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Hidden Baggage: Behavioral Responses to Changes in Airline Ticket Tax Disclosure†

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We examine the impact of a January 2012 enforcement action by the US Department of Transportation that required US air carriers and online travel agents to modify their web interfaces to incorporate all ticket taxes in up-front, advertised fares. We show that the more prominent display of tax-inclusive prices is associated with significant reductions in consumer tax incidence, demand, and ticket revenues along more heavily taxed itineraries. In particular, the fraction of unit taxes that airlines passed onto consumers fell by roughly 75 cents for every dollar of tax. These results present evidence of consumer inattention in a novel institutional setting featuring quasi-experimental variation in tax salience, economically significant tax amounts, and endogenous price responses. (*JEL* D91, H22, H25, H31, L84, L93)

A growing body of literature has established that tax salience (i.e., visibility or transparency) can have a pronounced effect on behavioral responses to taxation for a variety of tax and tax-like instruments.[1] One of the earliest and most robust findings from this literature is that consumers often fail to fully internalize total tax-inclusive prices when base prices and sales taxes are disclosed separately, as is the norm for US retail sales (Chetty, Looney, and Kroft 2009; Feldman and Ruffle 2015). Due to the primarily experimental nature of the prior literature vis-à-vis consumption tax salience, however, seller pricing behavior and possible exploitation of salience effects remains less studied. If consumers are inattentive to low-salience taxes, such that the elasticity of demand with respect to taxes

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[1] See, for example, Chetty, Looney, and Kroft (2009); Goldin and Homonoff (2013); Feldman and Ruffle (2015); and Feldman, Goldin, and Homonoff (2018) (sales and excise taxes); Finkelstein (2009) (electronic tolls); Bradley (2017) (property taxes); or Chetty and Saez (2013) and Feldman, Katuščák, and Kawano (2016) (tax credits).

is less than the elasticity of demand with respect to tax-exclusive (base) prices, producers will generally find it easier to pass taxes through to consumers and will bear a smaller share of the burden of the tax.[2] Conversely, an increase in tax salience should lead to diminished tax incidence on consumers and a reduction in producer revenue (Chetty, Looney, and Kroft 2009).

We evaluate the effects of increased tax salience on airline ticket pricing, demand, and revenues in the context of a regulatory change to the advertising of commercial airline tickets mandated by the US Department of Transportation (DOT), whereby US air carriers and online travel agents were required as of January 26, 2012 to incorporate all mandatory taxes and fees in their advertised fares. To our knowledge, this constitutes the only instance of a regulatory change from tax-exclusive to tax-inclusive pricing regimes at the national level in the United States, such that this paper represents the first quasi-experimental test of the basic framework from the prior experimental literature. Moreover, the market for air travel presents a unique setting in which to examine tax salience due to the fact that airline ticket taxes are economically large and account for a nontrivial fraction of total airfares, such that search costs are unlikely to provide a plausible rationalization for nonstandard behavior.[3]

Prior to 2012, DOT regulations allowed airlines and online travel agents to advertise fares to US consumers exclusive of specific (unit) tax amounts so long as ticket taxes and fees were revealed at later stages of the online ticket-buying process. Thus, variation in unit taxes due to differences in itinerary characteristics (including origin and destination airports, the number and location of layovers, and, occasionally, operating airlines) remained relatively invisible to consumers in their initial search stages. In this environment—the industry norm—learning about variation in unit taxes would require consumers to initiate the ticket-purchasing process multiple times for different flight itineraries, thereby forcing (attentive) consumers to exert costly effort to compare tax-inclusive prices. Justifying the effort to do this would, at a minimum, require prior knowledge of the existence of variation in unit taxes—precisely the type of environment where inattention and failure to "learn by noticing" might be particularly pronounced (DellaVigna 2009; Hanna, Mullainathan, and Schwartzstein 2014). Not only were taxes and fees less visible due to their exclusion from posted prices prior to 2012, but tax amounts also were (and continue to be) highly variable among the various itineraries linking the same origin-destination markets.[4]

[2] If consumers are wholly inattentive such that the tax elasticity of demand is zero, it is easy to see that the tax will fall entirely on consumers, at least in the short run. See Chetty, Looney, and Kroft (2009) or Reck (2016) for a discussion of the implications of longer-run budgetary adjustments. This situation is indistinguishable in a static environment from complete pass-through resulting from infinitely elastic supply in a perfectly competitive market in long-run equilibrium, even where taxes are fully salient.

[3] Average and median unit tax amounts in our sample of US international flights amount to roughly \$100, or 16 percent of the average total ticket price.

[4] This scenario differs from the sales tax environment examined in Einav et al. (2014), where knowledge of opportunities for cross-border tax avoidance (on- or off-line) is relatively widespread. Indeed, a large proportion of commenters on this paper have noted being surprised to learn that ticket taxes are *not* constant across itineraries serving the same origin-destination market. This view generally holds for *domestic* flights, such that more "experience" in purchasing US domestic air travel may actively deter learning about the true scale of variation that exists for international flights.

Whereas cognitive biases have served to motivate the implementation of various consumer protections, primarily in the area of financial products,[5] the DOT's full-fare advertising rule represents the first instance of an application of tax salience considerations to US federal regulations. These full-fare advertising rules (henceforth "FFAR" in our terminology) provide a unique opportunity to study the importance of limited attention in modulating consumer responses to taxation and to quantify the magnitude of taxpayer optimization errors that arose under the prior low-salience ticket tax regime.[6] Given FFAR's emphasis on consumer protection, we deviate from the literature on optimal tax salience (e.g., Congdon, Kling, and Mullainathan 2009; Gamage and Shanske 2011; Goldin 2015), and we leave aside consideration of any welfare losses attributable to behavioral distortions resulting from increased tax salience.

Using restricted-use (international) ticket data from the Bureau of Transportation Statistics' Origin and Destination Survey (BTS) over a period of 19 quarters surrounding the DOT rule change, we make use of identifying variation derived from differences in itinerary-specific unit taxes *within* origin-destination city market pairs and find that the more prominent presentation of tax-inclusive air fares following the implementation of FFAR is associated with a sharp decline in pass-through rates for unit ticket taxes. Prior to FFAR, airlines passed through nearly the entire tax onto consumers in the form of higher base and total fares, while in the post-FFAR period, only about 25 cents of every dollar of unit taxes is passed onto consumers. In addition, pass-through rates for other sources of airport- and route-specific costs that were not the subject of the new disclosure rules (e.g., runway fees, gate fees, navigation charges, noise and emissions fees, etc.) were not significantly affected. We also find that reductions in pass-through rates were generally largest in more highly concentrated markets, consistent with the elementary textbook theory of tax incidence under imperfect competition. Airlines thus appear to have partially insulated inattentive consumers from *perceived* fare increases due to the implementation of tax-inclusive pricing through large offsetting reductions in base fares.

On balance, reduced ticket tax pass-through rates combined with the negative effects of unit taxes on ticket demand in the post-FFAR period together translate into significant reductions in airline ticket revenues along higher-tax routes, consistent

[5] See Barr, Mullainathan, and Shafir (2009) for a broad discussion of arguments in favor of these types of regulations. Examples of such policies include the Pension Protection Act of 2006 (intended to promote automatic enrollment in retirement savings plans), elements of the Dodd-Frank Act (i.e., the mandatory provision of mortgage escrow accounts to new homebuyers) or the Credit Card Accountability Responsibility and Disclosure Act of 2009 (minimum payment disclosures).

[6] Equivalently, ticket taxes may be viewed through the lens of partitioned pricing as a type of "shrouded attribute" (Gabaix and Laibson 2006). To this point, FFAR also required airlines to provide more prominent links to information regarding baggage fees, which represent a clear example of partitioned pricing similar to cases considered elsewhere in the behavioral literature, such as printer ink cartridges (Gabaix and Laibson 2006), shipping costs (Hossain and Morgan 2006), or booking fees (Blake et al. 2017). Brueckner et al. (2013) examine the incentives for baggage fee unbundling and their resulting impacts on airline revenues, albeit without discussing the role of consumer inattention. Agarwal et al. (2014) provide a methodology for measuring the effects of fee disclosure on consumer welfare with a hypothetical application to baggage fees. We are not able to assess the effects of FFAR's ancillary provisions regarding baggage fee disclosure due to a lack of available data. However, we expect any potential effects to be heavily muted in our sample given our emphasis on international flights, where the major US legacy carriers and their codeshare partners have historically waived baggage fees on travelers' first piece of checked luggage.

with the predicted consequences of increasing tax salience and substitution away from high-tax routes. Controlling for all unobserved determinants of quarterly passenger demand by origin-destination city market and instrumenting for carriers' endogenously chosen base fares using a measure of competing carriers' route availability, we find that a \$10 increase in unit taxes (roughly equal to the average standard deviation in tax amounts within origin-destination markets) is associated with an 8.4 percent reduction in passenger volume in the post-FFAR period. Allowing for attenuation of these demand effects due to reduced pass-through, price and quantity effects resulting from the same \$10 tax increase contribute to a net reduction in airline ticket revenue of 4.8 percent, and we cannot reject equal demand sensitivity to tax and nontax fare components after the adoption of FFAR.[7] These effects reflect a relatively high elasticity of demand with respect to advertised fares—consistent with a high degree of cross-itinerary substitutability *within* origin-destination city markets.

Taken together, these findings provide strong quasi-experimental support for the main conclusions and predictions about the consequences of inattention to commodity taxes in the tax salience literature. However, relative to the field- and lab-generated experimental evidence presented in Chetty, Looney, and Kroft (2009) and Feldman and Ruffle (2015), respectively, we offer two key distinctions in our setting. First is the ability of sellers to adjust pretax prices and—in the longer term—product availability. Demand responses to more salient tax information are therefore partially attenuated through diminished tax incidence on consumers. Second, prior literature has for the most part focused on fixed-rate commodity taxation where the consequences of salience and inattention may primarily operate through "frictions" related to search costs or rational inattention as opposed to "mental gaps" (e.g., neglecting to realize where or how taxes apply) (Handel and Schwartzstein 2018). In contrast, by increasing the visibility of tax-inclusive prices, FFAR not only reduced the mental cost of attending to ticket taxes in general but also served to inform consumers of the mere existence of variation in ticket taxes across itineraries—thereby alleviating inattention due to *both* frictions and mental gaps. Consequently, consumer responses to the DOT's intervention might arguably exceed those in contexts where rational inattention or search costs are sufficient to justify tax salience effects and where learning (about the existence of tax variation) is less relevant.

