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

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**Abstract**

We examine the impact on air travelers of an enforcement action issued by the U.S. Department of Transportation (DOT) in 2012 requiring that domestic air carriers and online travel agents incorporate all mandatory taxes and fees in their advertised fares. Consistent with the literature on tax salience, we find quasi-experimental evidence that the more prominent display of tax-inclusive prices is associated with a reduction in tax incidence on consumers, and this effect varies non-monotonically with market concentration. Ticket revenues are commensurately reduced, while passenger demand and average per-passenger tax revenue between origin and destination airport-pairs likewise decline following the introduction of full-fare advertising.

Keywords: tax salience, airlines, ticket taxes, tax incidence

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# 1 Introduction

A growing body of literature has established that tax salience (i.e. visibility) matters for how individuals respond to the various tax instruments that they face. A robust finding from this literature shows that consumers often fail to fully internalize the total tax inclusive price when base prices are presented separately from a sales tax (see, for example, Chetty, Looney and Kroft (2009) or Feldman and Ruffle (2015)). What has been less studied thus far is how sellers may take advantage of such salience effects when pricing their goods. If consumers are inattentive to low-salience taxes (i.e. the elasticity of demand with respect to taxes is less than the elasticity of demand with respect to tax-exclusive prices), producers will find it easier to pass taxes through to consumers and will bear a smaller share of the burden of the tax.[1] Conversely, an increase in tax salience should lead to diminished tax incidence on consumers (Chetty, Looney and Kroft, 2009).

We address this and other questions by making use of a regulatory change to the advertising of commercial airline tickets whereby the U.S. Department of Transportation (DOT) adopted new airline ticket tax disclosure rules, including a requirement that domestic air carriers and online travel agents incorporate all mandatory taxes and fees in their advertised fares. Prior to this, domestic airlines had been allowed to advertise fares exclusive of specific (unit) tax amounts while publishing ticket taxes and fees separately—potentially at later stages in the ticket-buying process— thereby rendering variation in airport-specific unit taxes relatively invisible to consumers in their initial search stages. It is, to our knowledge, the only case where the tax regime switches from having a more US-style sales tax with base prices separated from the taxes and fees to a more European-style VAT with tax and fee inclusive prices presented up front. Moreover, the airline industry presents a unique setting

[1] 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 (2014) 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 which to examine tax salience in the context of economically large taxes.[2]

Whereas cognitive biases have served to motivate the implementation of various consumer protections, primarily in the area of financial products,[3] the DOT's full-fare advertising rule represents the first instance of an application of tax salience considerations to U.S. 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.[4]

Using restricted-use International Origin and Destination Survey (DB1B) ticket data collected by the Bureau of Transportation Statistics over a period of six years surrounding the DOT rule change, we 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. Moreover, 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 owing to tax-inclusive pricing through offsetting reductions in base fares.

In addition, we also find that reduced ticket tax pass-through rates combined with significant 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, consis-

[2]The average tax amount in our data is roughly $100 or X% of the average flight ticket.

[3]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).

[4]Equivalently, ticket taxes may be viewed through the lens of partitioned pricing as a type of "shrouded attribute" in the terminology of Gabaix and Laibson (2006). To this point, FFAR also explicitly addressed the disclosure of baggage fees, which represent a clear example of partitioned pricing akin to the cases of printer ink cartridges (Gabaix and Laibson, 2006) or shipping costs (Hossain and Morgan, 2007). 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 an application to baggage fees.

tent with the predicted consequences of increasing tax salience. Controlling for all unobserved determinants of within-year trends in passenger demand by origin-destination city market and instrumenting for carriers' endogenously-chosen base fares using a combination of crude oil price and flight distance cost shifters, we find that a one standard deviation ($39) increase in unit taxes is associated with a 3.6-4.7 percent reduction in ticket revenue and a 4.4-5.1 percent reduction in passenger volume in the post-FFAR period.[5] These last effects on passenger volume reflect both aggregate demand responses (as if all air travel were perceived as more costly post-FFAR) as well as changes in demand due to cross-itinerary substitution.

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 experimental evidence presented in Chetty, Looney and Kroft (2009) and Feldman and Ruffle (2015), a key distinction in our setting is the ability of airlines to adjust pre-tax prices and—in the longer-term—route availability. Demand responses to more salient tax information are therefore attenuated through diminished tax incidence on consumers.

Our results also help to inform the relatively narrow literature on commodity tax incidence, including Poterba (1996); Besley and Rosen (1999); or Carbonnier (2013), and we provide the first large-scale estimates of airline ticket tax pass-through rates.[6] Given the nature of the market for air travel, our estimates serve as a test of theoretical predictions about 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) which emphasize the effects of market structure and supply conditions on tax incidence. Finally, our results also extend the literature de-

[5]Perhaps not surprisingly, U.S. airlines have lobbied extensively to prevent and subsequently reverse the implementation of FFAR. Consistent with these objectives, the U.S. 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 113$^{th}$ Congress, however.

[6]Huang and Kanafani (2010) exploit variation in U.S. 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 U.S. airports. Karlsson, Odoni and Yamanaka (2004) provide descriptive evidence on effective ticket tax rates for domestic U.S. airfares.

voted to studying the impact of consumer disclosures, including Agarwal et al. (2014, 2015), and Keys and Wang (2015).

The remainder of the paper is organized as follows: Section 2 describes the motivation for FFAR and its precise details in the context of the DOT's ongoing regulatory action, Section 3 characterizes the data used in our analysis, Section 4 presents a general estimation framework, Section 5 presents and discusses our empirical results, and Section 6 concludes.

## 2 Full-Fare Advertising Rules

The DOT's full-fare disclosure rule was issued on April 20, 2011 and subsequently implemented on January 26, 2012 after a delay requested by U.S. air carriers to comply with the technical requirements. Strictly speaking, FFAR was not so much a regulatory change as an enforcement action. Under C.F.R. §399.84, airlines and travel agencies were already previously required to include all carrier-imposed charges (including fuel surcharges) as well as most government-imposed taxes. However, the DOT had previously exercised discretion in terms of enforcement and exempted taxes and fees that were imposed on a per-passenger basis and specific in nature. Ad valorem taxes, including the U.S. domestic transportation tax, for example, should thus have appeared in airlines' posted prices.[7]

2004, The DOT's stated motivation for implementing FFAR in 2012 focused on consumer protection and concerns related to consumers being mislead as a result of tax- and fee-inclusive prices being less than fully transparent. Figure 1 highlights the nature of the potential challenge facing consumers in selecting airline tickets if 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 (JFK) and Tel Aviv (TLV) ranked by total tax-inclusive fares versus tax-exclusive base fares (a rank of 1 designating the lowest fare). As shown, itineraries above the 45-degree line are relatively more expensive

[7]Based on conversations with staff in the DOT's Office of the Assistant General Counsel for Aviation Enforcement and Proceedings, enforcement along this latter dimension may have also been less than 100 percent.

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, the least expensive itinerary on a tax-inclusive basis, JFK DL TLV :: TLV DL JFK would only appear as the sixth least expensive itinerary 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 (tied for the lowest base fare), despite this itinerary ranking eighth in tax-inclusive terms, and costing \$49.51 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 \$90 for a non-stop Delta flight to a high of \$225 for an El Al flight with a layover in Paris (CDG) in both directions.

Similar variation within and across the 300 largest international origin-destination city markets served by U.S. carriers can be seen in Figure 2 in terms of either unit tax amounts (2a) or effective tax rates (i.e. unit taxes as a percentage of the total fare; 2b). As shown, Western European and Caribbean destinations (purple circles and light blue squares, respectively) tend to exhibit among the highest unit tax amounts as well as the highest standard deviation thereof, which reflects a combination of high taxes at the destination airport as well as increased taxes accruing at stopover points on longer routes. Relative to total fares, Caribbean and Central American destinations trigger by far the highest effective tax rates (Figure 2b).

Suggestive evidence of passengers substituting toward lower-taxed itineraries within this set of 300 origin-destination city markets is depicted in Figure 3. As shown, the share of passengers travelling via relatively high-tax itineraries (i.e. the set of itineraries for which unit taxes weakly exceed the median tax amount within origin-destination city market) began to decline systematically in each quarter following the implementation of FFAR. Measured in year-over-year differences, the blue bars thus suggest an increasing sensitivity to ticket taxes in the first four post-FFAR quarters—consistent with the growing share of passengers who would have purchased their tickets under tax-inclusive pricing over this time—and this shift in demand away from higher-taxed itineraries continues throughout the remainder of the sample period, albeit at a declining rate. In contrast, changes in the share of passengers flying along high-tax itineraries appears largely random in the pre-FFAR period.

# 3 Data

The data for this project are drawn from the Department of Transportation's restricted use International Origin and Destination (O&D) Survey (DB1B) for the period 2009Q1-2014Q3. The data consist of a 10 percent sample of all complete ticketed itineraries sold by U.S. air carriers with at least one point located outside the U.S. and are reported quarterly, based on date of travel.[8] 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- and fee-inclusive fare per passenger.

