# Econometrics II - Tutorial 4

Karolin Süß

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## Exercise 1: DiD - Paper discussion

### Research Question

The authors' main goal is to assess the effectiveness of enforcement efforts aimed at reducing the consumption of Methamphetamine in the US. More specifically, they want to size up the impact of state restrictions on three aspects: First, the sales of retail cold medicines used to produce Methamphetamine on the production; second, the consumption of it, and third, drug related arrests.
The authors investigate the effects on both the supply and the demand side. Since it is the legislation's ultimate goal to reduce drug consumption, we believe that the focus should be shifted rather towards the consumers. The investigation on the consumer side is restricted on one type of drugs. Thereby, the analysis fails to acknowledge consumers' substitution towards similar drugs (e.g. ecstasy). On top of that, it would be interesting to shed more light on the interaction between on supply and demand side effects.

### Contribution

It is proclaimed that the paper contributes to the literature by offering more credible estimates analysing the success of a smaller, but more typical enforcement effort. This accounts for the problem that evaluating large enforcement efforts might not be a good predictor of the effects induced by typical enforcement efforts. Thus, analysing smaller enforcement efforts yields higher external validity. The authors claim that the combination of specific regulation and its well-defined and known implementation as well as rich administrative data sets is essential for the contribution of this paper.
It is clear that - so far - there exists no consensus in the literature regarding the effec-

tiveness of enforcement efforts in reducing drug use. Thus, the paper contributes to the existing literature by providing empirical evidence from a different angle.

## Aim of the Analyzed Policy

The aim of the analyzed policy is the reduction of Methamphetamine use by addressing the channel of drug production. In particular, the policy consists of the following measures:

- Sales limits and product placement
- Implementation of purchasing quotas, Placement in secure areas (35 states)
- Inspection of ID
- Implementation of logbook (24 states)

## Meth(odology)

The method of Difference-in-differences (DiD) is applied in order to reliably identify causal effects by ruling out endogeneity of regressors. The causal effect is measured relative to a control group which has not received the treatment yet. This helps to control for factors that are correlated with the treatment dummy as well as the error term. Time and state fixed effects further capture omitted variables.
Event studies constitute an important tool checking for non-linear trends relative to the implementation of the law. Adding linear state-specific time trends and further controls is useful to evaluate whether the identification assumptions for DiD are fulfilled.
There is no control group, as every state implements a law at some point. Hence the classical DiD design is not feasible here. This can be seen as a threat to validity. Some patterns observed across all states might be caused by common time trends instead of the treatment variable.
Furthermore, one might suspect some form of endogeneity since states facing larger problems with methamphetamine consumption are expected to implement the legislation rather sooner than later. Hence, the treatment is not randomly assigned between states.
Furthermore, the design does not account for heterogeneity across states regarding the total production of methamphetamine. They only deliver an ATE but not a LATE or MTE conditional on the pre-treatment methamphetamine production, which might be more insightful.

## Identifying Variation

The identifying variation is the variation in the timing of states' implementation of the OTC regulations. Without this variation, the time fixed effects would absorb the event-time dummies entirely, making identification impossible.

## Key Identifying Assumption

The Key Identifying Assumption in DiD models in general is the common trend assumption. As they control for state specific linear and quadratic time trends, the key identifying assumption only requires that there are no unmeasured non-linear and non-quadratic state specific trends correlated with the enactment of the regulations. This is hard to test but seems plausible by the authors' explanation.

## Data

Administrative data from various sources:

- Data for methamphetamine production:
  - NCLSS: Seized/Discovered labs
  - STRIDE: purity and price of methamphetamine
- Data for methamphetamine consumption:
  - HCUP: positive drug tests (workers)
    *Only from Jan 2000 - Apr 2006*
  - HCUP (NIS - Nationwide Inpatient Samples): positive drug tests (hospital admissions)
    *From Jan 2000 - Dec 2007*
- Data on drug-related arrests
  - UCR: arrests for possession and sale of illegal drugs
    *From Jan 2000 - Dec 2007; Reporting voluntary*

Without naming any reasons, the dataset is restricted to the time period from 2000 to 2007. The dataset is not very homogeneous over the time dimension as it is a combination from various sources. Furthermore, it is lacking information on how many drug stores / pharmacies actually comply with the new regulation (and in return does not reveal the number of never-takers). After all, Missouri enacted similar restrictions already in 2003 but this is not included in the dataset.

