with data elements including vehicle year, make, model, body type, and fuel type. For more information, refer to the FARS homepage: https://www.nhtsa.gov/crash-data-systems/fatality-analysis-reporting-system [NHTSA 2025].

2. Suitability for Linkage to VIUS

At the core of this research is the question of whether HSS, freight data (i.e., FAF and CFS), NHTS, and FARS have the potential to complement and enhance VIUS. To that end, each data source was reviewed for suitability in linking to VIUS (i.e., using the datasets in conjunction with the VIUS data such as mapping data at an aggregate level). Suitability factors include the following:

- Frequency and timeline
- Geospatial scale of the released data (e.g., census tract, county, and state)
- Target population and coverage rate
- Key data items that can be linked to VIUS data
- Potential shortcomings of the data collection for being linked to VIUS data
- Potential strengths of the data collection for being linked to VIUS data
- Challenges of collaborating with other data-collection programs to meet BTS data needs
- Opportunities for partnership to enhance the connection between data programs

The results of the suitability assessment are summarized in the following sections.

2.1. LINKING VIUS WITH THE HIGHWAY STATISTICS SERIES

VIUS and HSS provide estimates of the universe of the vehicle population by body for the United States and at the state level. Prior to linking the two datasets, the following aspects should be considered:

- **Universe definition**—The 2021 VIUS design excludes vehicles owned by federal, state, and local governments; ambulances; buses; motor homes; farm tractors; unpowered trailer units; and trucks reported to have been disposed of prior to January 1, 2021. HSS tables include all registered vehicles, regardless of ownership. Not all HSS tables separate the vehicle counts by ownership (public or private). Some interpolation across HSS tables will be required prior to attempting a linkage as the publicly owned vehicles would need to be excluded from any VIUS linkage.
- **Truck definition**—VIUS includes all trucks with GVWR classes 1–8. HSS includes all vehicles, with those classified by light duty wheelbase (short or long), single unit or combination, and number of axles being directly relevant for linking to VIUS. Since body type does not directly match across the two datasets, a crosswalk would need to be established prior to attempting a linkage. VIUS truck classifications are defined per footnote 1 in the Introduction. HSS vehicle types are defined as part of Table VM-1.[5] The discussion in this report assumes the linkage between VIUS and HSS would be an aggregation of GVWR classes within the VIUS data and vehicle type within the HSS tables. The correspondence would include the following:

[5] Refer to Table VM-1 at the following link: https://www.fhwa.dot.gov/policyinformation/statistics/2021/vm1.cfm.

    - VIUS GVWR classes 1 and 2 to HSS Light Duty Vehicles (an aggregation of the short and long wheelbase categories)
    - VIUS GVWR classes 3–6 to HSS Single Units
    - VIUS GVWR classes 7 and 8 to HSS Single Units or Combinations, depending on whether the VIUS survey responses indicate there is a trailer

  More advanced VIUS data users are encouraged to explore developing more refined vehicle aggregations within VIUS that consider multiple variables.

  Two limitations of aggregation by GVWR class in VIUS include the following:
    - VIUS does not capture passenger cars, so the total VIUS counts will not sum directly to the HSS Light Duty Vehicle totals.
    - Pickups with more than two wheels on their rear axle that do not tow a trailer could be misclassified as a Light Duty Vehicle when in HSS. These vehicles should be in the Single Unit vehicle category. This misclassification could impact state-level estimates in areas where these large pickups are more prevalent.
- **Potential added value**—VIUS data could be strengthened by adding HSS data on VMT by highway functional class, total registrations, vehicle occupancy, and motor fuel consumption.
- **Point of linkage**—The main point of linkage would be in the direction of HSS to VIUS at the aggregate level of GVWR categories. After processing the HSS data tables to summarize the data for private trucks for light duty, single unit, and combinations, VIUS GVWR classes can similarly be aggregated into the same HSS vehicle categories. Once the two datasets have the same truck-type definitions, the identified HSS data elements can be linked onto specific records within the VIUS PUF according to the common truck-type definition and state of truck registration. VIUS would not need to be reweighted because no change occurs in the number of VIUS records or population (the change in population is in the HSS data).

For comparison purposes across the various datasets assessed, the following is a summary of characteristics of HSS as it relates to potential linkages with VIUS:

- **Frequency and timeline**—HSS data are reported on an annual basis with roughly a 1-year lag between the current year and available year of data. These data are currently available from the years 1945–2022.
- **Geospatial scale of the released data**—Data are publicly presented at the national and state levels, which reflects the current FHWA reporting standards for states.
- **Target population and coverage rate**—HSS data are submitted by each state to FHWA. HSS is the authoritative source of general highway statistics and represents actual measures of highway usage and expenditures. The vehicle data in scope include all registered vehicles for a particular state. How complete each state's submission is with respect to the count of registered vehicles is unknown.
- **Key data items that can be linked to VIUS data**—HSS and VIUS data can be linked at the point of cross-walked body type and state of vehicle registration (not where vehicle is domiciled). It should be noted that the vehicle counts in HSS are by state of registration (which is not always the state in which the vehicle was operated) and the vehicle miles are by state where the miles were generated. VIUS records include both state of registration and base state which indicates state of operation. From HSS, key metrics brought into VIUS can include VMT by highway functional class, total registrations, vehicle occupancy, and motor fuel consumption.

- **Potential shortcomings of the data collection for being linked to VIUS data**—As noted in the universe definition discussion, the truck universe differs between the two datasets as does the truck body types, requiring some sub-setting of both datasets prior to the linkage to bring the truck universe and body types to agreement and thus allow for the linking. However, a preliminary crosswalk has been tested by BTS suggesting the linking process is feasible.
- **Potential strengths of the data collection for being linked to VIUS data**—HSS data represent the total universe of VMT as reported by each state, highway users, and finances. They are used by the transportation community for weighting and expansion baselines, validating model outcomes, trending, and general comparisons. These data are widely recognized as the de facto measurement of the condition of the U.S. highway system.
- **Challenges of collaborating with other data-collection programs to meet BTS data needs**—Data collection and submission by states to FHWA follow a well-structured and documented process mandated by federal legislation and supported by partnerships with state DOTs. Consequentially, the data-submission process has been streamlined to reduce reporting burden while meeting mandates. Given these requirements, changes to reporting standards or processes in the state data-submission process may not be feasible.
- **Opportunities for partnership to enhance the connection between VIUS and HSS programs**—HSS tables are publicly available and presented at the national and state levels. Some data are presented by vehicle body type[6], which could be linked with VIUS data to provide external baselines and context of truck usage and volumes. Once the relationship is validated for the survey years, HSS could be used to model some base VIUS truck details in nonsurvey years. In addition, although the state data submission process is not likely a candidate for modification, depending on how the data are collected and stored, BTS may consider exploring the possibility of new tables being added to HSS or special VIUS or HSS tabulations being created that allow for direction linkage between the two data sources.