The ticket data do not, however, provide a breakdown of the fare composition. In order to back out tax-exclusive prices, we consequently apply itinerary-specific tax information obtained from 30844 online fare searches performed over the dates December 30, 2014 - January 29, 2015. The group of initial web scrapes consists of all routes in the DB1B sample flown by more than 36 passengers (in either direction) over the 2012Q4-2013Q3 period (i.e. averaging at least one passenger per day in the full 100 percent sample).[9] On routes for which only a single reporting carrier met this minimum-volume threshold, we attempt an additional search for the same route involving a different carrier. Evidence of matching tax

[8]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 pair* encompasses all possible itineraries connecting the same origin and final destination airports. For example, PHL DL CDG :: CDG AF LHR DL PHL represents a round-trip itinerary Philadelphia to Paris on Delta Airlines with a layover in London on the return trip with the initial segment operated by Air France. The corresponding route, offered by potentially multiple carriers, would simply be PHL CDG :: CDG LHR PHL.

[9]These routes account for approximately 60 percent of total passenger volume. We exclude lower-volume routes from the set of initial scrapes out of concern that changes in passenger traffic along these are subject to a high degree of unexplained variability. Nevertheless, as shown in the summary statistics table below, we ultimately match a non-trivial number of lower-volume itineraries where we have determined that taxes apply uniformly across carriers.

amounts is used as justification for applying the same taxes to all itineraries following the same route, regardless of carrier, whereas inconsistent tax amounts are evidence of either ad valorem taxes or carrier-imposed surcharges and are treated as fare- or carrier-specific.[10]

Each scraped itinerary yields an extract of base fares, surcharges, and specific and ad valorem tax amounts corresponding to multiple individual tax codes.[11] In total, our ticket tax database consists of 255 unique foreign tax codes spread across 107 countries worldwide. Concretely, we distinguish ad valorem taxes from unit taxes by running separate regressions of each tax code on scraped base fares plus a scrape date indicator. We treat all taxes featuring a statistically significant base fare coefficient in excess of 0.5 percent and a regression R-squared of at least 0.5 as ad valorem and record the applicable tax rate rounded to the nearest 0.5 percent.

Having isolated unit tax amounts and ad valorem tax rates, we apply the set of itinerary-specific foreign taxes retroactively to matching itineraries in the DB1B, adjusting unit tax amounts for nominal bilateral exchange rate movements between the date that the tax information was scraped and the quarter of the DB1B data.[12,13] A limitation of this approach is that we are unable to account for statutory changes in foreign tax amounts over time. For U.S.-imposed taxes, we apply the historical airport-specific schedule.[14] If taxing authorities are responsive to changes in passenger demand (e.g. as one might expect if airports compete for volume), this may bias our estimates of the effect of the full-fare advertising rules toward zero. If this approach instead induces classical measurement error whose variance is increasing the further back in time we go, a more serious concern is that attenuation bias may

[10]This latter category includes, for example, the U.K. Passenger Service Charge, which is levied at the discretion of the airlines to cover general airport-imposed costs, such as landing fees. Only per-passenger specific tax amounts were newly-affected by FFAR.

[11]U.S. airports alone levy up to 7 distinct taxes on international flights.

[12]Itineraries associated with Northwest or Continental Airlines as the reporting carrier in the earlier quarters of the DB1B data are re-coded as their merger partners, Delta and United Airlines, respectively, prior to matching with the contemporaneous (i.e. post-merger) web scrapes.

[13]The merged sample utilizes tax data from 20974 unique carrier-specific itineraries and 11710 carrier non-specific routes with valid tax information and accounts for around 35 percent of total quarterly passenger volume in the DB1B data (including low-volume itineraries, which we intentionally exclude) and 45 percent of round-trip traffic.

[14]We are grateful to Joakim Karlsson and the MIT Airline Ticket Tax Project for sharing their data.

give the appearance of increased demand sensitivity to ticket taxes in the later (post-FFAR) periods. We intend in the near future to bound the magnitude of this bias based on observed differences in tax amounts scraped one year apart.[15]

Once matched to the appropriate specific tax amounts and ad valorem tax rates, we aggregate each individual observation in the quarter $t$ DB1B sample to a carrier $i$, route $j$, and product category $k$ (i.e. origin-destination city pair) in order to compute passenger volume totals and passenger-weighted average base fare amounts. Consistent with the literature, we focus exclusively on coach-class, non-award travel.[16,17] 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) which may trigger the application of different taxes.[18] Likewise, we omit itineraries involving U.S. territories, Alaska, or Hawaii due to the application of different U.S. ticket tax rules.[19] Finally, we exclude all group tickets covering more than 9 passengers on the grounds that these are likely to involve negotiated fares whose purchasers (e.g. tour operators or the U.S. government) are unlikely to be subject to the same behavioral biases as individual consumers.

For computational tractability, we ultimately limit our analysis to the top 300 international origin-destination city markets (ranked by total outbound and inbound passenger vol-

[15] Regrettably, the sole provider of international ticket tax data, the International Air Transport Association, has not been forthcoming in selling their data for research purposes.

[16] We define award travel as all tickets featuring a cost-per-mile of less than \$0.02. We select this threshold based on the observation that among carriers that report a relatively small fraction of tickets costing precisely \$0, these carriers instead report a relatively large proportion of flights costing between \$0 and \$0.02. According to the DOT, systematic differences across carriers in award fare amounts may reflect whether the carriers include taxes paid for award fares. Award travel thus appears to account for up to 5 percent of passenger volume. 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.

[17] 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.

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

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

ume in 2011), each of which are serviced by an average of more than 13 available itineraries and account for 66 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 top 500 city markets (accounting for 77 percent of matched passenger volume) yield qualitatively similar, yet less precisely-estimated results, consistent with this last concern.

Table 1 reports basic summary statistics from our full data sample at the consumer $c$ and itinerary $ij$ levels. Mean and median specific taxes are just over \$100, with a standard deviation of approximately \$50. Ad valorem ticket taxes apply to fewer than one percent of all ticketed itineraries and correspondingly average \$3 per ticket in the full sample.[20] Mean and median passenger volume per quarter remain quite modest, with the spread between these and the large standard deviation giving a partial glimpse of the highly skewed nature of itinerary traffic.

# 4 Empirical Specifications

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 de-biasing induced by the switch to tax-inclusive pricing (Chetty (2009); Chetty, Looney and Kroft (2009)). Following standard principles of tax incidence (e.g., assuming linear demand), this effect may be especially large in imperfectly-competitive markets. 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,

[20] Ticket-level observations are expanded to one observation per passenger, whereas itinerary-level averages and medians are presented on an unweighted basis, hence the larger implied ad valorem tax amount based on itinerary-level aggregates. Ad valorem tax rates reach as high as 40 percent in Argentina, where taxes on airline tickets and credit card transactions are used as a form of capital control.

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.[21]

Following Weyl and Fabinger (2013) and Conlon and Rao (2015), we estimate the share of each dollar in ticket taxes that is passed through into total fares according to the following general specification in order to measure pre- and post-FFAR tax incidence on consumers:

$$\begin{aligned} TotalFare_{cijkt} &= \alpha + \beta_1 UnitTaxes_{ijkt} + \beta_2 I[Qtr > 2012Q1]_t \\ &+ \beta_3 UnitTaxes_{ijkt} \times I[Qtr > 2012Q1]_t + \tilde{\gamma}\tilde{\mathbf{X}}_{\mathbf{jk}} + \eta_{it} + \nu_{kt} + \varepsilon_{cijkt} \end{aligned} \tag{1}$$

$TotalFare_{cijkt}$ represents the total fare paid by consumer $c$ for a flight operated by carrier $i$ on route $j$ connecting origin-destination city-pair $k$ in quarter $t$. Unit taxes $UnitTaxes_{ijkt}$ are defined at the corresponding itinerary (carrier-route) level, and the post-FFAR period indicator, $I[Qtr > 2012Q1]_t$, is set to 1 in all periods falling after the first quarter of 2012 and is zero otherwise.[22] Beyond these main variables of interest, $\tilde{\mathbf{X}}_{\mathbf{jk}}$ represents a vector of route and city pair characteristics, including a cubic polynomial in distance flown, the number of connecting flight segments, and—depending on specifications—measures of market concentration and market size. Finally, unobserved sources of variation in total fares are attributed to $\eta_{it}$, $\nu_{kt}$, and $\varepsilon_{cijkt}$. $\eta_{it}$ accounts for unobserved time-varying carrier-specific attributes that might be correlated with the tax salience effects of FFAR, such as pre-existing 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 $\nu_{kt}$. An implicit assumption is that

[21] This situation differs from the "sufficient statistic" 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 from the changes in estimated pass-through rates and passenger demand *conditional* on final prices adjusting endogenously to mitigate the consequences of increased tax salience.

[22] Given that the DOT disclosure rules only went into effect on January 26, 2012 and that our ticket data are dated only by the quarter flown, we expect that very few observations in our DB1B sample from 2012Q1 would have likely involved ticket purchases under the full-fare advertising regime.

unobserved (non-tax) determinants of route $j$ ticket prices are uncorrelated (conditional on distance, carrier, etc.) with the timing of FFAR or ticket tax amounts, such that these do not represent a source of omitted variable bias.

