Winners and Losers from an Announced Excise Tax Hike: Tesla in Denmark

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Abstract

In 2015, the Danish government announced a tax hike on electric vehicles several months before its implementation. There was a dramatic surge in sales of Tesla Model S vehicles just before the tax came into effect, and a dramatic ebb in the months following. We find that the government lost more than 160 million DKK (21 million Euro) in tax revenue on luxury vehicles by announcing the tax change before its implementation. We further find that speculation played at most a limited role in the Tesla sales surge. In total, final consumers of Teslas gained from the rollout of the law change by avoiding the new tax.

Introduction

In December of 2015, the Tesla Model S – an expensive, fully electric luxury sedan – was the best-selling vehicle in Denmark with 1248 new registrations. It is unusual that a luxury car is an overall best seller. Even more unusual, this best seller was an electric vehicle (EV). Immediately following the sales surge was a dramatic sales ebb. Only 78 Tesla Model S cars were sold in 2016. Behind these dramatic market fluctuations was a tax hike passed by the Danish government in October 2015. The law ended a registration tax exemption for alternative-fuel vehicles. Buyers rushed to purchase Teslas before the new tax regime took effect in January 2016.

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The Danish government chose to announce the tax change well before the implementation date, allowing auto buyers ample time to purchase new vehicles ahead of the tax increase. Some of these buyers may have intended to speculate and re-sell their cars shortly after the law's implementation. The aim of this note is to determine which parties gained and lost from the structure of the tax law's implementation, with a particular focus on the long window between announcement and enactment. The big loser in our calculations is the government. By announcing the tax change in advance, the government lost tax revenues from auto sales. We estimate that the government's losses were on the order of hundreds of millions of Danish Kroner (tens of millions of Euros). Our baseline estimate is that the government lost more than 160 million Danish Kroner. Using data we scraped from the most popular online used car marketplace in Denmark, we find little evidence of speculation in the used car market. Instead, our evidence suggests that most of the late 2015 Tesla sales were to consumers who were originally planning on buying in 2016. It is likely that final consumers of new Tesla's gained from the tax rollout and avoided the new tax by purchasing in 2015.

There is a large literature which studies the consumption response to overall tax changes and the anticipation of tax changes.[1] Yet there is surprisingly little consensus in the literature about whether consumers react to anticipated changes in income. To pick out a few, Poterba [1988], Parker [1999], Mertens and Ravn [2011] find little impact of the anticipation of income changes on consumption, while Browning and Collado [2001] find that consumers do smooth consumption. Hsieh [2003] finds that consumers smooth with respect to some income shocks, but not others. There are fewer studies which focus the effect of sales taxes on consumption, but these papers find an increase in durable consumption prior to a VAT increase.[2] While our findings are consistent with this extant literature, we focus on a much narrower tax change – an increase in the tax on only new electric cars. We find that the anticipation of a sales tax increase has a significant effect on purchases of durables. The pre-announced tax hike on electric vehicles led to more cars on the road in the short run. Similar shifts in the timing of vehicles purchases as a response to incentives have been observed in the United States [Mian and Sufi, 2012, Hoekstra et al., 2017].[3]

[1] For a recent survey, see Attanasio and Weber [2010].

[2] Cashin and Unayama [2016] find that Japanese consumers increased durables consumption just before a VAT increase. In European data, Büttner and Madzharova [2016] find an elasticity of short-run durable purchases to VAT increases of one to five percent.

[3] This finding also lends empirical support to a theoretical literature emphasizing how scheduled VAT or sales tax hikes can be used as unconventional fiscal policy to stimulate the economy without government borrowing [Feldstein, 2003, Hall, 2011, Correia et al., 2013].

Background

In the years leading up to 2015, the Danish registration tax for new cars was among the highest in the world and, consequentially, prices paid by consumers for cars were also among the highest. Electric vehicles were exempt from the registration tax but still subject to the 20 percent VAT. Until mid-2015 it was expected that the tax break on electric vehicles would remain unchanged in 2016 [Skatteministeriet, 2015a,c].

On October 9, 2015 the government announced that all electric cars would gradually lose their tax exemption with a phase-in beginning with a 20 percent registration tax from January 1, 2016, and an increase of 20 percent in each year until 2020. Numerical examples on the effects on various electric cars were provided, and widely referred to in the media at the time, suggesting that for the Tesla S P85D the price paid by consumers would rise by 81 percent in 2016 to 1,522,000 DKK to reach 1,802,000 DKK (241,000 Euro) by 2020.[4]

While we are focused on changes in the registration tax on electric vehicles, on November 19, 2015 the Danish Government also announced with immediate effect that the general registration tax on non-electric cars would be lowered with the top rate reduced from 180 percent to 150 percent. We will need to take this change into account in our lost revenue calculations below.

