Turbulence in Taxation: A Study on Tax Avoidance with Private Jets[*]

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Abstract

Private jets, iconic symbols of luxury, are increasingly used by the super-rich for private aviation. This study is the first to systematically analyze administrative aircraft registry data from 41 European countries and tax havens, revealing that one-third of all private jets in Europe are registered in countries which are known as tax havens such as San Marino, the Isle of Man, Guernsey, Bermuda, the Cayman Islands, Luxembourg, and Malta. Using flight data, I show that these jets rarely operate within their registered countries, instead flying primarily across other European countries while benefiting from tax exemptions, including VAT deductions. Furthermore, I find that private jets registered in tax havens disproportionately travel to vacation destinations, despite frequently being declared as corporate assets. These findings expose a systemic pattern of tax avoidance and potential tax evasion facilitated by registration in countries with minimal oversight and generous tax incentives. The results highlight an urgent need for policy reform to close these loopholes.

Keywords: tax avoidance, tax evasion, private jets

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1 Introduction

Recent years have seen growing concern over the ability of the ultra-rich to exploit legal and administrative loopholes to significantly reduce their tax burdens. While tax authorities strive to ensure equitable contributions across income groups, high-net-worth individuals continue to deploy increasingly sophisticated methods of tax minimization—often by shifting assets or activities to jurisdictions with minimal oversight. Amidst rising public pressure for tax justice and fairness, the question of where taxation should take place—in the jurisdiction of true economic activity versus where only a shell or letterbox firm is located—has become a central theme in global tax debates. This issue is particularly salient in the context of luxury assets, such as private jets, which are both highly mobile and largely inaccessible to the general population. Studying how these assets are used to avoid taxes contributes to our understanding of both inequality and the limitations of current tax enforcement frameworks.

In 2017, the Paradise Papers—a leak of documents from the offshore law firm Appleby—revealed widespread use of offshore jurisdictions by the global elite to minimize taxes and obscure asset ownership. One striking example was the registration of private aircraft in the Isle of Man, which was used by celebrities, oligarchs, and multinational executives to claim value-added tax (VAT) refunds on aircraft that were, in many cases, used primarily for private purposes within Europe. The leak spurred public outcry and political attention, prompting the European Union to launch an investigation into the United Kingdom's handling of VAT exemptions on jet imports through the Isle of Man. The European Commission concluded that the Isle of Man had facilitated systematic VAT avoidance, requesting explanations and remedial action from the UK government. Despite these revelations, rigorous academic research on the scope and mechanisms of tax avoidance through private jet registration has remained scarce.

This paper presents the first systematic analysis of private jet ownership and tax avoidance in Europe, based on a newly assembled dataset that combines administrative aircraft registry data from 41 countries with high-frequency flight tracking data (ADS-B). I identify a total of 1,902 private jets registered in Europe as of December 2024, and trace their movement patterns over time. By matching each jet's registered location with its actual flight behavior, I provide compelling evidence of jurisdictional arbitrage for the purpose of VAT avoidance.

The analysis reveals that approximately 5% of all European private jets are registered in known tax havens, including the Isle of Man, Cayman Islands, San Marino, Malta, Bermuda, and Guernsey. Crucially, the vast majority of these jets never operate in their country of registration—only 7 out of 664 jets registered in tax havens are most frequently grounded in the tax haven itself. This strongly suggests that these jurisdictions serve as paper hosts for ownership rather than genuine hubs of economic use.

Using price estimates for typical private jets, I estimate that approximately $1.05 billion in VAT has been avoided through the strategic use of tax havens over the past 15 years. Exploiting cross-country variation in VAT rates, I further show that a 1 percentage point increase in a country's VAT rate raises the probability that a jet is registered in a tax haven by 3.8 percentage points, implying an avoidance elasticity of 0.22. Taken together, these findings point to significant distortions in the location of asset registration caused by weak international

coordination and the availability of low-tax jurisdictions.

This study contributes to a growing literature on tax avoidance and the mobility of taxable assets among the wealthy. Zucman (2013) estimates that approximately 8% of the world's household financial wealth is held offshore, while Alstadsæter et al. (2018) map the distribution of such offshore wealth across countries and income groups. In a follow-up study, Alstadsæter et al. (2019) show that tax evasion is highly concentrated at the top of the wealth distribution, reinforcing concerns about equity and enforcement capacity. From a theoretical and empirical perspective, Saez et al. (2012) provide estimates of the elasticity of taxable income ranging from 0.2 to 0.4, with Slemrod (2007) emphasizing the context-dependence of these elasticities in his broader review of tax evasion literature.

Closer to the topic of this paper, Strumpf (2013) investigates how private jet owners in the United States relocate their aircraft shortly before a local "tax day," illustrating the strategic behavior that arises in response to spatial tax variation. However, to date, no study has conducted a similarly comprehensive analysis of private jet tax avoidance within Europe, despite the increasing use of aircraft registries in tax havens and the availability of high-frequency flight data.

The remainder of the paper proceeds as follows. Section 2 provides institutional background on the tax treatment of private jets and the regulatory role of aircraft registries. Section 3 describes the construction of the dataset, including administrative registry data, flight trajectories, and other auxiliary variables. Section 4 presents the main empirical findings on tax haven registrations, geographic usage patterns, and estimated tax avoidance. Section 5 explores specific case studies that illustrate common avoidance strategies. Section 6 concludes with policy implications and avenues for future research.

2 Institutional Background

The purchase and operation of private jets in Europe is subject to a complex and often opaque tax framework. In principle, when a private individual acquires a jet and uses it - even partially - for personal or leisure purposes, the transaction is subject to value-added tax (VAT). The VAT is levied on the full purchase price of the aircraft. However, if the owner establishes a legal entity that claims to use the aircraft exclusively for business purposes, depending on the country the jet is registered, it is possible to deduct the VAT or even obtain a full VAT refund. This creates a strong tax incentive to formalize the jet's use as commercial, even if the actual usage is predominantly private.

Most European countries have implemented controls to verify the true usage of jets. For instance, in Switzerland, aircraft owners are required to submit detailed flight activity logs to the tax authorities. These records are used to assess whether the declared business use is credible or whether the aircraft is, in practice, being used for private travel. Other countries enforce minimum thresholds for business use—often stipulating that at least two-thirds of flights must be business-related to qualify for favorable tax treatment. However, enforcement intensity and legal definitions of "business use" vary widely across countries, leaving significant room for interpretation and evasion.

In the United Kingdom, VAT law requires a clear distinction between business and pri-

vate use, and the entitlement to reclaim VAT hinges on robust record-keeping, such as detailed flight logs and passenger manifests. Without such documentation, tax authorities can deny input VAT recovery or reclassify usage as private, triggering additional liabilities. This highlights how VAT treatment not only affects the cost of acquisition and operation but also creates strong incentives for aircraft owners to structure usage and registration strategically, often seeking jurisdictions with more favorable or less strictly enforced rules.

This institutional environment has led to a proliferation of aggressive tax planning strategies among the super-rich. As revealed in the Paradise Papers, it is common for wealthy individuals to establish offshore companies in jurisdictions such as the Isle of Man, Guernsey, or Malta, where tax enforcement is lenient. These firms are often managed by local nominees or consulting companies who provide ready-made corporate structures and offer services such as hiring local directors or arranging fictitious leases. Such arrangements allow the private jet to be registered in a tax haven, thereby minimizing or entirely avoiding VAT obligations in the owner's country of residence.

