E-CIGARETTES: AN ASSESSMENT OF THE SO-CALLED "GATEWAY EFFECT" BASED ON PRODUCT CLASSIFICATION

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1. Introduction/context

Since electronic cigarettes (e-cigs) have become popular as alternatives to conventional cigarettes (CC), with subsequent market growth amongst adult smokers, there is currently a debate as to whether e-cigs may serve as a gateway to CC smoking or not. Such fears are related to the possibility that prior use of e-cigs could conceivably result in CC smoking initiation amongst never smokers. Although the common definition of a "gateway effect" is based on the concern that current use of a potential low-risk product could facilitate the use of higher-risk products in the future, there is currently no agreed method for assessing the so-called "gateway effect" for e-cig products. This creates a lack of clarity and confusion amongst researchers, politicians, media, vapers and smokers, which often leads to misleading study interpretations and conclusions being drawn with a negative impact on policy and regulatory decisions.

To that end, we propose and describe a framework based on product classification to assess any so-called "gateway effect": 'alternative product', 'transition product', 'substitution product' or 'gateway product'.

Each of these four categories corresponds to a different probability of a consumer switching from a potential low-risk product to a high-risk product, and vice versa, based on the motives for using them. Using an approach such as dynamic population modelling, it is possible to classify e-cigs in one of these four product categories and thereby to assess whether e-cigs are a gateway *to* or a gateway *from* CC smoking. Here we describe this innovative approach.

2. Framework definition

To evaluate the gateway hypothesis for e-cigs, it is necessary to investigate:

1) the probabilities to switch from e-cigs to cigarettes consumption
2) The motivation of people to vape and/or to smoke

Considering these two key points, four different product groups can be defined (Figure 1): **substitution products** and **transition products** that are used by consumers who are motivated to smoke CCs and **alternative products** and **gateway products** that are used by consumers who are not necessary motivated to smoke CCs.
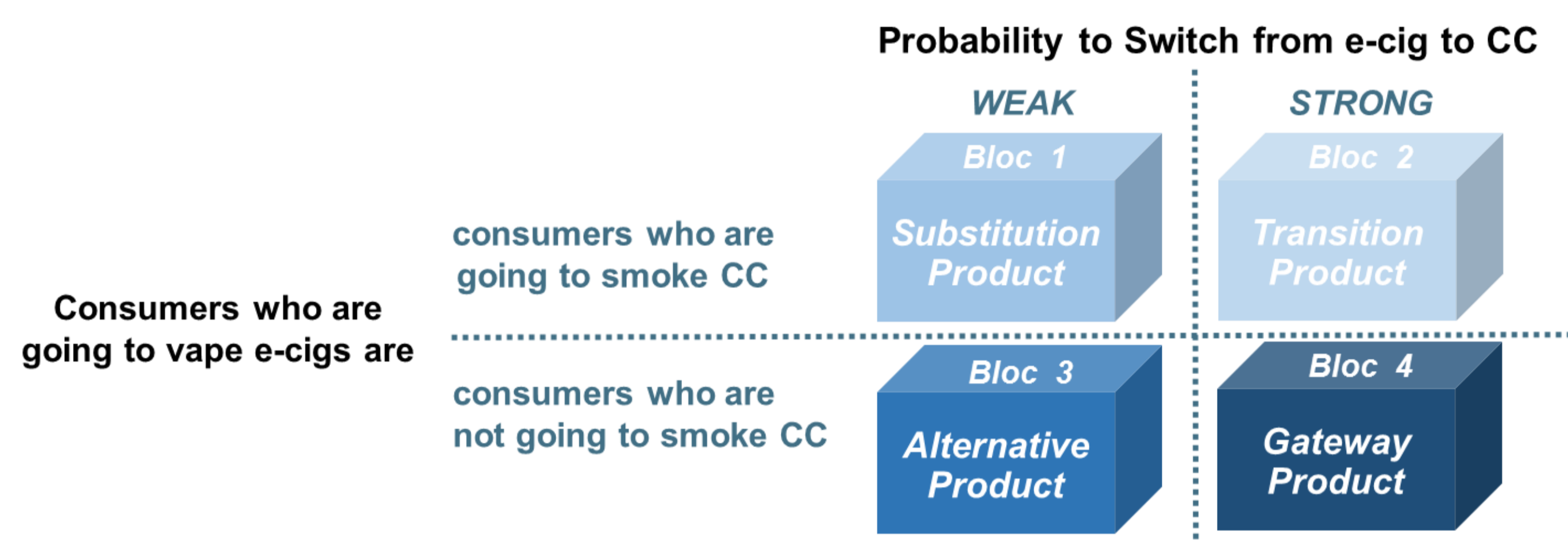

