

# **excise report**

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# Executive summary

aowkoakwoakwo

# 1 Introduction

Prospera was tasked to help Directorate General of Customs & Excise (DGCE) evaluating the impact of cigarette excise. More specifically, we are to estimate price elasticity of demand for cigarettes and how an increase in excise would matter.

The study become even more important since the introduction of electric cigarettes. DGCE was starting to collect data (and excise) for e-cigarettes since 2020. It can be argued that e-cigs created an alternative to traditional cigarettes, which may

We rely on Prasetyo and Adrison (2020) for estimation comparison and some insight.

## 2 Data

This paper relies solely on data sourced by DGCE. The data contains information on both traditional and e-cigarettes, albeit on different details.

The traditional cigarettes dataset contains information on annual production (in unit) and excise revenue for three kinds of traditional cigarettes, SKM, SKT and SPM. It also contain two types of regulated price data, HTP (retail price) and HJE (base price to calculate the excise liabilities), both quarterly.

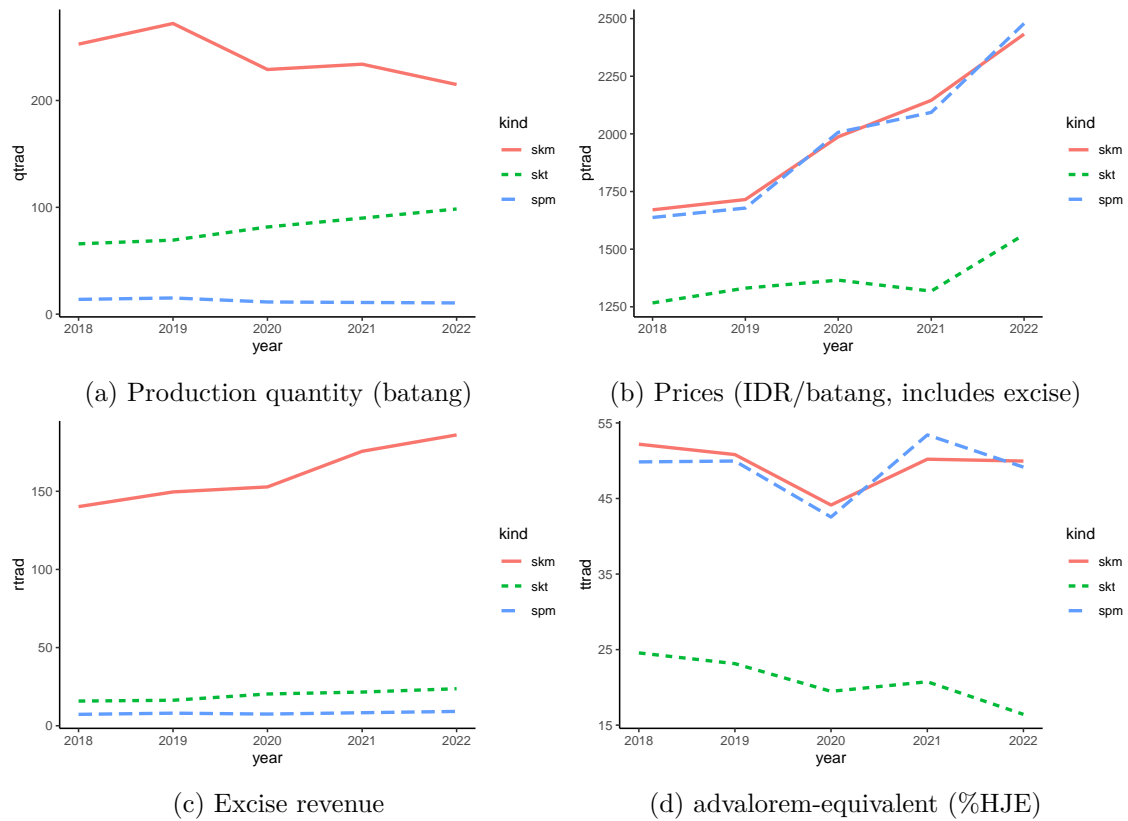


Figure 2.1: Statistics of traditional cigarettes, 2018-2022

The Figure 2.1 shows us some shit. Satuan is fucking horrible.

