Epidemiological models of heroin epidemics and social outcomes to evaluate Illicit Drug Policy in various countries

Carla Rossi

University of Rome "Tor Vergata" and Centre of Statistical and Social Studies (Ce3S), Italy

Representative of Nonviolent Radical Party Transnational Transparty (NRPTT) to UNODC

Drug Policy in Italy in the last decades (evaluation)

- In all the legal contexts in force in Italy since 1990, the political approach has always been quite prohibitive and repressive and even **ascientific**, as can be seen from data on the consequences related, in particular, to heroin and opiates (supply and demand).

- The second wave of heroin epidemics was observed in recent years, about 25 years after the first intense wave in the late 1980s and early 1990s (https://read.oecd-ilibrary.org/social-issues-migration-health/addressing-problematic-opioid-use-in-oecd-countries_a18286f0-en#page54).

- All this shows that political interventions organized in the sectors prevention, therapy, harm reduction and repression, were not suitable to prevent, for example, the second epidemic wave of heroin, as, however, also in other western countries it is observed.

Methodological tools for forecasting phenomena of interest

- The methodological tools that allow to evaluate "a priori" and forecast the consequences of situations linked to the drug policy are dynamic mathematical models of the epidemiological phenomenon of drug use.

- Such models enable prevalence and incidence to be estimated, scenario analyses to be carried out and trends to be predicted, on the basis of indirect indicators such as therapy presentations, incarcerations, deaths and so forth.

- They have been widely used in the study of the AIDS epidemic and to model epidemics related to the use of psychotropic substances, in particular heroin (first wave) and opiates. There are similarities between the spread of drug use, in particular the spread of use of addictive drugs such as heroin, and that of infectious diseases.

Closed or open population in a dynamic model

- The dynamic models proposed for the problematic use of heroin (or other substances) can be with closed populations or open populations. The former consider a group of subjects, in which new subjects do not enter, demographic inputs are not taken into account;

- they are only suitable for short-term forecasts and represent just the evolution of the use of substances in a single group.