## Results/Findings

Aim of the policy is achieved judging by figures 2 & 3. The suppliers of methamphetamine seem to have taken a hit.
Methamphetamine production

- Production capacity: The estimation results suggest that the laws caused a 36% reduction in the number of methamphetamine laboratories, with the largest decline among labs with capacity between 2-8 oz (54%). Furthermore, it hints that the enforcement efforts lead to a decline of 25% in the domestic production of methamphetamine.
- Purity and price: There is a large drop in purity in 2005, but also changes in purity before the enactment of the law. There is no change in the nominal price.

Methamphetamine consumption

- No significant impact of regulations on drug test outcomes for workers and inpatients.

Drug related arrests

- There is no evidence that restrictions reduced drug related arrests.

Spatial spillovers

- Evidence that there exist spillover effects reducing the regulation's impact on production when the neighbouring state did not implement the law. When the neighbouring state implements the law, this effect vanishes and the reduction of methamphetamine production converges to the level of non-border counties.

Regression table 1 shows that the coefficient of interest does not change considerably over the different specifications. The high robustness of the results supports the identification assumption.

## Interpretation of the Results/Implications/Policy Relevance

The implications of the paper are twofold: On the one hand, enforcement efforts do significantly reduce the supply of methamphetamine. On the other hand, they do not have an impact on the market equilibrium regarding price and quality, suggesting that there are no effects on consumption. To draw policy conclusions, as mentioned earlier, it would be crucial to understand why the observed reduction in the supply of methamphetamine is not reflected in a decrease in consumption. It would be necessary to shed more light on the interaction between effects on the supply and the demand side. Fur-

ther, when drawing implications for policy makers, some limitations of the paper should be considered (see next point).

### Limitations of the Paper

One clear shortcoming is that the paper only analyses data for the discovered labs. The findings are based on the assumption that the probability of the lab being seized remains constant after the introduction of the law. Thereby, incentives of the police to lower investigation efforts are not considered. Furthermore, it is imaginable that that there is a development towards more professional producers being able to better hide their activities.
Moreover, the general problem might not be solved as producers substitute to other drugs that they offer to their costumers.
There are further limitations regarding the consumer side results. The rate of consumers with positive test results is not necessarily linearly dependent of aggregated consumption. A consumer for example can reduce her consumption by one half but still has a positive test result. Noticeably, it is difficult to detect whether consumers have switched to other drugs since common tests can not reliably distinguish between different drugs. Furthermore, substitution to other drugs or changes in the amount consumed can lead to the same observed prices and purity measures although methamphetamine production has decreased.
Moreover, the policy implications do not apply to all kinds of drugs. Some drugs are mainly produced outside the US.
Finally, the results on drug use might be driven by self selection in the measurement of methamphetamine consumption: It is likely that only those patients and workers with a record of drug use will be subject to methamphetamine tests.

## Exercise 2: DiD - practical application

### a.

Figure 1: Replication of Figure 2 of Dobnik et al. (2014)