Meanwhile, e-cigarettes have a very interesting statistics, which presents problems with its use in an analysis, at least for the time being. Firstly, unlike traditional cigarettes which

are all measured in “batang”, e-cigs’ measurement varies. For example, an EET-batang is measured by batang, EET-cair in mililitre, EET-cartridge in cart (2020) and pods (2021), and REL-padat in grams. Worse, some types discontinued in 2022 and replaced with entireley new types (see Table 2.1).

Table 2.1: E-cigs data structure

| Types             | measure   | year      |
|-------------------|-----------|-----------|
| EET-batang        | batang    | 2020-2021 |
| EET-cair          | ml        | 2020-2021 |
| EET-cartridge     | cart/pods | 2020-2021 |
| REL-padat         | gr        | 2022      |
| REL cair terbuka  | ml        | 2022      |
| REL cair tertutup | ml        | 2022      |

The different measurement renders it hard to compare between types of electric cigarettes, and between electric cigarettes and its traditional counterparts. DGCE must find a way to make a measure of “batang equivalent” of e-cigs so one can compare its elasticity with traditional cigarettes. Inconsistency of types also don’t help.

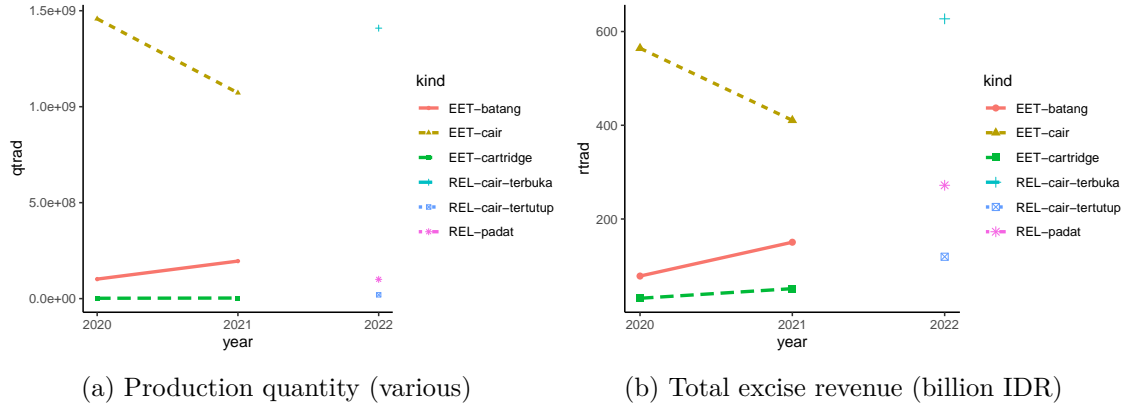


Figure 2.2: Statistics of electroic cigarettes, 2018-2022

Figure 2.2 shows us another shit. Figure 2.2b is even shitter.

### 3 Method

Let a standard elasticity parameters

$$Q_i = AP_i^{-\varepsilon}$$

which can be approximately log-linearized

$$q_i = a - \varepsilon p_i$$

where a lowercase is the log version of its uppercase counterparts. We can, thus, econometrically estimated the above equation with a regression. Additionally, we follow the theory in having an income elasticity with GDP per capita as a proxy. We then estimate:

$$q_{it} = a - \varepsilon p_{it} + \gamma y_{it} + \epsilon_{it}$$

We assume an iid  $\epsilon_{it}$  for now and uses own-price elasticity since we lack information on the price of electric cigs. The parameter  $\varepsilon$  is the own-price elasticity of demand, which we expect to be negative, while  $\gamma$  is the income elasticity of demand which is assumed to be positive.