Data

Our analysis relies on three data sources. The primary data contains monthly data 2004-2016 aggregated to the segment level from Statistics Denmark. For our purposes, the segment of primary importance is the "premium" segment which includes Tesla Model S, and has as representative cars the Audi A6, BMW 5 Series, and Mercedes Benz E Class. For comparison, we also consider registrations of the larger "Large" segment, which includes for instance Audi A4, BMW 3 Series, and Mercedes Benz C Class. For each segment in each month, the total number of new vehicles registered is reported along with their average price. We also have monthly data from the Danish Car Importers Association on the number of Tesla Model S cars registered each month for the period 2013-2017 (the first was registered in August 2013), and data on sales per segment in 2017.

Figure 1 presents the monthly time series of new Tesla Model S registered in Denmark around the change in tax law from 2012-2017. The solid

[4]On the 17th of December, the Directorate-General for Competition decided that the proposed tax change on electric vehicles was an anti-competitive subsidy to small vehicles in violation of EU rules, and the Danish government made amendments the following day. According to the government's new calculations, the revised tax would lead to a 21 percent increase in the price of the Tesla S P85D to 1,051,000 DKK in 2016 and gradually increase to 1,626,000 DKK in 2020. For more government price estimates see Skatteministeriet [2015b].

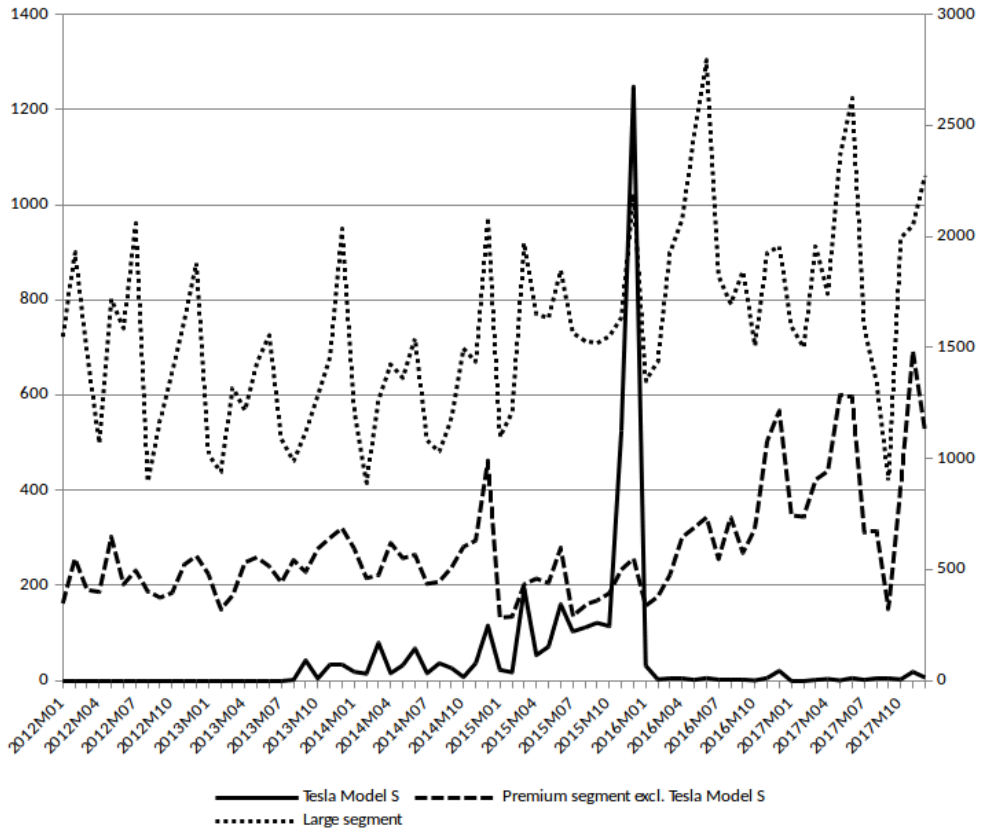

Figure 1: Registrations of new vehicles in Denmark

line is Tesla registrations and the dashed line is other premium segment registrations. The dotted line is registrations in the large segment. The left side y-axis applies to the premium segment vehicles, and the right side y-axis applies to the large segment vehicles. There is a swift rise in the number of Tesla registrations leading up to December 2015, and then a dramatic fall beginning in January 2016.