Importantly, the location where the aircraft is registered plays a central role in determining the applicable tax treatment. Most European countries require that a jet be registered either by a citizen or a corporation of that country. By using shell companies in tax havens, aircraft owners can bypass this requirement while benefiting from favorable tax regimes. Yet, flight data shows that jets registered in tax havens rarely, if ever, operate from or within these jurisdictions—an indication that the registration is primarily for tax purposes rather than operational convenience.

In addition to VAT, private jets may also be subject to other taxes such as corporate profit taxes or duties on aviation fuel and services. However, these levies tend to be smaller and are often limited to domestic flights. The present study focuses exclusively on VAT liabilities at the point of purchase, as this represents the most substantial and immediate tax burden for jet owners. Given the high transaction values involved, the potential for VAT avoidance through strategic registration and usage claims is both significant and economically relevant.

3 Data

3.1 Aircraft Registry Data

This study builds on a uniquely assembled dataset of aircraft registry data from 41 European countries. The data provide detailed information on aircrafts that were registered and operational as of the end of 2024. My aim is to comprehensively identify the universe of private jets registered across Europe, with particular attention to those used for potential tax planning purposes.

For nine countries—Bermuda, Finland, Germany, Greece, Italy, Monaco, Poland, Romania, and San Marino—I rely on aircraft data collected via the OpenSky Network. The OpenSky Network is an open-source platform that aggregates air traffic surveillance data, including a database of aircraft information observed in European airspace. While the data from OpenSky is somewhat limited in scope, it provides basic aircraft characteristics and sufficient identifiers for integration with the rest of the dataset.

For the remaining 32 countries, I collected official aircraft registry data directly from national civil aviation authorities or publicly accessible administrative sources. These registries typically include the following variables: aircraft manufacturer and model, serial number, maximum takeoff mass (in kilograms), year of construction, date of registration, last modification date, home base airport, number of passenger seats, transponder type, previous registration history, as well as information on legal ownership, operator, and contract type (e.g. leasing arrangements). A full list of variables and the country-specific sources is provided in the Appendix.

The reference date for the data collection is December 31, 2024. For each country, I used the version of the aircraft registry that was most current and available as of this date. In cases where only earlier registry snapshots were accessible, I selected the entry closest to this cut-off date to ensure consistency across countries.

To identify business jets among the registered aircraft, I matched the collected models with the Aircraft Product List 2024 published by the European Union Aviation Safety Agency (EASA). EASA is the EU's regulatory authority for civil aviation safety, certification, and environmental standards. Its Aircraft Product List includes a classification of aircraft types, including a list of models typically used for business aviation. According to EASA, only models produced by Bombardier, Gulfstream, Embraer, Dassault, and Textron (which includes Cessna and Beechcraft) are considered business jet manufacturers. The specific model names used for filtering are listed in the Appendix.

After applying this classification, I identified a total of 1,901 private jets registered across the 41 European countries in my sample. These jets form the core of my analysis in subsequent sections, where I investigate registry patterns, country-level ownership characteristics, and potential tax avoidance behavior.

3.2 Flight Data

To analyze the real-world movement and usage of registered private jets, I rely on high-frequency flight data derived from ADS-B (Automatic Dependent Surveillance–Broadcast) signals. ADS-B has become the global standard for aircraft surveillance over the past 15 years. In contrast to traditional primary radar systems, ADS-B is significantly more cost-effective, offers greater accuracy, and transmits a broader set of real-time information—such as aircraft altitude, geographic coordinates, velocity, vertical speed, and call sign. These advantages have led to its widespread adoption in civil aviation oversight.

However, despite ADS-B's technical transparency, access to data on private jet flights remains institutionally constrained. In the United States, the Federal Aviation Administration (FAA) operates the Aircraft Situation Display to Industry (ASDI), which allows non-commercial aircraft owners to request that their flights be included on a so-called "blocking list." This list restricts the visibility of affected aircraft in data feeds made available to third-party services. Most commercial tracking platforms, including Flightradar24, comply with this list—either voluntarily or under pressure from the FAA, which has threatened to limit cooperation with non-compliant providers.

Only a few platforms—most notably ADS-B Exchange and the OpenSky Network—do not enforce such restrictions and make available data on otherwise "blocked" aircraft, includ-

ing some military and high-profile private jets. Consequently, these sources are particularly valuable for studying ownership structures and travel behavior among wealthy individuals seeking discretion.

A study by researchers at the University of Oxford (Pfeffer et al. 2018) highlights the extent of this opacity. Analyzing a random sample of 500 aircraft, they find that 56% of business aircraft are mitigated by ASDI blocking, and that 68.6% obscure their ownership through the use of shell companies. Nonetheless, the authors conclude that blocking is not an effective privacy tool, as platforms such as OpenSky and ADS-B Exchange continue to display this information—and, paradoxically, the attempt to conceal aircraft often draws additional attention from planespotters and aviation enthusiasts.

For this study, I use flight data from the OpenSky Network. While its global coverage is not as extensive as that of ADS-B Exchange or commercial providers like FlightAware or Flightradar24, its coverage over Europe and the United States—the two most important regions for private jet activity—is sufficiently dense for the purposes of this analysis. Together, these two regions represent over 95

The OpenSky flight data includes high-resolution records of each aircraft's movements, identified by the aircraft's unique 24-bit ICAO address (icao24). For each detection, the dataset contains key variables such as timestamp, latitude, longitude, barometric altitude, ground speed, vertical rate, and heading. By combining consecutive signals, I reconstruct flight routes and identify flight origins and destinations based on the first and last position signals per flight. These reconstructed trajectories form the basis for evaluating aircraft usage patterns—such as frequency of travel, geographic dispersion, and alignment with declared registry countries.

[Insert summary table here]

In addition to flight trajectories, OpenSky provides a regularly updated list of currently active aircraft, including information on registration numbers and transponder codes. This information is used to augment the administrative registry data described in Section 3.1. A cross-check between OpenSky aircraft metadata and the official registries confirms a high degree of consistency for those countries where both datasets are available, further validating the reliability of the OpenSky platform as a source for private jet tracking in Europe.

3.3 Airport Data

To analyze private jet traffic and identify the locations most frequently visited by the aircraft in the registry, I construct a comprehensive airport database, drawing on multiple sources to ensure full coverage and accuracy. Given that private jets frequently use smaller airports or specialized business aviation hubs—such as Paris Le Bourget or Farnborough—it is crucial to include not only major commercial airports but also smaller aerodromes and regional facilities that may not appear in standard commercial databases.

Airport identification is based on the ICAO (International Civil Aviation Organization) coding system, which assigns a unique four-letter identifier to every aerodrome worldwide. While IATA codes are more commonly used in commercial passenger aviation (e.g. for baggage routing), ICAO codes offer broader coverage, including small and private airfields. As

a result, all airport-level analysis in this study relies on ICAO codes to ensure that private jet activity at smaller or non-commercial airports is fully captured.

A particular challenge arises from incomplete flight data in which arrival or departure airports are missing. In such cases, I rely on the latitude and longitude coordinates recorded in the flight data to approximate the nearest airport. This matching allows me to assign flights to geographic destinations even in the absence of explicit ICAO codes, improving coverage for smaller or private landing strips.