2.2. LINKING VIUS WITH FREIGHT DATA (FAF AND CFS)

While CFS is one FAF input, VIUS links to each data source differently. In this section, the results of a suitability assessment conducted on each data source are reported.

2.2.1. VIUS and the Freight Analysis Framework

VIUS and FAF provide estimates of goods movement across the country. This summary only considers the current version of FAF, which is FAF5. Prior to linking the two datasets, the following aspects should be considered:

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[6] Vehicle classification for HSS Table VM-1 are light duty vehicles with short wheelbases (passenger cars, light trucks, vans and SUVs with a wheelbase less than or equal to 121 inches), motorcycles, buses, light duty vehicles with long wheelbase (large passenger cars, vans, pickup trucks, and SUVs with wheelbases greater than 121 inches), single-unit trucks (2-axles and at least 6 tires or a GVWR exceeding 10,000 pounds), and combination trucks.

- **Universe definition**—FAF is a database of U.S. freight flows by commodity and mode, including those made by truck (company owned and for-hire). The 2021 VIUS was a survey of trucks owned by nongovernment entities and, for each truck, collected the type of commodity hauled (if applicable).
- **Truck definition**—VIUS samples and surveys trucks. The FAF origin–destination commodity-mode database represents all truck flows with a single mode (truck), then uses payload factors (developed using VIUS) to convert truck tons into number of vehicles for simulating volumes on the highway network.
- **Potential added value**—While FAF data cover all freight modes, linking the VIUS data to flow estimates for the truck mode would provide additional context to commercial vehicles' activity, including tonnage, value, and activity (ton-miles) by commodity type, origin, and destination. Historically, VIUS data were also linked to FAF to convert the units of flow from number of tons to number of trucks. BTS plans to incorporate the 2021 VIUS into updated versions of FAF.
- **Point of linkage**—Filtering FAF for truck mode data only, the VIUS attributes would be linked to the FAF network based on geography (state or metropolitan area) by commodity type.

For comparison purposes across the various datasets assessed, the following is a summary of characteristics of FAF as it relates to potential linkages with VIUS:

- **Frequency and timeline**—FAF5 offers annual and forecasted estimates of freight flows with a base year of 2017. Major version updates to FAF occur following new releases of CFS. CFS releases occur every 5 years. With the release of the 2022 CFS in Spring 2025, FAF6 is anticipated to be released in 2026.
- **Geospatial scale of the released data**—Data are available at the FAF zonal level, which is based on groups of counties and state-boundaried Core-Based Statistical Areas (CBSAs). These zones can be aggregated to the state level. An experimental FAF data product comprised of county-level estimates was released in early 2025 [Shaw, Hettige 2025].
- **Target population and coverage rate**—FAF is a modeled product representing freight flows (tonnage, commodity, and value) by all modes (highway or truck, rail, water, air, multiple modes and mail, and pipeline) at the state and metropolitan levels. It combines data from multiple sources, including CFS, Census Foreign Trade Statistics, Economic Census data, U.S. Department of Agriculture's Census of Agriculture, VIUS, Highway Performance Monitoring System, the U.S. Energy Information Administration, and other industrial data.
- **Key data items that can be linked to VIUS data**—While FAF data cover all freight modes, linking VIUS data to flow estimates for the truck mode would provide additional context to commercial vehicles' activity. The additional context includes truck attributes (e.g., semi versus tanker), truck operational details (e.g., payload factors), and other VIUS attributes to the FAF truck flows, which can then be used to summarize total truck tons (for example) by fleets and their operational characteristics. It should be noted that freight movements by truck appear in three of the FAF/CFS modes: truck only, multiple modes and mail, and air and truck. Multiple modes and mail includes parcel shipments on intermodal carriers that could be partially or completely by truck, and air cargo for shipments heavier than parcels are assumed to have a truck leg between the shipper and the airport.

- **Potential shortcomings of the data collection for being linked to VIUS data**—The current version of FAF reflects prepandemic freight flows. Additionally, one of the data inputs of FAF is the 2002 VIUS, which is used to estimate the "typical 'area of operation' of trucks carrying agricultural products" [BTS 2016]. Therefore, the agricultural flow patterns in FAF may be outdated, so caution is advised when conducting linked analysis for agricultural products. The new FAF benchmark for 2022 will be released in early 2026.
- **Potential strengths of the data collection for being linked to VIUS data**—Given that an older version of VIUS is used for modeling FAF, this history of fusion between the two datasets offers promise of both future implementations of the newer VIUS in FAF's creation as well as proof of concept for successfully linking the two datasets.
- **Challenges of collaborating with other data-collection programs to meet BTS data needs**—FAF is created using a list of source datasets. VIUS is a BTS product that is fielded by Census. Given the BTS–Census partnership, modifications may be possible but at the cost of increased respondent burden. In addition, analyses of agricultural movements should be limited given the source of that data within FAF is the 2002 VIUS. The development of a suitable correspondence between VIUS truck owner attributes or commodity types and the same in FAF may take some time but is possible.
- **Opportunities for partnership to enhance the connection between the FAF and VIUS programs**—The FAF truck or highway mode represents the combined freight flows completed by commercial trucks. The main connection point, then, is commodity type. This link would require a crosswalk to fully join the two datasets on this element. Future discussions between the VIUS, CFS, and FAF programs could focus on where and how the kind of business activity and commodity classifications might be able to be reclassified in future survey versions to strengthen the connections between the two surveys on this topic (and thus, allow for direct connectivity between the surveys and potentially also future FAF versions).

2.2.2. VIUS and the Commodity Flow Survey

VIUS and CFS provide estimates of goods movement across the country by truck. This assessment considers the 2022 CFS, which is the most recent year the survey was conducted. Prior to linking the two datasets, the following aspects should be considered:

- **Universe definition**—The 2022 CFS was a shipper survey of establishments from the mining, manufacturing, wholesale trade, and auxiliaries (i.e., warehouses and distribution centers) industries as well as select retail and service trade industries. The 2021 VIUS was a survey of trucks owned by nongovernment entities. The commercial trucks surveyed by VIUS were used by commercial enterprises for business purposes and were not limited to any type of industry, other than being nongovernment in nature. This circumstance means that, prior to any type of linking consideration, VIUS should be filtered to consider only those industries that were sampled for the inclusion in CFS. Further definition can be added by considering whether the shipments were made with company-owned transportation or for-hire vehicles.