Beyond our contributions to the literature on tax salience, our results also help to inform the relatively narrow literature on commodity tax incidence—including Poterba (1996), Besley and Rosen (1999), and Carbonnier (2013)—and we provide

[7] Perhaps not surprisingly, US airlines have lobbied extensively to prevent and subsequently reverse the implementation of FFAR. Consistent with these objectives, the US House passed the Transparent Airfares Act in June 2014, which would have allowed airlines to revert to advertising tax-exclusive fares. The bill failed to reach the Senate before the conclusion of the 113th Congress. The FAA Reauthorization Bill of 2018—which passed the US House on April 27, 2018 by a vote of 393/13—would likewise have eliminated tax-inclusive pricing requirements, but this provision was ultimately dropped from the conference version of the bill. Our within-market identification strategy does not allow for examination of aggregate demand or revenue effects which could have resulted from a perception of increased fares following the adoption of the full-fare disclosure regime or—correspondingly—its reversal, but the airline industry's opposition to FFAR offers prima facie evidence of such concerns.

the first large-scale estimates of airline ticket tax pass-through rates.[8] Given the nature of the market for air travel, our estimates serve as a test of the theoretical predictions on tax incidence in imperfectly competitive markets (Anderson, de Palma, and Kreider 2001; Weyl and Fabinger 2013) and complement recent estimates by Marion and Muehlegger (2011) and Conlon and Rao (2015) that emphasize the effects of market structure and supply conditions on tax incidence. Finally, our results also extend the literature devoted to studying the impact of consumer disclosures, including Agarwal et al. (2014, 2015), and Keys and Wang (2019).

The remainder of the paper is organized as follows: Section I describes the motivation for FFAR and its precise details in the context of the DOT's ongoing regulatory action; Section II characterizes the data used in our analysis; Section III presents a general estimation framework; Section IV presents and discusses our empirical results; and Section V concludes.

I. Full-Fare Advertising Rules

The DOT's full-fare disclosure rule was issued on April 20, 2011 in response to concerns about consumers being mislead as a result of tax- and fee-inclusive prices being less than fully transparent when making online purchases—the method of choice for 72 percent of airline passengers in the period leading up to 2012 (Econometrica, Inc. 2011). FFAR subsequently went into effect on January 26, 2012 after a delay requested by US air carriers to comply with technical deployment requirements. Strictly speaking, FFAR was not so much a regulatory change as an enforcement action. Under C.F.R. §399.84, airlines and online travel agents (OTAs) like Expedia, Orbitz, etc., were already required to include all ad valorem taxes as well as carrier-imposed fuel surcharges in posted prices prior to 2012.[9] However, the DOT had previously exempted taxes that were imposed on a per passenger basis.

There is ample evidence that neither airlines nor OTAs voluntarily included unit taxes in posted prices prior to 2012 and that ticket tax information was only made available to consumers after the initial display of online search results.[10,11]

[8] Huang and Kanafani (2010) exploit variation in US passenger facilities charges in order to obtain estimates of ticket tax incidence. Their results are limited to very modest variation in tax amounts across a sample of 50 US airports. Karlsson, Odoni, and Yamanaka (2004) provide descriptive evidence on effective ticket tax rates for domestic US airfares.

[9] Likewise, airport charges levied on a per movement (i.e., per takeoff or landing) basis rather than a per passenger basis—such as most runway fees, air navigation charges, noise and emissions fees, etc.—could not be broken out as separate passenger charges and were therefore incorporated into airlines' base fares before the imposition of FFAR.

[10] Approximately 20 percent of airline tickets are sold by OTAs (Harteveldt 2016). Ownership and contractual agreements between airlines and OTAs imply that airline preferences dictate the terms of OTA fare advertising practices, a representative illustration of which appears in online Appendix B. We cannot fully refute the existence of specialized fare aggregator websites that might have allowed modifying the default tax-exclusive ordering of fare search results prior to 2012. However, actively seeking such information presumably reflects a higher level of consumer attention and sophistication, and a larger fraction of purchases made on this basis would merely attenuate our estimates of debiasing.

[11] A small number of EU carriers complied with FFAR prior to its enforcement date and issued press releases accordingly at that time. This likely reflects the fact that foreign carriers had already been subject to similar regulations in the EU and Australia, thereby facilitating compliance. Issuing such releases highlights that they were *not* posting tax-inclusive prices prior to the end of 2011, and the DOT's Office of the Assistant General Counsel for Aviation Enforcement and Proceedings confirms that their office was not aware of any other (i.e., domestic) carriers

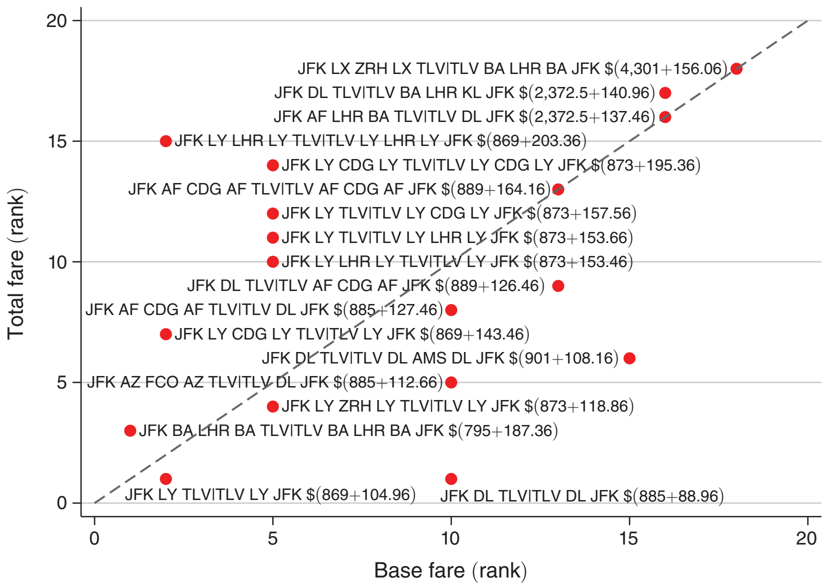

Figure 1. Tax-Inclusive versus Tax-Exclusive Fare Rankings: New York City (JFK) to Tel Aviv (TLV)

Notes: Dollar amounts in parentheses alongside each itinerary represent base fares + unit taxes. Fare amounts are drawn exclusively from online fare searches (non-DB1B) performed between December 30, 2014 and January 25, 2015 (ITA Software 2014–2015).

The fact that US airlines collectively requested a delay in order to implement the technical requirements needed to update their websites (and lobbied aggressively against FFAR both before and after its implementation) emphasizes that this was not common practice in the pre-FFAR period. In addition, there are multiple cases in which the DOT issued fines against US carriers or OTAs for related forms of "false" advertising, such as advertising fares that did not properly include fuel surcharges.[12]

Figure 1 highlights the nature of the potential challenge facing consumers in selecting airline tickets when ticket taxes are not immediately disclosed in advertised fares and consumers exhibit limited attention. The figure shows 18 possible round-trip itineraries between New York City's John F. Kennedy airport (JFK) and Tel Aviv (TLV) ranked by total tax-inclusive total fares versus tax-exclusive base fares (a rank of 1 designating the lowest fare).[13] As shown, itineraries above the

or OTAs that complied ahead of the deadline, whereas brief delays in compliance occurred in a small number of cases (as attested to by the screen captures from Expedia.com in online Appendix Figure A1).

[12] See, for example, "DOT Fines Travelocity for Violating DOT Price Advertising Rule" (https://www.transportation.gov/briefing-room/dot-fines-travelocity-violating-dot-price-advertising-rule) or "DOT Fines Southwest for Violating Price Advertising Rule, Assesses Additional Penalties for Violating Previous Cease and Desist Provisions" (https://www.transportation.gov/briefing-room/dot-fines-southwest-violating-price-advertising-rule-assesses-additional-penalties).

[13] We define an "itinerary" as a sequence of flight segments and ticketing carriers, while a "route" represents a sequence of flight segments only (i.e., departing and arriving airports, including an origin, final destination, and all stopovers). An "origin-destination airport-pair" encompasses all possible itineraries connecting the same origin and final destination airports. The latter are nested within "origin-destination city-pairs," which comprise all airports within a 100-mile radius of the largest population center in the area. For example, JFK DL TLV :: TLV AF CDG

45-degree line are relatively more expensive in ordinal terms than their base fare rank would suggest, whereas itineraries below the line ought to be more attractive to consumers than their base fare rank would suggest. Thus, for example, one of the two least expensive itineraries on a tax-inclusive basis, JFK DL TLV :: TLV DL JFK, would only be ranked tenth out of 18 flights in tax-exclusive terms (in a three-way tie). A consumer might consequently be more inclined to choose JFK LY CDG LY TLV :: TLV LY JFK (in a three-way tie for the second lowest base fare), despite this itinerary ranking eighth in tax-inclusive terms, and costing about $40 more than the lowest-cost ticket overall. More broadly, much of the differences across total fare amounts can be attributed to relatively wide variation in tax amounts, ranging from a low of $89 for a nonstop Delta flight to a high of $195 for an EL AL flight with a layover in Paris Charles de Gaulle (CDG) in both directions.

Table 1 underscores the specific sources of underlying tax variation by presenting a breakdown of unit taxes for three sample itineraries linking JFK and TLV. The first row lists the base fare, or the fare that would have been advertised to consumers at the first stage of the ticket-buying process pre-FFAR, whereas the total fare inclusive of all taxes (bottom row) would have only appeared at a later stage. As the table illustrates, there are numerous country-specific taxes built into the final prices. As all flights in our data originate or end in the United States, all incur US taxes. The remaining taxes are determined by the set of foreign airports where the flight "touches down" for a layover or as a final destination, and, in some cases, by route (e.g., based on arriving or departing distance, or whether segments are between EU airports). In rare cases, taxes may also vary by airline flown, and all taxes are subject to changing over time.[14] If ticket taxes are not taken into account by the consumer at the time of initial fare selection, one may think that column 3 offers the lowest price. Once presented with the additional cost attributable to taxes on a subsequent screen in the ticket-buying process, the consumer might infer—without comparable information from other itineraries to suggest otherwise—that taxes would apply uniformly across ticket choices.[15] Instead, the itinerary in column 3 is clearly the most expensive of the three options once unit taxes are included in the total price.

The net effect of this type of route-specific tax variation within and across the 300 largest international origin-destination city markets served by US carriers can be seen in Figure 2 in terms of either unit tax amounts (panel A) or effective tax rates (i.e., unit taxes as a percentage of average total fares; panel B). As shown, Western

AF JFK represents a round-trip itinerary between New York City's John F. Kennedy Airport and Tel Aviv's Ben Gurion Airport with an outbound flight on Delta Airlines and a return trip (with a layover in Paris's Roissy Charles de Gaulle Airport) operated by Air France. The corresponding route, offered by potentially multiple carriers, is JFK TLV :: TLV CDG JFK and the origin-destination airport-pair is simply JFK :: TLV. The origin-destination city-pair consists of potentially multiple airports located within a 100-mile radius of either origin or destination city. This includes seven airports in the vicinity of JFK, including New York's La Guardia (LGA); Newark, New Jersey (EWR); and Philadelphia, Pennsylvania (PHL); along with three secondary airports.

[14] In practice, statutory unit tax amounts change infrequently and are generally tied to long-term budgetary outlays, such as funding for infrastructure improvement projects, or reflect periodic inflation adjustments. Bilateral exchange rate movements drive more frequent changes in dollar-denominated tax amounts for taxes levied in foreign currencies.