To assemble the airport dataset, I followed a multi-step procedure combining automated API queries, manual validation, and cross-referencing across several data sources: 1. First, I extracted a list of all ICAO airport codes appearing in the OpenSky flight dataset, ranked by frequency of use. This was done via a custom R script in the project's OpenSky data folder. 2. I then registered with the ICAO Data Services API to access the "Aerodrome Location Indicators" (dataset no. 17), which provides metadata on all aerodromes by country. Using country ISO3 codes, I downloaded full CSV files for each country and merged them using a Python script. 3. These records were incorporated into a structured Excel sheet containing key attributes such as ICAO code, airport name, geographic coordinates (latitude and longitude), and associated country. 4. To improve coverage for frequently visited airports not found in ICAO or OpenSky datasets, I used the OpenSky Network's online airport profiles (https://opensky-network.org/airport-profile) and additional metadata from OurAirports (https://ourairports.com/data/). 5. For any remaining unmatched airports (typically those with at least 10 observed arrivals or departures), I queried the METAR-TAF aviation weather API and consulted publicly available sources such as world-airport-codes.com and manual Google searches. This step addressed missing entries due to outdated codes or inactive aerodromes. 6. Country ISO2 codes were linked using a separate mapping file, and special cases—such as Guernsey Airport, Rimini Fellini Airport, and Isle of Man Airport—were manually corrected and flagged for transparency. The Cayman Islands were excluded due to the absence of relevant traffic in the data.

The final airport dataset includes all aerodromes visited by private jets in the sample, along with their location data and country identifiers. This comprehensive mapping forms the basis for subsequent analysis of travel patterns, distance calculations, and destination classifications (e.g. business vs. leisure). A summary of visited airports, including frequency of arrivals and departures, is provided in the appendix. A map visualization of the most visited destinations complements the statistical overview.

3.4 Linking Up

A key methodological challenge in this study is the alignment of administrative aircraft registry data with flight trajectory data from ADS-B surveillance. While registry data provide detailed information about ownership, aircraft specifications, and registration identifiers, flight data are structured differently and lack persistent identifiers that can be directly matched.

Aircraft registries typically identify each aircraft by its registration mark, a national identifier analogous to a vehicle license plate. These marks are composed of a country-specific prefix (e.g. "M-" for the Isle of Man, "D-" for Germany) followed by a sequence of up to four alphanumeric characters. However, registration marks are not permanent: they can be reas-

signed to different aircraft by the relevant civil aviation authority once an aircraft is sold or decommissioned. Therefore, they are not suitable for long-term or international identification of individual aircraft.

In contrast, flight data derived from ADS-B transmissions identify aircraft by their unique 24-bit transponder address, known as the icao24 code. This address, issued under standards developed by the International Civil Aviation Organization (ICAO), is globally unique and allows for consistent identification of a specific aircraft in the context of air traffic surveillance. However, even the icao24 code may change over time—for example, when the aircraft is transferred to a new owner, re-registered in another country, or fitted with a new transponder.

To ensure accurate linkage between registry and flight data, I rely on a combination of open-source aviation databases and enthusiast-curated platforms. These include the OpenSky Network aircraft metadata, as well as third-party databases such as Planespotters.net and Airframes.org. These platforms aggregate and verify historical records from aviation spotters, including photographs of aircraft with visible registration marks, associated icao24 addresses, and manufacturer details. This community-driven data is particularly valuable for historical matching, as it often documents transitions in registration or ownership that may not yet be reflected in official databases.

By triangulating across these sources, I match each aircraft in the administrative registry data (identified by registration mark and aircraft model) to its corresponding icao24 transponder code in the ADS-B flight data. This matching allows me to observe flight behavior at the aircraft level, while preserving the correct link to the owner and registration status at the time of observation. Special care is taken to avoid conflating different aircraft that may have shared the same registration mark at different points in time.

This multi-source linkage enables a high-quality dataset that connects legal aircraft registration with real-world usage patterns, forming the empirical foundation for analyzing tax-related behavior of private jet owners in Europe.

3.5 Other variables

In addition to registry and flight data, the empirical analysis draws on several external sources to account for institutional, demographic, and economic heterogeneity across countries and destinations. These variables are used both to characterize the tax and economic environment in which private jets are registered and operated, and to interpret behavioral patterns in jet usage.

To capture country-level tax policy relevant to aircraft ownership, I use value-added tax (VAT) rates from the Tax Foundation (2024), which provides harmonized VAT data for all European countries. These rates are used to estimate the tax burden associated with the acquisition of a private jet, which is one of the central concerns of this study. Additionally, I incorporate statutory corporate income tax rates from the OECD (2024) to reflect the overall tax environment faced by companies that may be used as legal entities for jet registration.

To evaluate the role of secrecy jurisdictions in enabling tax avoidance, I include the Tax Haven Index published by the Tax Justice Network (2024). This index measures the extent to which a jurisdiction facilitates corporate tax abuse through low or zero tax rates, weak regulatory oversight, and financial secrecy. Countries with high index scores are more likely

to offer structures that allow private jet owners to obscure beneficial ownership or reduce tax liabilities.

As a demographic control, I use population data from the World Bank (2024) This allows for normalization in descriptive statistics—for instance, computing the number of registered private jets per capita or per million residents.

To approximate the economic value of each aircraft, I compiled private jet price estimates from a variety of publicly available aviation trade magazines and online marketplaces. These prices represent the typical market value of a ten-year-old business jet by manufacturer and model, which corresponds roughly to the average aircraft age in the registry. The resulting price estimates are used to scale potential tax savings from VAT deductions and to evaluate the concentration of high-value assets across countries.

Finally, to analyze the purpose of jet travel—particularly whether destinations serve leisure or business functions—I developed a classification of cities with airports. Using a combination of heuristic rules and iterative refinement via ChatGPT, I classified each city into one of four categories: (1) business, (2) leisure, (3) mixed business/leisure, and (4) other (e.g. military bases, farms, or technical airstrips). This classification enables analysis of flight patterns and usage intensity across different types of destinations, providing insight into whether jets registered in tax havens are predominantly used for business purposes, as often claimed for tax compliance, or for personal leisure.

4 Main Results

4.1 Other variables

A first look at the distribution of private jets in Europe reveals significant variation in registration patterns across countries. As shown in Figure 1, the largest absolute number of private jets is registered in Germany, followed by the United Kingdom, France, and Switzerland. However, among the top countries is also the Isle of Man, a jurisdiction with fewer than 90,000 residents, but with one of the highest concentrations of jet registrations in Europe. This initial observation suggests that population size alone does not explain the prevalence of private jet ownership in a country.

To adjust for population and better capture registration intensity, Figure 2 reports the number of private jets per million inhabitants. The picture becomes even more revealing: the highest concentrations are found in small jurisdictions commonly associated with tax benefits and regulatory leniency, such as San Marino, the Isle of Man, the Cayman Islands, Guernsey, Bermuda, and Malta. These countries, despite their limited domestic markets and often lacking large aviation sectors, host disproportionately high shares of Europe's private jets.

The case of San Marino is particularly striking. Although it ranks among the highest in jets per capita, San Marino does not operate its own airport. Instead, it shares access to Federico Fellini International Airport in nearby Rimini, Italy, highlighting the symbolic rather than functional role of the registration. A similar situation holds for Monaco, another high-income microstate with no airport infrastructure of its own; private jet traffic serving Monaco

typically uses Nice Côte d'Azur Airport in France. These examples reinforce the notion that jet registration in such locations is unlikely to reflect real operational use, and more plausibly reflects strategic registration choices motivated by favorable tax treatment or lax oversight.