Analysis of Lost Tax Revenue

To calculate the revenue implications of the tax change we need to establish a counterfactual. We obtain a simple benchmark for the number of Tesla Model S cars that would have been sold had there been no tax change by predicting sales using data until September 2015, just before the EV registration tax announcement. We take as our starting point August 2013, the month in which the first Tesla Model S was registered. As is evident from Figure 1, sales volumes fluctuate widely across months and there are also trends in the series. We control for these with monthly dummy variables and time trends. The explanatory power of our predictive regression is high (Adj. $R^2 = 0.67$). We also estimate a positive time trend as Tesla

	Data (1)	No Tax Change (2)	General Tax Reduction (3)
Oct-2015	114	76	76
Nov-2015	525	104	104
Dec-2015	1248	144	144
Jan-2016	31	90	81
Feb-2016	2	86	77
Mar-2016	4	206	185
Late 2015	1887	324	324
2016 total	78	1689	1514
Period total	1965	2013	1838

Table 1: Tesla Model S registrations, projections and data

registrations were increasing over the period since 2013. For brevity, the output from the regression is not shown.

Table 1 provides the least squares predictions. Column (1) shows the actual data and column (2) presents the predictions assuming no other tax changes. We will discuss column (3) momentarily. Not surprisingly, the sales of 1887 Teslas in late 2015 (column (1)) far exceed the 324 predicted had there been no change in any of the taxes (column (2)). For the 2016 calendar year only 78 Teslas are sold compared to the predicted 1689. The total period sales from October of 2015 to December of 2016 are approximately the same, around 2000 Teslas sold. We take this as evidence that the increase in registration tax did not dramatically decrease Tesla Model S sales. Instead, the law change simply shifted sales from 2016 to 2015. In column (3) of Table 1, we use the elasticities discussed below to adjust projected Tesla sales to account for the 2016 general reduction in the registration tax (tax reduction for all non-electric vehicles) which was announced as a surprise close to its implementation in January 2016. The predictions in column (3) are slightly muted relative to those in column (2).[5]

To get the predicted sales of Tesla Model S and non-Tesla premium

[5]While it might have been forecast that the liberal government would reduce vehicle taxes, the finance law containing the overall reduction in the registration tax was not passed until November 19, 2015. Since our focus is on the electric vehicle tax, we assume that this tax change was not anticipated by the market. Our estimates will be affected if consumers who moved planned 2016 Tesla purchases to 2015 to avoid the EV tax, after learning of the reduction in registration taxes overall would have preferred to buy some other vehicle in 2016. We believe this case to be sufficiently rare that its effect on our calculations will be marginal.

vehicles after a surprise 20% tax announcement we need the own-price elasticity of Tesla, and the cross-price elasticity of Tesla on non-Tesla. Although we are not able to estimate an own-price elasticity for Tesla, a number in the range of one to five appears reasonable and in line with other studies.[6] Using three as a benchmark suggests that 606 Tesla would have been sold in 2016 at a 20% higher price. We choose 0.93 as our benchmark cross-elasticity as it is the number estimated in Jensen et al. [2013] for the cross-price elasticity between electric and non-electric vehicles, and also because it roughly delivers the relationship reported in Berry et al. [2004] that the total market elasticity of a price increase is close to one. At this elasticity, a 20% higher price on Tesla causes 702 additional non-Teslas to be sold.

Finally, we must determine mean prices of both Tesla Model S and non-Tesla vehicles in order to calculate tax revenues. In our register data, we have a mean monthly price for premium segment autos. Since we know the monthly market shares of Tesla and non-Tesla cars and if we assume prices remain constant, two months of data are sufficient to back out prices. In practice, we minimize squared residuals for the period September 2014-September 2015 and find a mean price of 655,380 for Tesla and 558,669 for non-Tesla premium vehicles.[7]

	2015 Price	Data tax rev.	Surprise tax rev.	Diff.
Tesla Model S	0.655	268	201	-67
Non-Tesla Prem.	0.559	1,514	1,747	233
Total		1,782	1,948	**166**

Table 2: Lost revenue (millions DKK) from early announcement of tax change

Table 2 compares actual tax revenues from premium segment vehicles in the period October 2015 to December 2016 to counterfactual revenues had the registration tax been announced and implemented on January 1, 2016. Our benchmark estimate is that the lost tax revenue from preannouncing the increase in the registration tax on the Tesla Model S amounted to 166,006,433 DKK. While the total tax take from Tesla cars is 67m DKK lower under surprise announcement, it is more than offset by an increase of

[6] Berry et al. [2004] find an own-price partial elasticity of -3.94 for the 1993 American market, Jensen et al. [2013] find an own-price elasticity of -1.22 for electric vehicles overall.