[15] Even post-FFAR, popular fare aggregator websites and airlines' own websites rarely feature the complete breakdown of taxes and fees by levying country that appears in Table 1. This reduces the probability that a consumer could learn, for example, that layovers in CDG contribute roughly $90 in additional taxes and fees relative to a nonstop flight that avoids CDG.

TABLE 1—SAMPLE TAX AND FARE DECOMPOSITION: NEW YORK CITY (JFK) TO TEL AVIV (TLV)

	JFK-TLV TLV-JFK (1)	JFK-FCO-TLV TLV-JFK (2)	JFK-CDG-TLV TLV-CDG-JFK (3)
Base Fare	**$885.00**	**$885.00**	**$873.00**
Fare	279.00	279.00	873.00
(*of which nontax charges*)[a]	16.86	22.86	39.67
Fuel surcharge (YQ or YR)	606.00	606.00	0.00
Total Ticket Taxes	**$88.96**	**$112.26**	**$195.36**
US Intl Departure and Arrival Tax (US)	35.00	35.00	35.00
US Sept. 11 Security Fee (AY)	5.60	5.60	5.60
US Passenger Facility Charge (XF)	4.50	4.50	4.50
USDA APHIS Fee (XA)	5.00	5.00	5.00
US Immigration Fee (XY)	7.00	7.00	7.00
US Customs Fee (YC)	5.50	5.50	5.50
Israel Departure Tax (IL)	26.36	26.36	26.36
Israeli Security and Insurance Surcharge (AP)[b]			16.00
Italy Passenger Service Charge Departure (MJ)		1.10	
Italy Council City Tax (HB)		9.10	
Italy Security Charge (VT)		3.10	
Italy Embarkation (IT)		10.00	
French Intl Passenger Service Charge (QX)			52.20
French Airport Tax (FR)			38.20
Total Fare	**$973.96**	**$997.26**	**$1,068.36**

[a] Aircraft-specific nontax charges are based on 2014:II levels (in current US$) and include various airport fees, including takeoff and landing charges, parking and terminal fees, noise and environmental charges, navigation charges, etc. Charges are allocated on a per passenger basis assuming 100 percent seating capacity utilization.
[b] AP applies only to flights operated by the Israeli national airline, EL AL.

Sources: ITA Software and RDC Aviation

European and Caribbean destinations (yellow circles and dark blue squares, respectively) tend to exhibit among the highest unit tax amounts as well as the highest standard deviation thereof, reflecting a combination of high taxes at destination airports as well as increased taxes accruing at stopover points on longer routes. Relative to total fares, Caribbean destinations trigger by far the highest effective tax rates (Figure 2, panel B), which exceed 30 percent in certain cases.

Suggestive evidence of passengers substituting toward lower-taxed routes as a result of FFAR within this set of 300 origin-destination city markets is shown in Figure 3. The figure depicts average four-quarter changes in the high-tax share of passenger volume accruing to the set of routes in the top and bottom quartiles of the ticket tax distribution (based on a balanced panel of ever-available route offerings within origin-destination city market). As shown, the share of passengers traveling via relatively high-tax routes was generally growing prior to the implementation of FFAR and remained roughly unchanged in 2012:I and 2012:II (during which time only a fraction of travelers would have been exposed to tax-inclusive pricing at the time of ticket purchase). Beginning in 2012:III, however, high-tax routes

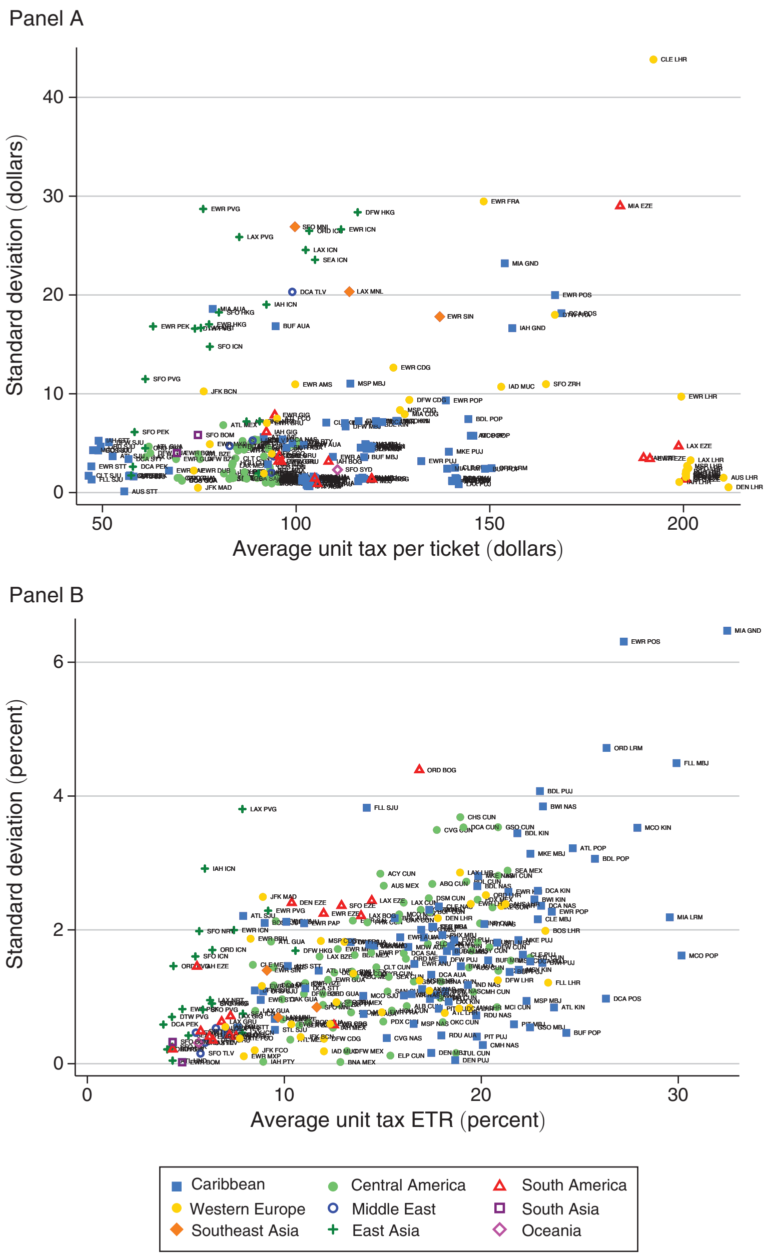

Figure 2. Variation in Unit Taxes across and within Origin-Destination City Markets (2011:IV)

Notes: Airport labels refer to the largest single origin-destination airport-pair by passenger volume within each origin-destination city market. Effective tax rates (ETR) are computed as the ratio of unit taxes paid to total fares. Each point in the figure is computed from at least two unique routes with different unit taxes. Average tax amounts and ETRs are all measured on a passenger-weighted basis within origin-destination city market pairs.

Sources: DB1B (Bureau of Transportation Statistics) and RDC Aviation

experienced persistent declines in volume share in favor of lower-taxed routes, with this effect gradually tapering off after eight quarters.

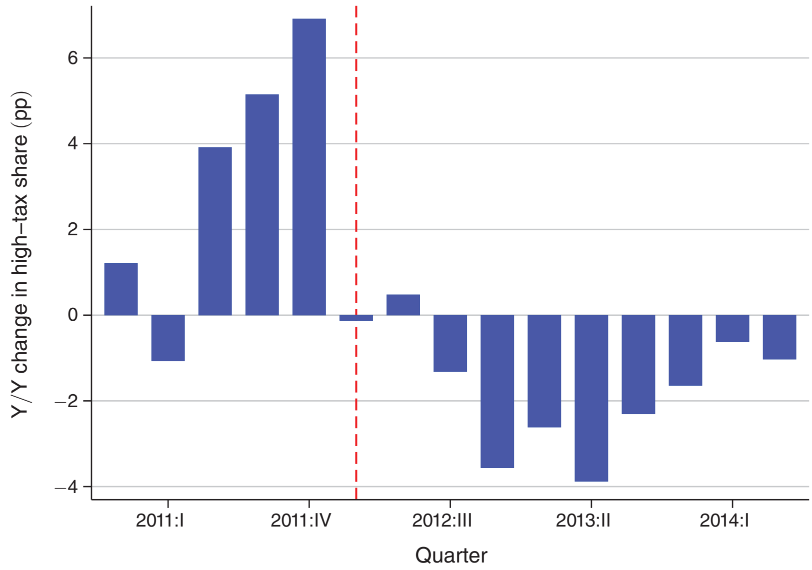

Figure 3. Four-Quarter Changes in High-Tax Route Volume Shares

Notes: Routes are categorized as "high tax" and "low tax" relative to the top and bottom quartile tax amounts within origin-destination city market pair, respectively, and are based on a balanced panel of ever-available route offerings. Only origin-destination city markets featuring at least one high-tax route and one low-tax route are included.

Sources: DB1B (Bureau of Transportation Statistics) and RDC Aviation

II. Data

The primary data for this project are drawn from the restricted-use (international) portion of the DOT's Origin and Destination Survey (DB1B) for the period 2009:IV–2014:II (BTS), used in conjunction with data on airport charges from RDC Aviation (2009–2014) plus detailed fare composition information scraped via a flexible fare search platform (ITA Software 2014–2015). The DB1B data consist of a 10 percent sample of all complete ticketed itineraries involving a US operating carrier and are reported quarterly based on date of travel. From this sample, we extract only the set of international itineraries that either originate or terminate at a US airport. Crucially, these data include all route and carrier characteristics, as well as the number of passengers traveling, distance flown, fare class, and the total tax-inclusive fares paid per passenger.