# 4 Results

We use data that are made available by DGCE for us. Data contains production, revenue, base price (HJE) for tax purposes and retail price (HTE) for consumers for various types of traditional and electric cigarettes. Unfortunately, the availability of those data differs quite tremendously. Some are collected monthly, some others are quarterly and annually. Common denominator suggests us to conduct the analysis annually.

Since we lack degree of freedom amid lack of data, it does make sense to group kinds of cigarettes into two: traditional and electric. We aggregate variables using weighted average using production data of each kind of cigarettes as the weight.

## 4.1 Elasticities: traditional cigarettes

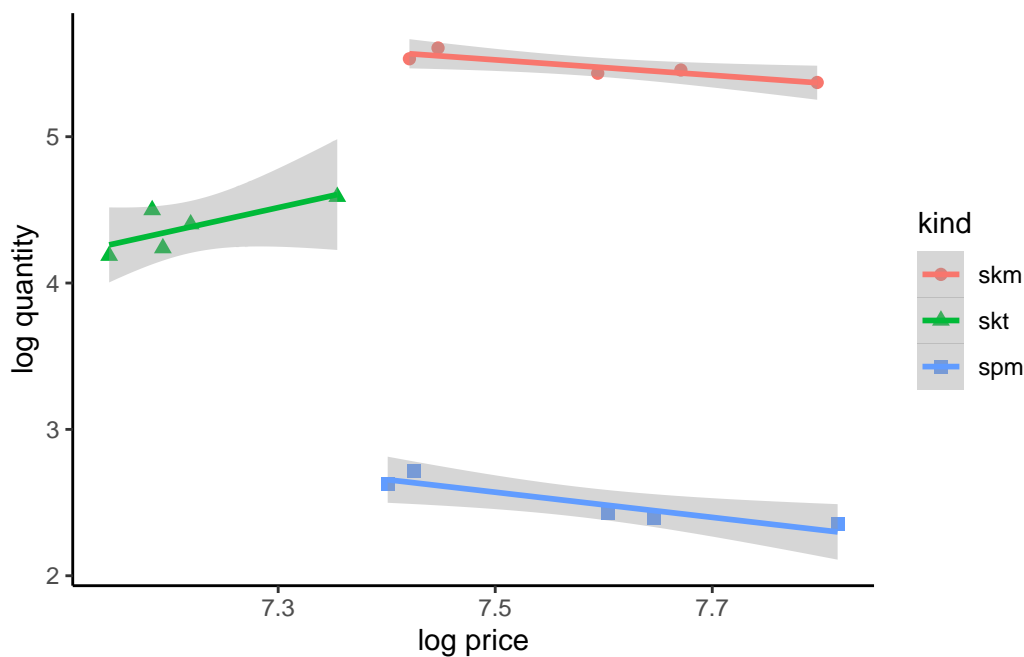


Figure 4.1: wkwkwkkw

kwwkw

Table 4.1: Demand elasticity estimation for three kinds of traditional cigarettes

|   | Traditional SKM |         | SKT     | SPM     |
|---|-----------------|---------|---------|---------|
| (Intercept)                                       | 25.750**        | 6.592+  | -9.257  | 4.212   |
|   | (1.571)         | (2.048) | (6.921) | (3.185) |
| own-price   | -0.479          | -0.782+ | 0.873   | -1.216* |
|   | (0.212)         | (0.202) | (1.497) | (0.274) |
| y   | 0.525           | 0.578   | 0.879   | 0.900   |
|   | (0.311)         | (0.369) | (1.403) | (0.546) |
| Num.Obs.  | 5               | 5       | 5       | 5       |
| R2  | 0.722           | 0.917   | 0.663   | 0.935   |
| R2 Adj.   | 0.444           | 0.835   | 0.326   | 0.870   |
| AIC   | -17.4           | -15.3   | -2.1    | -10.9   |
| BIC   | -18.9           | -16.9   | -3.6    | -12.5   |
| Log.Lik.  | 12.692          | 11.657  | 5.039   | 9.473   |
| F   | 2.597           | 11.089  | 1.967   | 14.360  |
| RMSE  | 0.02            | 0.02    | 0.09    | 0.04    |
| + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001 |                 |         |         |         |

The elasticity of the traditional cigarettes is -0.4791002 which is the decrease in sales if prices go up by 1%. Meanwhile, 0.5248967 is the income-effect, that is, how much more sales go up if GDP per capita rises by 1%.