A different but related pattern can be observed in Portugal, a country with a moderate number of registered jets but a rapidly growing role in the European business aviation market. The presence of NetJets, a private aviation firm that offers fractional jet ownership schemes, has contributed to this development. Through such programs, ultra-wealthy individuals purchase a share of a jet in exchange for a guaranteed number of flight hours per year. NetJets is believed to operate through Madeira, a Portuguese autonomous region with preferential tax treatment, which likely enhances the financial attractiveness of Portuguese registration. In recent years, the Portuguese government has actively encouraged the registration of international jets and yachts, positioning the country as a business-friendly and strategically located jurisdiction for asset registration.

Together, these patterns underscore a central finding of this paper: the location of private jet registration often bears little relation to actual usage or economic activity. Instead, it reflects a combination of legal arbitrage, tax minimization, and the availability of low-friction registration services. In the following sections, I quantify the extent to which such practices contribute to tax avoidance and explore how they respond to tax incentives.

In addition to documenting the country of registration, this study provides an overview of the manufacturers and models of private jets operating in Europe. As shown in the appendix, Cessna, Bombardier (Canada), Dassault (France), and Gulfstream (United States) dominate the European market. Among them, Bombardier, Gulfstream, and Dassault are widely regarded as premium manufacturers, associated with long-range, high-performance aircraft. When looking at individual models, the Bombardier BD-700 series stands out as the most active and frequently flown aircraft in the dataset.

Importantly, Figure A3 in the Appendix provides further evidence on the relationship between aircraft quality and tax avoidance: tax havens consistently show a higher share of jets from premium manufacturers such as Bombardier, Gulfstream, and Dassault. This pattern suggests that the more valuable the aircraft, the stronger the incentive for strategic registration in low-tax jurisdictions, given the substantial VAT liabilities that can be avoided on high-end jet purchases. These findings reinforce the interpretation that registration location is not random, but systematically related to the size of potential tax savings.

A full breakdown of aircraft by manufacturer and model can be found in Figures A1 to A3 in the Appendix.

4.2 VAT rate

A central hypothesis of this paper is that the registration of private jets is responsive to value-added tax (VAT) incentives, particularly through the strategic use of low-VAT jurisdictions. To test this, I examine the relationship between a country's net-of-VAT rate—defined as 1 - VAT rate—and the number of registered private jets per million inhabitants.

As shown in Figure 4, there is a strong and statistically significant positive relationship between the log number of jets per capita (demeaned) and the log net-of-VAT rate (demeaned). The slope coefficient of the linear fit is 22.39, with a robust standard error of 2.02, implying that

Figure 1: Private Jets per Country

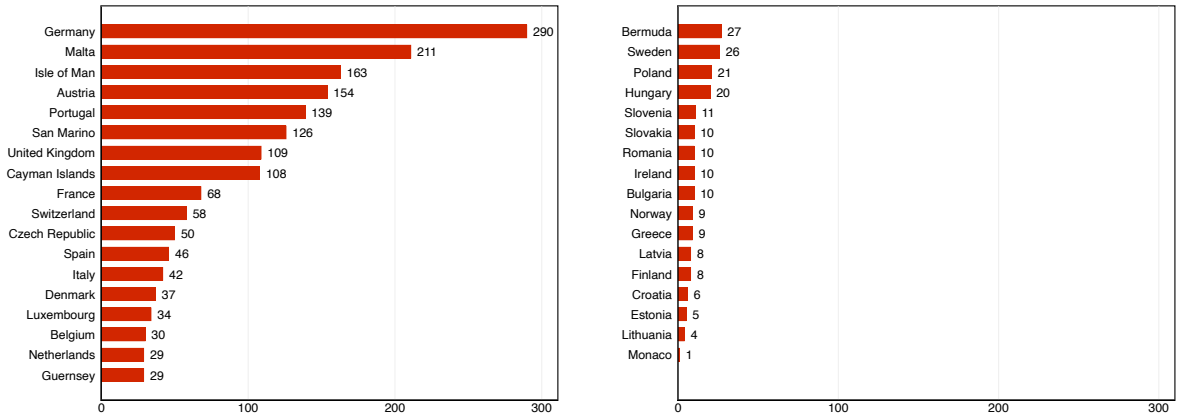


Figure 2: Private Jets per 1 Million inhabitants per country

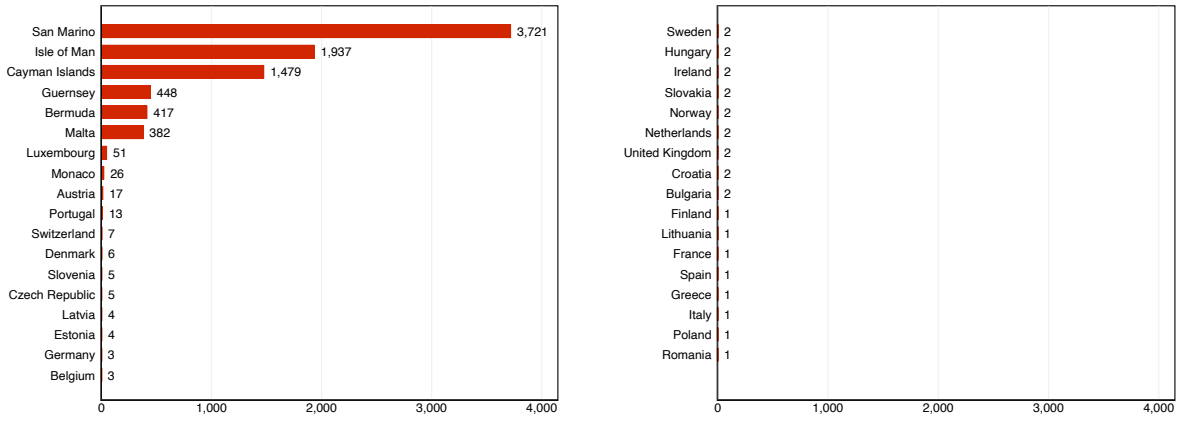
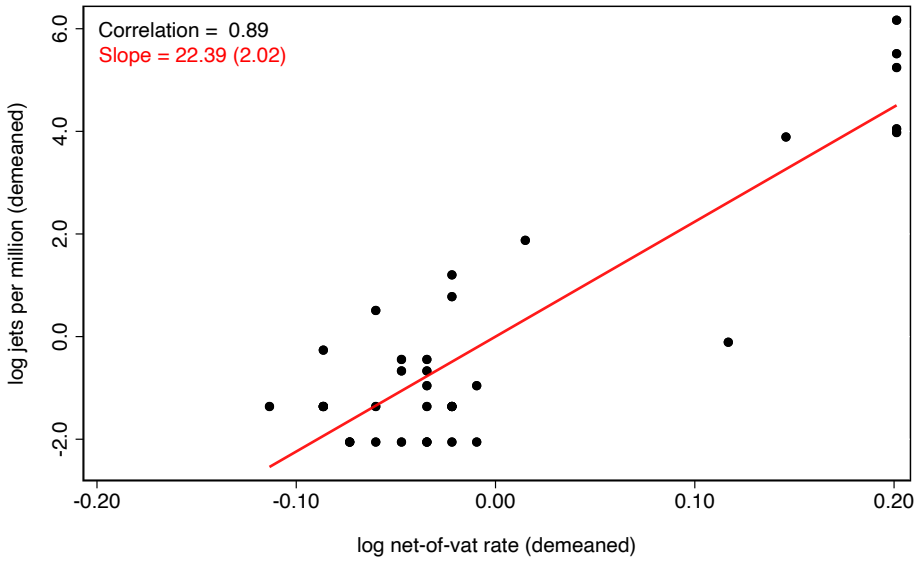


Figure 3: Caption



a one-percentage-point increase in the net-of-VAT rate is associated with a markedly higher jet density. The correlation coefficient is 0.89, indicating a very tight linear relationship between the two variables.