- **Truck definition**—VIUS samples and surveys trucks, and CFS surveys establishments (within specific industries) about their shipments. Truck-related transport modes listed on CFS include parcel, U.S. Postal Service, or courier; company-owned truck; or for-hire truck. These two datasets cannot be reconciled based on truck definition in their current formats. Users must filter VIUS to only include the industries surveyed in CFS. Linking can then occur based on geography (state or metropolitan area), commodity type, and whether the truck is company-owned or for-hire.
- **Potential added value**—Linking CFS to VIUS would provide additional context to commercial vehicles' activity with respect to geography, commodity type, industry, transport of hazardous materials, use of refrigeration in shipping, and whether the truck is company-owned or for-hire.
- **Point of linkage**—After being filtered for CFS industries, the points of linkage between VIUS and CFS include geography, commodity, and whether shipment is by company-owned or for-hire trucks.

For comparison purposes across the various datasets assessed, the following is a summary of characteristics of CFS as it relates to potential linkages with the VIUS:

- **Frequency and timeline**—CFS is conducted every 5 years, with the most recent survey conducted in 2022. VIUS is also conducted every 5 years, with the most recent VIUS conducted in 2021.
- **Geospatial scale of the released data**—CFS data are available at the national, state, and metropolitan geographies. The 2021 VIUS is also available at the state level.
- **Target population and coverage rate**—CFS surveys establishments to obtain details about shipments. Coverage rates for the 2022 survey are not yet available.
- **Key data items that can be linked to VIUS data**—After accounting for the industries that are surveyed in CFS, CFS and VIUS can be linked on commodity and geography.
- **Potential shortcomings of the data collection for being linked to VIUS data**—By design, the CFS data only reflect a specific window of shipments. In addition, the establishments ship using company-owned and for-hire trucks. So, the CFS data available to be linked are only for a specific subset of the VIUS dataset.
- **Potential strengths of the data collection for being linked to VIUS data**—The CFS data provide details about geography, mode of transportation, commodity type, industry, transport of hazardous materials, use of refrigeration in shipping, and whether the truck is company owned or for-hire.
- **Challenges of collaborating with other data-collection programs to meet BTS data needs**—Both surveys are BTS products that are conducted on 5-year cycles that are sequential, so linkage will always be between surveys that were conducted 1 year apart. In addition, CFS has a finite focus on industries that ship, so increasing the range of industries surveyed is not possible due to CFS' scope.
- **Opportunities for partnership to enhance the connection between the CFS and VIUS programs**—Future discussions between the VIUS and CFS programs could discuss where and how the kind of business activity and commodity classifications might be able to be reclassified in future survey versions. Such reclassifications might strengthen the connections between the surveys on this topic (and thus, allow for direct connectivity between the surveys and potentially also future FAF versions).

2.3. LINKING VIUS WITH THE NATIONAL HOUSEHOLD TRAVEL SURVEY

As a subset of what is collected in VIUS (i.e., GVWR classes 1–8), specific questions asked in the survey can be used to estimate the universe of vehicles with GVWR classes 1–8 that are used for personal purposes. NHTS provides estimates of the universe of household vehicles in the United States. Prior to linking the two datasets, the following aspects should be considered:

- **Universe definition**—VIUS sampled vehicles with GVWR classes 1–8 and surveyed owners of those vehicles. NHTS sampled occupied housing units (capturing noninstitutionalized population only) then requested the household representative to enumerate all household vehicles licensed for use on the road, including cars, trucks, vans, SUVs, and so on. Thus, for VIUS, the sampling unit is the vehicle, while for NHTS, the sampling unit is the household. Within the VIUS dataset, filtering for trucks that were used only for a personal purpose would be a necessary first step prior to any consideration of data linking. For NHTS, filtering for household vehicles that are in scope for VIUS is also a necessary first step.
- **Truck definition**—Truck body type does not directly match across the two datasets. A crosswalk would need to be established prior to attempting linkage. This crosswalk should only be developed after the VIUS data are filtered for trucks that were used for personal purposes only.
- **Potential added value**—Linking VIUS to NHTS as well as adding NHTS to VIUS could add value to both datasets as follows:
    - The VIUS light-vehicle survey collects several data elements that are of interest to the NHTS data community. These elements include the following:
        - Vehicle features (Section F of the VIUS Questionnaires) to enhance basic truck vehicle details collected in NHTS.
        - Vehicle miles (Section I of the VIUS Questionnaires) for validation against user estimates associated with household trucks captured in NHTS.
        - Use of vehicles for commercial purposes (Section M of the VIUS Questionnaires) as this is a grey area in the NHTS data when it comes to VMT trends associated with this type of travel. To be more specific, although NHTS asked questions about the use of household vehicles for commercial vehicles, few households indicated such usage. By understanding the type of vehicles used for commercial purposes, as documented in VIUS, the attributes associated with that subset of VIUS vehicles can inform more in-depth research into this phenomenon. While this information may not result in a direct linkage, understanding the qualitative connection may lead to a linkage in future survey years for both data programs.
        - Once a linkage is established between VIUS and NHTS, this national example can be used by state and regional transportation agencies who conduct their own travel surveys to link to VIUS and use the data in a comparable manner.

    Prior to attempting any linking, the VIUS data would need to be filtered to remove any vehicles used by a commercial entity, and then, the remaining body types would need to be cross-walked to match the specific body types in the NHTS vehicle file. Similarly, the NHTS vehicle file records would need to be cross-walked to match the VIUS categories. This filtering is necessary to address the differences in universes between the two surveys (i.e., noninstitutionalized households for NHTS versus registered trucks with GVWR classes 1–8 minus government vehicles for VIUS).

    - For the VIUS, the following strengths of being attached to NHTS are anticipated:
        - For NHTS household vehicles (once cross-classified according to the VIUS truck body type and associated with VIUS vehicles for which a personal use was reported in the VIUS dataset), it would be possible to bring in NHTS details of how the vehicles were used on a daily basis (e.g., hours of the day, distance, trip durations, driver characteristics).
        - As a complementary dataset, NHTS household vehicles can be summarized by body type and model year to provide validation benchmarks when assessing the trucks for which a personal use was reported in the VIUS data.
- **Point of linkage**—The potential exists for linking from VIUS to NHTS as well as from NHTS to VIUS. The linkage, both ways, would be at the aggregate level of vehicle model year and body type for vehicles that were used for a personal purpose. VIUS would not need to be reweighted because no change occurs in the number of VIUS records or population (the change in population is in the NHTS data).