However, to preserve degree of freedom, we can estimate all kinds in one regression, albeit using dummy variables for different kinds of traditional cigarettes. This technique will force all non-dummy variables to be assumed parallel. That is, we will force the three kinds of cigarettes to have the same elasticity.

Table 4.2: Demand elasticity estimation, pooled with dummy

| (1)               |
|-------------------|
| (Intercept) 2.283 |
| (3.416)           |



|  | (1)                  |
|--|----------------------|
| own-price  | -1.099*<br>(0.367)   |
| y  | 1.383*<br>(0.606)    |
| kindskt  | -1.500***<br>(0.153) |
| kindspm  | -2.985***<br>(0.073) |
| Num.Obs.   | 15                   |
| R2   | 0.994                |
| R2 Adj.  | 0.992                |
| AIC  | -16.4                |
| BIC  | -12.2                |
| Log.Lik.   | 14.207               |
| F  | 431.007              |
| RMSE   | 0.09                 |
| + p < 0.1, * p < 0.05,<br>** p < 0.01, *** p < 0.001 |                      |

As we can see, this approach improves degree of freedom and provides a more robust standard error. The elasticity of the traditional cigarettes is -1.0994769 which is the decrease in sales if prices go up by 1%. Meanwhile, 1.3828417 is the income-effect, that is, how much more sales go up if GDP per capita rises by 1%. However, judging from Figure 4.1, this estimation may be bias, especially since one of the type has a visual positive relationship.

Now that we have various estimators, it may takes a bit of a guesswork here. We can use an aggregated estimators, or the pooled-dummy estimators. Our options are:

| parameter     | aggregate value | pooled-dummy value |
|---------------|-----------------|--------------------|
| price-effect  | -0.4791002      | -1.0994769         |
| income-effect | 0.5248967       | 1.3828417          |

| parameter | aggregate value | pooled-dummy value |
|-----------|-----------------|--------------------|
|-----------|-----------------|--------------------|

We can then propose an elasticity equation as such:

$$Q_{trad} = \frac{Y^{0.52}}{P_{trad}^{0.48}} \cdot e^{25.75}$$

or such:

$$Q_{trad} = \frac{Y^{1.38}}{P_{trad}^{1.38}} \cdot e^{2.28}$$

The first equation is actually make sense. The inelasticity of cigarette demands is quite well-known. Additionally, since the parameters are not statistically different from 0, it's even more inelastic.

The second equation gives us a better statistical power, albeit a possibility of bias. Additionally, an elasticity larger than 1 suggests a relatively elastic goods, which may not the mainstream characteristics of a cigarettes.

In short, the results may be inconclusive, but the technique can be used by DGCE in the presence of better availability of data.

## 4.2 Tax-price pass through

In the terms of excise, DGCE is interested in knowing how much their additional excise matters for the change in prices, which in turn matter in the change in quantities. We estimate how much prices changes when excise changes with the following specification:

$$\ln P_t = \alpha + \beta \ln T_t + \varepsilon_t$$

The result of that regression is as follows:

Table 4.4: Tax-to-price pass through for three kinds of traditional cigarettes

|             | Traditional SKM | SKT      | SPM      |
|-------------|-----------------|----------|----------|
| (Intercept) | 1.940*          | 2.399**  | 4.299    |
|             | (0.493)         | (0.257)  | (12.330) |
| own-excise  | 0.879**         | 0.798*** | 0.532    |
|             |                 |          | 0.759**  |

|          | Traditional SKM |         | SKT     | SPM     |
|----------|-----------------|---------|---------|---------|
|          | (0.078)         | (0.039) | (2.248) | (0.074) |
| Num.Obs. | 5               | 5       | 5       | 5       |
| R2       | 0.977           | 0.993   | 0.018   | 0.972   |
| R2 Adj.  | 0.969           | 0.990   | -0.309  | 0.963   |
| AIC      | -20.5           | -24.1   | -6.2    | -16.5   |
| BIC      | -21.7           | -25.2   | -7.4    | -17.7   |
| Log.Lik. | 13.267          | 15.031  | 6.118   | 11.246  |
| F        | 127.688         | 407.922 | 0.056   | 104.179 |
| RMSE     | 0.02            | 0.01    | 0.07    | 0.03    |

+ p < 0.1, \* p < 0.05, \*\* p < 0.01, \*\*\* p < 0.001

This estimation result tells us a very strong impact of taxation on prices. That is, for each 1% increase in excise, it passes 0.8792325 % to the consumer via increased price. This estimation is arguable higher than Prasetyo and Adrison (2020) which conducted a firm-level estimation.

Likewise, we can improve the statistical power by pooling the three types with a quite restrictive assumption of a parallel marginal effect.

Table 4.5: tax-price passthrough estimation,pooled with dummy

|             | (1)      |
|-------------|----------|
| (Intercept) | -0.463   |
|             | (1.234)  |
| own-excise  | 0.622*** |
|             | (0.091)  |
| y           | 0.480*   |
|             | (0.183)  |
| kindskt     | 0.267*   |
|             | (0.097)  |
| kindspm     | 0.002    |

|  |         |
|--|---------|
|  | (1)     |
|  | (0.026) |
| Num.Obs.   | 15      |
| R2   | 0.974   |
| R2 Adj.  | 0.964   |
| AIC  | -46.8   |
| BIC  | -42.5   |
| Log.Lik.   | 29.380  |
| F  | 94.809  |
| RMSE   | 0.03    |
| + p < 0.1, * p < 0.05,<br>** p < 0.01, *** p < 0.001 |         |

This estimation result tells us a very strong impact of taxation on prices. That is, for each 1% increase in excise, it passes 0.6219979 % to the consumer via increased price. This estimation is arguable higher than Prasetyo and Adrison (2020) which conducted a firm-level estimation.

### 4.3 Revenue from price and from tax rate

Table 4.6: tax elasticity of revenue for three kinds of traditional cigarettes

|             | Traditional SKM   | SKT               | SPM                  |
|-------------|-------------------|-------------------|----------------------|
| (Intercept) | -2.543<br>(1.602) | -2.072<br>(1.946) | -45.522+<br>(11.411) |
| own-excise  | 0.592+<br>(0.168) | 0.375<br>(0.135)  | 5.914+<br>(1.781)    |
| y           | 0.483<br>(0.278)  | 0.565<br>(0.309)  | 1.923*<br>(0.425)    |
| Num.Obs.    | 5                 | 5                 | 5                    |

|   | Traditional SKM |        | SKT    | SPM    |
|---|-----------------|--------|--------|--------|
| R2  | 0.972           | 0.964  | 0.924  | 0.977  |
| R2 Adj.   | 0.944           | 0.927  | 0.848  | 0.954  |
| AIC   | -17.9           | -16.9  | -9.1   | -21.7  |
| BIC   | -19.5           | -18.5  | -10.7  | -23.3  |
| Log.Lik.  | 12.953          | 12.447 | 8.572  | 14.870 |
| F   | 34.587          | 26.577 | 12.186 | 42.580 |
| RMSE  | 0.02            | 0.02   | 0.04   | 0.01   |
| + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001 |                 |        |        |        |

Same. lol.