The DB1B ticket data do not, however, provide a breakdown of the fare composition. We consequently rely on data from RDC Aviation and fare scrapes to construct a historical database of itinerary-specific ticket taxes and nontax charges, which we match to the DB1B data in order to back out tax-exclusive prices (i.e., base fares). This process involves a complex series of steps, which we describe in greater detail in online Appendix A. In essence, this procedure requires parsing information from RDC Aviation on all applicable airport charges for a sample of over 50,000 unique quarterly airport-route-aircraft combinations in order to separate individual charge items into either government-imposed taxes and fees (levied on a per passenger unit basis and thus, affected by FFAR) or nontax charges (levied on a per movement basis, and thus, unaffected by FFAR). Performing this decomposition in turn relies on fare construction information that we gleaned from over 30,000 online fare searches performed over the period December 30, 2014–January 29, 2015. Each scraped itinerary yields an extract of all applicable ticket tax codes, descriptive names, and corresponding dollar amounts, thereby enabling us to flag matching charges from the RDC database at the airport-route level and assemble these across all relevant airport-route segments on a historical basis. This group of initial charge and fare queries represents all routes in the DB1B sample flown by more than 36 passengers (in either direction) over the 2012:IV–2013:III period (i.e., averaging at least one passenger per day in the full 100 percent sample).[16]

A sample concordance between the set of scraped French ticket taxes levied on a round-trip flight, PHL DL CDG, and the corresponding set of per passenger charges for arriving or departing flights in Paris (CDG) as reported by RDC Aviation are given in online Appendix Table A1. We confirm that the remaining set of nine charges identified by RDC as being levied at CDG—shown in online Appendix Table A2—are indeed levied on a per movement basis and fall broadly into the general categories of air navigation, infrastructure, noise, parking, runway, or terminal charges.[17] We divide the resulting total amount for these nontax charges according to the seating capacity of the aircraft used to service the flight segment in question in order to allocate these on a per ticket basis.[18] A similar set of tax and nontax charges likewise apply for the arriving and departing flight segments at PHL, which we consequently combine with the set of applicable charges at CDG to construct complete tax and nontax charge amounts for the full PHL DL CDG itinerary.[19]

Matching our resulting itinerary-specific unit tax and nontax charge amounts with the full set of ticketed itineraries in the DB1B yields over 45,000 unique matched itineraries with valid ticket tax information, covering more than 4.5 million passenger trips over the period 2009:IV–2014:II. After subtracting itinerary-specific tax and nontax charge amounts from total ticketed fares to recover a measure of tax-exclusive base fares, we aggregate each matched observation in the quarter t DB1B sample to the carrier c, route i-level and define measures of total passenger volume and passenger-weighted average base fares. Collectively, ci constitutes a unique itinerary whose endpoints define an origin-destination airport-pair j and origin-destination city market pair k.

[16] These routes account for approximately 60 percent of total passenger volume. We exclude lower-volume routes from our set of initial queries out of concern that changes in passenger traffic along these routes might be subject to a high degree of unexplained variability.

[17] Other categories of charges, such as government charges, can encompass either taxes levied on a per passenger basis or a per movement basis and require special care.

[18] See online Appendix A for a description of data sources used in making determinations of aircraft usage.

[19] US ticket taxes on international flights consist of six distinct tax codes. We rely on multiple US government sources, including the Federal Aviation Administration (2014, 2016), the Transportation Security Administration (2016), the Animal and Plant Health Inspection Service (2016), and Customs and Border Protection (2016) to construct a complete historical record of airport-specific US ticket taxes rather than use the RDC database for this purpose.

Consistent with other applications of the DB1B data in the literature (see e.g., Brueckner 2003), we focus exclusively on round-trip, coach-class, non-award travel.[20, 21] We also exclude tickets flagged by DOT as involving unrealistically high costs per mile (conditional on fare class), as well as all ticketed itineraries featuring multiple trip breaks (i.e., extended stopovers) that may trigger the application of different taxes.[22] Likewise, we omit itineraries involving US territories, Alaska, or Hawaii due to the application of different US ticket tax rules.[23] Finally, we exclude all group tickets covering more than nine passengers on the grounds that these are likely to involve negotiated fares whose purchasers (e.g., tour operators or the US government) are unlikely to be subject to the same behavioral biases as individual consumers.

We ultimately limit our analyses to the top 300 international origin-destination city markets (ranked by total outbound and inbound passenger volume in 2011), each of which is serviced by an average of 6.5 available itineraries and accounts for 55 percent of total passenger volume in our matched DB1B-tax sample. This restriction has the virtue of excluding thinner markets where idiosyncratic variation in passenger demand may be especially prevalent and contribute to statistical imprecision. Unreported sensitivity analyses involving the complete sample of 498 city markets for which we have non-missing ticket tax and nontax charge data (and nonzero within-market variation therein) account for 62 percent of matched passenger volume and yield qualitatively similar, yet less precisely estimated results, consistent with this last concern.

Table 2 reports basic summary statistics from our final estimation sample. As shown, total tax- and charge-inclusive fares (*TotalFare*) average \$750, while mean and median specific taxes (*UnitTaxes*) are roughly \$100, with a standard deviation of approximately \$45.[24] Nontax charges (*NonTaxCharges*) account for a relatively smaller fraction of total fares and amount to roughly \$20, albeit with a greater degree of dispersion around the mean than unit taxes. Owing in part to the difficulty of assembling ticket tax and charges data for secondary airports, we see that the median itinerary in our sample involves zero layovers, and in practice, we are unable to match any itineraries featuring more than four layovers on a round-trip ticket (i.e., six flight segments).

[20] We apply multiple criteria based on cost per mile for defining award travel. See online Appendix A.1 for details. Award travel thus defined accounts for up to 10 percent of passenger volume.

[21] For tickets featuring different fare class segments, we define an itinerary as coach-class so long as the coach portion of the itinerary accounted for at least 90 percent of miles flown. Tests of differential FFAR reactions by class of service (not shown) suffer from low power. As a result, we cannot conclude whether first and business class travelers are any more or less sensitive than coach passengers to the implementation of tax-inclusive pricing.

[22] The UK Air Passenger Duty, for example, is only payable on flights *originating* in the United Kingdom. The tax does not therefore generally apply to international flights with a layover in the United Kingdom, *unless the layover exceeds* 24 *hours in duration*. Similar rules apply to flight segments within the United States as part of an international itinerary, with differing application of domestic transportation and segment taxes depending on the duration of these domestic layovers.

[23] With respect to US territories, exceptionally high passenger volume moreover likely reflects the transportation of US military personnel, the majority of whom presumably do not book their own air travel.

[24] For comparison, *within* origin-destination city markets, unit taxes exhibit a mean volume-weighted standard deviation of just under \$5 across all 300 markets. In addition, the volume-unweighted average difference between the highest and lowest taxed itineraries within an origin-destination city market is roughly \$26 (not shown).

Table 2—Quarterly Ticket and Itinerary Characteristics: 2009:IV–2014:II

	Mean	Median	SD
Average ticket characteristics ($00s):			
$TotalFare_{cit}$	7.50	6.07	3.67
$BaseFare_{cit}$	6.19	4.91	3.48
Observations		1,088,155	
Itinerary characteristics:			
$Passengers_{cit}$	44.03	16.00	95.63
$UnitTaxes_{cit}$ ($00s)	1.08	0.98	0.45
$NonTaxCharges_{cit}$ ($00s)	0.23	0.18	0.19
$Distance_i$	5.10	3.74	3.28
$Layovers_i$	0.79	0.00	0.96
HHI_{jt}	0.56	0.50	0.24
$Load_{cit}$	85.84	87.33	7.09
$\ln(OriginVolume_{cj^o t})$	11.79	12.17	1.42
$Itineraries_{c^{-j}t}$	29.94	21.00	30.54
Observations (itinerary-quarters)		24,712	

Notes: Observations include only round-trip flights with a US origin and exclude all business, first-class, and award travel. Data from 2012:I are omitted. All itinerary characteristics with the exception of $Passengers_{cit}$ and $Itineraries_{c^{-j}t}$ are passenger-weighted. See online Appendix Table A3 for variable definitions.

Sources: DB1B (Bureau of Transportation Statistics) and RDC Aviation

III. Model

A. *Tax Incidence and Tax Salience*

Despite FFAR having had no effect on the true level of ticket taxes owed, heightened awareness of these tax amounts should yield a shift in the tax burden from formerly inattentive consumers onto producers—in proportion to the extent of debiasing induced by the switch to tax-inclusive pricing. Depending on the magnitude of the resulting reduction in base fares, consumers may have been more or less shielded from perceiving prices as varying by the full amount of unit ticket taxes in the post-FFAR period. Consequently, changes in tax incidence due to FFAR are not only informative with respect to the costs of consumer inattention but are also indicative of the remaining potential for consumer demand to show marked reactions to FFAR.[25]

We adapt Chetty (2009) and Chetty, Looney, and Kroft (2009) to derive predictions regarding the effect of tax salience on the economic incidence of a unit tax in perfectly competitive versus monopoly markets. Under the standard neoclassical theory of tax incidence, net-of-tax producer prices (e.g., base fares), p,

[25] Our empirical approach differs from the "sufficient statistics" approach advocated by Chetty, Looney, and Kroft (2009), whereby estimates of tax incidence can be recovered as a function of the tax and price elasticities of demand (which differ only due to inattention) and the elasticity of supply. Here, we infer inattention directly from estimated changes in elasticities of passenger demand *conditional* on final prices adjusting endogenously to mitigate the consequences of increased tax salience.

adjust to the imposition of a unit tax, t, according to the relative elasticities of supply and demand, where the latter elasticity is assumed to be the same regardless of whether changes in gross-of-tax consumer prices $(q = p + t)$ are driven by changes in net-of-tax prices or taxes. However, if consumers are subject to limited attention and taxes are less than fully salient, this introduces the possibility that consumers may respond differently to changes in prices that arise from changes in base prices compared to changes that arise from tax changes. We model this possibility by allowing consumers to perceive a fraction $\theta \geq 0$ of the true tax amount, $q_\theta = p + \theta t$, such that observed consumer demand can be expressed as $D(q_\theta) = D(p + \theta t)$. In the full attention, full salience case (as in the neoclassical model), $\theta = 1$ and $D(q_\theta) = D(q)$. By assumption, taxes that are included in posted prices are fully salient, such that $\theta_{Qtr>2012:\mathrm{I}} = 1$. Note that $\theta = 0$ when consumers are instead fully inattentive and ignore taxes altogether when making purchasing decisions. More generally, θ represents the degree of tax salience (inattention) and can be measured as the ratio of the price elasticities of demand with respect to the tax price versus the base price (evaluated at the perceived tax-inclusive price): $\varepsilon_{D,q|t} = \theta(\partial D/\partial q)\big(q_\theta/D(q_\theta)\big) = \theta\varepsilon_{D,q|p}$.

Assuming perfect competition, total differentiation of the market-clearing condition yields

$$\text{(1)} \qquad \frac{dp}{dt} = -\frac{\partial D/\partial q_{|t}}{\partial D/\partial q_{|p} - \partial S/\partial p} \equiv -\frac{\theta \cdot \varepsilon_{D,q}}{\varepsilon_{D,q} - \frac{q_\theta}{p}\varepsilon_{S,p}},$$

$$\text{(2)} \qquad \frac{dp}{d\theta} = \frac{dq}{d\theta} = -\frac{t \cdot \varepsilon_{D,q}}{\varepsilon_{D,q} - \frac{q_\theta}{p}\varepsilon_{S,p}},$$

where $\varepsilon_{S,p} = \big(\partial S/\partial p\big)\big(p/S(p)\big)$ represents the elasticity of supply at the net-of-tax price. When $\theta = 1$, equation (1) produces the standard full-optimization result, whereby the incidence of a unit tax on producer prices is proportional to the magnitude of the elasticity of demand relative to the magnitude of the combined elasticities of supply and demand. The tax burden borne by producers—all else equal—is hence increasing in θ, conditional upon a nonzero demand elasticity. Unsurprisingly, producers bear none of the tax burden when the tax is fully obfuscated from inattentive consumers and $\theta = 0$. This situation is empirically indistinguishable from standard results involving perfectly inelastic demand or perfectly elastic supply, as in a perfectly competitive market in long-run equilibrium. Independent variation in θ (induced by FFAR), t, and the degree of market competition are therefore key to separately identifying tax salience effects from demand and supply elasticity effects in our analysis.