In our preferred specification involving a full set of origin-destination city $\times$ quarter ($\nu_{kt}$) and carrier $\times$ quarter ($\eta_{it}$) 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. $\beta_3$ is thus the difference-in-differences estimator of the change in ticket tax pass-through rates associated with FFAR and reflects the combined impact of de-biasing (i.e. bringing the tax elasticity of demand into alignment with the price elasticity of demand) along with the effect of market structure and competition. In further specifications, we allow for this effect to vary as a function of market concentration in order to test for the possibility of larger shifts in tax incidence in markets where individual airlines bear greater responsibility for price-setting. We also introduce controls for ad valorem tax amounts—whose inclusion in advertised fares was already required under DOT regulations prior to 2012—in order to compare post-FFAR responses.[23]

Our empirical strategy with respect to estimating the effects of FFAR on additional demand outcomes involves a similar difference-in-differences or triple-differencing approach. Depending on the outcome of interest, it is necessary for this purpose to aggregate consumer ticket information to the itinerary $ij$ or product $k$ levels (technically, an origin-destination *airport*-pair sub-category within city market). Adding controls for average base fares to the empirical model yields a simple adaptation of (1):

$$\begin{aligned} ln(Y_{[ij]kt}) = \alpha + \beta_1 AvgBaseFare_{ijkt} + \beta_2 UnitTaxes_{ijkt} + \beta_3 I[Qtr > 2012Q1]_t \\ + \beta_4 UnitTaxes_{ijkt} \times I[Qtr > 2012Q1]_t + \tilde{\gamma}\tilde{\mathbf{X}}_{\mathbf{jk}} + \eta_{it} + \nu_{kt} + \varepsilon_{ijkt} \end{aligned} \quad (2)$$

[23]A caveat to this approach is that ad valorem taxes apply to only approximately 5 percent of tickets in our sample, and apply primarily to destinations in the Americas. We consequently have limited power to distinguish the mechanical feedback from prices to ad valorem taxes versus underlying rates of pass-through.

where $Y_{[ij]kt}$ alternately represents itinerary-level tax-inclusive ticket revenue or passenger volume, or average tax revenue or number of flight segments measured at the origin-destination airport level.

The first of these measures reflects a combination of endogenous price responses (i.e. changes in pass-through rates) as well changes in passenger demand. Passenger volume may in turn be affected both through aggregate demand (such as if inattentive consumers perceived airfares to have risen across the board as a result of FFAR) as well as through cross-itinerary substitution. Manifestations of such substitution patterns ought to be reflected in the last two outcome measures of within-origin-destination airport-pair average ticket tax revenue and number of flight segments if, for example, consumers substituted towards itineraries with fewer layovers to avoid the accumulation of unit taxes at each departing and arriving airport. As in (1), we allow the main tax effect to vary pre- and post-FFAR for each of these outcomes through the $UnitTaxes_{ijkt} \times I[Qtr > 2012Q1]_t$ interaction.

Furthermore, we also allow in additional specifications for pre- and post-FFAR tax effects to differ according to whether passengers were traveling on outbound or inbound (vis-à-vis the U.S.) itineraries on the premise that inbound passengers were less likely subject to FFAR, which applied only to domestic carriers' and online travel agents' U.S.-facing websites. The European Union and Australia had already enacted similar full-fare advertising regulations prior to FFAR, such that the timing of FFAR implementation in the U.S. should have made no difference to consumers whose itinerary originated in these countries. Itineraries originating in other foreign countries, meanwhile, may have still seen some impact of FFAR, both because these countries had no similar rules in place and because U.S. carriers may have been less likely to maintain foreign-facing websites (not subject to FFAR) in less developed or smaller markets outside of the EU. We account for possible response heterogeneity along these lines by including additional interactions of specific tax amounts, the post-FFAR indicator, and two binary indicators, $I[Inbound_{EU}]$ and $I[Inbound_{ROW}]$, denoting inbound travel from each of these two foreign country groups, respectively.

In order to strip out any potential confounding variation due to unobserved time-varying itinerary-level determinants of each of our demand outcomes (e.g. such as itinerary-level seasonal demand patterns that may be spuriously correlated with unit tax amounts and the timing of FFAR), we estimate (2) in four-quarter differences. The inclusion of $\nu_{kt}$—redefined as origin-destination city $\times$ *year* fixed effects—is hence equivalent to controlling for a complete set of annual origin-destination city-pair time trends. Due to the static nature of our scraped ticket tax data, four-quarter changes in unit taxes are excluded from the model.[24] Our main difference-in-differences estimator of the FFAR treatment effect thus captures the impact of $UnitTaxes_{ijkt} \times \Delta_{t,t-4}I[Qtr_t > 2012Q1]$ on $\Delta_{t,t-4}ln(Y_{ijkt})$ (i.e. the change in the semi-elasticity of outcome $Y$ with respect to unit taxes). The addition of further interactions with $I[Inbound_{EU}]$ and $I[Inbound_{ROW}]$ yields a triple-difference.

As with all demand models, prices and quantities in our revenue and volume specifications are simultaneously determined. We consequently use a supply-side cost shifter as an instrument for base fares in these specifications and estimate these via both OLS and two stage least squares (IV) for comparison. Concretely, we use itinerary distance plus an interaction of itinerary distance with quarterly West Texas Intermediate crude oil prices as instruments.[25]

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, $\beta_1$, as to variation in unit taxes in the pre-period, $\beta_2$ (ignoring differencing for simplicity of exposition).

[24]This is an acknowledged limitation of our data. As discussed in Section 3, time series variation in unit taxes in our sample does arise in two specific contexts: first, through known historical variation in nominal U.S. tax amounts and second, through the quarterly nominal bilateral exchange rate adjustments that we impose. However, the former are mainly intended as a matter of policy to preserve U.S. ticket tax amounts unchanged in real terms (and thus have little bearing on demand, controlling for nominal ticket prices), whereas the latter source of variation should be largely absorbed in the controls for annual origin-destination city-pair time trends.

[25]Uninteracted oil prices are absorbed in the year $\times$ quarter fixed effects. Alternate measures of fuel costs, such as quarterly jet fuel prices, lagged NYMEX crude oil 6-month futures contracts, or carriers' own reported fuel cost per passenger-mile (from the Bureau of Transportation Statistics' Air Carrier Financials, Schedule P-12(a)) yield qualitatively similar IV first stage results but tend to amplify rather than correct the extent of implied endogeneity bias. The latter measures may more accurately capture the impact of airlines' individual fuel hedging strategies but are limited to a subset of the largest carriers appearing in the DB1B.

Correspondingly, $\beta_4$ ought to equal zero in this case. In the alternative, $\theta_{Qtr\leq 2012Q1} \equiv \frac{\beta_2}{\beta_1}$ measures consumer inattention in the pre-FFAR period, whereas $\theta_{Qtr>2012Q1} \equiv \frac{\beta_2+\beta_4}{\beta_1}$ measures consumer inattention post-FFAR. By assumption, consumers are expected to optimize fully with respect to taxes when these are included in posted prices, such that we would expect $\theta_{Qtr>2012Q1} = 1$. The difference between these, $\theta_{Qtr>2012Q1} - \theta_{Qtr\leq 2012Q1} = \frac{\beta_4}{\beta_1}$, hence reflects the extent of de-biasing associated with the more salient presentation of unit taxes under full-fare advertising.

# 5 Results

## 5.1 Tax Incidence

Table 2 presents the results from estimation of (1) to test the effect of increased ticket tax salience on tax incidence. Whereas specification (1) only includes controls for flight distance and number of flight segments, specification (2) (and all specifications hereafter) further incorporates our preferred set of carrier × quarter and origin-destination city-pair × quarter fixed effects. Large differences between Columns 1 and 2 in estimated pass-through rates in both the pre- and post-FFAR periods highlight the importance of controlling for unobserved time-varying product and carrier characteristics which might otherwise yield a spurious association between ticket taxes and total fares. Based on the results in Column 2, ticket-tax pass-through in the pre-FFAR period is approximately 0.83, consistent with consumers having borne a disproportionate share of the tax burden prior to 2012, either because of relatively low "true" elasticity of demand 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 implied by the coefficient on $UnitTaxes_{cijkt} \times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$.

Columns 3 and 4 of Table 2 introduce the possibility of heterogeneous effects of FFAR on tax incidence as a function of market concentration. According to the basic theory—based on linear demand and fully-salient taxes—taxes should fall relatively more heavily on firms in less competitive markets. This prediction has not been tested for less than fully-salient taxes, let alone in an environment 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 informative comparisons. We hence 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—and we divide this number by 10000 to obtain HHI values ranging from 0 (perfect competition) to 1 (monopoly).[26] Focusing on the interaction effects of HHI with unit taxes (Column 3), we find that pass-through rates remain near \$0.81 on the dollar in the pre-FFAR period and that these effects do not significantly differ according to market concentration—seemingly contrary to the textbook theory of incidence in imperfectly-competitive markets with linear demand, but consistent with an environment in which the tax elasticity of demand is near zero due to inattention. Following the adoption of tax-inclusive pricing, however, pass-through rates for unit taxes are shown to drop most sharply in the most highly concentrated markets, consistent with a combination of substantial de-biasing and standard tax incidence results under imperfect competition.