- The open population models take into account the incomes due to births or immigration in the population, so they can be used for, at least, qualitative forecasts even in the medium and long term.
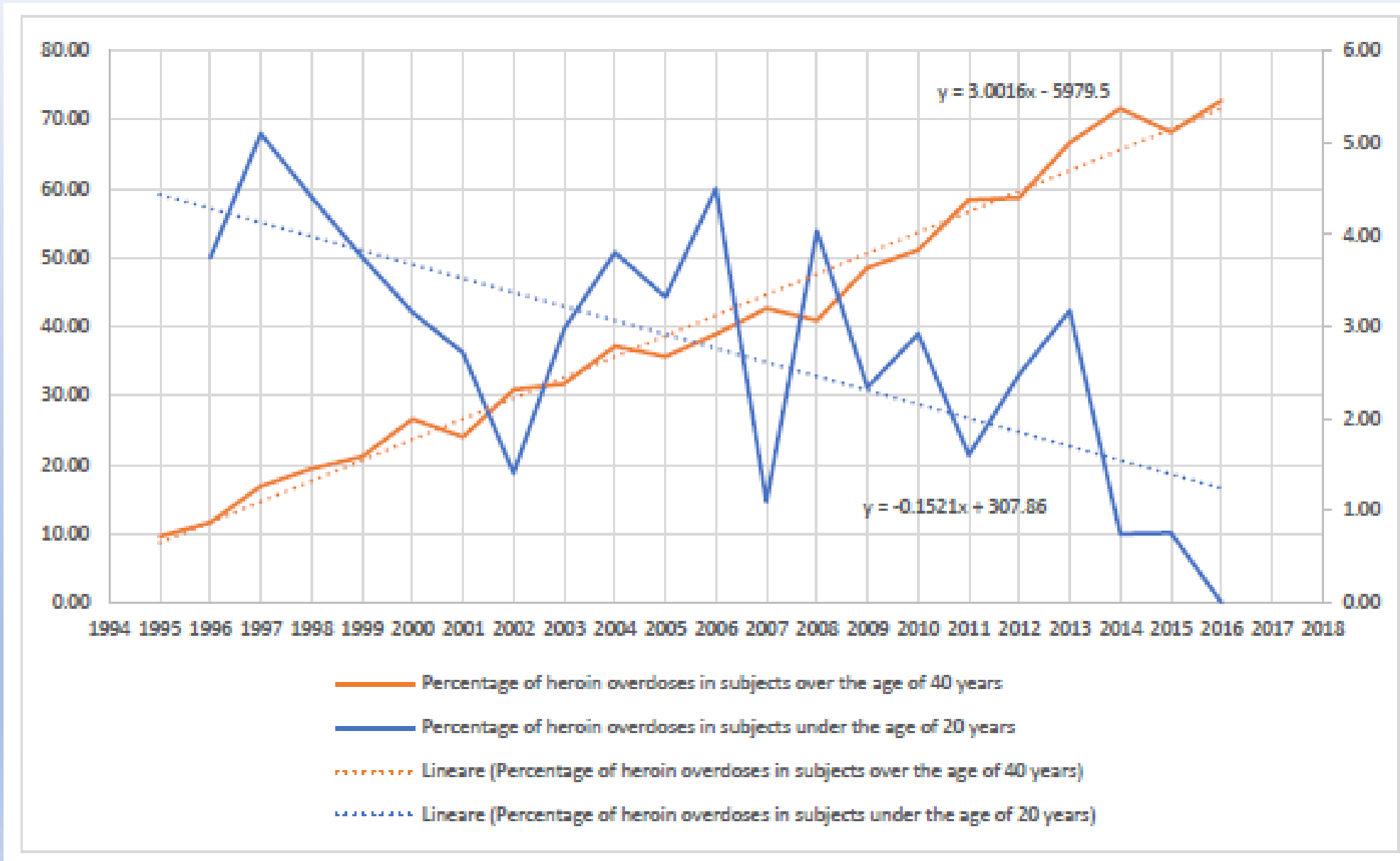
Mover-Stayer models with open populations

- In models with open populations it is important to subdivide subjects, that are not yet users, into two categories:

- those that are not likely to be induced into use (such as subjects vaccinated for infectious diseases) and those that risk being induced to use.

- In formal words the former can be referred to as **"stayers"** and as **"movers"** the latter.

- A model of this type will be used to compare the epidemic trend of heroin use in Italy and endemic in Switzerland and to evaluate policies.

Epidemic phase in Italy and endemic phase in Switzerland

- A Mover-Stayer model with open populations is used to understand why in Switzerland, where the Heroin Assisted Treatment "HAT" is used since 1997 as an usual therapeutic intervention, the second heroin epidemic wave is not in progress. (https://www.academia.edu/13150470/Operational_models_for_epidemics_of_problematic_drug_use_the_Mover_Stayer_approach_to_heterogeneity).

- First let us consider evidences (data on the deaths of young subjects) allowing to distinguish that presently the endemic phase in Switzerland and the epidemic phase in Italy are in progress.

Opioids (also heroin) overdoses in Switzerland (age distribution %)

$y = 3.0016x - 5979.5$

$y = -0.1521x + 307.86$

Percentage of heroin overdoses in subjects over the age of 40 years

Percentage of heroin overdoses in subjects under the age of 20 years

Lineare (Percentage of heroin overdoses in subjects over the age of 40 years)

Lineare (Percentage of heroin overdoses in subjects under the age of 20 years)