For comparison purposes across the various datasets assessed, the following is a summary of characteristics of NHTS as it relates to potential linkages with VIUS:

- **Frequency and timeline**—Up to 2017, NHTS was conducted every 5–8 years (2001, 2009, and 2017). Then, beginning in 2022, FHWA began conducting the survey every other year, with the 2024 NHTS currently in field and plans for the 2026 NHTS recently announced. With VIUS planned for 5-year increments, the two survey cycles are in similar but not exactly matching data-collection cycles.
- **Geospatial scale of the released data (e.g., census tract, county, state)**—NHTS is a national survey, with the 2017, 2022, and 2024 surveys designed for analysis at the national, census region, and census division levels. The NHTS sample design also supports estimation precision at the urban or rural metropolitan-statistical-area size and residential density aggregations. The 2001 and 2009 survey designs allowed for analysis at the state levels, which was more compatible with the VIUS design.
- **Target population and coverage rate**—NHTS is a survey of U.S. households and excludes those living in group quarters (i.e., those living in military barracks, college dormitories, and nursing homes). The 2022 NHTS and 2024 NHTS survey 7,500 out of approximately 131 million U.S. households (less than 0.01 percent). For prior NHTS surveys (2001, 2009, and 2017), the larger national sample size was 26,000 households. VIUS samples trucks with GVWR classes 1–8 that were used for both business and personal purposes. The overlap between the two datasets are vehicles with GVWR classes 1–8 that are used for personal purposes. The first step in any linkage consideration would be to assess available sample sizes in both NHTS and VIUS.
- **Key data items that can be linked to VIUS data**—The key points of linkage between NHTS and VIUS are in three variables in the NHTS vehicle file: vehicle model year, body type, and fuel type. Other data fields that are similar between the two datasets (which may be suitable for cross-validation but not necessarily linking) include annual vehicle miles, whether the vehicle is a hybrid vehicle (yes or no), and type of the hybrid vehicle. Like VIUS, NHTS collects vehicle make and model. However, due to privacy considerations, the 2022 NHTS only publishes vehicle make data. On the other hand, VIUS publishes neither vehicle make nor vehicle model data.

- **Potential shortcomings of the data collection for being linked to VIUS data**—The two surveys have different data-collection cycles (now every 2 years for NHTS and 5 years for VIUS). In addition, the NHTS design no longer supports analysis at the state level, while the smallest spatial level of the VIUS is the state. Finally, since the scope of these two collections only overlap partially, the number of usable responses is limited, and therefore, the statistical power of analyses could be low.
- **Potential strengths of the data collection for being linked to VIUS data**—The VIUS light-vehicle survey collects several data elements that are of interest to the NHTS data community. These elements include vehicle features, vehicle miles, and use of vehicles for commercial purposes.
  For VIUS, adding NHTS household vehicle details to trucks for which a personal use was reported in the VIUS dataset could have the benefit of linking in details of how the NHTS trucks were used on a daily basis (e.g., hours of the day, distance, trip durations, driver characteristics).
- **Challenges of collaborating with other data-collection programs to meet BTS data needs**—NHTS is a long-established survey and already collects a lot of details (high respondent burden). In addition, the differing survey cycles may make it difficult for the datasets to align temporally on a regular basis. Further, NHTS is household-based and VIUS is vehicle-based, so the ability to link the two datasets would depend on the number of household vehicles reported by NHTS respondents that meet the VIUS definition of a truck (i.e., vehicles with GVWR classes 1–8). Finally, to the extent that state-level analyses are important, these analyses are not possible with the more recent NHTS designs (i.e., 2017, 2022, and 2024) no longer providing information about the state where the survey households were located.
- **Opportunities for partnership to enhance the connections between the NHTS and VIUS programs**—The roster of household vehicles owned is a standard file within the NHTS dataset, which includes light-duty trucks, minivans, vans, and SUVs—similar to what is included in the VIUS. This circumstance makes NHTS a consideration for linking. The availability of vehicle body type and model year provides a stable connection point for linking the datasets at the aggregate level of vehicle body type and model year for vehicles that were used for a personal purpose. Both datasets could be linked using publicly available data, although the linking could be strengthened if BTS were able to release vehicle make in the VIUS PUF. In addition, to the extent that NHTS variables are found to be beneficial descriptors when added to the VIUS PUF records and a larger sample size were desired, discussions could be undertaken with FHWA.

2.4. LINKING VIUS WITH THE FATALITY ANALYSIS REPORTING SYSTEM

VIUS is a national survey of trucks (used for commercial and/or personal purposes), their physical features, operational characteristics, and usage, while FARS is a census of crashes that involve a motor vehicle traveling on a public roadway and result in the death of a vehicle occupant or nonoccupant within 30 days of the crash. Prior to linking the two datasets, the following aspects should be considered:

- **Universe definition**—VIUS sampled trucks with GVWR classes 1–8, used for business or personal purposes, and sent surveys that were answered by the truck owners. FARS is a census of crashes and details of those crashes, including the specifics of the motor vehicles involved. Thus, for VIUS, the sampling unit is the truck, while for FARS, as a census, the organizing unit in the dataset is the crash. The FARS vehicle details are in a second file, in which each record represents one vehicle involved in a fatal crash (one crash can have multiple vehicles involved. Each vehicle would have one record in the vehicle file). The vehicles in the FARS vehicle file can be owned by government, companies, or households. Since VIUS does not include vehicles owned by the government, filtering out government-owned vehicles in the FARS data would be a necessary step prior to proceeding with the linking process.
- **Truck definition**—Truck body type does not directly match across the two datasets. A crosswalk would need to be established prior to attempting linkage, after filtering the FARS vehicle file to remove any government-owned vehicles.
- **Potential added value**—There is potential added value both by linking VIUS to FARS as well as linking FARS to VIUS. VIUS would not need to be reweighted because no change occurs in the number of VIUS records or population (the change in population is in the FARS data). The following variables are candidates for linking:
  - The VIUS light- and heavy-vehicle surveys collect several data elements that would be of interest to the FARS data community. These elements include the following:
    - Vehicle features (Section F of the VIUS Questionnaires) to enhance basic vehicle details collected in FARS.
    - Vehicle miles (Section I of the VIUS Questionnaires), which could be used to estimate the denominator for crash rate exposure statistics (such as crashes per miles traveled).
    - Typical load details and vehicle use for commercial purposes (Section M of the VIUS Questionnaires), which when merged with crash data, could be used to assess potential commercial vehicle driver policies.
    - VIUS is designed to support analysis at the state level.
  - For VIUS, the following descriptors from the FARS data have the potential to add value to the VIUS data:
    - Crash rates associated with specific vehicle body types and vehicle model years, which when analyzed in conjunction with the introduction of truck features, can help assess the impact of the introduction of various truck features on future U.S. fleet composition mixes.
    - FARS considers all vehicle types (including light and heavy trucks).
- **Point of linkage**—The potential exists for linking from VIUS to FARS as well as from FARS to VIUS. The linkage, both ways, would be at the aggregate level of vehicle model year and body type for nongovernment-owned vehicles in VIUS. VIUS would not need to be reweighted because no change occurs in the number of VIUS records or population (the change in population is in the FARS data).