Column 4 brings further nuance to this result by assigning origin-destination airport markets to discrete market structure categories. We adapt Borenstein and Rose's 1994 definition of monopoly, duopoly, and competitive markets (originally based on carrier shares of the number of daily flights) and translate these into minimum threshold HHI values. An origin-destination airport pair is hence defined as a duopoly if its HHI falls between 4050 and 8100 (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: $2 * 45^2 = 4050 \leq HHI < 8100 = 90^2$). A monopolistic market ($I[Monopoly] = 1$) is defined

[26]Measured market concentration is predictably somewhat higher when we treat all members of the SkyTeam, Star, and OneWorld alliances as belonging to a single firm. 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 code-sharing agreements.

as having an HHI of at least 8100. All remaining markets with an HHI of less than 4050 are considered "competitive."[27,28]

The results in Column 4 once again imply high rates of pass-through in the pre-FFAR period followed by a significant decline. However, pass-through rates are shown to be initially lower and subsequently fall by a larger amount in duopoly markets than in either competitive *or* monopolistic markets. This suggests that the effect of increased tax salience is non-monotonic in the degree of market competition. Whereas the comparison between competitive and duopoly markets is consistent with those shown in Column 3 for continuous measures of HHI, and can be rationalized by standard salience and incidence results, this is not true for the most highly concentrated markets. 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.

In order to more narrowly pin down the main effect of declining unit tax pass-through rates after 2012Q1 to the provisions of FFAR, Table 3 tests for a comparable (counterfactual) break in pass-through rates for ad valorem taxes, recalling that ad valorem taxes were already required to be included in advertised fares prior to FFAR. Naturally, there exists a strong reverse causal relationship from prices to dollar-valued ad valorem tax amounts which dominates the pre-FFAR estimates of the effect of $AdValoremTaxes$. The coefficient on $AdValoremTaxes$ can be thus interpreted as implying an average ad valorem rate of $1/14.0 \approx 7$ percent among affected tickets in the estimation sample. This obscures the true

[27]In practice, mean and median HHI levels in our estimation sample are 5170 and 4746, respectively, such that "competitive" markets account for just over half of all observations, whereas monopolistic markets account for only approximately 5 percent of observations.

[28]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 code-sharing agreements with U.S. reporting carriers. We may consequently under- or overstate the true degree of market concentration depending on the importance of direct competition from foreign carriers versus the treatment of code-share or alliance partners. This may serve as an argument in favor of using discrete measures of market competition.

underlying incidence of ad valorem taxes in the pre-FFAR period. Nevertheless, pronounced changes in "pass-through" should raise concerns about the existence of remaining unobserved correlated factors influencing fares in the post-period.[29] The statistically-significant negative interaction effect of $AdValoremTaxes$ with the post-FFAR indicator is hence potentially important. However, this effect represents a near negligible (less than 1 percent) reduction in the pre-FFAR pass-through rate and could be readily rationalized by a slight shift in demand-weighted average ad valorem taxes, thereby supporting the interpretation of the sharp decline in unit tax pass-through rates in the post-FFAR period as being a result of the new disclosure rules.

## 5.2 Ticket Revenue

Estimates of the effect of FFAR on the incidence of unit ticket taxes across specifications (2)-(6) of Tables 2 and 3, imply a range of pre- and post- pass-through rates depending on market competition. The main thrust of these, however, is that pass-through rates fell from approximately 80 cents per dollar, on average, down to around 10 cents per dollar (e.g. Table 2, Column 1), with larger (smaller) changes occurring in relatively more (less) concentrated markets. For the average ticket sold post-FFAR, this should constitute a significant loss in ticket revenue (through reduced base fares alone), and though faced with only modest increases in advertised fares (relative to total unit taxes) as a result, consumer inattention should nevertheless lead to further possible revenue losses through reductions in demand.

Table 4 presents estimates of these combined effects on four-quarter changes in itinerary-level tax-inclusive ticket revenue (measured in logs). Ignoring the simultaneous determination of base fares and equilibrium quantities, OLS results are shown in Columns 1 and 2, while Columns 3 and 4 report IV results for the corresponding specifications following the strategy described in Section 4. As expected, the coefficient on $UnitTaxes$ measured in *levels*

[29] Alternatively, enforcement of pre-existing ad valorem tax disclosure rules by the DOT could have tightened as a side-effect of FFAR, thereby leading to a real, yet unexpected reduction in pass-through of ad valorem taxes.

(in hundreds of dollars) has no significant impact on *four-quarter changes* in ticket revenue across all specifications. In contrast, the difference-in-differences estimator associated with $UnitTaxes \times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ implies a reduction of 9 to 12 percent in total itinerary revenue stemming from a $100 increase in unit taxes. Based on an average tax-inclusive fare amount of $818 in the post-FFAR period in the estimation sample, this corresponds to a $75-$99 reduction in ticket revenue—very nearly in line with the negative impact on the airlines implied by the pass-through estimates. Insignificant coefficients on the triple-differenced estimators of differential FFAR effects by outbound-versus-inbound flight status in Columns 2 and 4 fail to support our conjectures in Section 4 regarding ticket purchases made from the EU or Australia.

Importantly, it is possible 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. If airline markets were perfectly competitive, this is precisely the expected response due to carriers adjusting to restore equality between (fee-inclusive) prices and marginal cost (Agarwal et al., 2015). Though this last characterization surely does not apply to airlines, we are unable to assert that our estimates of ticket revenue losses or reduction in unit tax pass-through rates represent a pure transfer of surplus from airlines to consumers.[30]

## 5.3 Passenger Demand

Table 5 has an identical structure to Table 4 but focuses on the post-FFAR effect of unit taxes on itinerary-level passenger volume. Regardless of specification, unit taxes have a sizeable negative impact on passenger volume, such that a one standard deviation ($39) increase in unit taxes within origin-destination city market is associated with a 4.4-5.1 percent reduction

[30] Appendix A.1 characterizes the evolution of the largest U.S. 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 passenger demand post-FFAR. Failing to account for the simultaneity of equilibrium fares and quantities yields positively biased OLS estimates of the price semi-elasticity of demand, as expected. Focusing on exogenous (cost-driven) variation in base fares, our estimates in Columns 3 and 4 imply an elasticity of demand of 1.6-1.7 evaluated at the average base fare amount of $673 in our estimation sample.[31]

A key parameter of interest in this context is the ratio of the estimated semi-elasticity of demand with respect to unit taxes in the post-period to the semi-elasticity of demand with respect to base fares. As discussed in Section 4, this provides a direct measure of the change in consumer inattention resulting from the implementation of full-fare advertising. Using our IV estimates from Column 3, we obtain an estimate of de-biasing of approximately 0.5 (i.e. $-0.126/-0.250 = 0.50$). Assuming that consumers optimize fully when taxes are included in advertised fares, this implies that $\theta_{Qtr \leq 2012Q1} = 1-(-0.126/-0.250) = 0.5$, such that consumers under the prior tax-exclusive pricing regime would have responded equally to a $10 increase in unit taxes as to a $5 increase in base fares. By way of comparison, Chetty, Looney and Kroft (2009) find that their experimental introduction of tax-inclusive pricing on grocery store shelves is associated with a change in inattention of 0.65, suggesting a relatively higher rate of inattention with respect to sales taxes imposed at the register.

## 5.4 Cross-Itinerary Substitution

In order to test whether the tax semi-elasticities in Table 5 reflect changes in aggregate demand or whether these instead reflect substitution toward lower-taxed itineraries within the same origin-destination markets, we conclude by estimating the effects of itinerary-level unit taxes on average ticket tax amounts and the number of flight segments within origin-

[31] This lies toward the higher 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 U.S. 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.

destination airport-pairs. As shown in Table 6, higher unit taxes are associated with a statistically-significant reduction in ticket taxes averaged across all flights flown between the same origin-destination airports in the period following implementation of FFAR (Columns 1 and 2). A one standard deviation increase in specific taxes is thus associated with a 0.8 percent reduction in average taxes owed (i.e., approximately $0.90). Moreover, this effect is fully offset for inbound travel originating in the EU or Australia, whereas average taxes paid for other inbound flights are not substantially differently affected than for outbound flights. Columns 3 and 4 reveal no significant impacts of FFAR on the average number of segments flown between origin-destination pairs, although the point estimates are consistent with a slight reduction in number of passenger layovers where individual itineraries would otherwise trigger higher specific taxes.[32] Taken together, these results confirm the existence of cross-itinerary substitution patterns consistent with tax salience effects, yet these appear to be insufficiently important as to motivate consumers to shift toward non-stop flights on a large scale.

# 6 Conclusion

Summarizing the results from the previous section, we find that the switch from tax-exclusive to tax-inclusive pricing of airfares mandated by the DOT 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 as a result of limited attention among consumers. The implementation of FFAR is thus associated with the near-complete elimination of unit tax pass-through from a level of 80-90 cents per dollar under the previous tax-exclusive pricing regime, with relatively larger reductions in pass-through arising in less competitive markets. Ticket revenues accruing to carriers are reduced by a commensurate amount, declining by

[32] Opportunities for reducing the number of connecting flights within our sample of routes may be relatively limited, which range only from 2-4 flight segments.

3.6-4.7 percent for every one standard deviation increase in specific tax amounts. These results imply 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.