Comparison of opioids overdoses in subjects aged less than 20 in Italy and Switzerland
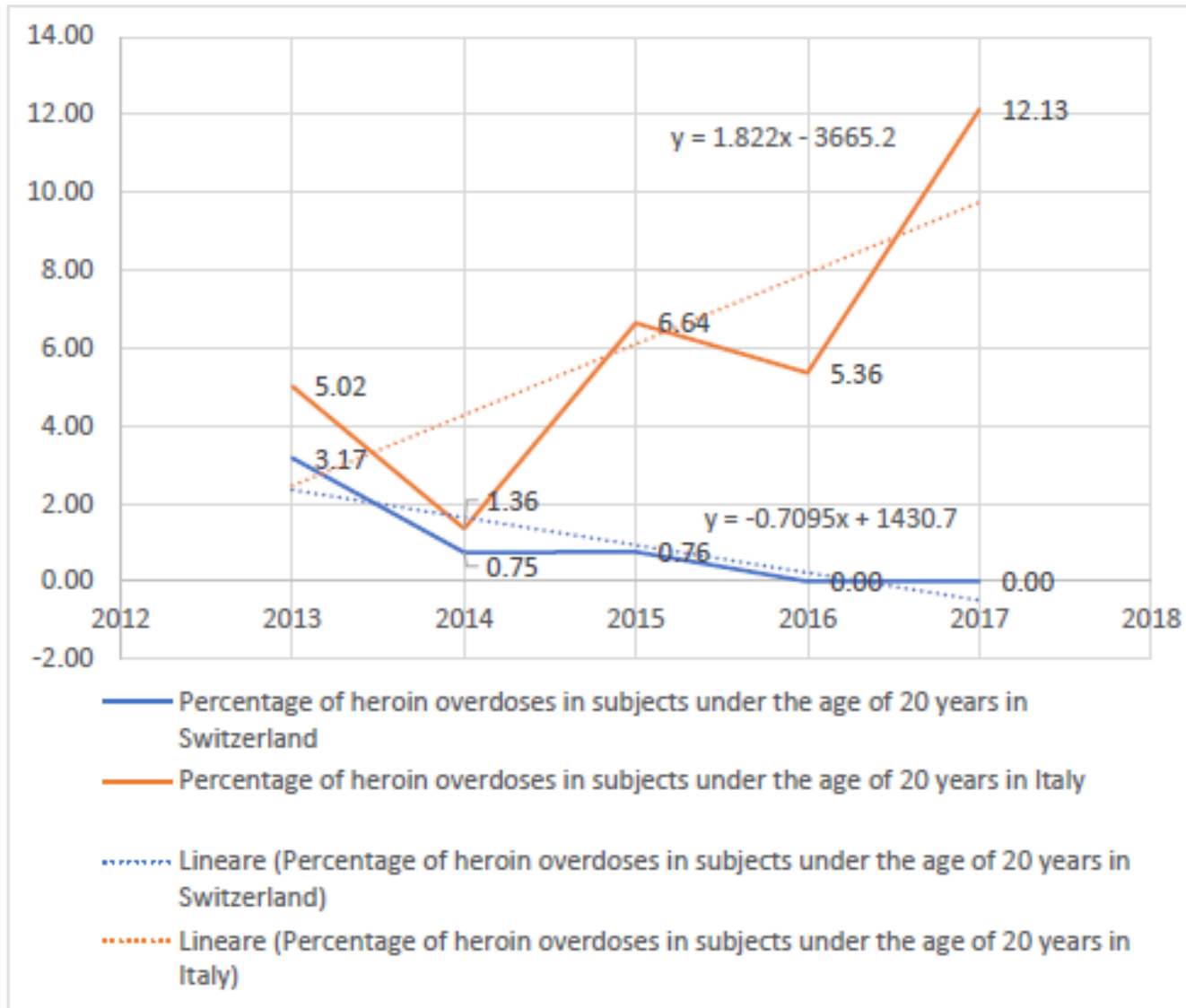
Similar comparisons could be made on the second epidemic wave of heroin and indicator of deaths with Canada, USA or other Western countries such as the UK or the Netherlands instead of Italy. (http://www.ce3s.eu/wp-content/uploads/2019/04/Seconda-epidemia-eroina-rapporto.pdf)