For comparison purposes across the various datasets assessed, the following is a summary of characteristics of FARS as it relates to VIUS when it comes to the potential of linking the two datasets:

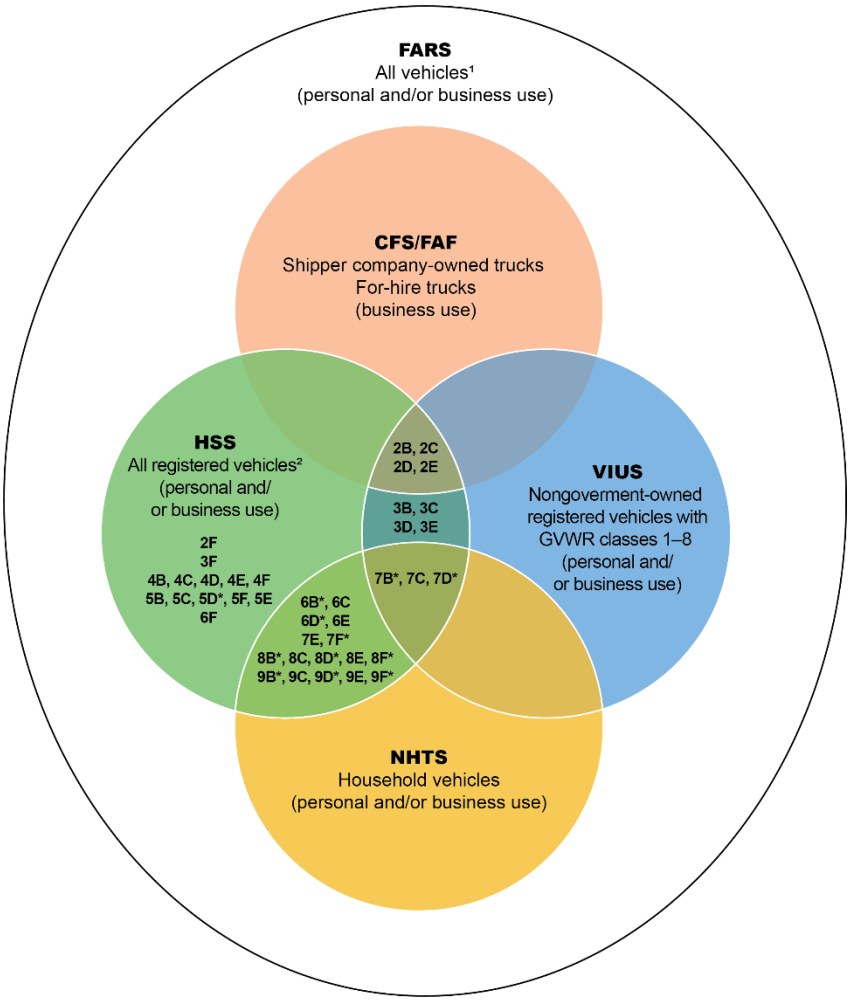
- **Frequency and timeline**—FARS data are published annually but with a 2-year lag. For example, the 2022 data are published in 2024. In terms of timeline for linking, if 2026 is the timing for the next FARS survey, this means the 2026 FARS data would be released in 2028. The expected release date of 2026 VIUS data is 2029, which provides a reasonable temporal suitability between the two surveys.

- **Geospatial scale of the released data (e.g., census tract, county, state)**—Each crash is geolocated at the *x*,*y* coordinate (i.e., longitude and latitude) level. The data can be aggregated and analyzed at the state level if desired, making it suitable for linking with VIUS on this aspect.
- **Target population and coverage rate**—FARS documents motor vehicle crashes involving a fatality. A coverage rate is not associated with the FARS data.
- **Key data items that can be linked to VIUS data**—The key points of linkage between FARS and VIUS are vehicle model year, body type, and fuel type. Like VIUS, FARS also collects vehicle make and model. Given that VIUS publishes neither vehicle make nor model data, vehicle body type is the next best linkage point.
- **Potential shortcomings of the data collection for being linked to VIUS data**—Although each record in FARS reflects a fatality and, thus, is of significance, the total size is much smaller than VIUS, and the number of records varies each year. As such, analysts would need to review the number of FARS entries each year and be prepared to adjust their statistical methods, as needed, based on the number of FARS records available.
- **Potential strengths of the data collection for being linked to VIUS data**—The VIUS light- and heavy-vehicle surveys collect several data elements that are of interest to the FARS data community, including vehicle features, vehicle miles, typical load details, and vehicle use for commercial purposes. For VIUS, the strengths of being attached to FARS are anticipated to include crash rates associated with specific vehicle body types and model years.
- **Challenges of collaborating with other data-collection programs to meet BTS data needs**—The FARS forms are completed at the site of the crash by first responders (sometimes enhanced by hospital personnel). Thus, modifying the forms across all states and territories could be a complicated process, not to mention doing so would add burden to those completing the in-field reports.
- **Opportunities for partnership to enhance the connections between the FARS and VIUS programs**—FARS records motor vehicle crashes involving a fatality. Motor vehicles include the truck types surveyed as part of VIUS. The availability of body type and vehicle model year in both datasets provides a stable connection point for linking the datasets. FARS documents the conditions associated with the crash, while VIUS documents the vehicle features, most notably the vehicle safety features.

2.5. SUMMARY DIAGRAM AND TABLES

Figure 1 depicts the universe of vehicles for each of the datasets discussed in Section 2.1 through Section 2.4. The figure note provides information on the vehicle type and registration type included in each dataset. Figure 1 can be used in conjunction with Table 3 in the Appendix.