[7] We also assume that the assessed tax rate on non-Teslas is 170% in 2015 and 140% in 2016. The calculation of the registration tax for a particular vehicle can be quite complicated, and it is typically somewhat lower than the sticker registration tax rate, in our case 180% in 2015 and 150% in 2016.

233m DKK in the total tax take from other premium segment cars. Table 3 below shows total tax revenue under different assumptions about elasticities. Intuitively if the own price elasticity is higher revenue is lower since fewer Tesla are sold after the tax change, and if the cross-price elasticity is higher revenue is higher since more non-Teslas are sold.

	Own		
Cross	-5	-3	-1
0.75	-38	125	287
0.93	7	**166**	325
1	24	182	340

Table 3: Cross and Own-Price Elasticities: Tax losses relative to surprise announcement in millions (DKK)

Discussion: Who Gained?

After the electric vehicle registration tax announcement in October 2015, Tesla Model S sales first spiked and then fell to a trickle. Compared to a counterfactual with immediate implementation, the foregone tax revenues from the unusual sales pattern of Tesla Model S and accompanying substitution effects on sales of other premium cars were more than 60 million DKK. The government clearly lost, but who gained? It could have been final consumers who were planning on buying in 2016 anyway, but it could also have been speculators planning to buy low immediately before the tax hike and sell high immediately afterwards.

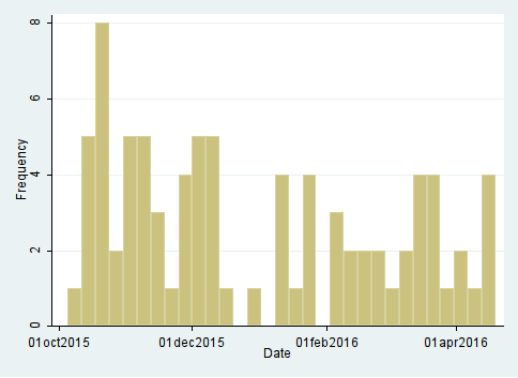

Figure 2: Listings of new Tesla Model S by week

Although there were media reports of individuals planning to arbitrage the introduction of the registration tax by buying in 2015 and selling in 2016 when prices would be higher, there is little evidence for such speculation in our data. Speculators would presumably buy and register new Teslas in

2015, and then list them for sale on bilbasen.dk in 2016. Figure 2 shows, however, that the number of bilbasen.dk listings for used Teslas with zero on the odometer (new Teslas) does not increase in our data after January 1, 2016. Moreover, in the first 17 weeks of 2016, the period for which we have scraped bilbasen.dk data, we see 37 new Teslas put up for sale, less than 3% of the number of Teslas sold in December 2015.

Since speculation seems not to have been an important driver of the demand for Tesla Model S in late 2015, we conclude that it was rather the relatively wealthy consumers of luxury vehicles who gained from the rollout of the registration tax. Most of these consumers were first time Tesla buyers, but some owners of older Tesla models also upgraded to a newer model earlier than planned to avoid the EV registration tax. Figure 3 shows that the stock of used Tesla advertisements on bilbasen.dk increased by around 50 advertisements at the end of 2015.

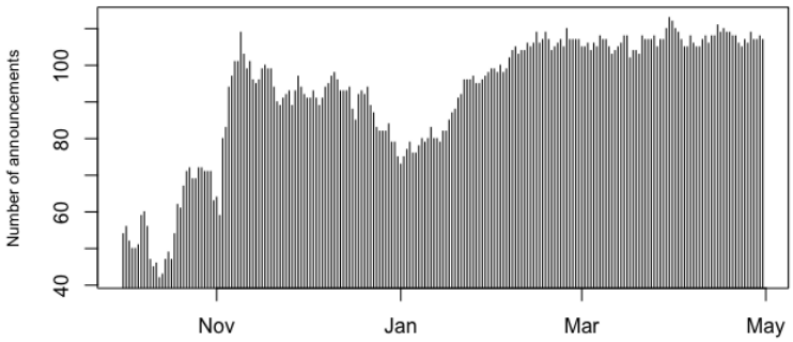

Figure 3: Daily stock of Tesla Model S ads on Bilbasen.dk

Conclusion

In this paper we described the market for new and used Tesla Model S vehicles just before and after a dramatic increase in the Danish registration tax on electric vehicles. We presented evidence that speculation did not account for the surge in sales. Rather it was simply consumers moving planned purchases of Teslas forward. We estimated that the losses to the Danish tax authorities by announcing the tax hike well in advance amount to several hundred million of Danish Kroner. Moreover these tax revenues would have been collected from the relatively wealthy who purchase luxury automobiles.