Equation (2) characterizes the impact of full debiasing resulting from a shift in saliency regime on both net-of-tax and gross-of-tax prices in the presence of preexisting taxes. As equations (1) and (2) suggest, small changes in pass-through rates of ticket taxes to total fares resulting from the adoption of FFAR could result either from $\theta_{Qtr<2012:\mathrm{I}} \approx 1$, $\varepsilon_{D,q} \approx 0$, or $\varepsilon_{S,p} \approx \infty$ (or some combination thereof). Regardless of salience effects, consumers might consequently be unaffected by FFAR if the market for international air travel were perfectly competitive and subject to constant marginal costs. In reality, of course, the airline industry is not generally considered to be perfectly competitive, and we exploit the fact that individual markets may differ widely in their degree of market concentration for our analysis.

In the case of imperfect competition, the monopolist confronted by inattentive consumers must solve the modified profit maximization problem

$$\max_p p \cdot D(p + \theta t) - C\big(D(p + \theta t)\big),$$

which yields the conventional Lerner Formula, with the modification that the marginal cost of production, $C'(\cdot)$, and elasticity of demand, $\varepsilon_{D,q}$, are implicit functions of θ:

$$(3) \qquad p^* \left[1 + \frac{D(p^* + \theta t)}{\partial D / \partial q_{|p}} \frac{1}{p^*}\right] \equiv C'\big(D(p^* + \theta t)\big)$$

$$(4) \qquad \Leftrightarrow p^* = \frac{C'\big(D(p^* + \theta t)\big)}{1 + \frac{1}{\varepsilon_{D,q|p}} \frac{q_\theta^*}{p^*}},$$

where p^* is the profit-maximizing net-of-tax price for the monopolist. By the Implicit Function Theorem,

$$(5) \qquad \frac{dp^*}{dt} = \frac{-\theta\left[1 - \frac{D(\cdot)D''(\cdot)}{\left(D'(\cdot)\right)^2} - C''(\cdot)D'(\cdot)\right]}{1 + \left[1 - \frac{D(\cdot)D''(\cdot)}{\left(D'(\cdot)\right)^2} - C''(\cdot)D'(\cdot)\right]}.$$

A zero salience tax $(\theta = 0)$ again delivers full pass-through onto consumers, but θ otherwise plays a more nuanced role depending on the underlying nature of demand. For illustration, we consider two simplifying cases involving constant marginal costs, $C'(\cdot) = \kappa$, and either linear demand or constant demand elasticity.

Assuming linear demand of the form $D(p + \theta t) = a - b(p + \theta t)$,

$$(6) \qquad p^* = \frac{1}{2}\left[\kappa + \frac{a}{b}\right] - \frac{1}{2}\theta t,$$

$$(7) \qquad \frac{dp^*}{dt} = -\frac{1}{2}\theta,$$

$$(8) \qquad \frac{dp^*}{d\theta} = -\frac{1}{2}t.$$

Following standard principles of tax incidence, a fully salient tax $(\theta = 1)$ hence falls equally on both consumers and the monopolist. Correspondingly, full debiasing leads to the net-of-tax producer price falling by exactly half of the unit tax amount, or 50 cents per dollar. This suggests a large potential impact of FFAR on ticket tax pass-through rates in imperfectly competitive markets (assuming approximately linear demand), even if demand is otherwise relatively inelastic or airlines face near-constant marginal costs.

If demand instead exhibits constant elasticity of the form $D(p+\theta t) = A(p+\theta t)^{-b}$, such that $\varepsilon_{D,q|p} = -b$ and $\varepsilon_{D,q|t} = -\theta b$, then

$$p^* = \frac{\kappa}{1 + \frac{1}{\varepsilon_{D,q}} \frac{q_\theta^*}{p^*}}, \tag{9}$$

$$\frac{dp^*}{dt} = -\theta \cdot \frac{1}{1+\varepsilon_{D,q}} \Rightarrow \frac{dq^*}{dt} = \frac{(1-\theta) + \varepsilon_{D,q}}{1+\varepsilon_{D,q}}, \tag{10}$$

$$\frac{dp^*}{d\theta} = -t \cdot \frac{1}{1+\varepsilon_{D,q}} = \frac{dq^*}{d\theta}. \tag{11}$$

A fully salient tax in this context will be *overshifted* onto consumers whenever $\varepsilon_{D,q} < -1$. Contrary to the perfectly competitive case or the linear demand monopoly case, θ thus *amplifies* rather than attenuates tax incidence on consumers, and debiasing due to the adoption of FFAR could conceivably *raise* profit-maximizing net-of-tax prices in this admittedly special case. More generally, the effect of an increase in tax salience on tax incidence in any given market is theoretically less certain than in the basic Chetty, Looney, and Kroft (2009) model, and ultimately depends upon the curvature of demand, marginal costs, and market structure.

B. *Empirical Specifications*

In order to measure consumer ticket tax incidence pre- and post-FFAR, we estimate the average dq/dt following Weyl and Fabinger (2013) and Conlon and Rao (2015) as the share of each dollar in ticket taxes that is passed through to total fares according to the following general specification:

$$TotalFare_{cit} = \alpha_0 + \alpha_1 UnitTaxes_{cit} + \alpha_2 UnitTaxes_{cit} \times I[Qtr > 2012{:}\mathrm{I}]_t + \tilde{\gamma}\tilde{\mathbf{X}}_{ij} + \eta_{ct} + \nu_{kt} + \varepsilon_{cit}. \tag{12}$$

Here, $TotalFare_{cit}$ represents the average total fare paid by consumers for a flight operated by carrier c on route i in quarter t.[26] Unit taxes ($UnitTaxes_{cit}$) are defined at the corresponding itinerary level, and the post-FFAR period indicator, $I[Qtr > 2012{:}\mathrm{I}]_t$, is set to 1 in all periods falling after the first quarter of 2012 and is zero otherwise. We omit 2012:I data from our analysis given that FFAR went into effect on January 26, 2012 and that our ticket data are dated only by the quarter flown, such that it is uncertain what fraction of 2012:I travelers would have been exposed to the new FFAR pricing regime.[27] As a placebo test, we extend equation (12) with

[26] For the remainder of the paper (and variable subscripts throughout), t is used to denote time.

[27] Though statistics on the timing of ticket purchases are scarce, an industry study of 7 million North American and European flight bookings indicates that 23 percent of tickets are purchased within 10 days of travel and over

controls for pre- and post-FFAR effects of nontax charges $(NonTaxCharges_{cit})$, which were always required to be included in advertised fares. Beyond these main variables of interest, $\tilde{\mathbf{X}}_{ij}$ represents a vector of route and origin-destination airport-pair characteristics, including categorical indicators for the number of connecting flight segments as well as cubic polynomials in distance flown, market concentration, capacity utilization, and the log of total carrier passenger volume at the (US) airport of origin (for both domestic and international flights). The term η_{ct} accounts for unobserved time-varying carrier-specific attributes that might be correlated with the tax salience effects of FFAR, such as preexisting variation in the transparency of tax information on carriers' own websites or differences in the existence of baggage fees and their associated disclosure. Seasonality effects and secular trends influencing origin-destination city-pair pricing are captured in ν_{kt}. Remaining unobserved sources of variation in total fares are attributed to ε_{cit}. The validity of this approach rests on the assumption that any such unobserved determinants of route i ticket prices are uncorrelated with ticket tax amounts and the timing of FFAR.[28] Insofar as consumers exhibit preferences over itinerary attributes, which we are not able to account for explicitly in our empirical specification (e.g., connecting airports, flight schedules, etc.), we assume that any changes in these preferences over time are uncorrelated with the timing and intensity of FFAR treatment.[29]

In our preferred specification involving a full set of origin-destination city $\times$ quarter (ν_{kt}) and carrier $\times$ quarter (η_{ct}) fixed effects, identification rests on within-quarter variation in ticket taxes and total fares across itineraries serving the same city pairs, allowing for the relationship between taxes and total fares to vary pre- and post-FFAR. Thus, α_2 is the difference-in-differences estimator of the change in ticket tax pass-through rates associated with FFAR and reflects the impact of debiasing (i.e., bringing the tax elasticity of demand into alignment with the price elasticity of demand), conditional on market supply conditions. We allow this debiasing effect to vary more generally with market concentration and capacity utilization in later specifications to test for heterogenous effects related to these supply conditions. In all but our basic specifications, estimation of pre- and post-FFAR pass-through rates for nontax charges alongside unit taxes offers a valuable comparison given that only the latter were subject to new disclosure rules under FFAR. Accounting for nontax charges in this manner helps corroborate the validity of our

50 percent are purchased within 50 days (https://www.yieldr.com/consumer?file=consumer_booking_study.pdf). Moreover, airlines do not generally allow ticket purchases more than 10 months prior to the date of travel. To the extent that a shrinking fraction of passengers traveling in the last three quarters of 2012 might have still purchased their tickets under the pre-FFAR regime, this would tend to attenuate our estimates of the effects of FFAR.

[28] A potential concern in this context is that if taxing authorities are responsive to changes in passenger demand (e.g., such as if airports compete actively for volume), unit tax amounts may respond endogenously to tax salience effects. Given the asynchronous timing between our measurement of ticket tax amounts and the DB1B's reporting of passenger volume on the basis of the date of *travel* as opposed to the date of purchase, this would tend to bias our estimates of the effect of the full-fare advertising rules toward zero (because an endogenous reduction in ticket taxes due to a reduction in ticket *purchases* in the prior quarter, for instance, would be partially matched with a continued decline in passenger *traffic* in the quarter(s) after the rate cut). As indicated above, statutory changes in unit taxes occur infrequently across the set of airports in our analysis.

[29] Along with FFAR, the DOT's enforcement action encompassed a number of other consumer protections, including rules related to tarmac delay and contingency plans, overbooking and denied boarding compensation, and customer service plans—none of which would reasonably be expected to alter consumer demand for itineraries in a manner related to ticket taxation.

general difference-in-differences identification strategy, despite our inability to exploit more precise timing variation as a result of the manner in which the DB1B data are recorded.