Figure 1. Universe of Vehicles for Datasets



Source: BTS.
2 = large commodity-carrying trucks; 3 = large trucks that do not carry commodities; 4 = ambulances and other specialized vehicles; 5 = buses; 6 = recreational vehicles; 7 = pickups, vans, minivans, and SUVs; 8 = sedans; 9 = motorcycles; B = registered to carriers; C = registered to rental or leasing companies; D = registered to other businesses; E = registered to households and individuals; F = registered to government.
* This occurrence may be rare in all or some of the data sources; refer to Table 3 in the Appendix for more information.
[1] All vehicles can be in FARS if the vehicle is involved in a fatal crash.
[2] For more information, refer to MV tables in HSS.

Table 1 and Table 2 summarize the key highlights presented in Section 2.1 through Section 2.4. For more information regarding any entry in either table, please refer to the more detailed text in the appropriate report section.

Table 1. Linkage Details

Dataset	Universe definition	Potential added value	Point of linkage
VIUS 2021 (discussed throughout report)	The 2021 VIUS universe included all registered vehicles with GVWR classes 1–8 in the 50 states and DC, excluding government-owned vehicles, ambulances, fire engines, buses, farm tractors, passenger cars, and motor homes.	Not applicable.	The point of linkage varies based on the dataset (refer to other entries in this table).
HSS (Section 2.1)	HSS captures all registered vehicles (i.e., all truck types) by all owner types.	VIUS data could be strengthened by adding HSS data on: • VMT by highway functional class • Total registrations • Vehicle occupancy • motor fuel consumption	The main point of linkage would be in the direction of HSS to VIUS. Prior to linkage, the VIUS data would need to be aggregated to cross-walk to the HSS vehicle types. In addition, HSS would need to be filtered to remove government vehicles. VIUS would not need to be reweighted.
FAF (Section 2.2)	The FAF highway mode reflects movement by trucks, as modeled using data from multiple sources.	FAF data could enhance understanding of: • Truck attributes (e.g., semi versus tanker) • Truck operational details (e.g., payload factors) Once linked, users can summarize total truck tons (for example) by fleets and their operational characteristics.	After filtering VIUS to match the industries modeled in FAF, the VIUS attributes could be linked to the FAF network as attributes by commodity type and home base.
CFS (Section 2.2)	CFS is a survey of establishments that ship within select industries regarding their shipping.	CFS data could enhance understanding of: • Commodity type • Transport of hazardous materials • Refrigerated goods transport • Company-owned versus for-hire vehicles	After being filtered for the CFS industries, VIUS attributes would be linked by commodity type and home base.
NHTS (Section 2.3)	NHTS sampled occupied housing units (capturing noninstitutionalized population only), then requested the household representative to enumerate all household vehicles licensed for use on the road.	Attributes of interest include details of how the trucks were used on a daily basis (e.g., hours of the day, distance, trip durations, driver characteristics).	Linking could exist from VIUS to NHTS and from NHTS to VIUS. The linkage would be at the aggregate levels of truck year and body type for vehicles that were used for personal purposes. No-reweighting would be required.
FARS (Section 2.4)	FARS is a census of crashes and details of those crashes, including the specifics of the motor vehicles involved in those crashes.	Attributes of interest include: • vehicle features • VMT • typical load details • crash rates	There is the potential for linking from the VIUS to the FARS as well as from the FARS to the VIUS. The linkage both ways would be at the aggregate levels of vehicle model year and body type for nongovernment-owned vehicles. No reweighting would be required within the VIUS dataset (as the FARS data are not weighted).

Table 2. Summary of Assessment

Assessment details	HSS	FAF	CFS	NHTS	FARS
Frequency and timeline	Data are published annually, typically with a 1-year lag. Tables are currently available for 1945–2022.	Major version updates to FAF occur following new releases of CFS. FAF5 has a base year of 2017. The new FAF benchmark (FAF6) will be released in 2026.	CFS is conducted every 5 years. The 2022 CFS is the most recent survey.	Up to 2017, NHTS was conducted every 5–8 years (2001, 2009, and 2017). Beginning in 2022, the survey is conducted every other year. The 2024 NHTS is currently in field and plans for the 2026 NHTS were recently announced.	FARS data are published annually with a 2-year lag.
Geospatial scale of the released data	Data are summarized at the national and state levels.	Data are available at the FAF zonal level. The FAF zonal level is based on groups of counties and state-boundaried CBSAs. The FAF zones can be aggregated to the state level. An experimental data product comprised of county-level estimates was released in early 2025.	Data are available at the state and metropolitan geographies.	NHTS is a national survey. The 2017, 2022, and 2024 survey data are designed for analysis at the national, census region, and census division levels. The 2001 and 2009 survey designs allowed analysis at the state level.	Each crash is geolocated at the *x*,*y* coordinate (i.e., longitude–latitude) level. The data can be aggregated and analyzed at the state level.
Target population	HSS targets vehicles registered by state. The population includes light duty, single unit and combination vehicles.	FAF is a modeled product representing freight flows (tonnage, commodity, and value) by all modes (highway or truck, rail, water, air, multiple modes and mail, and pipeline) at the state and metropolitan levels.	The population includes establishments that ship.	NHTS targets U.S. households. NHTS excludes those living in group quarters (i.e., those living in military barracks, college dormitories, nursing homes, etc.).	FARS documents motor vehicle crashes involving a fatality.

Assessment details	HSS	FAF	CFS	NHTS	FARS
Key data items that can be linked to VIUS data	HSS and VIUS data can be linked at the point of aggregated body type by state of vehicle registration.	VIUS attributes can be linked to the FAF network based on geography (state or metropolitan area) by commodity type.	CFS and VIUS can be linked by geography, commodity type, industry, transport of hazardous materials, use of refrigeration in shipping, and whether vehicle is company owned or for-hire.	The linkage would be at the aggregate level of vehicle model year and body type for vehicles that were used for a personal purpose.	The key points are vehicle model year, body type, and fuel type.
Potential shortcomings of the data collection for being linked to VIUS data	The truck universe differs between the two datasets. The body types require aggregation and recoding prior to the linkage.	The current version of FAF uses 2017 CFS data, which reflects prepandemic freight flow patterns The 2022 VIUS is an input into FAF5, which may introduce unwanted influences from the older data.	By design, CFS data only reflect a specific window of shipments. Establishments ship using company-owned and for-hire trucks.	The two surveys target different populations (households and vehicles). The NHTS design no longer supports analysis at the state level, while the smallest spatial level of VIUS is the state.	Each record in FARS reflects a fatality and, thus, is of significance. Analysts would need to review the number of FARS records each year and be prepared to adjust their statistical methods as needed based on the number of FARS records available.
Potential strengths of the data collection for being linked to VIUS data	HSS data represent the total universe of reported VMT, highway users, and finances. It is used by the transportation community for weighting and expansion baselines, validating model outcomes, trending, and general comparisons. These data are widely recognized as the de facto measurement of the condition of the U.S. highway system.	Although an older version of VIUS is used for modeling FAF, this history of fusion between the two datasets offers promise for future implementations of the newer VIUS in FAF's creation as well as proof of concept for successfully linking the two datasets.	CFS data can enhance details about geography, commodity type, transport of hazardous materials, use of refrigeration in shipping, and whether company used or for-hire.	NHTS provides details of how the trucks were used on a daily basis—hours of the day, distance, trip durations, and driver characteristics. Prior to attempting any linking, both datasets would need to be filtered. This filtering is necessary to address the differences in universes.	FARS can inform vehicle features, VMT, typical load details, and crash rates.