This finding provides compelling support for the view that VAT differentials across countries are a powerful determinant of where private jets are registered, consistent with economic models of tax-induced mobility of capital assets. It further underscores the elasticity of private jet registration behavior in response to fiscal incentives, reinforcing the broader conclusion that the current regulatory framework enables substantial tax planning opportunities through jurisdictional arbitrage.

In addition to VAT incentives, I examine other country-level factors that may explain the geographic concentration of private jet registrations. Figure 5 in the Appendix presents analogous relationships between the number of jets per million inhabitants and (i) the statutory corporate income tax rate, (ii) the Tax Haven Index, and (iii) the Tax Haven Score, a measure of financial secrecy and regulatory laxity compiled by the Tax Justice Network. All three indicators display similar patterns to the VAT analysis: jurisdictions with lower tax rates, lower transparency, and higher haven scores tend to register disproportionately more private jets.

These findings suggest that tax havens do not merely offer low VAT rates, but instead exhibit a systematic positioning strategy—combining low statutory rates, minimal disclosure requirements, and ease of firm establishment—to attract high-net-worth individuals and mobile assets. The consistency of these patterns across multiple dimensions of tax and regulatory policy reinforces the interpretation that strategic jet registration is part of a broader form of legal tax arbitrage, enabled by institutional and policy choices in these jurisdictions.

4.3 Where Are the Jets Really Used? Evidence from Grounding Behavior

A common counterargument to the idea that private jet registration in tax havens reflects tax avoidance is that owners of such jets may actually reside in these jurisdictions, for instance

to minimize personal income taxes. If this were the case, we would expect to observe their aircraft regularly operating from, or being grounded in, the country of registration. To test this, I analyze detailed ADS-B flight data for all jets in the registry over a two-year period (2023–2024), focusing on the location where each aircraft is most frequently grounded.

Figure 6 examines the extensive margin—i.e., the share of aircraft that are mostly grounded in their country of registration. Among the larger EU countries such as Spain, Italy, France, and the United Kingdom, a large majority of jets are indeed predominantly based domestically, with shares above 90%. However, a stark contrast emerges for the group of countries classified as tax havens. For example, not a single jet registered in the Cayman Islands, Bermuda, San Marino, or the Isle of Man was grounded primarily in the country of registration over this two-year period. Even in Malta and Guernsey, which host relatively large registries relative to their size, fewer than 5% of registered jets are actually based there. This strongly suggests that the decision to register in these jurisdictions is not driven by real geographic proximity or residence, but rather by regulatory and fiscal considerations.

To further explore the intensity of aircraft use across jurisdictions, Figure 7 considers the intensive margin, measuring the share of total grounded hours that each aircraft spends in its country of registration. The results reinforce the earlier finding: while jets registered in France, Spain, and Italy spend the overwhelming majority of their grounded hours domestically (e.g., 85.4% in France), aircraft registered in the Cayman Islands, San Marino, the Isle of Man, Guernsey, and Bermuda are overwhelmingly based abroad. In the case of the Cayman Islands, jets spent 100% of their grounded hours outside of the jurisdiction in which they are registered.

This behavior is difficult to reconcile with a model in which registration follows the location of the owner or operator. Instead, these findings are consistent with the interpretation that registration in tax havens serves a symbolic, legal, or tax-structuring function, while the actual operation of the jet occurs elsewhere. The systematic divergence between the place of registration and the place of economic activity further supports the view that these are not random coincidences, but rather purposeful strategies to minimize tax liabilities by exploiting cross-jurisdictional regulatory differences.

4.4 Estimating VAT Avoidance on Jet Purchases

To assess the fiscal implications of private jet registration in tax havens, I estimate the value-added taxes (VAT) that are avoided at the point of purchase. Given that VAT is typically levied on the full transaction value of the aircraft when acquired for private use, even small differences in registration location can translate into substantial foregone tax revenue for high-value assets such as business jets.

I approximate the market value of each jet using a dataset of aircraft prices collected from a range of industry magazines and jet brokerage platforms. To account for depreciation, I use machine learning tools to generate AI-assisted price estimates for a typical 10-year-old pre-owned jet, which reflects the average age structure of aircraft in the registry. This approach provides a conservative estimate of value, as newer jets tend to be substantially more expensive and are more likely to be associated with tax planning efforts.

As shown in Figure 8, there is significant cross-country variation in the average value of registered jets. Strikingly, the highest jet prices are observed in tax haven jurisdictions,

