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**Data source**: France passenger vehicle fleet from 2005 to 2019

**Question (1) — Prediction of the annual fleet sale-weighted average CO2 emissions of France PV fleet from 2020 to 2025**

**Method**: Regression Analysis is a method known to establish a fixed relationship—a continuous function, to roll-up and represent the scattered data points, which then can be used to make prediction. Based on different data background, different types of regression will be chosen to reach better prediction accuracy. Here, Polynomial Regression (2nd degree)[[1]](#footnote-1) is adopted to represent the sale-weighted average CO2 emission[[2]](#footnote-2) of year 2006-2019 as *Function 1*, to predict the average CO2 emission of year 2020-2025.

**Result**: *Function 1* establishes the regression of average CO2 emission upon Year, which offer us the prediction of 2020-2025 average CO2 emission, as shown in *Table 1*. It can also be seen in *Fig 1*, the regression line as a continuous function (plotted in blue) represents the historical CO2 emission data of year 2006-2019 (plotted in black) and make the prediction of the CO2 emission of year 2020-2025 (plotted in red).

We predict and expect the major tendency of CO2 emission goes down from the perspective of year 2005-2025, based on the data 2005-2019. However, we have to notice that the average CO2 emission has a partial tendency of going up in 2016-19 and it is therefore believed that the prediction of the CO2 emission will carry on this tendency to partially going up in 2020-2025.

Function 1:

|  |  |
| --- | --- |
| Table 1 | |
| Year | Predicted  CO2-emission (g/km) |
| 2020 | 112.2062 |
| 2021 | 113.1611 |
| 2022 | 114.6246 |
| 2023 | 116.5967 |
| 2024 | 119.0773 |
| 2025 | 122.0665 |

Chart, line chart

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**Accuracy**: This model is considered to be accurate — intuitively speaking, the regression line smoothly and closely fit the historical data points. To improve accuracy, we can collect more data and adopting more complex model.

**Question (2) – Calculation of the annual government revenue/expense as result of the bonus-malus policy from 2020 to 2025, assuming the bonus-malus policy stays at 2020 level**

**Assumption and Method:**

* The malus and bonus of France PV fleet in 2020-2025 **under 2020 policy** can be predicted through the regression of the ‘estimated’ malus and bonus of France PV fleet in 2006-2019 **under 2020 policy**. (note: these are not ‘actual’ 06-19 malus/bonus values, which should be based **under actual policy of 06-19 each year correspondingly**). Polynomial (2nd degree) Regression is adopted to predict the malus fee and Linear Regression is adopted to predict the bonus fee.[[3]](#footnote-3)
* Simplified rough calculation: ‘Estimated’ malus and bonus of France PV fleet under 2020 policy[[4]](#footnote-4) are roughly calculated under such assumption: (1) Bonus is unanimously calculated as €6,000 for light vehicles with CO2 emission levels up to 20 g/km (2) Malus, which should be calculated upon the curve Malus 2020\_WLTP, is simplified to be calculated under a linear function, with a min €50 for CO2 <138g/km and max €20,000 for CO2>213g/km

**Result:** The calculation of 2020-2025 predicted government revenue and expense (as the malus fee and bonus fee) is shown in *Table 2*. It can also be seen in *Fig 2* and *Fig 3* the regression lines (plotted in blue) represent the historical passenger vehicle malus fee (government revenue) and bonus fee (government expense) of year 2006-2019 (plotted in black) and make the prediction of the malus fee and bonus of 2020-2025 (plotted in red).

|  |  |  |
| --- | --- | --- |
| Table 2 | | |
| Year | Predicted Revenue--  Malus Fee(€) | Predicted Expense--  Bonus Fee(€) |
| 2020 | 1200136075 | 3501600 |
| 2021 | 1720284802 | 3025200 |
| 2022 | 2379973427 | 2548800 |
| 2023 | 3179201949 | 2072400 |
| 2024 | 4117970367 | 1596000 |
| 2025 | 5196278684 | 1119600 |

Chart, line chart

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**Accuracy**: This is a rough calculation, not considered to be highly accurate—mainly because: (1) lack of information: not able to obtain the exact mathematical function of curve Malus 2020\_WLTP to conduct accurate calculation; lack of vehicle fleet info which required in the 2020 malus/bonus policy—such as: price of light vehicles, whether the vehicle is type approved-WVTA (2) small data base: especially, light vehicles eligible for bonus (CO2 <20g/km) only appeared in 2015-2019 in the database, but is intended to predict for 2020-2025

1. 2nd degree Polynomial Regression is in the form of ;

   Linear Regression is in the form of [↑](#footnote-ref-1)
2. Sale-weighted average CO2 emission is calculated through [↑](#footnote-ref-2)
3. Different type of regressions are adopted dependent on different type of data background; Here, Polynomial (2nd) Regression fit the malus fee data better, while Linear Regression fit the bonus fee data better [↑](#footnote-ref-3)
4. Please refer to ACEA\_Tax\_Guide\_2020.pdf for the 2020 Malus/Bonus policy [↑](#footnote-ref-4)