Figure 1. *Product classification based on the switching probabilities.*

3. Framework evaluation

To allocate a product shown in *Figure 1*, appropriate surveys and specific analytical tools such as population modelling are required and need to be considered with and without the presence of e-cigs.

Definitions of all the possible states of the base and current case (see figure 2) related to product consumption have to be established; and the transition probabilities from moving from one state to another have to be estimated according to relevant individual characteristics (for example: age, gender, time in the state, quantity of products used).

Comprehensive and flexible computational models such Dynamic Population Modelling (DPM) should be used to model population behaviours using the transition probabilities estimated above.

Two cases are considered:
- the **base-case** with three states: NS, "never smoker"; S, "current smoker"; and FS, "former smoker" and;
- the **current case** where an e-cig is available on the market.

Additional states include: EU "e-cig user" or DU "dual user"; some states may also change such as FS to FU "former user" and NS to NU "never user".

Figure 2 highlights the important transitions (P1, P2, P3 and P4) to consider in order to allocate a product to a specific category.

Figure 2. *State diagram with transition probabilities with and without e-cig on the market.*
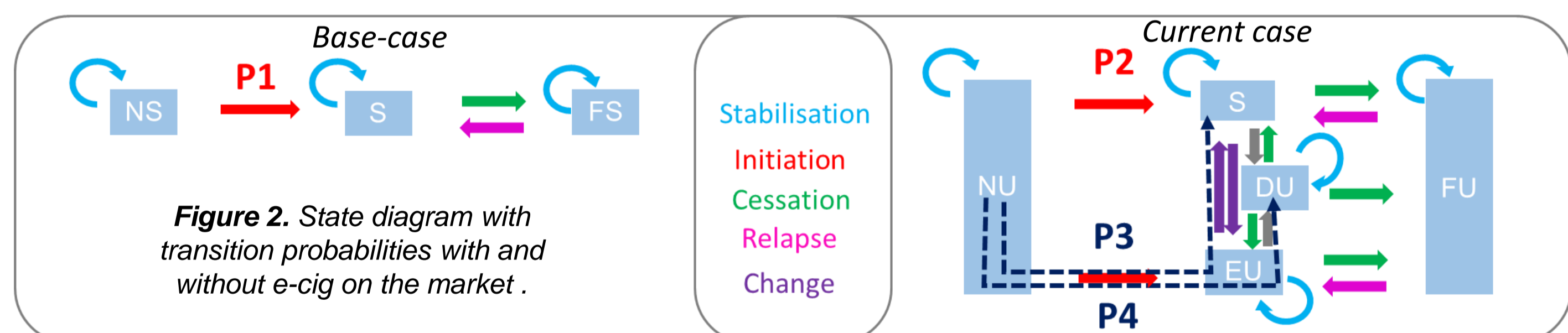
4. Product classification

In the state diagrams, the probabilities P1, P2, P3 and P4 are direct or indirect probabilities of transition from one state to another. These probabilities can integer multiple information such as user history (time spent in the different states), consumption levels, socio-demographic factors (for example: age, education, gender…).

To classify a product according the different probabilities, an indicator P can be evaluated as follow:

$$P = P_{ii} - P_{id}$$

With
$P_{ii} = (P3 + P4)$, the probability to initiate CC smoking indirectly (via an e-cig)
$P_{id} = (P1 - P2)$, the change of probability to initiate CC smoking directly after the introduction of e-cig.

Figure 3 shows the product classification according to the probabilities P_{ii} and P_{id}.