Our empirical strategy with respect to estimating the effects of FFAR on additional demand outcomes involves a similar difference-in-differences approach. Adding controls for average base fares to the empirical model yields a simple adaptation of (12):

$$\begin{aligned}(13)\ \ln\left(Y_{cit}\right) \ =\ & \beta_0 + \beta_1 BaseFare_{cit} + \beta_2 BaseFare_{cit} \times I\left[Qtr\ >\ 2012\text{:I}\right]_t \\ & + \beta_3 UnitTaxes_{cit} + \beta_4 UnitTaxes_{cit} \times I\left[Qtr\ >\ 2012\text{:I}\right]_t \\ & + \beta_5 NonTaxCharges_{cit} + \beta_6 NonTaxCharges_{cit} \times I\left[Qtr\ >\ 2012\text{:I}\right]_t \\ & + \tilde{\gamma}\tilde{\mathbf{X}}_{ij} + \eta_{ct} + \nu_{kt} + \varepsilon_{cit},\end{aligned}$$

where Y_{cit} alternately represents either itinerary-level passenger volume or tax-exclusive ticket revenue. In this latter case, we exclude $\beta_1 BaseFare_{cit} + \beta_2 BaseFare_{cit} \times I\left[Qtr\ >\ 2012\text{:I}\right]_t$ from our model in order to measure the combined impact of FFAR on ticket revenue coming from both endogenous price responses (i.e., changes in pass-through rates) as well as changes in passenger demand. Base fares are measured as the difference between total fares and the sum of unit taxes and nontax charges, and we allow consumers to exhibit differing price elasticities of demand pre- and post-FFAR. Naturally, the simultaneous determination of prices and quantities yields biased ordinary least squares estimates of the semielasticity of demand with respect to base fares, and this issue is further compounded by the possibility of endogenous variation in pass-through rates resulting from FFAR. Due to the specificity of the set of fixed effects used in our preferred empirical approach, it is difficult to construct instruments with suitable within variation. Consequently, we use a measure of exogenous price competition as an instrument for base fares (alone and interacted with the same $I\left[Qtr\ >\ 2012\text{:I}\right]_t$ indicator) and estimate (13) via two-stage least squares (IV). In line with the IV strategies used in Berry and Jia (2010), our preferred instrument for this purpose is measured as the number of itineraries offered by competing carriers servicing the same origin-destination airport-pair (excluding codeshare or alliance partners) in a given quarter in the full DB1B sample. Instrument exogeneity rests on the assertion that FFAR did not impact the number of competing itineraries servicing the same market *after accounting for unit taxes and other controls*.[30]

If ticket taxes were fully salient prior to FFAR, we should expect demand for airline tickets to be equally sensitive to changes in appropriately instrumented base fares, β_1, as to variation in unit taxes in the pre-period, β_3. Correspondingly, β_4 ought

[30] We also consider the use of cost shifter instruments constructed as an interaction of trip distance and quarterly jet fuel or oil (West Texas Intermediate) prices, or six-month NYMEX futures thereof. Given heterogeneity in airline fuel and exchange rate hedging strategies coupled with unobserved airport-specific variation in delivered dollar-denominated fuel prices, these instruments suffer from instrument weakness in most tests. Results are available from the authors upon request.

to equal β_2 (assumed to be zero) in this case. In the alternative, $\theta_{Qtr<2012:\mathrm{I}} \equiv \beta_3/\beta_1$ measures consumer inattention in the pre-FFAR period, whereas $\theta_{Qtr>2012:\mathrm{I}} \equiv (\beta_3 + \beta_4)/(\beta_1 + \beta_2)$ measures consumer inattention post-FFAR. By assumption, consumers are expected to optimize fully with respect to taxes when these are included in posted prices. Hence $\theta_{Qtr>2012:\mathrm{I}} - \theta_{Qtr<2012:\mathrm{I}}$ reflects the extent of debiasing associated with the more salient presentation of unit taxes under full-fare advertising.

It is important to note that changes in passenger volume in response to FFAR may have arisen either through shifts in aggregate demand (such as if inattentive consumers perceived airfares to have risen across the board as a result of FFAR) or through cross-itinerary substitution. Increased tax salience might, for instance, induce consumers to substitute toward itineraries with fewer layovers or layovers at more lightly taxed airports to avoid the accumulation of unit taxes at each departing and arriving airport along their route. By exploiting within origin-destination city market $\times$ quarter variation in unit tax amounts, our identification strategy addresses only the latter channel. As such, our estimates cannot readily be translated into *aggregate* demand or *aggregate* ticket revenue effects.

IV. Results

A. *Tax Incidence*

Table 3 presents the results from the estimation of equation (12). All specifications include the full set of controls in $\tilde{\mathbf{X}}$. These are suppressed from Table 3 for brevity but can be found in online Appendix Table A4. Additionally, column 1 controls for carrier $\times$ quarter fixed effects, while columns 2 and 3 further incorporate origin-destination city-pair $\times$ quarter fixed effects and represent our preferred specifications. We compute clustered standard errors at the origin-destination city-pair level across all regression specifications and weight observations by itinerary-level passenger volume in order to account for wide dispersion in itinerary popularity and high idiosyncratic volatility of passenger volume along low-volume routes (Goolsbee and Syverson 2008).[31]

Large differences between columns 1 and the others in estimated pass-through rates in both the pre- and post-FFAR periods highlight the importance of controlling for unobserved time-varying product characteristics that might otherwise yield a spurious association between ticket taxes and total fares. Based on the results in column 2, the ticket tax pass-through rate in the pre-FFAR period is approximately 0.99, consistent with consumers having borne essentially all of the tax burden prior to 2012, either because of relatively low "true" elasticity of demand (high elasticity of supply) or because of a high degree of consumer inattention. Only this last possibility, however, can explain the sharp reduction in average pass-through rates following the adoption of tax-inclusive pricing. In the post-FFAR period, the ticket tax pass-through rate falls by 0.743 (α_2) so that, on net, every dollar increase in unit

[31] This weighting strategy is analogous to estimating ticket tax pass-through at the ticket level with appropriate clustering.

Table 3—Ticket Tax Pass-Through

$Y = TotalFare_{cit}$	(1)	(2)	(3)
$UnitTaxes_{cit}$	0.768	0.992	0.958
	(0.100)	(0.312)	(0.307)
$UnitTaxes_{cit} \times I[Qtr > 2012{:}\mathrm{I}]_t$	0.700	−0.743	−0.711
	(0.134)	(0.418)	(0.413)
$NonTaxCharges_{cit}$	-	-	0.351
	-	-	(0.127)
$NonTaxCharges_{cit} \times I[Qtr > 2012{:}\mathrm{I}]_t$	-	-	0.022
	-	-	(0.186)
Controls:			
$Layovers_i$	x	x	x
$Distance_i$ (cubic)	x	x	x
HHI_{jt} (cubic)	x	x	x
$\ln(OriginVolume_{cj^o kt})$ (cubic)	x	x	x
$Load_{cit}$ (*cubic*)	x	x	x
Fixed Effects:			
Carrier × Qtr (η_{ct})	x	x	x
O&D City × Qtr (ν_{kt})		x	x
Observations	25,175	24,712	24,712
R^2	0.854	0.964	0.964

Notes: Standard errors clustered by origin-destination airport-pair appear in parentheses. Observations are weighted by passenger volume.

Sources: DB1B (Bureau of Transportation Statistics) and RDC Aviation

taxes is associated with a \$0.25 increase in total fares. Three-quarters of every dollar in ticket taxes are thus borne by the airlines in the post-FFAR period, in marked contrast to the pre-FFAR period when consumers bore the entire tax.

Column 3 of Table 3 introduces our measure of itinerary-specific nontax charges. Due to the manner in which nontax charges are levied (i.e., on a per movement basis instead of a per passenger basis), these constitute a cost of airline operations much like any other, and their inclusion in advertised fares was consequently unaffected by FFAR. Thus, nontax charges serve as a type of placebo control in that pass-through rates for these charges should have remained unchanged in the post-FFAR period and, furthermore, should be similar to unit tax pass-through rates once both are treated equally: namely, once both are required to be presented as part of a single tax-inclusive price post-FFAR.[32] The results show that the pass-through rate in the pre-FFAR period for unit taxes is little changed from column 2 at 0.958 cents for every dollar of unit taxes. Nontax charges, however, show a significantly lower pass-through rate in the pre-period (p-value $= 0.065$), which is consistent with their inclusion in posted prices having precluded airlines from

[32] Strictly speaking, given the differing margins at which nontax charges and passenger ticket taxes are incurred, these may potentially be passed through to ticket prices at differing rates. We abstract from this distinction for purposes of testing for placebo effects and implicitly assume that airlines treat nontax charges as though these were incurred on a per passenger basis when setting average fares.

shifting these itinerary-specific costs fully onto consumers. Moreover, pass-through rates for nontax charges are virtually unchanged post-FFAR. This is expected given that the rule change did not impact the presentation of these charges to consumers. Taken together, we cannot reject a null hypothesis of equal pass-through rates in the post-FFAR period of 0.247 and 0.373 for unit taxes and nontax charges, respectively (p-value $=$ 0.708), consistent with both sources of price variation being presented in an equally salient manner.

B. *Passenger Demand and Tax-Exclusive Total Revenue*

Table 4 follows the same structure as the last column of Table 3 but focuses on the post-FFAR effect of unit taxes on itinerary-level passenger volume (columns 1–2) and total revenue (column 3). As discussed in Section III, we present both ordinary least squares (OLS) and instrumental variable (IV) results for passenger volume, using the number of itineraries offered by competing carriers servicing the same origin-destination airport-pairs to instrument for base fares.[33]

As shown in the previous section, ticket prices were endogenously impacted by FFAR, with larger reductions in base and total fares arising along higher-taxed routes. As always, failing to account for the simultaneous determination of equilibrium prices and quantities should yield positively biased estimates of the price semielasticity of demand, and this is indeed the pattern reflected in the OLS results in column 1 of Table 4. As such, the IV estimates in column 2 are informative in multiple important respects. First, although the point estimates suggest the possibility of some heightened demand sensitivity with respect to base fares in the post-FFAR period, we cannot reject that changes in base fares affect demand similarly in both the pre- and post-FFAR periods. The same is true for nontax charges. Unit taxes, however, show no statistically significant impact on demand in the pre-period but show a large negative impact in the post-period. Moreover, t-tests of the equality of estimated coefficients show that we cannot reject equality of the impact of base fares and nontax charges on demand either pre- or post-FFAR (p-values of 0.311 and 0.483, respectively), whereas we can reject equality of each with unit taxes in the pre-FFAR period (p-values of 0.000 and 0.005, respectively). Post-FFAR, we cannot reject a test of equality of demand effects due to base fares, unit taxes, or nontax charges (p-value $=$ 0.126). Consumers' underreaction to components of the total price that are not fully salient (i.e., unit taxes in the pre-FFAR period) serves as further evidence of the pronounced effects of limited attention. Adoption of FFAR, however, is associated with significant debiasing, such that when base fares, unit taxes, and nontax charges are all included in total fares in an equally salient manner, consumers respond to each equally—consistent with the standard theory of (attentive) consumer behavior.

The results from column 2 can also be interpreted as estimated elasticities, presented in the bottom half of the table. In order to convert our semielasticity estimates into directly comparable price elasticities of demand, we evaluate each

[33] Corresponding IV first-stage results can be found in Table A6.