Beyond these pricing-level responses, we also show that itinerary-level passenger volume is reduced in the post-period by 4.4-5.1 percent for every one standard deviation increase in unit taxes and that the same magnitude difference in itinerary-level unit taxes results in a 0.8 percent reduction in average taxes paid per ticket within origin-destination city markets via consumer substitution between available carrier-route offerings. Assuming full optimization with respect to taxes included in advertised fares, our estimates of the ratio of the tax semi-elasticity of demand in the post-period relative to the price semi-elasticity of demand imply that consumers previously reacted to a \$10 increase in unit taxes as equivalent to a \$5 increase in base fares, thereby essentially ignoring half of the unit tax amount when these were excluded from advertised fares.

The only piece of somewhat contradictory evidence is that passengers traveling on inbound itineraries respond in generally indistinguishable ways to those traveling on outbound flights who were more assuredly confronted with the impact of FFAR at the time of purchasing their tickets. However, this may simply reflect a violation of the underlying conjecture about inbound ticket purchases, and it may be that most consumers buying tickets from U.S. reporting carriers (as required for a ticket to be included in the DB1B sample) made their purchases from U.S. facing websites affected by FFAR, regardless of flight direction. Only in the case where we examine average origin-destination airport-level taxes as the dependent variable do we observe diminished sensitivity to tax-inclusive pricing on the part of passengers traveling on inbound flights from countries where similar disclosure rules were already in effect prior to 2012.

These findings emphasize the profound influence which 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. This should be tempered, however, 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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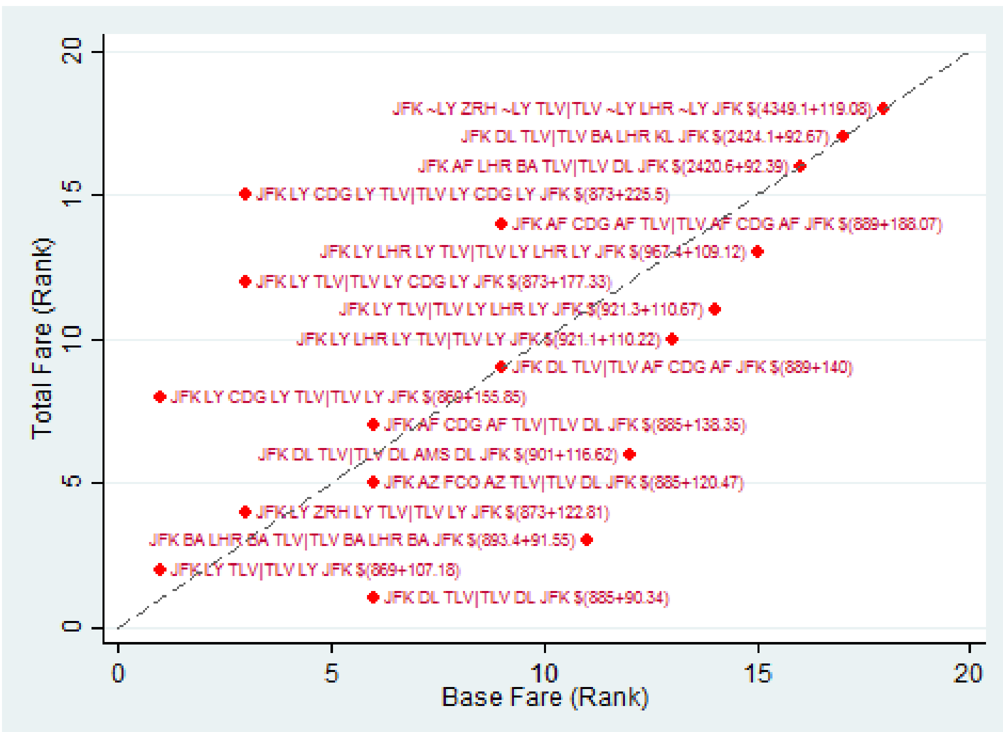
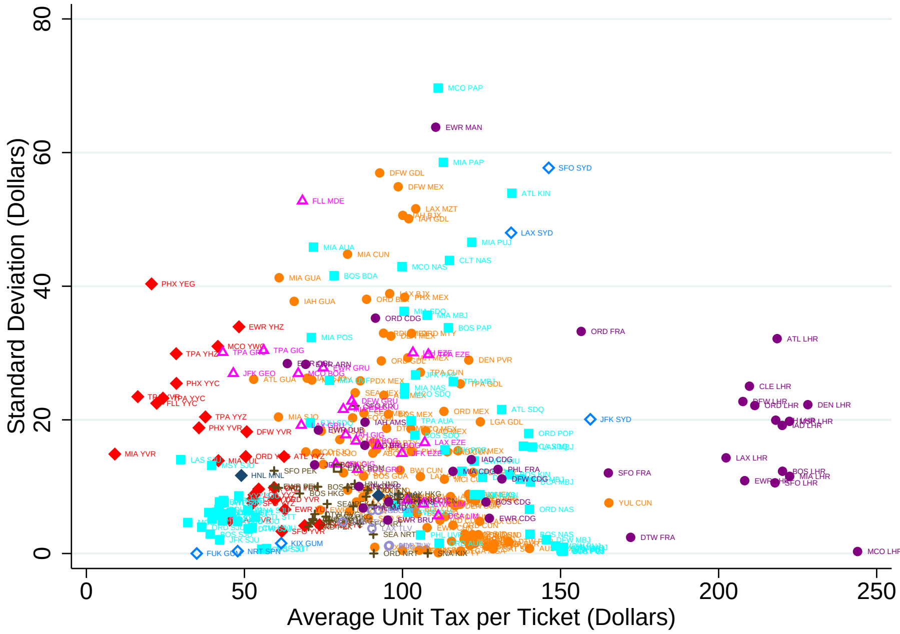
Figure 1. Tax-Inclusive Versus Tax-Exclusive Fare Rankings:
New York City (JFK) to Tel Aviv (TLV)

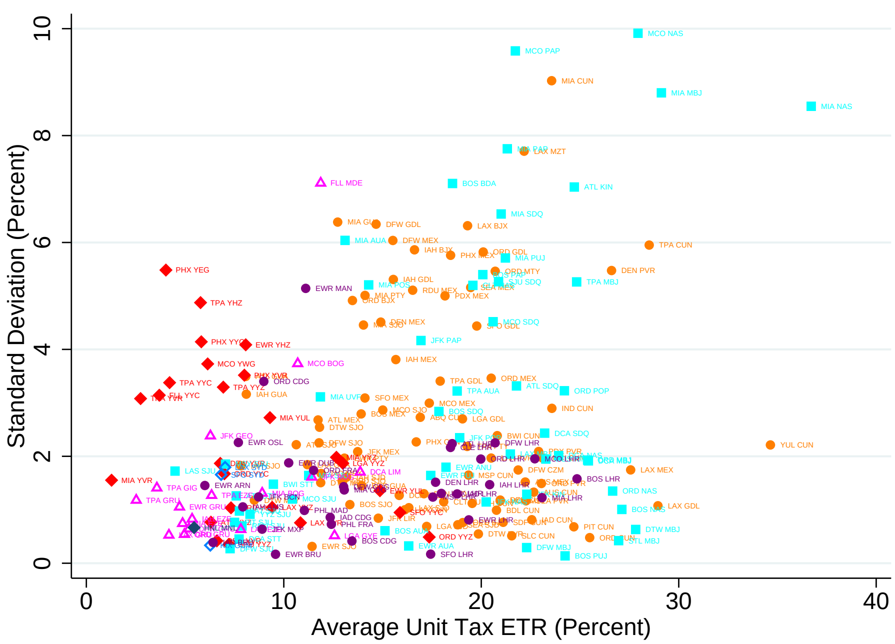



Dollar amounts in parentheses alongside each itinerary represent base fares + unit taxes. Fare amounts are drawn exclusively from online fare searches performed between December 30, 2014 and January 25, 2015 (non-DB1B).

Figure 2. Variation in Unit Taxes Across and Within Origin-Destination City Markets (2011Q4)



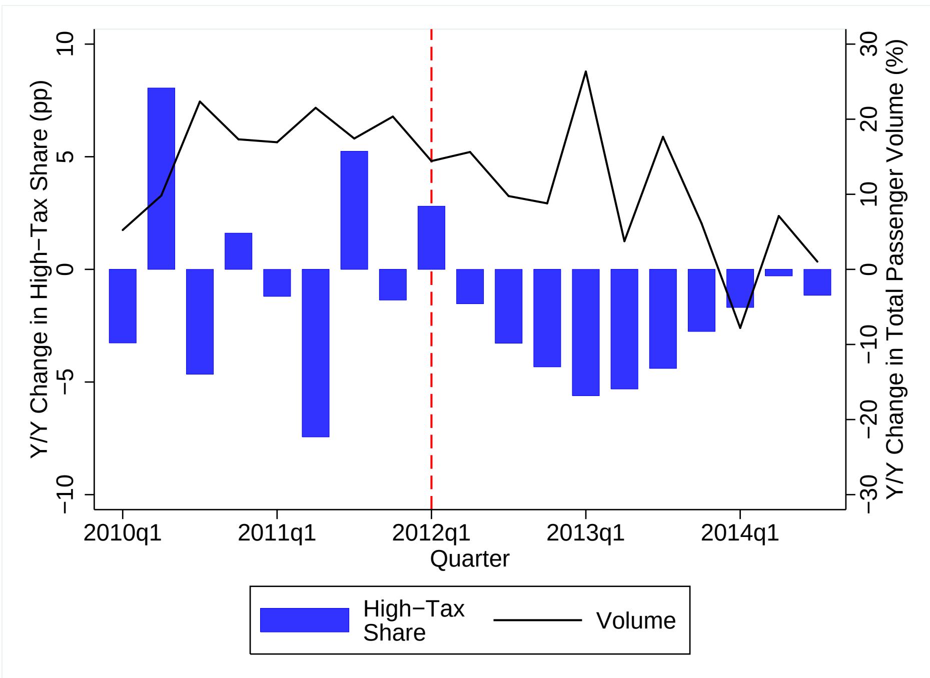

(a)




(b)


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. Average tax amounts and ETRs are all measured on a passenger-weighted basis within origin-destination city market pairs.