Figure 4: Caption

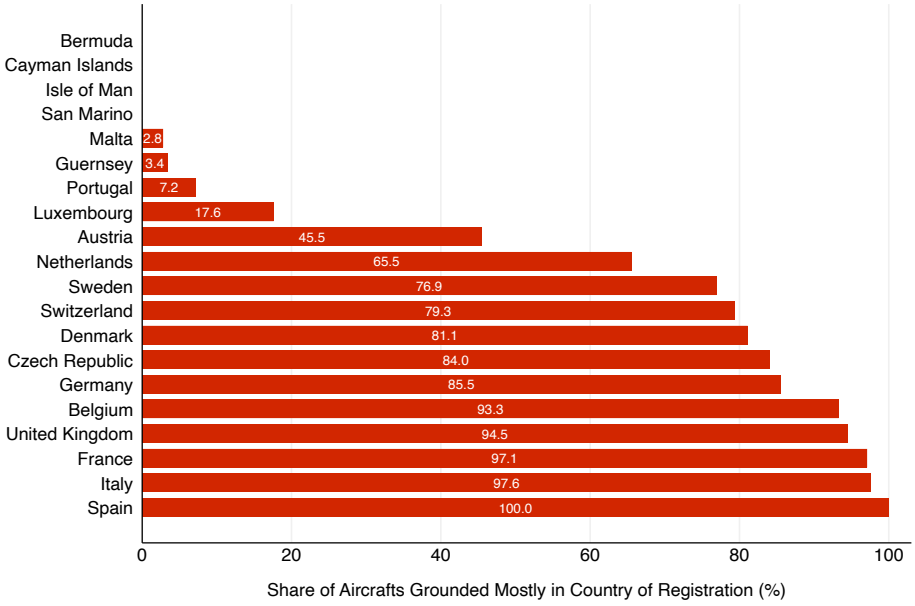


Figure 5: Caption

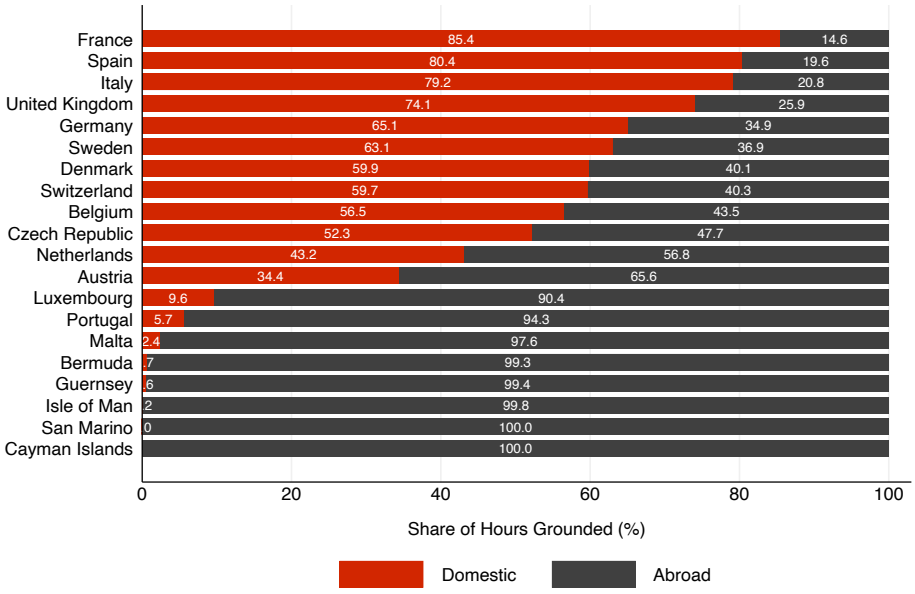


Figure 6: Caption

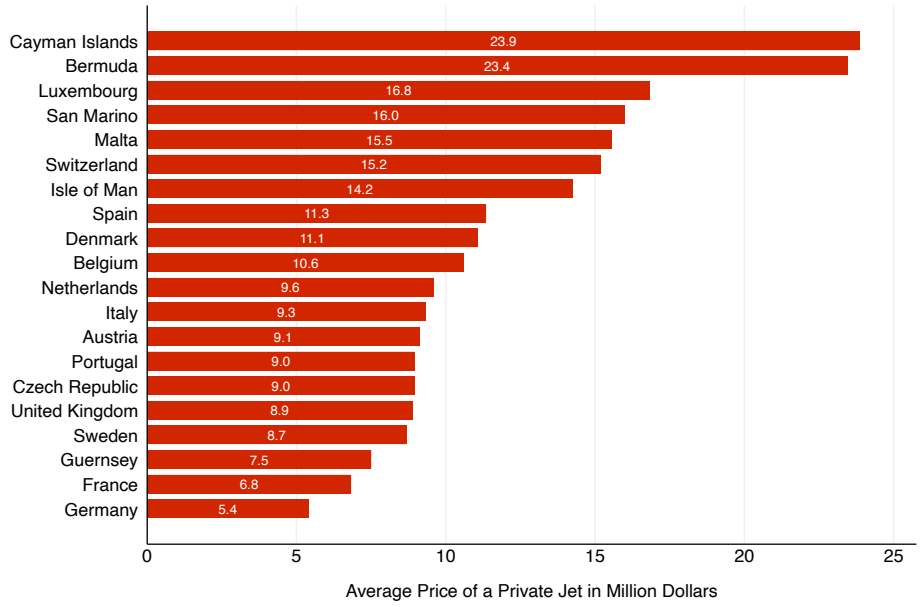
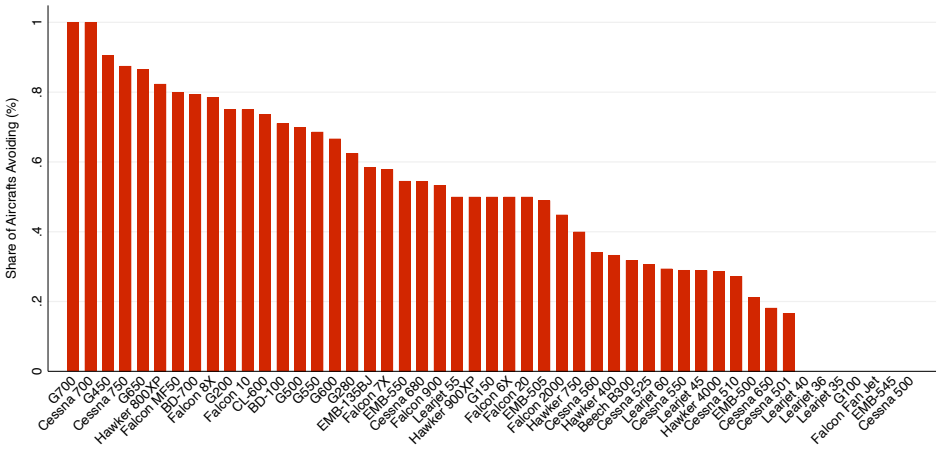


Figure 7: Caption



including the Cayman Islands (ca.$24M), Bermuda, Luxembourg, San Marino, and Malta, all well above the European average. In contrast, countries such as Germany, France, and the UK—which host the largest registries in absolute terms—exhibit lower average jet values between $5M and $7M.

These price differentials are not random. Jets registered in tax havens are often ultra-luxurious aircraft with customized interiors, enhanced technical features, and premium delivery specifications. Furthermore, anecdotal evidence suggests that first-time registration is a particularly relevant moment for avoidance behavior, especially when a new aircraft is purchased directly from the manufacturer. Since VAT is levied as a one-off tax at the time of purchase or importation, the marginal benefit of avoidance increases sharply with aircraft value, making high-end purchases the most tax-sensitive.

This mechanism is further illustrated in Figure A4 in the Appendix, which presents a scatter plot of the log price of each jet model against the share of those models registered in countries with lower VAT rates than the owner's likely residence country. The relationship is statistically strong, with a slope of 0.17 (s.e. 0.03) and a correlation of 0.64. This figure confirms that more expensive jets are disproportionately registered in low-VAT jurisdictions, highlighting the central role of asset value in driving avoidance behavior.

Based on these price estimates, I compute a lower-bound estimate of foregone VAT revenues by applying the statutory VAT rate of the aircraft owner's likely country of residence to the observed price differential. Under conservative assumptions—treating all aircraft as if they were 10 years old and ignoring potential inflation in value due to new purchases—I estimate that approximately $1.05 billion USD in VAT has been avoided over the past 15 years due to registration in tax havens.

It is important to note that this estimate is likely highly conservative. It excludes several factors that could drive the true tax gap higher: (i) many aircraft are likely newer and more expensive than the 10-year benchmark; (ii) avoidance incentives are likely stronger for high-end jets, which are disproportionately concentrated in tax havens; and (iii) jets that would not have been purchased absent the tax benefit are not accounted for. However, this analysis focuses solely on the taxes avoided among jets that are observed, thereby providing a lower-bound estimate of the fiscal cost of registry-based avoidance behavior.

4.5 Who Bears the Cost? Countries Most Affected by VAT Avoidance

The economic cost of tax haven registrations does not fall on the tax havens themselves but on the countries where the aircraft are primarily based and used—the so-called ground countries. By identifying the actual operational base of each aircraft and comparing it to the registration country, I estimate where jets would have been registered in the absence of avoidance. Table 1 lists the countries most affected by this behavior.

The data show that the United Kingdom, France, and the United States are the most affected jurisdictions, together accounting for nearly 500 jets that are currently registered offshore but appear to be predominantly grounded in their territory. These countries are followed by Germany, Switzerland, the United Arab Emirates, Italy, and Singapore. The list reflects a combination of high-net-worth resident populations, developed aviation infrastructure, and high VAT rates, which together create both a strong incentive for avoidance and a

substantial revenue loss for domestic tax authorities.