Table 4.7: tax-price passthrough estimation,pooled with dummy

|             | (1)       |
|-------------|-----------|
| (Intercept) | 15.632*** |
|             | (2.533)   |
| own-excise  | 0.079     |
|             | (0.188)   |
| y           | 1.157*    |
|             | (0.375)   |
| kindskt     | -2.035*** |
|             | (0.199)   |
| kindspm     | -2.990*** |
|             | (0.054)   |
| Num.Obs.    | 15        |
| R2          | 0.997     |
| R2 Adj.     | 0.996     |
| AIC         | -25.2     |
| BIC         | -20.9     |

| (1)  |         |
|--|---------|
| Log.Lik.   | 18.591  |
| F  | 807.620 |
| RMSE   | 0.07    |
| + p < 0.1, * p < 0.05,<br>** p < 0.01, *** p < 0.001 |         |

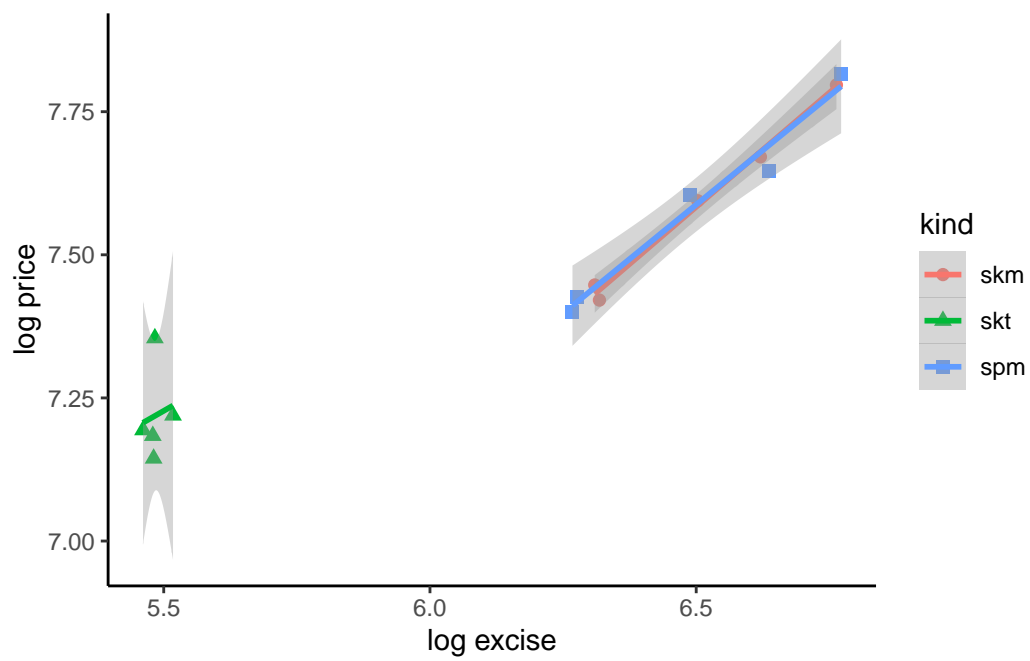


Figure 4.2: wkwkwkwk

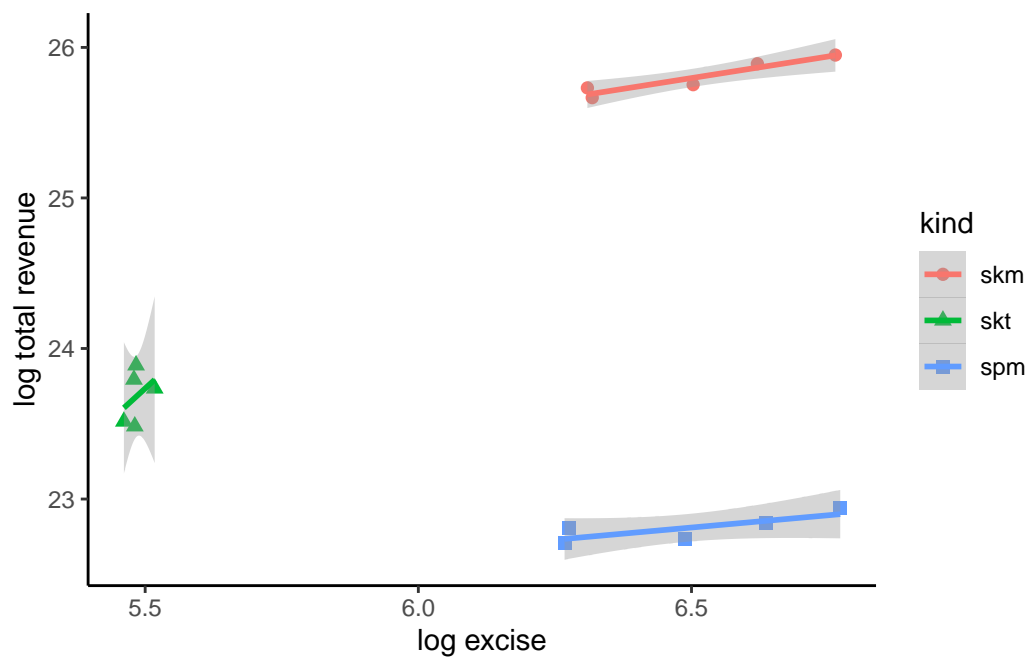


Figure 4.3: wkwkwkwk

## 5 Electric

Unfortunately, analyzing electric cigarettes is heavily constrained by the data. Since 2022 is the only year with a complete observation of production, revenue and prices, we cannot use econometric methods. We can, however, construct a direct derivation of elasticity from a simple algebra.

Assume a demand function as follows:

$$Q_{el} = AP_{el}^{\nu}$$

We can derive the elasticity  $\nu$  by first doing a log-linearization

$$\ln Q_{el} = \nu \ln P_{el} + \ln A$$

While this structure allows for an estimation of  $\nu$  and  $A$  as the intercept, parameterizing both are impossible unless we have more than 1 data point at the very least<sup>1</sup>.

One of a way to estimate  $\nu$  is to use  $A$  from the traditional cigarettes estimation. We use the aggregated traditional cigarettes (since this is also aggregated) which is  $A = 25.75$

which gives us:

$$\ln Q_{el} = \nu \ln P_{el} + 25.75$$

In this form, it is trivial to get

$$\nu = \frac{\ln Q_{el} - 25.75}{\ln P_{el}}$$