Assessment details	HSS	FAF	CFS	NHTS	FARS
Challenges of collaborating with other data-collection programs to meet BTS data needs	Data collection and submission by states to FHWA follow a well-structured and documented process mandated by federal legislation and supported by partnerships with state DOTs.	FAF is created using many source datasets. The current version of FAF reflects prepandemic freight flows. The 2002 VIUS is an input to FAF5, which is used to estimate the "typical 'area of operation' of trucks carrying agricultural products" [BTS 2016].	Given the limited industries surveyed in CFS, sample size must be considered prior to any linking attempt.	The differences in target population and definition of vehicles documented limit the amount of linking that can be done.	The FARS forms are completed at the site of the crash using a prescribed process. Changes in the details documented may not be possible.
Opportunities for partnership to enhance the connection between the VIUS and HSS programs	HSS could be used to model some base VIUS truck details in nonsurvey years. It may be possible to coordinate the development of new tables being added to HSS or generate special tabulations that incorporate the aggregations necessary to allow for linkage.	Future discussions between the VIUS, FAF, and CFS programs could discuss where and how the kind of business activity and commodity classifications might be able to be crosswalked in future survey versions (and thus, appended also to future FAF versions).	Future discussions between the VIUS and CFS programs could focus on where and how the kind of business activity and commodity classifications might be able to be reclassified to allow for direct connectivity between the surveys and potentially also future FAF versions.	The availability of body type and year provides a stable connection point for linking the datasets after aggregation.	FARS documents the conditions associated with the crash, while VIUS documents the vehicle features, most notably the vehicle safety features.

3. Questions Answered by Linking to VIUS

The 2021 VIUS provides the most comprehensive data on the physical and operational characteristics of trucks being driven on U.S. roadways. Its primary use is to understand how trucks are being used for various goods transport. VIUS provides rich data that can be leveraged to inform decisions regarding investments in transportation infrastructure, vehicle technologies and parts, safety, energy consumption, and more.

This report investigates the possibility of linking VIUS with various well-known and well-used national datasets: HSS, BTS' freight data from FAF and CFS, NHTS, and FARS. Each dataset was reviewed using publicly available documentation against a set of standard criteria to assess its suitability for linking to VIUS. For each dataset, points of connection that suggest suitability were identified as were caveats that require more research. In this chapter, a summary of the research questions that could be studied through these linkages is provided.

3.1. VIUS AND THE HIGHWAY STATISTICS SERIES

In evaluating HSS for its suitability to be linked to the VIUS, several opportunities for linking were identified. The research questions that could be studied as a result of those linkages are summarized as follows:

- How do estimates of VMT and vehicle registrations differ between VIUS and HSS? HSS totals could allow for a consistent and recognized source, adding confidence to VIUS estimates. In addition, linking would help to establish VIUS as a trusted validation source for HSS estimates during the pre-release quality-control process.
- Where do target vehicles generate the most mileage and motor fuel revenue? Similar to VMT totals, linking highway usage metrics from HSS to VIUS offers additional context for the purposes of state- or regional-level analyses, where the vehicle body type matches for vehicles not owned by government agencies. This type of analysis could then be used to support revenue forecasts under differing fuel-tax scenarios as well as estimating changes in fleet fuel mix.

3.2. VIUS AND FREIGHT DATA (FAF AND CFS)

In evaluating FAF and CFS for their suitability to be linked to VIUS, several opportunities for linking were identified. The research questions that could be studied as a result of those linkages are summarized as follows:

- What quantities of freight are carried by different segments of the VIUS sample? This question can be addressed by first linking the VIUS data to FAF using the stated "kind of business" or "commercial activity" variables in VIUS and the commodity type information from FAF. Then, the FAF freight flow options of tonnage, value, or ton-mile can be summarized. This analysis could be further evaluated by filtering VIUS for the same industries surveyed in CFS and a similar analysis can be performed.
- What types of trucks are used for what type of FAF and CFS freight? This question could be answered by first filtering the VIUS data for the specific industries or commodity types, then adding the VIUS attributes of truck type (e.g., semi versus tanker) and commodity. Other VIUS attributes to the FAF truck flows then summarize total truck tons (for example) by fleets and their operational characteristics. With CFS, VIUS can be

linked by geography, commodity type, industry, transport of hazardous materials, use of refrigeration in shipping, and whether vehicle is company owned or for-hire.
- What are the operational attributes of FAF and CFS trucks? This question could be answered by first filtering the VIUS data for the specific industries or commodity types, then adding the VIUS attributes of truck type (e.g., semi versus tanker) and truck operational details (e.g., payload factors), then summarizing total truck tons (for example) by fleets and their operational characteristics.

3.3. VIUS AND THE NATIONAL HOUSEHOLD TRAVEL SURVEY

In evaluating NHTS for its suitability to be linked to VIUS, several opportunities for linking were identified. However, the differences in scope and focus may limit the value of directly linking these two datasets. After careful assessment of scope and available sample size, the research questions that could be studied as a result of those linkages are summarized as follows:

- What advanced safety and technology features are associated with the U.S. household fleet, and are the presence of certain features associated with particular travel patterns? These questions assume VIUS light-vehicle characteristics (of those for personal use) are appended to household vehicles and that sufficient sample size exists to reliably answer. As vehicles become more technologically complex with advanced safety and technology features, transportation professionals want to understand the impact of these features on driving behavior.
- What insights could knowledge about the vehicle driver demographics or the vehicle usage (e.g., time of day of travel, trip purposes, trip length, and trip duration) bring to interpreting VIUS data? Such research might provide insights into the question of who is driving these light vehicles, for what purpose, at what time of day, and so on, assuming the sample size (after adjusting each dataset for compatibility) is sufficient to support this type of analysis.