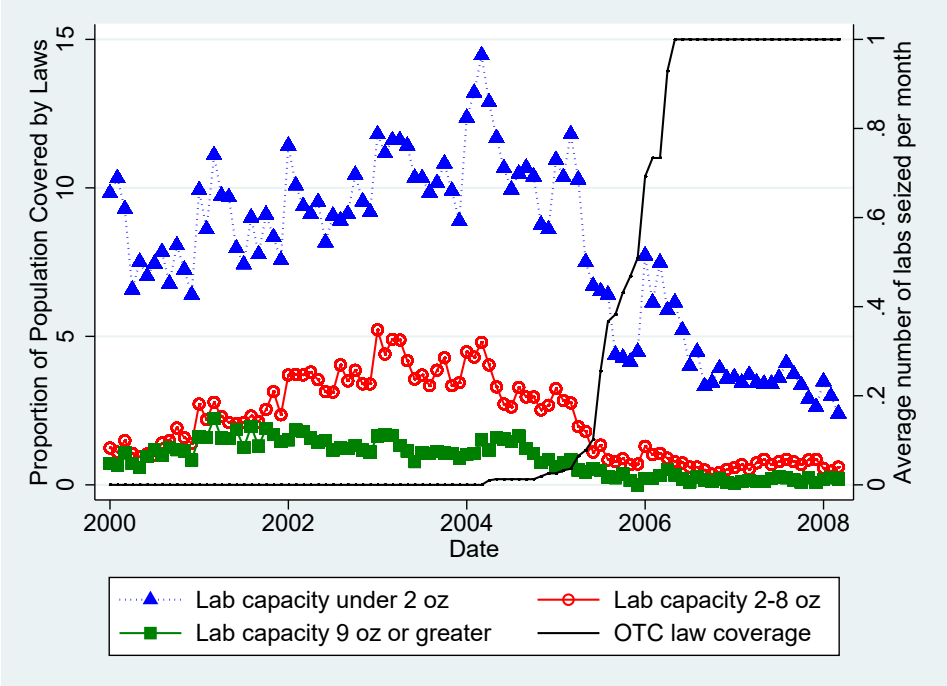
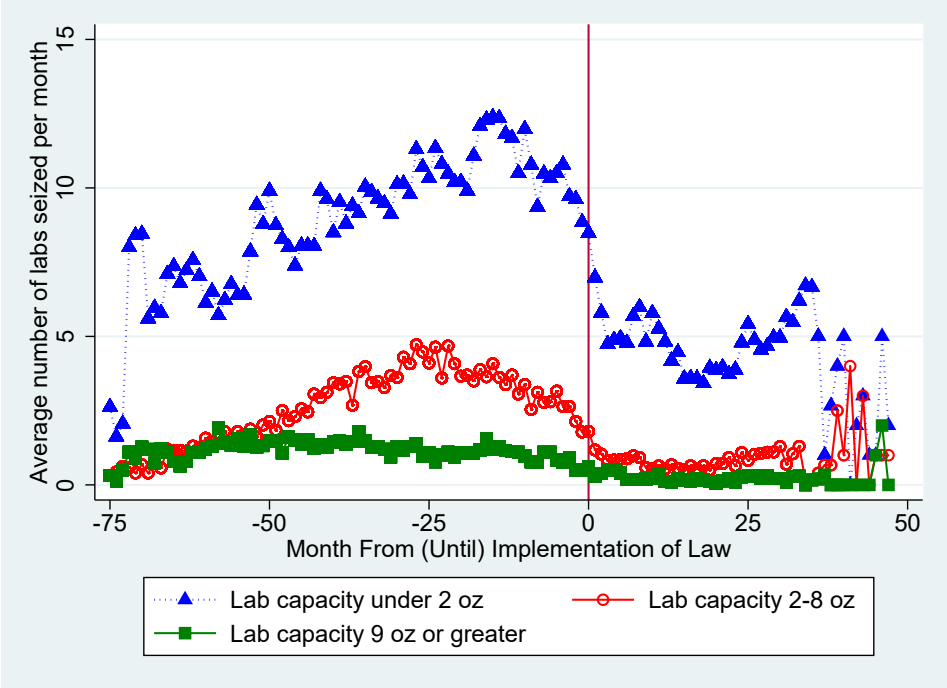



Figure 1 reveals a clearly negative relationship between the number of labs seized per month and the proportion of population covered by the law. The decrease in the average number of labs seized per month is the largest the smaller the lab capacity (in absolute terms). The plot suggests that the introduction of the law was effective in reducing the average number of labs seized. However, further regression analysis is necessary in order to identify causal links.

The figure also includes observations from 2000-2002. These observations were dropped in the paper. We can see that the number of labs of a medium size increases in this period. Taking only the graph into account, this makes is more questionable whether the decrease in labs seized after 2005 can be attributed to law restrictions or other reasons.

**b.**

Figure 2: Average number of labs discovered in event time by lab size




The figure depicts a decline in the number of labs seized by the police starting just before the implementation of the law in the respective state. However, the number of labs starts increasing again around 24 month after the law was implemented. This period was left out in the paper as well. For the period of 33 month after the implementation of the law we only have observations for 1-10 states. The drop in observations explains the volatility from month 33 onward.