Table 4—Itinerary-Level Passenger Volume and Tax-Exclusive Ticket Revenue

$Y =$	$\ln(Passengers_{cit})$		$\ln(Revenue_{cit})$
	(1-OLS)	(2-IV)	(3-OLS)
(a) $BaseFare_{cit}$	−0.008	−0.438	-
	(0.011)	(0.180)	-
(b) $BaseFare_{cit} \times I\left[Qtr > 2012{:}\mathrm{I}\right]_t$	−0.067	−0.113	-
	(0.015)	(0.202)	-
(c) $UnitTaxes_{cit}$	0.289	0.304	0.195
	(0.121)	(0.218)	(0.119)
(d) $UnitTaxes_{cit} \times I\left[Qtr > 2012{:}\mathrm{I}\right]_t$	−0.791	−1.179	−0.682
	(0.198)	(0.350)	(0.195)
(e) $NonTaxCharges_{cit}$	-0.017	−0.303	−0.169
	(0.092)	(0.134)	(0.087)
(f) $NonTaxCharges_{cit} \times I\left[Qtr > 2012{:}\mathrm{I}\right]_t$	−0.154	−0.163	−0.135
	(0.128)	(0.161)	(0.122)
Elasticity of demand with respect to:			
Base fares:			
Pre-FFAR		−3.23	
		(1.31)	
Post-FFAR		−4.05	
		(0.88)	
Unit taxes:			
Pre-FFAR		2.31	
		(1.67)	
Post-FFAR		−6.35	
		(1.48)	
Nontax charges:			
Pre-FFAR		−2.25	
		(0.98)	
Post-FFAR		−3.44	
		(0.86)	
Controls:			
$Layovers_i$	x	x	x
$Distance_i$ (cubic)	x	x	x
HHI_{jt} (cubic)	x	x	x
$\ln(OriginVolume_{cjo_t})$ (cubic)	x	x	x
$Load_{cit}$ (cubic)	x	x	x
Fixed Effects:			
Carrier × Qtr (η_{ct})	x	x	x
O&D City × Qtr (ν_{kt})	x	x	x
Observations	24,712	24,712	24,712
R^2	0.836	0.780	0.866
Kleibergen-Paap F-statistic		15.27	

Notes: All elasticities evaluated for a 1 percent change in base fares equal to $7.50. This is equivalent to a 6.9 percent change in unit taxes and a 32.6 percent change for nontax charges evaluated from their respective means. Standard errors clustered by origin-destination airport-pair appear in parentheses. Observations are weighted by passenger volume. p-values of tests of equality of estimated coefficients from column 2: (a) $=$ (c): 0.000; (a) $=$ (e): 0.311; (c) $=$ (e): 0.005; (a) + (b) $=$ (c) + (d) $=$ (e) + (f): 0.126.

Sources: DB1B (Bureau of Transportation Statistics) and RDC Aviation of our point estimates in relation to the average value of total fares (about \$750). The bottom panel of Table 4 reports these calculations. An increase in base fares equal to 1 percent of total fares (roughly \$7.50) in the pre-FFAR period thus implies a 3.23 percent reduction in demand. This elasticity increases slightly in absolute terms in the post-period but is statistically indistinguishable from the pre-period. The elasticity of demand with respect to nontax charges at -2.25 and -3.44 is statistically similar to that of base fares in both the pre- and post-FFAR periods, respectively. In contrast, the demand elasticity with respect to unit taxes is positive and statistically insignificant in the pre-period but negative and significant in the post-period. Demand hence falls by 6.36 percent in response to an increase in unit taxes of an amount equal to 1 percent of total fares in the post-period. While larger than the elasticity of demand with respect to base fares, a 95 percent confidence interval around our estimate of the unit tax elasticity of demand spans a range of approximately -3.45 to -9.26, and we cannot reject that the post-FFAR base fare and unit tax elasticities are equal.[34]

Our estimated elasticities fall at the high end of the range of elasticity estimates for air travel reviewed in Gillen, Morrison, and Stewart (2003) or InterVistas (2007), which combine studies based on domestic and international travel, the latter markets tending toward higher elasticities given the relative importance of leisure travel. Berry and Jia (2010) document a trend toward increasing elasticities between 1999 and 2006 and report a main estimate of 1.05 for the latter period based on US domestic flights only. It is worth noting, however, that elasticity estimates based on DOT ticket data from the pre-FFAR era will systematically understate consumer sensitivity to advertised (base) fares as a result of inattention to the unit tax portion of total fares reported in the DB1B.[35] Furthermore, it is also important to emphasize that the source of identifying variation in our analyses arise *within* origin-destination city market, such that our estimates of demand responses depend fundamentally upon patterns of consumer substitution across itineraries serving the same origin and destination. This is a much narrower source of identifying variation than in most studies of airline demand, and consumers may reasonably view itineraries within such narrowly defined markets as more highly substitutable than itineraries serving the same general regions, origins, or destinations (separately).

A key parameter of interest with respect to tax salience is the degree of taxpayer inattention measured as the ratio of the estimated elasticity of demand with respect to taxes relative to the elasticity of demand with respect to tax-exclusive prices.

[34] Taken seriously, consumers could exhibit hypersensitivity to unit taxes for several reasons, especially in the short-run aftermath of the adoption of FFAR. While ticket taxes are now included in advertised prices, they are still enumerated before final purchase, thereby calling special attention to their magnitude. Moreover, consumers might have experienced initial shock at the shift in pricing norms, an effect to which particular carriers might have advertently or inadvertently drawn attention in their rollout of FFAR pricing rules. Spirit Airlines, for instance, made an explicit point of alleging on their website that the new DOT rule was requiring airlines to "hide" taxes from consumers (i.e., by rolling these into a single total fare). A newly attentive—or surprised—consumer might plausibly have exhibited tax aversion as a result, at least temporarily.

[35] Interestingly, the *Wall Street Journal* reported a claim by Delta Airlines in December 2017 that for every dollar increase in ticket taxes (specifically, US passenger facility charges), demand falls by 1 percent. Based on the typical average domestic fare of \$300 quoted in the same article, this implies an elasticity of -3, precisely in line with our calculations (https://www.wsj.com/article_e-mail/airports-want-to-raise-ticket-fees-airlines-say-no-fight-ensues-1512729000-lMyQjAxMTI3NDAwODgwMjg5Wj/).

As discussed in Section III, the post-FFAR change in this ratio provides a direct measure of the change in consumer inattention resulting from the implementation of full-fare advertising. Using our IV estimates from column 2 and taking into account the degree of statistical imprecision surrounding our point estimates, we cannot refute full inattention in the pre-period and full debiasing as a consequence of FFAR—assuming that consumers optimize fully when taxes are included in advertised fares.[36] By way of comparison, Chetty, Looney, and Kroft (2009) document a degree of inattention of approximately 0.35 under sales tax-exclusive pricing, such that their experimental introduction of tax-inclusive pricing on grocery store shelves is associated with a change in inattention of 0.65. It is a priori ambiguous whether to expect more or less severe inattention to ticket taxes under tax-exclusive pricing given the combination of larger financial stakes (i.e., more costly optimization errors) and fewer learning opportunities or experience to eradicate biases in the context of ticket taxes on international airfare, but our evidence suggests that the latter mechanism dominates. By extension, this tends to corroborate the view that inattention due to mental gaps—namely, lack of awareness of the existence of ticket tax variation—as opposed to simple frictions may play a more important role than in prior experimental studies involving better understood sales taxes.

As shown in Table 3, unit tax pass-through rates fell from approximately 1 to 0.25. For the average ticket sold post-FFAR along higher-taxed itineraries, this should constitute a significant loss in ticket revenue through reduced base fares. Moreover, the results from column 2 of Table 4 establish that increased ticket tax salience could lead to further possible revenue losses through reductions in passenger demand. Column 3 of Table 4 presents estimates of these combined price and quantity effects on itinerary-level ticket revenues exclusive of unit taxes and nontax charges (measured in logs). Consistent with the prior results, unit taxes in the pre-FFAR period have no statistically significant impact on revenues while nontax charges have a significant negative impact (reflecting both incomplete pass-through of the latter charges, as well as their negative demand effects). Post-FFAR, however, a \$5 increase in unit taxes is associated with a 2.4 percent reduction in ticket revenue.[37] For comparison, a simple back-of-the-envelope calculation of tax-exclusive revenue losses attributable to the product of price and quantity effects identified in Table 3 and column 2 of Table 4 would instead imply a 2.8 percent reduction in ticket revenue for a tax increase of the same magnitude.

Applied to the full pre-FFAR (2011) distribution of within-market-by-quarter demeaned unit tax amounts, these estimates imply an aggregate post-FFAR reduction in within-market ticket revenue of just over \$16 million across the 300 markets that we study. For comparison, after-tax revenues in our estimation sample totaled \$144 million in 2011. Scaled up to a full 100 percent sample, this amounts to \$160 million in revenue losses coming strictly from within-market substitution toward lower-tax itineraries and reduced ticket tax pass-through rates (i.e., without

[36] More precisely, we have that $\theta_{Qtr<2012:\mathrm{I}} = (\partial \ln(Passengers)/\partial UnitTaxes)/(\partial \ln(Passengers)/\partial BaseFare) = 0.304/-0.438 = -0.69$, with a 95 percent confidence interval spanning the range $[-2.06, 0.67]$, and $\theta_{Qtr>2012:\mathrm{I}} = (0.304 - 1.179)/(-0.438 - 0.113) = 1.59$, with a confidence interval spanning the range $[0.90, 2.28]$.

[37] i.e., $e^{(0.05\times(0.195-0.682))} - 1) = -0.024$.

accounting for any potential aggregate demand effects). These represent relatively large losses in ticket revenue and lend strong justification for the US airline industry's intense and persistent efforts to reverse FFAR through lobbying and public relations campaigns. It is important to note, however, that carriers may have compensated for lower base fares and ticket revenue through increased reliance on product unbundling and the use of less heavily regulated add-on fees, such as baggage and check-in fees, seat upgrades, in-flight meals and service, etc., whose costs to consumers we do not observe in the ticket data.[38] If airline markets were perfectly competitive, this would be the expected response due to carriers adjusting their menu of product offerings to realign their (fee-inclusive) prices with marginal costs (Agarwal et al. 2015). Though responses may be more nuanced in an imperfectly competitive setting, our estimates of ticket revenue losses or reductions in unit tax pass-through rates should not, therefore, be interpreted as a pure transfer of surplus from airlines to consumers.[39]

C. *Heterogeneity in Pass-Through: Market Concentration and Capacity Utilization*

In this section, we consider the possibility of heterogeneous effects of FFAR on tax incidence as a function of market supply conditions, including market concentration and capacity utilization. As we discuss in Section IIIA, the basic theory of tax incidence—based on linear demand and fully salient taxes—implies that taxes should fall relatively more heavily on firms in less competitive markets. More generally, however, pass-through rates in imperfectly competitive markets depend not only on the relative elasticities of supply and demand, but also on the curvature of demand, with the result that full pass-through or overshifting of taxes onto consumers are also possible. These predictions have not been tested for less than fully salient taxes, let alone in environments where the degree of salience (and changes therein) may depend in part on the availability of competing product offerings in order for consumers to make informed comparisons.