Now let's consider the MS model

Compartments and State variables

Exposed population «Susceptibles», of which a fraction S is not at risk ("stayers") and the other fraction 1-S is at risk ("movers"). State variable: **X.** Entrances and exits linked to the natural movement of the population.
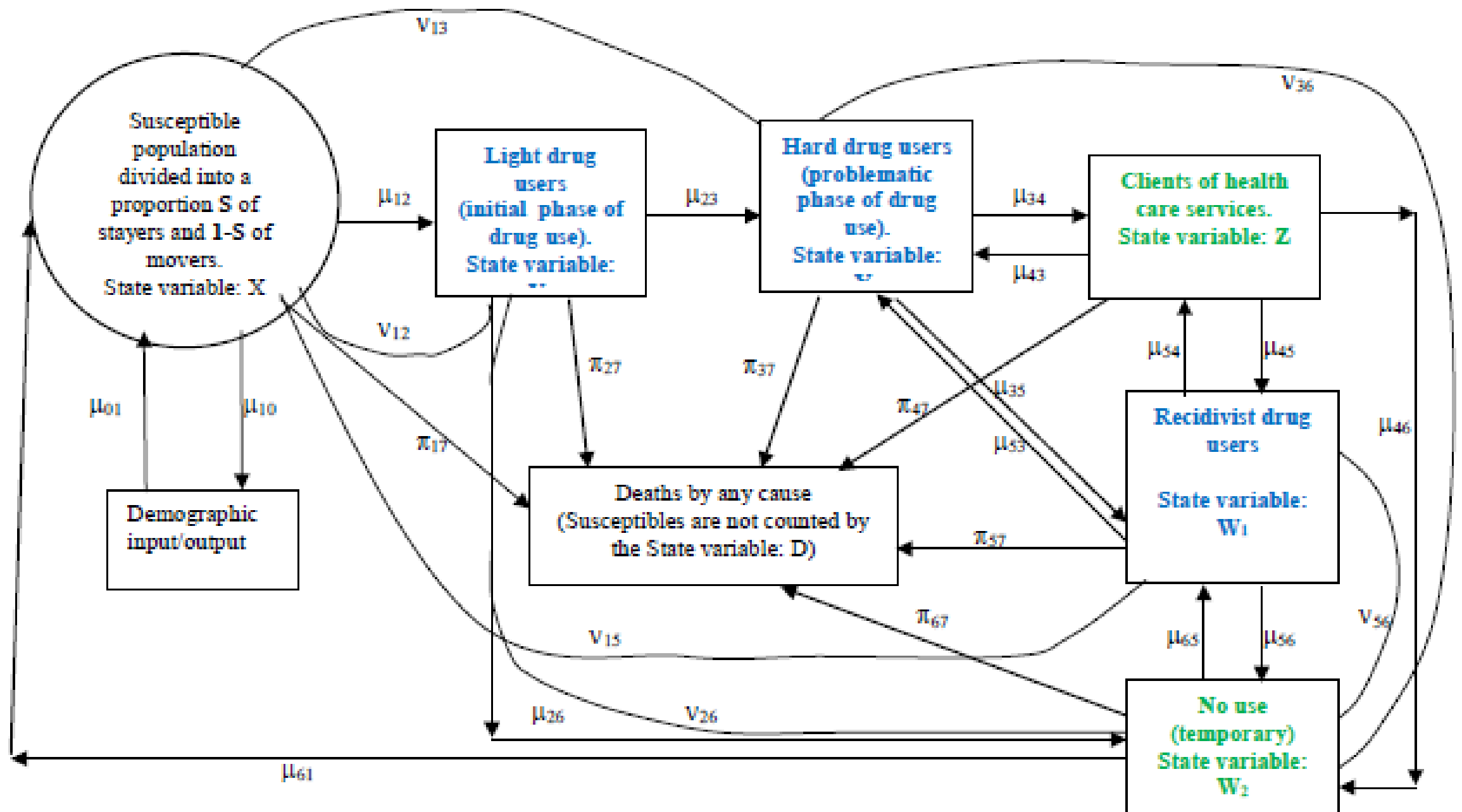
«Light" drug users (at an early stage). State variable: $\mathbf{Y_1}$