This reinforces the policy relevance of the findings: tax avoidance through jet registration is not a marginal phenomenon. It systematically shifts taxable activity away from large, high-tax economies toward small jurisdictions offering low transparency and minimal fiscal obligations.

4.6 Estimating the Tax Elasticity of Avoidance

To quantify how responsive private jet owners are to cross-country tax differentials, I estimate a linear probability model that explains whether a jet is registered in a tax haven as a function of the VAT rate differential and jet characteristics. The regression equation is specified as:

$$\text{avoid}_i = \beta_0 + \beta_1 \Delta t_i + \beta_2 \ln(\text{price}_i) + \text{FE}_i + u_i, \tag{1}$$

where:

- avoid_i: a binary variable equal to 1 if the aircraft is registered in a tax haven, 0 otherwise;
- Δt_i: the VAT differential between the country where the aircraft is most frequently grounded (ground country) and the registry country, measured in percentage points;
- $\ln(\text{price}_i)$: the natural logarithm of the aircraft's price;
- FE_i: fixed effects, including country, manufacturer, or model;
- u_i: the error term.

To calculate the tax avoidance elasticity with respect to VAT, I use the following transformation:

$$\eta = \beta_1 \cdot \frac{\overline{\Delta t_i}}{\overline{\text{avoid}_i}}, \tag{2}$$

where $\overline{\Delta t_i}$ and $\overline{\text{avoid}_i}$ are the sample means of the VAT differential and the avoidance dummy, respectively.

The regression results are summarized in Table 1. Across all specifications, the coefficient on Δt_i is approximately 3.8 and statistically significant at the 0.1% level. This implies that a one-percentage-point increase in the VAT differential increases the likelihood of registering in a tax haven by 3.8 percentage points. Using sample means, this corresponds to an avoidance elasticity of approximately 0.22.

Table 1: Linear Probability Model Estimating VAT Avoidance

	(1)	(2)	(3)	(4)
Δt_i	3.84***	3.77***	3.84***	3.80***
	(0.43)	(0.42)	(0.39)	(0.39)
$\ln(\text{price}_i)$	0.05***	0.01	0.01	-1.35
	(0.01)	(0.01)	(0.01)	(1.06)
Country FE	✓	✓	✓	✓
Manufacturer FE		✓	✓	✓
Model FE			✓	✓
R^2	0.634	0.641	0.657	0.673
Observations	1,902	1,902	1,902	1,902

Notes: Standard errors clustered at the ground country level.

Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

5 Case Studies

tbc

6 Discussion

This study provides new empirical evidence on the strategic use of tax haven registrations for private jets in Europe. While the data and results strongly support the interpretation that tax differentials drive avoidance behavior, several limitations warrant a cautious interpretation of the findings.

First, the empirical strategy relies on observed flight data to identify the country in which a jet is predominantly grounded—referred to here as the *ground country*. While this is a pragmatic proxy for the economic nexus of the aircraft, it does not capture all relevant legal or tax details, such as corporate residency of the owner, beneficial ownership structures, or actual locations of usage agreements. These dimensions are largely unobservable in public data and may introduce measurement error in identifying the "correct" registration location.

Second, price estimates are based on market values for 10-year-old jets, which may underestimate the true tax base for newer aircraft. While this choice makes the estimated tax gap conservative, it also leaves open the possibility that jets registered in tax havens are on average newer, larger, and more customized—thereby biasing tax avoidance estimates downward. Conversely, it is also possible that in the absence of tax havens, some of these jets would not have been purchased at all, meaning that part of the tax base may be endogenous to the policy environment.

Third, although the linear probability model used to estimate tax elasticity is intuitive and transparent, it assumes a homogeneous response across all aircraft types and owners. In reality, avoidance behavior may vary depending on aircraft size, individual tax planning strategies, or owner-level characteristics (e.g., firms vs. individuals), which are not observable

in the data. Further work could explore these heterogeneities using microdata on ownership structures, financing arrangements, or leasing contracts.

Finally, the analysis focuses solely on VAT avoidance at the time of purchase. It does not consider other channels of aviation-related tax avoidance, such as corporate income shifting, fuel exemptions, or depreciation-related deductions. Hence, the 1.05 billion figure likely underestimates the total fiscal cost associated with private jet tax planning in Europe.

Despite these limitations, the findings underscore an important pattern: the location in which a jet is registered often bears little relation to where it is actually based or used. This creates significant distortions in the allocation of tax revenue and calls into question the fairness and efficiency of the current international taxation framework for mobile luxury assets.

7 Conclusion

This paper provides the first systematic analysis of private jet registration and tax avoidance behavior in Europe. By assembling a novel dataset of 1,902 private jets across 41 countries and linking administrative registry data with high-frequency flight surveillance records, the study uncovers substantial evidence of tax-motivated registration behavior.

Approximately 5% of all European private jets are registered in tax havens, yet the overwhelming majority of these aircraft are neither based in nor frequently operate within the jurisdiction of registration. This pattern is particularly pronounced in jurisdictions such as the Cayman Islands, Isle of Man, Malta, and San Marino. The data reveal that these jurisdictions host disproportionately expensive jets, likely reflecting an effort to avoid substantial VAT liabilities associated with new or high-end aircraft.

Econometric analysis confirms that the probability of registering in a tax haven increases significantly with the VAT differential between the ground country and the registration country. The estimated elasticity of avoidance with respect to the VAT gap is 0.22, suggesting meaningful behavioral responses to cross-country tax incentives.

The results have clear policy implications. They highlight the need for stronger international cooperation and transparency in the registration and taxation of mobile assets. Policymakers should consider harmonizing VAT treatment of aircraft imports or implementing destination-based rules that better reflect the location of economic use. Absent such reforms, tax havens will continue to erode the fiscal base of high-tax jurisdictions through regulatory arbitrage.

Overall, the study demonstrates how luxury mobility assets like private jets can be used to exploit legal gaps between jurisdictions, and contributes to broader debates on tax fairness, enforcement, and global inequality.