We then input the data for  $\ln Q_{el}$  and  $\ln P_{el}$  which will gives us the parameter  $\nu = -0.54$ .

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<sup>1</sup>Obviously the more data point the better. While 2 data points are enough for parameterisation, it is not ideal.



## 6 Limitation & Suggestions

The main limitation is data. With the lack of annual data, we are limited to how much degree of freedom we can utilise. That is, we are limited to how much variable we can use in a single regression. Among the limitations are:

- traditional cigarettes:
  - quarterly HTP:HJE data is useful.
  - production and revenue data is annual. Common denominator principle suggests we can only use annual data.
  - Data is limited to 2018-2022 for a full year of observation.
- electronic cigarettes:
  - excellent monthly production and revenue data. However, monthly data often prone to seasonality and cyclical.
  - HJE and HTP are only available for June 2022 and June 2023.
  - Names of cigs are different between different years.
  - consequence is more severe: only 2022 observation can be used.

Going forward, here are our recommendations regarding data for the DGCE:

- have a robust datasets which can easily be extracted into familiar form.
- Keep collecting monthly data even though some HTP and HJE (or other regulations) do not change.
- We propose a structure which can be extremely useful for future usage.

For further analysis, we can recommend the use of other datasets, such as Susenas or other household surveys. Unfortunately, there is no going around the lack of data. Even if we can utilise other data, we will still need HTP:HJE and annual revenue from the DGCE.

## References

- Prasetyo, Bagus Wahyu, and Vid Adrison. 2020. "Cigarette Prices in a Complex Cigarette Tax System: Empirical Evidence from Indonesia." *Tobacco Control* 29 (6): 618–23. <https://doi.org/10.1136/tobaccocontrol-2018-054872>.