We compute a Herfindahl-Hirschman Index (HHI) of market concentration based on carrier revenue shares within origin-destination airport-pairs in the full DB1B sample—regardless of the availability of matching tax information, class of service, and outbound versus inbound or round-trip versus one-way status—and we divide this number by 10,000 to obtain values ranging from 0 (perfect competition) to 1 (monopoly). Mean and median HHI levels in our estimation sample are 5,600 and 5,000, respectively, such that what are typically considered "competitive" markets, based on an adaptation of the classification introduced by Borenstein and Rose (1994), account for just under half of all observations and monopolistic

[38] Indeed, the airline industry has likewise lobbied heavily—and thus far successfully—to prevent the DOT from requiring more prominent disclosure of add-on fees.

[39] Online Appendix D characterizes the evolution of the largest US carriers' sources of revenue from international and domestic operations on the basis of quarterly financial statement information compiled by the DOT. With the possible exception of United/Continental, it does not appear that the implementation of FFAR coincided with a sharp break in carriers' reliance on add-on fees. In the United/Continental case, the shift in reliance on add-on fees as a source of revenues more likely reflects the coincident timing of merger-related restructuring and opportunities afforded by the alignment of business practices at that time.

markets account for only approximately 5 percent of observations.[40,41] We allow for market concentration to affect pass-through rates by extending our basic empirical specification with an interaction of unit taxes and a cubic polynomial in HHI (pre- and post-FFAR). We depict the resulting partial effect estimates evaluated over the distribution of HHI deciles in Figure 4, which calls attention to several notable features. First, we find that we cannot reject complete pass-through at all levels of market concentration in the pre-FFAR period. Logically, if consumers do not react to changes in unit taxes due to inattention, then market concentration is irrelevant to pass-through. Second, at higher levels of competition (lower levels of HHI), the post-FFAR interaction with HHI continues to show near complete pass-through of unit taxes, consistent with standard theoretical predictions with respect to marginal cost pricing in competitive markets. However, pass-through rates for unit taxes are shown to drop most sharply in more highly concentrated (i.e., "duopoly") markets following the adoption of tax-inclusive pricing, consistent with a combination of substantial debiasing and standard tax incidence results under imperfect competition and linear demand. In these less competitive markets, pass-through is strictly less than one in the post-FFAR period and even negative over part of the range (albeit not statistically different from zero) before rising slightly in the top HHI decile. One possibility in this context is that tax salience is lower and remains lower—despite the implementation of tax-inclusive pricing—in markets where fare comparisons are largely impossible due to the presence of a single dominant carrier in the market, thereby offsetting otherwise lower pass-through rates due to monopolists' price-setting behavior. As such, market concentration may play a dual role with respect to FFAR, in terms of both conventional cost pass-through effects as well as in terms of modulating intrinsic consumer attentiveness and tax saliency.

Figure 5 provides comparable evidence of heterogeneous pass-through rates as a function of (standardized) capacity utilization across origin-destination airport-pairs within city markets. As airlines and airports bump into capacity constraints at high levels of capacity utilization (e.g., because of an inability to readily deploy larger aircraft types or acquire new landing slots in the short term), we expect this to be reflected in a lower elasticity of supply and lower ticket tax pass-through rates. Consistent with this conjecture, pass-through rates in both the pre- and post-FFAR

[40] Translation of Borenstein and Rose's (1994) definition of monopoly, duopoly, and competitive markets (originally based on carrier shares of the number of daily flights) into minimum threshold HHI values implies that markets with an HHI of less than 4,050 are considered "competitive." Values of HHI falling between 4,050 and 8,100 (i.e., corresponding to the range of HHI values in a market in which two firms collectively hold a 90 percent market share yet where no single firm holds 90 percent individually: $2 \times 45^2 = 4{,}050 \leq HHI < 8{,}100 = 90^2$) constitutes a "duopoly," and a "monopoly" is defined as having an HHI of at least 8,100. Regressions involving these discretized categorizations of market concentration yield a similar pattern of results as those involving the continuous measure of HHI (available upon request).

[41] Independent of the usual caveats regarding the use of HHI as a measure of market competitiveness, we are unable to measure HHI precisely due to the fact that the DB1B data only include information on foreign carriers through their codesharing agreements with US reporting carriers. We may consequently understate or overstate the true degree of market concentration depending on the importance of direct competition from foreign carriers versus the treatment of codeshare or alliance partners. Measured market concentration is predictably somewhat higher when we treat all members of the SkyTeam, Star, and OneWorld alliances as belonging to one of three "firms," respectively. We nevertheless obtain qualitatively similar results using a measure of HHI defined on the basis of airline alliances. See Brueckner (2003) for a discussion of airline competition with respect to alliances and codesharing agreements.

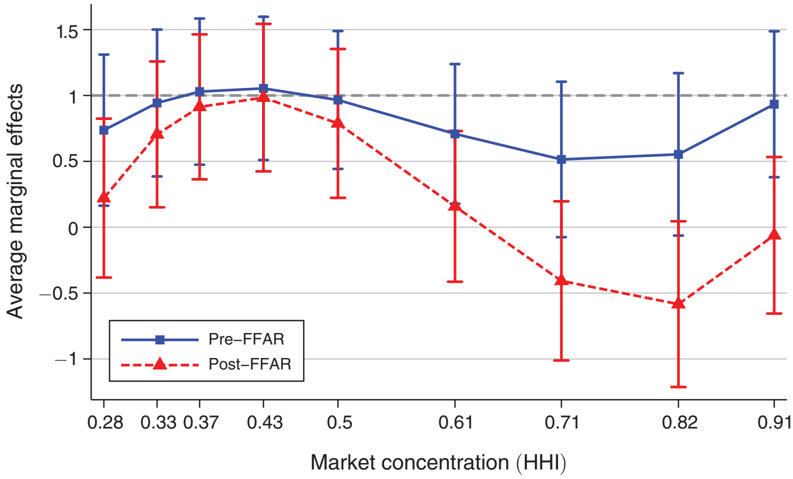

Figure 4. Pass-Through of Unit Ticket Taxes by Market Concentration

Notes: Average marginal effect estimates are based on a model fitted with pre- and post-FFAR unit taxes and airport charges interacted with a cubic polynomial in HHI. Whisker bars represent 90 percent confidence intervals.

Sources: DB1B (Bureau of Transportation Statistics) and RDC Aviation

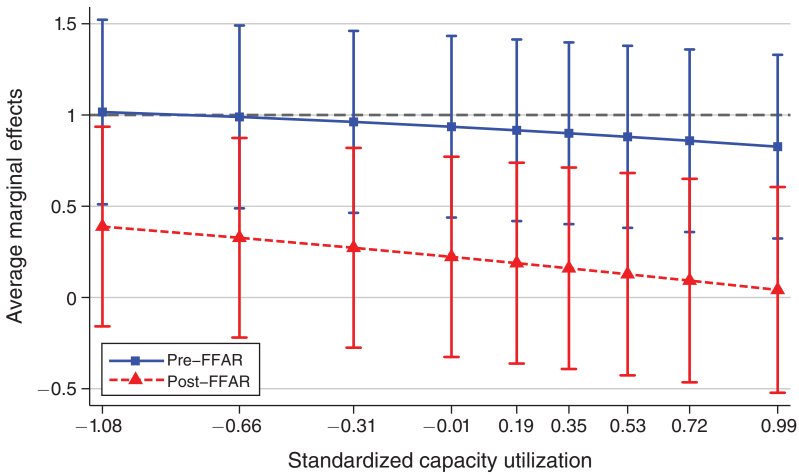

Figure 5. Pass-Through of Unit Ticket Taxes by Capacity Utilization Decile

Notes: Average marginal effect estimates are based on a model fitted with pre- and post-FFAR unit taxes and airport charges interacted with a cubic polynomial in HHI. Whisker bars represent 90 percent confidence intervals.

Sources: DB1B (Bureau of Transportation Statistics) and RDC Aviation

periods are indeed decreasing modestly in capacity utilization, albeit not significantly so in statistical terms. Moreover, the spread between pre- and post-FFAR pass-through rates at comparable rates of capacity utilization remains virtually unchanged over the capacity utilization distribution—despite estimation of complete interaction effects between unit taxes and a cubic polynomial in capacity utilization (pre- and post-). This suggests a relatively insignificant effect of this proxy for the elasticity of supply on pass-through rates or debiasing once other market characteristics—including market concentration—are accounted for among our general set of controls.

V. Conclusion

We find that the switch from tax-exclusive to tax-inclusive pricing of airfares mandated by the DOT in 2012 had a significant impact on ticket tax incidence and consumer demand. Contrary to the standard presumptions of well-informed rational consumer behavior, this confirms that tax salience plays a prominent role in affecting market outcomes when consumers suffer from limited attention, even in cases involving relatively large purchases and high effective commodity tax rates. The implementation of FFAR is associated with a significant decline in unit tax pass-through from near complete pass-through under the previous tax-exclusive pricing regime to a rate of roughly 25 cents on the dollar in the post-FFAR period—comparable to the pass-through rate on the set of nontax charges which were always subject to disclosure in advertised fares. Moreover, we estimate that pass-through of unit taxes onto consumers fell more in less competitive markets, consistent with the basic textbook theory of tax incidence under imperfect competition.

Accounting for these endogenous pricing responses—a novel feature of our quasi-experimental framework relative to the prior experimental literature on tax salience—we also show that a \$5 increase in unit taxes (approximately equal to the average standard deviation of unit taxes within origin-destination city market) is associated with a 4.3 percent reduction in itinerary-level passenger volume. In sharp contrast to evidence from the pre-FFAR period, consumers in the post-FFAR period are thus equally sensitive to tax-driven changes in total fares as they are to changes in total fares resulting from changes in underlying base fares. Given the within-market nature of our identification strategy, we attribute this reduction in demand to cross-itinerary substitution as consumers sought out lower-taxed routes.

The combined impact of reduced ticket tax pass-through and reduced passenger demand (in relation to the portion of the tax still born by consumers) together imply that a \$5 increase in unit taxes is furthermore associated with a 2.4 percent reduction in airline ticket revenue. While our within-market-by-quarter identification strategy and data limitations do not allow us to calculate the impact of FFAR on aggregate ticket revenues—let alone airline profits—these results point to a substantial transfer of surplus from airlines to consumers whose precise magnitude is subject to the aforementioned caveats about possible compensating adjustments in reliance on add-on fees. The airline industry's persistent and ongoing attempts to reverse FFAR serve as prima facie evidence of its negative effects on producer welfare due to increased tax incidence on airlines, as well as possible reductions in aggregate demand due to the perception of higher prices.

These findings emphasize the profound influence that disclosure rules may have in light of the prevalence of cognitive biases. This represents a potentially fruitful avenue for promoting consumer welfare through regulation and tax policy design. However, this should be tempered by the possibility of fostering unintended consequences. Consideration of possible such consequences in the context of FFAR—such as through the increased use of add-on fees as a source of revenues or through extensive-margin itinerary entry and exit supply decisions—is left for future work.

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