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The Soaring cost of Groceries: How much will it cost for me to fly to the Supermarket?

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Abstract
Following public criticism for overusing private jets, many memes have been made surrounding Taylor Swift. This paper explores the financial cost of utilising a private jet for a weekly grocery shopping trip. We calculate that the weekly round trip would take approximately 300 seconds releasing almost 13 metric tons of CO_2 per annum and consuming 1376 gallons of aviation grade kerosene. Assuming CO_2 emissions are offset using carbon credits, this results in a $80.80 USD increase to your weekly shopping bill.

Keywords: Meme; Physics; Mechanics; Environment; Private Jet; Carbon Credits

In 2024 global awareness to climate change is at an all-time high. Our individual carbon footprints are supposed to make people aware of the environmental impact our daily actions have. It is becoming increasingly worrying to see the emissions of celebrities to the point that 'memes' are being made regarding private jet usage (figure 1) [1]. This paper explores the environmental consequences of taking a private jet to do the weekly shopping how much the associated carbon credits to offset emissions would add to the weekly shopping bill.

Figure 1 – Meme depicting a jet in response to Taylor Swift's 'excessive' private jet usage [1].

Assumptions
In keeping with the meme (figure 1), we will assume the private jet in question is the Dassault Falcon 7X jet (as owned by Taylor Swift). Taylor Swift is American and therefore we will assume the grocery store of choice is 3.8 miles, or 6.11551 km, (D_{Total}) away from the start point of the journey, the average distance Americans travel to their preferred grocery store [2]. Whilst Dassault claim their jets can fly on 50% sustainable aviation fuel (SAF) we will calculate using the carbon emissions of kerosene as the traditional jet fuel is easier to acquire with well-established emissions. The CO_2 emissions of kerosene fuel is 9.33 $kg_{CO2}gal_{fuel}^{-1}$ [3]. The Dassault Falcon 7X burns 318 gallons of fuel per hour of flight [4]. The take-off distance (D_{TO}) of the Jet is 1740 m whilst landing distance (D_L) is 630 m [5]. V_2 (the generally accepted speed required for safe take-off) of this is jet is 113 kt (58.138889 ms^{-1}) [6] and we will assume the jet travels at a constant velocity for the duration of the flight until final approach (maximum approach speed (V_A) of this jet is 195 kmh^{-1} [5] or 54.1667 ms^{-1}). We make this assumption to minimise acceleration and deceleration throughout the flight.

Flight Time
To calculate fuel usage for a single return trip to the shops we must first calculate the travel time of the jet. This requires us to know the distances travelled at different speeds throughout the flight.

$$Cruising\ distance = D_{total} - (D_{TO} + D_L)$$
$$Distance_{Cr} = 6115.51 - (1740 + 630)$$
$$= 3745.51\ m$$

$$Takeoff\ time = \frac{2(D_{TO})}{V_2}$$
$$Time_{TO} = \frac{2(1740)}{58.1389} = 59.857\ s$$

$$Landing\ time = \frac{2(D_L)}{V_A}$$
$$Time_L = \frac{2(630)}{54.1667} = 23.26\ s$$

$$Cruising\ Time = \frac{2(D_{Cr})}{V_2 + V_A}$$
$$Time_{Cr} = \frac{2(3745.51)}{58.1389 + 54.1667} = 66.702\ s$$

$$Total\ Travel\ Time = Time_{TO} + Time_{Cr} + Time_L$$

$$Time_{total} = 149.819\ s$$

A one-way journey to the grocery store in the Dassault Falcon 7X using our assumptions takes 149.819 s. This means that the round journey takes 299.638 s.

CO_2 Emissions

Using the previously calculated flight time of 299.638 s and the stated fuel burn of 318 gallons hr^{-1}, this trip will consume 26.4680233333 gallons of kerosene. This equates to 246.9466577 kg of CO_2 emissions. Over the course of a year of weekly shops, you would use 1376.337 gallons of kerosene and emit 12,841.226 kg of CO_2.

What is a Carbon Credit?

Carbon Credits can be best described as 'permission slips' for emissions [7]. A purchased carbon credit gives an individual or business an allowance to produce one ton of carbon emissions. Carbon credits are assigned to companies by governments which can then be traded between companies if one company produces too much carbon dioxide whilst another is below their emission cap (Regulated market). The voluntary market is a scheme by which companies can invest into carbon offsetting projects to offset their own carbon emissions. The monetary value of a carbon credit varies based on the governing body. As of February 2023, the European Union's Emissions Trading System saw the price of a carbon credit exceed €100 per metric ton of carbon emissions [8] in this study I use European costs of carbon credits as the US carbon credit market is less heavily regulated than the European market, thus the European market offers more consistent pricing.

With this figure in mind, one would need to purchase 0.2469466577 carbon credits a week resulting in a cost of €24.69 ($26.91 USD) (As of 14/03/2024 €1: $1.09)

$$\frac{246.9466577kg}{1000} = 0.2469466577\ Tonnes$$
$$0.2469466577 \times €100 \approx\ €24.69$$

How expensive is my weekly shop?

To calculate the additional cost to a weekly shop I will ignore the initial cost of the jet as this can vary based on how new the jet is and if it is leased when not being used as well as owning the jet prior to using it for weekly shopping (as suggested in the source meme). Upfront costs aside, there will be an additional cost of $26.91 dollars for carbon credits and, assuming the current price of kerosene ($2.036/gallon [9]) the weekly fuel cost of to do your shopping is $53.89 USD. This results in an additional $80.80 per week.

Flaws

This paper has made many assumptions as does not take into consideration the maintenance and staffing costs of the Dassault Falcon 7X. Other short comings include the assumption that the jet burns fuel at the same rate regardless of speed and acceleration. Equally cruising speed assumes a constant retardation following take off to reach maximum approach speed by landing. This is different to normal aviation as ordinarily a plane will accelerate past take off speed to a cruising speed followed by rapid deceleration to landing speed. Another omission of this paper is the use of fuel when the plane is taxiing around the runway. This paper does not consider fluctuations in pricing with all numbers coming from individual sources.

Conclusion

If you already own a Dassault Falcon 7X private jet, your weekly shopping trip would consist of a 299.6 s journey and add an additional cost of $80.80 USD per week. These costs, whilst not unaffordable to the average private jet owner, pale in comparison to the irresponsible and unnecessary cost these carbon emissions can have on the environment and the global warming crisis.

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