Figure 3.
Product classification according the probabilities of transition from one state to another one.
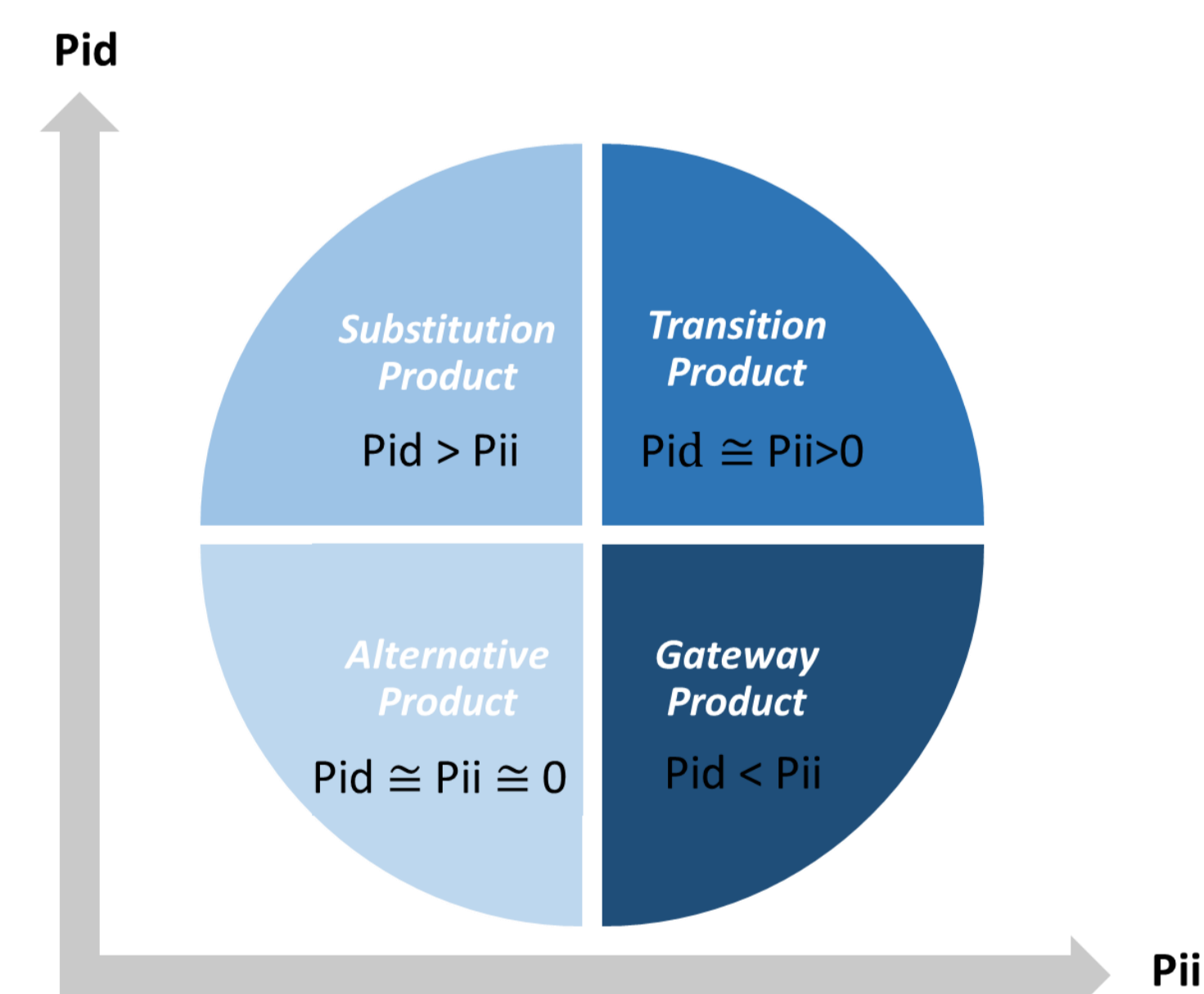
5. Conclusion

The gateway effect is a concept that requires an accurate specific study design and from which data shall be interpreted carefully. The framework proposed here allows product classification in one out of the four described categories: 'alternative product', 'transition product', 'substitution product' or 'gateway product'.

Definitions
States and link between states

Surveys
Transition probabilities data collected on a sample

Computational tools
population behavior simulation

Product classification
P = Pii − Pid estimation

Our next step is to define the states and to set up appropriate questionnaires to estimate the probabilities of transitions according to relevant factors (age, gender, consumption…). In this way, collected data will be used in our computational model in order to estimate the probabilities Pii, Pid and determine the product category.

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