Figure 3. Four-Quarter Changes in Passenger Volume
and High-Tax Itinerary Volume Shares




Itineraries are categorized as high- and low-tax relative to the median unit tax amount within origin-destination city market pair. Passenger counts are aggregated across the top 300 largest city markets by high-tax status.

Table 1. Quarterly Ticket and Itinerary Characteristics: 2009Q1-2014Q3

| | Mean | Median | Std. Dev. |
|---|---|---|---|
| Ticket Characteristics: | | | |
| $TotalFare_{cijkt}$ | 7.22 | 5.67 | 5.47 |
| $BaseFare_{cijkt}$ | 6.07 | 4.52 | 5.43 |
| $SpecificTaxes_{ijkt}$ | 1.13 | 1.16 | 0.39 |
| $AdValoremTaxes_{cijkt}$ | 0.03 | 0.00 | 0.11 |
| $HHI_{kt}$ | 0.54 | 0.50 | 0.23 |
| $Distance_{jkt}$ | 4799 | 3540 | 3389 |
| $Segments_{jkt}$ | 2.67 | 2.00 | 0.91 |
| Observations (Passengers) | | 2662067 | |
| Itinerary Characteristics (Unweighted): | | | |
| $Passengers_{ijkt}$ | 52.3 | 16 | 106 |
| $AvgTotalFare_{ijkt}$ | 7.88 | 6.11 | 5.17 |
| $AvgBaseFare_{ijkt}$ | 6.70 | 4.95 | 5.13 |
| $SpecificTaxes_{ijkt}$ | 1.15 | 1.18 | 0.39 |
| $AvgAdValoremTaxes_{ijkt}$ | 0.03 | 0 | 0.11 |
| $HHI_{kt}$ | 0.45 | 0.40 | 0.21 |
| $Segments_{jkt}$ | 3.33 | 4 | 0.86 |
| $Distance_{jkt}$ | 5626 | 4228 | 3744 |
| Observations | | 60736 | |

Observations exclude all first-class and award travel and include only round-trip flights. Dollar-denominated figures are measured in hundreds of current dollars. Itinerary-level statistics are presented on an unweighted basis.

[a] HHI is computed on the basis of carrier revenues by origin-destination airport-pair in the full DB1B sample and scaled to $[0, 1]$.

Table 2. Ticket Tax Pass-Through, by Market Competitiveness

| $Y = TotalFare_{cijkt}$ | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $UnitTaxes_{cijkt}$ | 1.314*** | 0.829*** | 0.807*** | 0.926*** |
| | (0.159) | (0.265) | (0.307) | (0.273) |
| $\Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | 0.170 | 2.889*** | 2.578*** | 2.807*** |
| | (0.214) | (0.350) | (0.436) | (0.366) |
| $UnitTaxes_{cijkt}$ | 0.622*** | -0.773*** | -0.395 | -0.587** |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | (0.183) | (0.282) | (0.330) | (0.284) |
| $HHI_{kt}$ | | | 0.533 | |
| | | | (0.470) | |
| $UnitTaxes_{cijkt} \times HHI_{kt}$ | | | -0.039 | |
| | | | (0.365) | |
| $HHI_{kt}$ | | | 0.659 | |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | | (0.467) | |
| $UnitTaxes_{cijkt} \times HHI_{kt}$ | | | -0.740** | |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | | (0.373) | |
| $I[Duopoly]_{kt}$ | | | | 0.442** |
| | | | | (0.180) |
| $I[Duopoly]_{kt} \times UnitTaxes_{cijkt}$ | | | | -0.276* |
| | | | | (0.161) |
| $I[Duopoly]_{kt}$ | | | | 0.262 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | | | (0.221) |
| $I[Duopoly]_{kt} \times UnitTaxes_{cijkt}$ | | | | -0.304* |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | | | (0.162) |
| $I[Monopoly]_{kt}$ | | | | 0.167 |
| | | | | (0.335) |
| $I[Monopoly]_{kt} \times UnitTaxes_{cijkt}$ | | | | 0.004 |
| | | | | (0.237) |
| $I[Monopoly]_{kt}$ | | | | 0.169 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | | | (0.268) |
| $I[Monopoly]_{kt} \times UnitTaxes_{cijkt}$ | | | | -0.138 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | | | (0.187) |
| *Controls:* | | | | |
| $Distance_{jkt}$ *(cubic)* | x | x | x | x |
| $Segments_{jkt}$ | x | x | x | x |
| Carrier × Quarter | | x | x | x |
| O&D City × Quarter | | x | x | x |
| Observations | 2,634,347 | 2,464,907 | 2,464,907 | 2,464,907 |
| R-squared | 0.390 | 0.471 | 0.471 | 0.471 |

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1, with standard errors clustered by origin-destination airport-pair in parentheses. Observations represent individual passengers.



HHI is computed on the basis of carrier revenues by origin-destination airport-pair in the full DB1B sample and scaled to $[0, 1]$. Markets are otherwise categorized as "perfectly competitive" versus "duopoly" and "monopoly" as a function of the degree of market concentration following an adaptation of Borenstein and Rose (1994): $I[Duopoly] = 1 \ \forall HHI \in [4050, 8100)$;

Table 3. Ticket Tax Pass-Through, Unit versus Ad Valorem Taxes

| $Y = TotalFare_{cijkt}$ | (5) | (6) |
|---|---|---|
| $UnitTaxes_{cijkt}$ | 0.798*** | 0.787** |
| | (0.268) | (0.309) |
| $\Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | 5.977*** | 6.102*** |
| | (0.824) | (0.872) |
| $UnitTaxes_{cijkt}$ $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | -0.696** | -0.307 |
| | (0.272) | (0.318) |
| $AdValoremTaxes_{cijkt}$ | 13.963*** | 14.718*** |
| | (0.184) | (0.467) |
| $AdValoremTaxes_{cijkt}$ $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | -0.134* | -0.313 |
| | (0.080) | (0.414) |
| $HHI_{kt}$ | 0.434** | 0.482 |
| | (0.183) | (0.452) |
| $UnitTaxes_{cijkt} \times HHI_{kt}$ | | 0.023 |
| | | (0.355) |
| $HHI_{kt}$ $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | 0.699 |
| | | (0.453) |
| $UnitTaxes_{cijkt} \times HHI_{kt}$ $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | -0.771** |
| | | (0.370) |
| $AdValoremTaxes_{cijkt} \times HHI_{kt}$ | | -1.243* |
| | | (0.650) |
| $AdValoremTaxes_{cijkt} \times HHI_{kt}$ $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | 0.247 |
| | | (0.732) |
| *Controls:* | | |
| $Distance_{jkt}$ *(cubic)* | x | x |
| $Segments_{jkt}$ | x | x |
| Carrier × Quarter | x | x |
| O&D City × Quarter | x | x |
| Observations | 2,666,087 | 2,666,087 |
| R-squared | 0.487 | 0.487 |

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1, with standard errors clustered by origin-destination airport-pair in parentheses. Observations represent individual passengers.

HHI is computed on the basis of carrier revenues by origin-destination airport-pair in the full DB1B sample and scaled to $[0, 1]$.

Table 4. Itinerary-Level Tax-Inclusive Ticket Revenue

| | OLS | | IV | |
|---|---|---|---|---|
| $Y = \Delta_{t,t-4} ln(Revenue)_{ijk}$ | (1) | (2) | (3) | (4) |
| $\Delta_{t,t-4} AvgBaseFare_{ijk}$ | 0.040*** | 0.040*** | -0.128* | -0.115* |
| | (0.003) | (0.003) | (0.072) | (0.069) |
| $UnitTaxes_{ijkt}$ | 0.028 | 0.012 | 0.033 | 0.012 |
| | (0.060) | (0.062) | (0.064) | (0.065) |
| $\Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | 0.464*** | 0.457*** | 0.522*** | 0.530*** |
| | (0.093) | (0.093) | (0.115) | (0.114) |
| $UnitTaxes_{ijkt}$ | -0.121*** | -0.093** | -0.117** | -0.092** |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | (0.044) | (0.045) | (0.046) | (0.046) |
| $I[Inbound_{ROW}]$[a] | | -0.013 | | -0.028 |
| | | (0.022) | | (0.024) |
| $I[Inbound_{EU}]$[b] | | -0.281*** | | -0.399*** |
| | | (0.067) | | (0.082) |
| $UnitTaxes_{ijkt} \times I[Inbound_{ROW}]$ | | 0.053** | | 0.067*** |
| | | (0.024) | | (0.024) |
| $UnitTaxes_{ijkt} \times I[Inbound_{EU}]$ | | 0.200*** | | 0.267*** |
| | | (0.050) | | (0.058) |
| $I[Inbound_{ROW}] \times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | -0.031 | | -0.032 |
| | | (0.061) | | (0.067) |
| $I[Inbound_{EU}] \times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | 0.157 | | -0.090 |
| | | (0.165) | | (0.183) |
| $UnitTaxes_{ijkt} \times I[Inbound_{ROW}]$ | | -0.028 | | -0.069 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | (0.061) | | (0.068) |
| $UnitTaxes_{ijkt} \times I[Inbound_{EU}]$ | | -0.193 | | -0.042 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | (0.125) | | (0.134) |
| $HHI_{kt}$[c] | 0.043 | 0.043 | 0.042 | 0.041 |
| | (0.026) | (0.027) | (0.027) | (0.027) |
| $Segments_{jkt}$ | -0.027*** | -0.028*** | -0.034*** | -0.034*** |
| | (0.010) | (0.011) | (0.011) | (0.011) |
| *Fixed Effects:* | | | | |
| Carrier × Quarter | x | x | x | x |
| O&D City × Quarter | x | x | x | x |
| Observations | 60,736 | 60,736 | 60,736 | 60,736 |
| R-squared | 0.280 | 0.282 | 0.088 | 0.119 |
| IV F-Stat | - | - | 5.5 | 5.7 |