«Hard" drug users (in the problem phase). State variable: $\mathbf{Y_2}$

Drug-related health service users. State variable: **Z**

«Recidivist" drug users. State variable: $\mathbf{W_1}$

«Ex» drug users (in temporary non-use phase). State variable: $\mathbf{W_2}$

Deceased subjects, for whatever reason. State variable: **D**

Connections between compartments

- The arrows in the graph completely describe all the possible transitions of a drug user career. Linear equations of the model.

- The curves connecting the drug use (infectives) compartments and the susceptible (or temporary no-use) compartments represent the possible interactions between drug users and susceptibles, bi-linear terms in the equations of the model.

- Such interactions may cause infections, that is, transitions from susceptibles (or temporary no-use) to drug use compartments.

- Effective political actions modify the value of the parameters and necessarily reduce the values of the state variables relating to the infectious compartments.

State variables and epidemic/endemic phases, using the model

- It is possible to define the epidemic coefficient $\rho(t)$ and show that if $\rho(t)>0$ the phase is epidemic while if $\rho(t)<0$ the phase is endemic.

- The mathematical formula of $\rho(t)$ shows that the lower the value of the variables Y_1, Y_2 and W_1, and the greater Z and X, the greater is the probability of $\rho(t)<0$ and therefore the epidemic can be decreasing and the endemic phase in progress.

- Let us now consider, using some scientific publications on the evaluation of HAT, the behaviours of the variables Y_1, Y_2, Z and W_1 in Switzerland (HAT available everywhere) with respect to Italy where HAT has never been used even experimentally.

Significant scientific evidence 1

….in particular, there is a great advantage in **retention in treatment,** which is a fundamental aspect to reduce mortality, improve the socio-health status, reduce contact with crime and facilitate the start of use reduction, as appears in Ferri et al. (2011). (Ferri M, Davoli M, Perucci CA. Heroin maintenance for chronic heroin-dependent individuals. *Cochrane Database of Systematic Reviews* 2011, Issue 12.).

This imply the increase of Z, due to the decrease of the parameter μ_{45} and then the decrease of W_1 and Y_1, Y_2 and then high probability of $\rho(t)<0$.

Significant scientific evidence 2

In Switzerland the use of heroin is considered as a disease that must be treated by a doctor, and it is not seen as a criminal act and the problem is no longer new consumers, but long-term consumers.
(https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(06)68804-1/fulltext)

Confirmed by the overdose data already shown

Effectiveness of HAT to reduce the value of ρ(t) ➡ ρ(t)<0

- All the scientific studies available for the evaluation of HAT interventions (very many indeed) show that:

- Y_1 subjects are reduced causing lower incidence of heroin use and growth of the variable X (...evidence 2),

- Y_2 subjects are reduced as there is a greater afference of Y_2 subjects in therapy (due to the increase of parameter μ_{34}) causing growth of the variables Z and X (...evidence 1),

- W_1 subjects are reduced too as there is a greater retention of subjects in therapy (decrease of parameter μ_{45}), causing growth of the variables Z and X (...evidence 1).

Conclusions: antiprohibitionism on therapies is necessary

- What can be concluded is that, despite the extensive scientific evidence on the effectiveness of HAT, it is not generally applied in any country, apart from local experiments, and this shows the **ascientific** approach of governments to the study and control of problematic heroin use, except the Swiss ones.

- This also shows why in all Western countries there is a worrying second epidemic wave of heroin use except in Switzerland where the endemic phase is going on.

- **Antiprohibitionism**, at least on therapies, must be more widespread in the world as also requested officially by 334 NGO (https://idpc.net/alerts/2019/04/ngos-call-on-world-leaders-to-address-global-health-and-human-rights-crisis).

Thanks for your attention