3.4. VIUS AND THE FATALITY ANALYSIS REPORTING SYSTEM

In evaluating FARS for its suitability to be linked to VIUS, several opportunities for linking were identified. The research questions that could be studied as a result of those linkages are summarized as follows:

- For each crash with a vehicle-type associated with those reported in VIUS, what safety and technology features did that vehicle have, by vehicle model year, body type, and fuel type? Of those vehicles identified, to what extent are they representative of the general VIUS population?
- Can VIUS be used to estimate the denominator of crash exposure rate for the FARS data? Specifically, is there sufficient information between the two datasets to calculate the following:
  - In FARS, some type of grouping of vehicles.
  - In VIUS, a similar grouping of vehicles.
  - Between files, a metric of crashes per vehicle universe for the exposure rate (such as crashes per miles traveled).

  When analyzed in conjunction with the introduction of vehicle features, crash rates associated with specific body types can help to assess the impact of the introduction of various vehicle technology and safety features on future U.S. fleet composition mixes.

- In cases when a heavy vehicle was involved in a fatal crash, what were the cargo or load details associated with those crashes? Typical load details and vehicle use for commercial purposes (Section M of the VIUS Questionnaires), when merged with crash data, could be used to inform commercial vehicle driver policies.

3.5. ADDITIONAL CONSIDERATIONS

The depth and breadth of details collected in the current VIUS instruments cover a considerable amount of detail regarding the U.S. fleet of trucks (GVWR classes 1–8). While VIUS use focuses on commercial truck aspects, the purpose of this research was to identify potential extensions by considering linkages to other national data sources. The datasets considered in this report are well-known and widely used for a variety of applications in and of themselves. The ability to enhance VIUS through linking to other national datasets is a possibility. This research identified several viable applications and possibilities that have the potential to increase the value of VIUS, both in linking other data to VIUS and linking VIUS onto other datasets.

This report presents preliminary ideas for linking VIUS data to the noted data sources and proposes research questions that could be addressed using those linked datasets. In this initial exploration of the concept, the questions reflect this preliminary stage of research. The limitations associated with these questions include the following:

- Each dataset is collected or compiled for a specific use and scope. These differences in scope must be accounted for when considering linkages.
- Each dataset has a unique universe and definition of truck. These differences in scope do not allow for a direct 1:1 linkage, requiring each dataset to be evaluated and adjusted in some way (filtering cases, aggregating vehicle body type, etc.) prior to linkage. Filtering, aggregating, and so on, can reduce the statistical power of the analysis.
- The vehicle make and model data are not released in the VIUS PUF. This omission limits linking to model year, body type, and fuel type. For example, instead of linking at the specific level of 2017 gas-powered Ford Edge and 2011 gas-powered Toyota Tundra, the linking is instead based on 2017 gas-powered SUVs and 2011 gas-powered trucks, which is a considerable reduction in analytic power.
- The current 5-year data collection cycle of VIUS makes it challenging for linking on a temporal basis with other sources, which are on an annual or biennial cycle. Possibilities exist within the temporal differences where cycles could line up.
- The 2021 VIUS is a rich dataset of nearly 68,000 vehicles. The other data sources have comparatively fewer records. These reduced number of records may limit the analyses that can be conducted.

4. References

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Appendix A. Vehicles in Datasets (by Registration and Type)

Table 3 summarizes vehicles included in each of the datasets discussed in this report and can be used in conjunction with the information depicted in Figure 1 in Section 2.5.

Table 3. Vehicles in Each Datasets by Registration and Vehicle Type

Vehicle type		Registration type				
		B	C	D	E	F
1	—	Registered to carriers	Registered to rental/leasing companies	Registered to other businesses	Registered to households and individuals	Registered to governments
2	Large commodity-carrying trucks	HSS MV tables VIUS CFS/FAF	HSS MV tables VIUS CFS/FAF	HSS MV tables VIUS CFS/FAF	HSS MV tables VIUS CFS/FAF	HSS MV tables
3	Large trucks that do not carry commodities	HSS MV tables VIUS	HSS MV tables VIUS	HSS MV tables VIUS	HSS MV tables VIUS	HSS MV tables
4	Ambulances and other specialized vehicles	HSS MV tables	HSS MV tables	HSS MV tables	HSS MV tables	HSS MV tables
5	Buses	HSS MV tables	HSS MV tables	HSS MV tables	HSS MV tables	HSS MV tables
6	Recreational vehicles	HSS MV tables (rare) NHTS when used by households (rare)	HSS MV tables NHTS when used by households	HSS MV tables (rare) NHTS when used by households (rare)	HSS MV tables NHTS when used by households	HSS MV tables
7	Pickups vans minivans SUVs	HSS MV tables VIUS NHTS when used by households (rare)	HSS MV tables VIUS NHTS when used by households	HSS MV tables VIUS NHTS when used by households (rare)	HSS MV tables NHTS when used by households	HSS MV tables NHTS when used by households (rare)
8	Sedans	HSS MV tables NHTS when used by households (rare)	HSS MV tables NHTS when used by households	HSS MV tables NHTS when used by households (rare)	HSS MV tables NHTS when used by households	HSS MV tables NHTS when used by households (rare)
9	Motorcycles	HSS MV tables NHTS when used by households (rare)	HSS MV tables NHTS when used by households	HSS MV tables (rare) NHTS when used by households (rare)	HSS MV tables NHTS when used by households	HSS MV tables NHTS when used by households (rare)

Note: Vehicles in all cells can be in FARS if the vehicle is involved in a fatal crash.
HSS = Highway Statistics Series; VIUS = Vehicle Inventory and Use Survey; CFS = Commodity Flow Survey; FAF = Freight Analysis Framework; NHTS = National Household Travel Survey.
—Not applicable.

List of Abbreviations, Acronyms, and Initialisms

BTS	Bureau of Transportation Statistics
CBSA	Core-Based Statistical Area
CFS	Commodity Flow Survey
DOT	Department of Transportation
FAF	Freight Analysis Framework
FARS	Fatality Analysis Reporting System
FHWA	Federal Highway Administration
GVWR	gross vehicle weight rating
HSS	Highway Statistics Series
NHTS	National Household Travel Survey
NHTSA	National Highway Traffic Safety Administration
PUF	Public Use File
SUV	sport utility vehicle
T13	Title 13
VIUS	Vehicle Inventory and Use Survey
VMT	vehicle miles traveled