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1, with standard errors clustered by origin-destination airport-pair in parentheses. Observations are weighted by itinerary passenger volume for the corresponding quarter of 2011 (Q1,Q2,etc.).

[a] $I[Inbound_{ROW}]$ denotes inbound flights originating from all countries except the EU or Australia.

[b] $I[Inbound_{EU}]$ denotes inbound flights originating from the EU *and Australia*.

[c] HHI is computed on the basis of carrier revenues by origin-destination airport-pair in the full DB1B sample and scaled to $[0, 1]$.

Table 5. Itinerary-Level Passenger Volume

| | OLS | | IV | |
|---|---|---|---|---|
| $Y = \Delta_{t,t-4} ln(Passengers)_{ijk}$ | (1) | (2) | (3) | (4) |
| $\Delta_{t,t-4} AvgBaseFare_{ijk}$ | -0.045*** | -0.046*** | -0.250*** | -0.238*** |
| | (0.005) | (0.005) | (0.077) | (0.074) |
| $UnitTaxes_{ijkt}$ | 0.041 | 0.035 | 0.047 | 0.036 |
| | (0.061) | (0.062) | (0.066) | (0.067) |
| $\Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | 0.502*** | 0.506*** | 0.573*** | 0.596*** |
| | (0.094) | (0.095) | (0.116) | (0.115) |
| $UnitTaxes_{ijkt}$ | -0.132*** | -0.114** | -0.126** | -0.114** |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | (0.049) | (0.048) | (0.049) | (0.048) |
| $I[Inbound_{ROW}]$[a] | | -0.006 | | -0.024 |
| | | (0.023) | | (0.026) |
| $I[Inbound_{EU}]$[b] | | -0.252*** | | -0.398*** |
| | | (0.068) | | (0.088) |
| $UnitTaxes_{ijkt} \times I[Inbound_{ROW}]$ | | 0.044* | | 0.062** |
| | | (0.025) | | (0.026) |
| $UnitTaxes_{ijkt} \times I[Inbound_{EU}]$ | | 0.168*** | | 0.251*** |
| | | (0.050) | | (0.062) |
| $I[Inbound_{ROW}] \times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | -0.071 | | -0.073 |
| | | (0.063) | | (0.075) |
| $I[Inbound_{EU}] \times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | 0.207 | | -0.101 |
| | | (0.170) | | (0.191) |
| $UnitTaxes_{ijkt} \times I[Inbound_{ROW}]$ | | 0.012 | | -0.039 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | (0.061) | | (0.073) |
| $UnitTaxes_{ijkt} \times I[Inbound_{EU}]$ | | -0.216* | | -0.027 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | (0.128) | | (0.139) |
| $HHI_{kt}$[c] | 0.046* | 0.042 | 0.045* | 0.041 |
| | (0.026) | (0.027) | (0.027) | (0.026) |
| $Segments_{jkt}$ | -0.029*** | -0.030*** | -0.037*** | -0.038*** |
| | (0.010) | (0.011) | (0.011) | (0.012) |
| *Fixed Effects:* | | | | |
| Carrier × Quarter | x | x | x | x |
| O&D City × Quarter | x | x | x | x |
| Observations | 60,736 | 60,736 | 60,736 | 60,736 |
| R-squared | 0.251 | 0.252 | - | - |
| IV F-Stat | - | - | 5.5 | 5.7 |

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1, with standard errors clustered by origin-destination airport-pair in parentheses. Observations are weighted by itinerary passenger volume for the corresponding quarter of 2011 (Q1,Q2,etc.).

[a] $I[Inbound_{ROW}]$ denotes inbound flights originating from all countries except the EU or Australia.

[b] $I[Inbound_{EU}]$ denotes inbound flights originating from the EU *and Australia*.

[c] HHI is computed on the basis of carrier revenues by origin-destination airport-pair in the full DB1B sample and scaled to $[0, 1]$.

Table 6. Origin-Destination Airport-Level Average Taxes Per Ticket and Average Number of Flight Segments

| $Y = \Delta_{t,t-4}$: | $ln(AvgUnitTax)_k$ (1) | $ln(AvgUnitTax)_k$ (2) | $ln(Segments)_k$ (3) | $ln(Segments)_k$ (4) |
|---|---|---|---|---|
| $\Delta_{t,t-4} AvgBaseFare_{ijk}$ | -0.001*** | -0.001*** | -0.000 | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| $UnitTaxes_{ijkt}$ | 0.046*** | 0.047*** | 0.017*** | 0.016*** |
| | (0.017) | (0.015) | (0.006) | (0.006) |
| $\Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | -0.069*** | -0.068*** | -0.020 | -0.021 |
| | (0.015) | (0.015) | (0.019) | (0.017) |
| $UnitTaxes_{ijkt}$ | -0.020** | -0.021** | -0.017 | -0.017 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | (0.009) | (0.010) | (0.012) | (0.011) |
| $I[Inbound_{ROW}]$[a] | | -0.004 | | -0.005 |
| | | (0.004) | | (0.004) |
| $I[Inbound_{EU}]$[b] | | 0.000 | | -0.003 |
| | | (0.015) | | (0.014) |
| $UnitTaxes_{ijkt} \times I[Inbound_{ROW}]$ | | 0.010*** | | 0.007* |
| | | (0.004) | | (0.004) |
| $UnitTaxes_{ijkt} \times I[Inbound_{EU}]$ | | -0.001 | | 0.000 |
| | | (0.011) | | (0.011) |
| $I[Inbound_{ROW}] \times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | 0.000 | | 0.007 |
| | | (0.019) | | (0.012) |
| $I[Inbound_{EU}] \times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | -0.051** | | -0.033 |
| | | (0.023) | | (0.024) |
| $UnitTaxes_{ijkt} \times I[Inbound_{ROW}]$ | | 0.002 | | -0.005 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | (0.022) | | (0.011) |
| $UnitTaxes_{ijkt} \times I[Inbound_{EU}]$ | | 0.032* | | 0.021 |
| $\times \Delta_{t,t-4} I[Qtr_t > 2012Q1]$ | | (0.017) | | (0.020) |
| $HHI_{kt}$[c] | 0.014** | 0.013** | 0.018*** | 0.018*** |
| | (0.007) | (0.007) | (0.006) | (0.006) |
| *Controls:* | | | | |
| $Segments_{jkt}$ | x | x | | |
| Carrier × Quarter | x | x | x | x |
| O&D City × Quarter | x | x | x | x |
| Observations | 60,736 | 60,736 | 60,736 | 60,736 |
| R-squared | 0.508 | 0.510 | 0.352 | 0.353 |

Significance levels are designated as *** p<0.01, ** p<0.05, and * p<0.1, with standard errors clustered by origin-destination airport-pair in parentheses. Observations are weighted by itinerary passenger volume for the corresponding quarter of 2011 (Q1,Q2,etc.).

[a] $I[Inbound_{ROW}]$ denotes inbound flights originating from all countries except the EU or Australia.

[b] $I[Inbound_{EU}]$ denotes inbound flights originating from the EU *and Australia*.

[c] HHI is computed on the basis of carrier revenues by origin-destination airport-pair in the full DB1B sample and scaled to $[0, 1]$.