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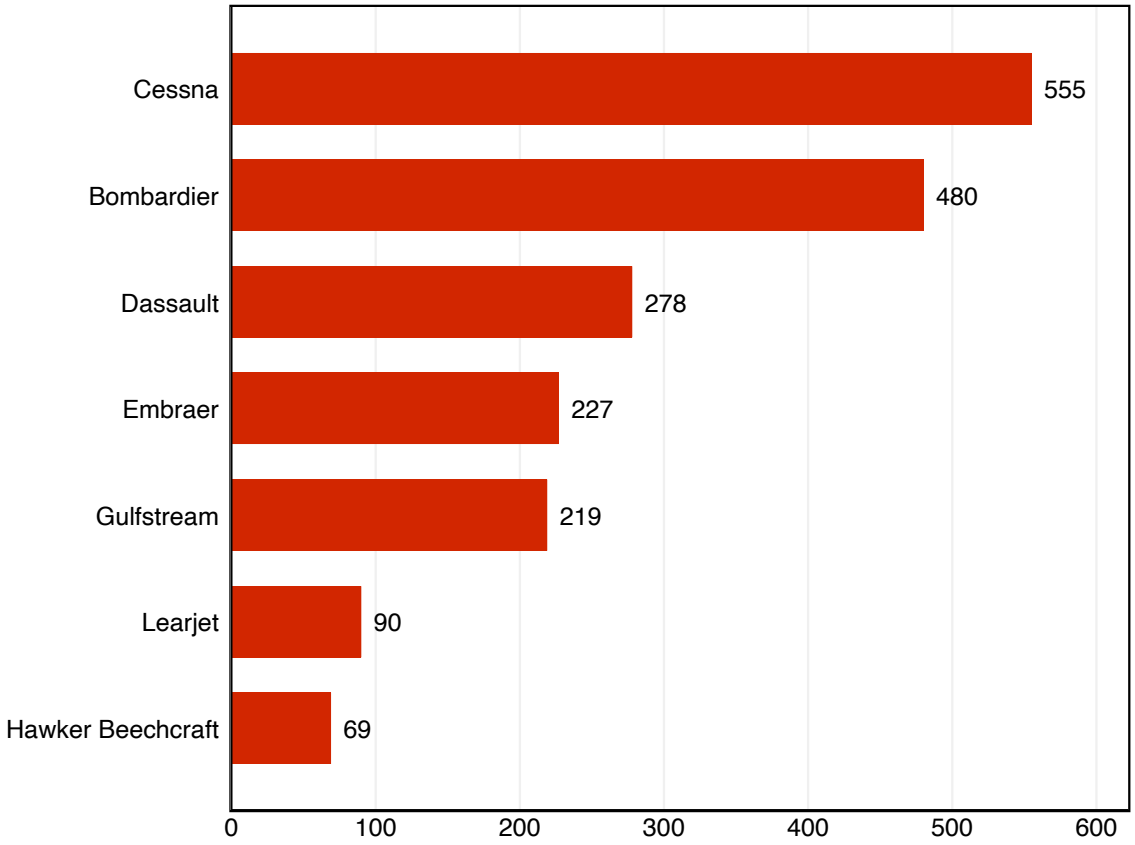
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Figure 8: Caption



A Appendix

A.1 Related empirical literature

Figure 9: Caption

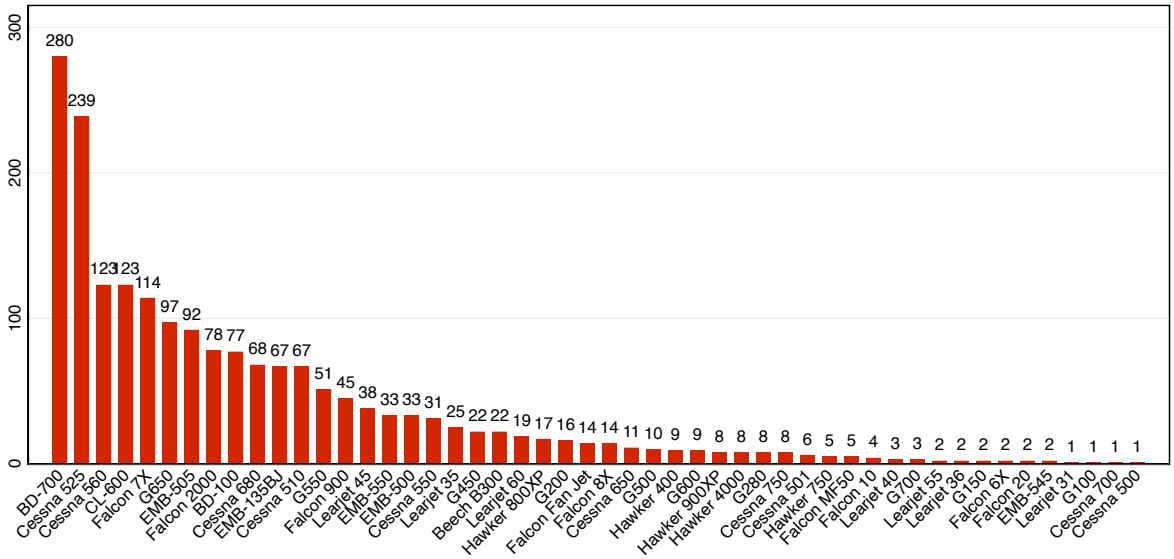


Figure 10: Caption

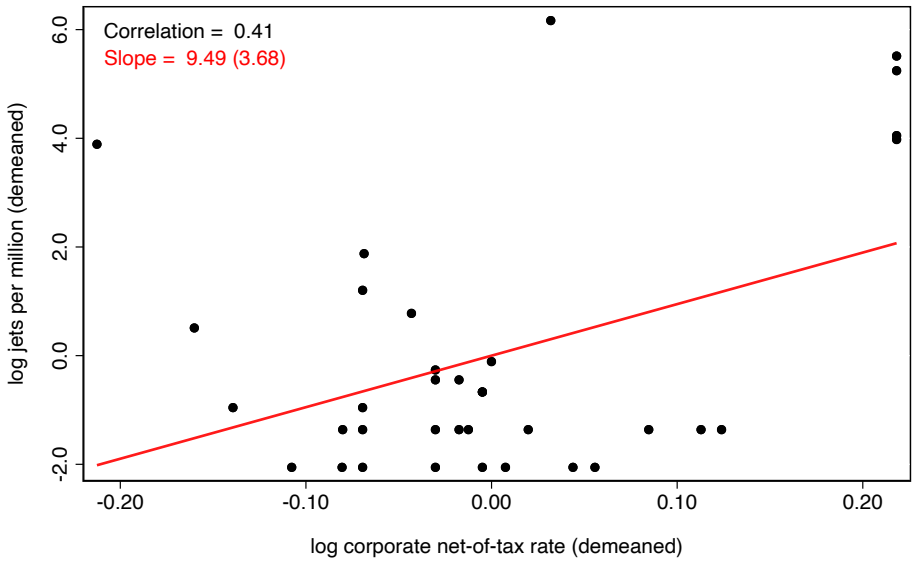


Figure 11: Caption

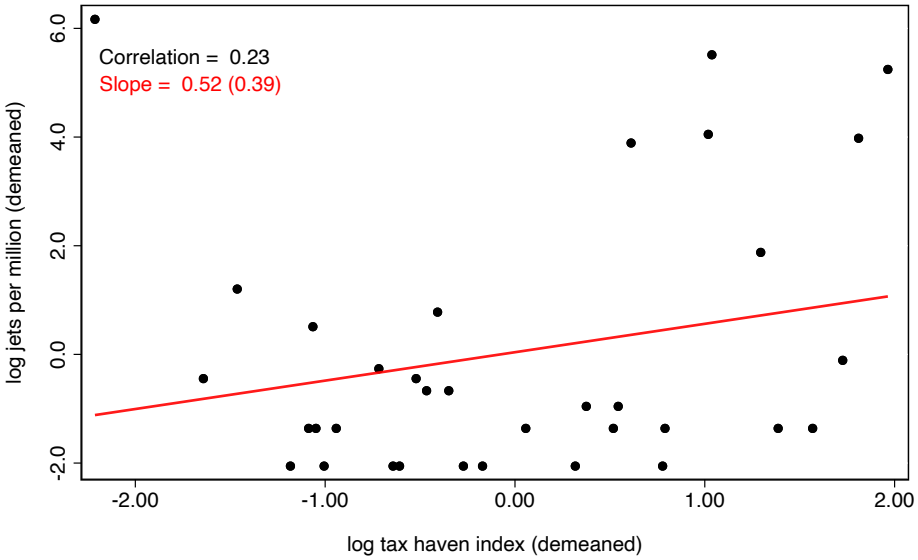


Figure 12: Caption