**c.**

To calculate the standard errors, we cluster on the state level because it is likely that the timing of the treatment depends on the state (for example due to institutional patterns). The estimated coefficients are close to the ones found in the paper (see Regression Table 1, specification 1). They slightly differ because we include the whole time sample and further do not have data for Florida. The results coincide with what we see on the plots: There is a negative effect of the law on the number of labs seized which is the more negative the smaller the lab size. The DiD regression results indicate a persistent

Table 1: Effect of law on number of discovered labs

| | (1) cap_under_2_oz | (2) cap_2_8_oz | (3) cap_over_9_oz | (4) tot_labs |
|---|---|---|---|---|
| OTC | -4.0207** | -2.1273*** | -0.2736 | -6.4216*** |
| | (1.1699) | (0.5116) | (0.3136) | (1.8172) |
| Constant | 9.7007*** | 1.2096* | 0.6994*** | 11.6097*** |
| | (1.8686) | (0.4652) | (0.1180) | (2.0354) |
| $N$ | 4937 | 4937 | 4937 | 4937 |
| adj. $R^2$ | 0.1243 | 0.1779 | 0.0557 | 0.1690 |

Robust standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

effect which is also depicted by the graphs. Otherwise the coefficients would not be significantly different from zero.

**d.**

- DiD common trend assumption: Consistency of the estimated regression requires that there are no state specific trends that are correlated with the OTC variable. Common trends are covered by the time fixed effects. Regression Table 1 reveals that the inclusion of a state specific linear and quadratic trend leads to estimates slightly closer to zero. Given that the coefficients do not change considerably, we expect the assumption to hold more or less. To detect whether the inclusion changes the coefficient one would need to perform a Wald test.

- Fixed effects assumption: Consistency of the estimated regression requires that state and time fixed effects are not correlated with the error term.

- DiD assumption no effect prior to the treatment (DiD.3): This assumption is questionable since some states implemented the law at a later point in time than other states which presumably implies anticipation effects.

- DiD.1,DiD.2 and DiD.5 hold.

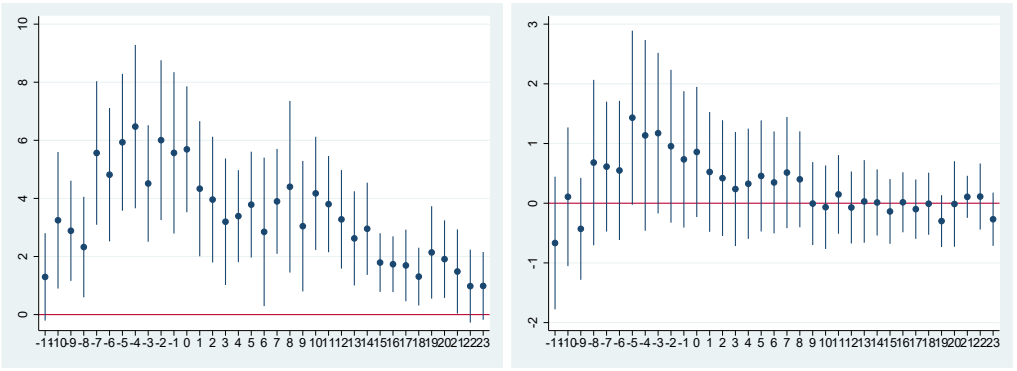
**e.**

Equation 1 of the paper restricts the treatment effect to be constant over time. $\beta$ estimates the average treatment effect across time and state. Equation 2 allows for

variation of the treatment effect over time but still not across states. This is more flexible and provides interesting insights into the temporary evolution.

**f.**

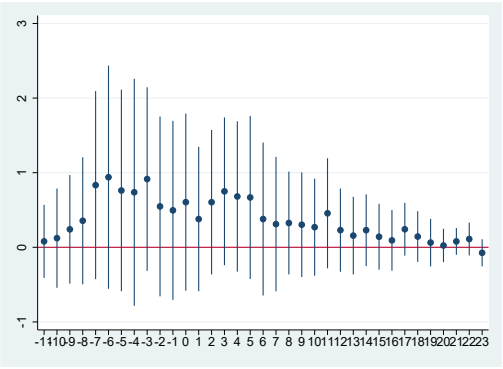
Figure 3: Estimates of event time dummies



(a) Lab capacity under 2 oz



(b) Lab capacity 2-7 oz



(c) Lab capacity 9 oz or greater

The dynamics for small labs look similar to the previous findings. The number of small labs reduces considerably over time, as the coefficient on the event-time dummies is always positive. The effect is not so clear regarding medium-size and large labs. Here the effect is not significantly different from zero for any period. Furthermore, for medium-size labs the effect is closer to zero than for large labs. This differs to the previous fixed effect regression in table 1. There we obtain a larger effect for medium-size labs than for larger ones.