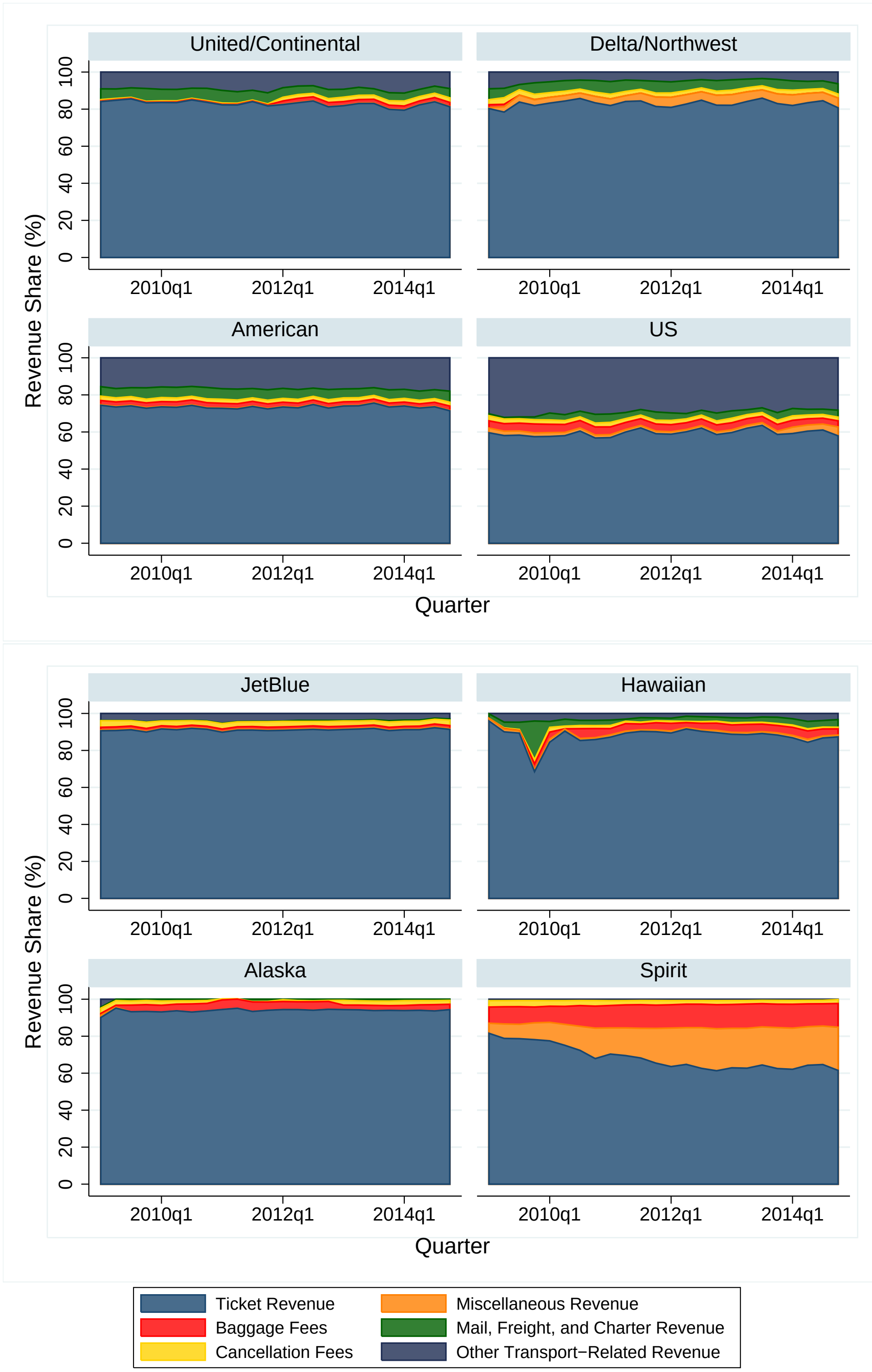
# A Appendix

## A.1 Add-On Fees

Detailed data on airline charges and fees are relatively scarce. Nevertheless, U.S. air carriers' quarterly financial statements provide a rough breakdown of sources of revenue from domestic and international operations. Of particular relevance to understanding the proliferation of carrier-imposed fees are baggage fees, cancellation and change-of-ticket fees, ticketing and check-in fees, fees for seat assignments and upgrades, and charges for in-flight food and beverages, entertainment, Wi-Fi, pillows and blankets, etc. Only the first two longest-established of these fees are reported separately on Form 41, Schedule P-1.2. More broadly, Schedule P-1.2 classifies revenues into: transport revenues from scheduled passengers, mail, freight, baggage fees, revenue from charter operations, change/cancellation fees, miscellaneous operating revenues, and transport-related revenues. Fees for seat assignments and upgrades or ticketing fees are included in general transport revenues along with base fares, while in-flight sales are included in transport-related revenues, which also incorporate revenue from code-share operations (flown by the partner airline), fuel sales, rental revenue, and revenue from maintenance performed for other carriers. Miscellaneous operating revenues includes pet transport fees (in the hold) and compensation for collection of passenger facility charges.

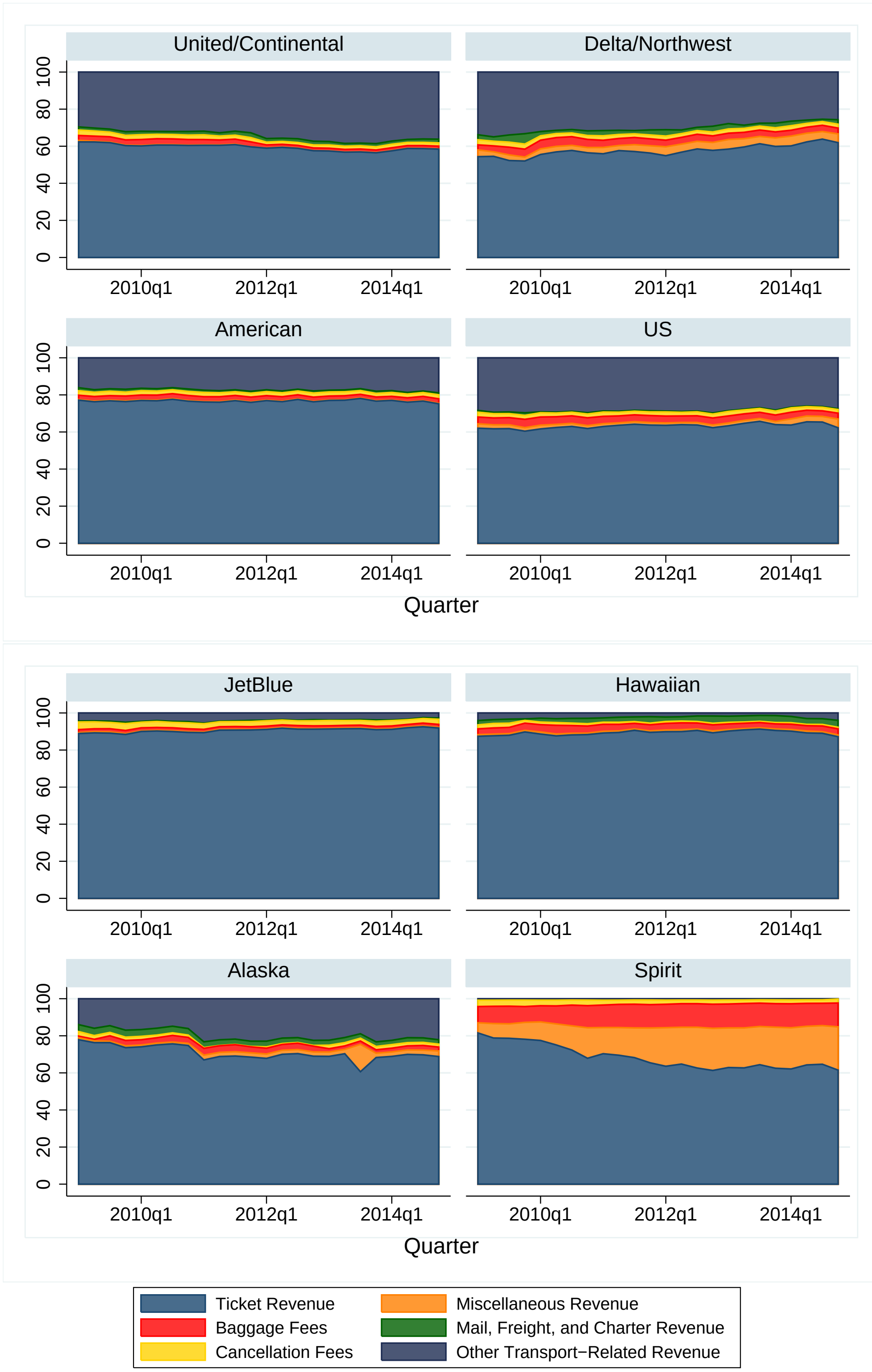
Figure A1 plots the evolution of six sources of revenue as a share of total revenue from international operations for the eight largest carriers by international revenue. The only notable break in reliance on baggage and cancellation fees around the implementation of FFAR occurs in 2012Q1 for the newly-combined United/Continental in their first period of joint financial reporting. Previously, neither constituent carrier levied baggage fees for international travel to any significant degree. Baggage fees for domestic travel on the "new United," meanwhile, decreased significantly as a share of total revenue (Figure A2) in the post-FFAR period. These apparent trend breaks appear to coincide with merger consummation, but it cannot be ruled out that these changes were implemented in reaction to reduced revenues from ticket sales on high-tax international routes.

Figure A1. Carrier Revenue Sources from International Operations




Delta/Northwest and United/Continental began reporting combined financial statements in 2010Q1 and 2012Q1, respectively. Revenues from merged carriers are combined for the entire sample.

Figure A2. Carrier Revenue Sources from Domestic Operations




Delta/Northwest and United/Continental began reporting combined financial statements in 2010Q1 and 2012Q1, respectively. Revenues from merged carriers are combined for the entire sample.