Other countries with high Tesla sales have also announced the end of subsidies for electric cars in advance; for example both Norway and Hong Kong announced the end of subsidies before they were implemented.[8] Hong Kong, which also has a high registration tax on vehicles, saw a similar surge

[8]Norway ended up scrapping the proposal before it was implemented in 2018.

and drop off in sales as in Denmark when they raised taxes on electric vehicles in 2017. The government there likely lost significant revenue from Tesla purchasers due to the early announcement. The bottom line is that governments must consider strategic responses when they consider the roll-out of excise tax changes on durable goods. Otherwise they may end up both losing revenue and implicitly subsidizing purchasers of the good being taxed.

References

O. P. Attanasio and G. Weber. Consumption and saving: Models of intertemporal allocation and their implications for public policy. *Journal of Economic Literature*, 48(3):693–751, 2010.

S. Berry, J. Levinsohn, and A. Pakes. Differentiated products demand systems from a combination of micro and macro data: The new car market. *Journal of Political Economy*, 112(1):68–105, 2004.

M. Browning and M. D. Collado. The response of expenditures to anticipated income changes: panel data estimates. *The American Economic Review*, 91(3):681–692, 2001.

T. Büttner and B. Madzharova. Pre-announced VAT increases and the sales of consumer durables, 2016.

D. Cashin and T. Unayama. Measuring intertemporal substitution in consumption: Evidence from a vat increase in japan. *Review of Economics and Statistics*, 98(2):285–297, 2016.

I. Correia, E. Farhi, J. P. Nicolini, and P. Teles. Unconventional fiscal policy at the zero bound. *The American Economic Review*, 103(4):1172–1211, 2013.

M. Feldstein. A role for discretionary fiscal policy in a low interest rate environment. *Rethinking Stabilization Policy*, 2003.

R. E. Hall. The long slump. *The American Economic Review*, 101:431–469, 2011.

M. Hoekstra, S. L. Puller, and J. West. Cash for corollas: When stimulus reduces spending. *American Economic Journal: Applied Economics*, 9 (3):1–35, 2017.

C.-T. Hsieh. Do consumers react to anticipated income changes? Evidence from the Alaska permanent fund. *The American Economic Review*, 93 (1):397–405, 2003.

A. F. Jensen, E. Cherchi, and S. L. Mabit. On the stability of preferences and attitudes before and after experiencing an electric vehicle. *Transportation Research Part D: Transport and Environment*, 25:24–32, 2013.

K. Mertens and M. O. Ravn. Understanding the aggregate effects of anticipated and unanticipated tax policy shocks. *Review of Economic Dynamics*, 14(1):27–54, 2011.

A. Mian and A. Sufi. The effects of fiscal stimulus: Evidence from the 2009 cash for clunkers program. *The Quarterly Journal of Economics*, 127(3): 1107–1142, 2012.

J. A. Parker. The reaction of household consumption to predictable changes in social security taxes. *The American Economic Review*, 89(4):959–973, 1999.

J. M. Poterba. Are consumers forward looking? evidence from fiscal experiments. *The American Economic Review*, 78(2):413–418, 1988.

Skatteministeriet. Aftale mellem regeringen (v, la, k), socialdemokratiet og radikale venstre om justering af aftalen om de fremtidige afgiftsvilkår for elbiler og brændselscellebiler af 9. oktober 2015 (nye lempelser for elbiler). http://www.skm.dk/media/1455610/aftale-om-elbiler.pdf, 2015a. [Online; accessed 26-Jan-2018].

Skatteministeriet. Priseksempler for udvalgte elbiler i 2016 - 2020 ved den aftalte indfasningsmodel ved registreringsafgift på 150 pct. samt ved bortfald af loftet. http://www.skm.dk/media/1305437/Faktaark-priseksempler-elbiler.pdf, 2015b. [Online; accessed 26-Jan-2018].

Skatteministeriet. Fritagelsen for el- og brintbiler foreslås forlænget. http://www.skm.dk/aktuelt/presse/pressemeddelelser/2015/april/fritagelsen-for-el-og-brintbiler-foreslaas-forlaenget., 2015c. [Online; accessed 26-Jan-2018].