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Research paper

Drug decriminalization and the price of illicit drugs☆

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ABSTRACT

Background: This study is an empirical assessment of the impact of the drug decriminalization policy followed by Portugal in July 2001, on the price of illicit drugs.
Methods: The analysis is performed using a difference-in-differences approach and the Synthetic Control Method in order to construct a synthetic control unit from a convex combination of countries.
Results: The results suggest that the prices of opiates and cocaine in the post-treatment period did not decrease in the sequence of the policy change.
Conclusion: We conclude that the drug decriminalization policy seems to have caused no harm through lower illicit drugs prices, which would lead to higher drug usage and dependence.

> One moderate alternative to the war on drugs is to follow Portugal's lead and decriminalize all drug use while maintaining the illegality of drug trafficking.
>
> by Gary S. Becker and Kevin M. Murphy (2013)

Introduction

The United Nations Office on Drug and Crime (UNODC) estimates that in 2009 between 172 million and 250 million people used illicit drugs and between 18 million and 38 million were drug dependent, worldwide. In fact, drug use and dependence is a major threat to global health, representing one of the top ten risk factors in the developed countries. The risk of contracting infectious diseases such as HIV, AIDS, Hepatitis, and Tuberculosis is higher for drug users than for nonusers.

The relevance of the social and economic costs implied by drug use and dependence contributes to the current hot debate on drug policy in many countries such as the United Kingdom, Australia, and the United States. Policymakers and economists have been discussing a comprehensive response to drug use and trafficking for decades but the solution is far from being unanimous. Furthermore, policymakers have been reluctant to reform drug laws.

The alternative law enforcement schemes that have been at the center of the debate are the illicit drugs legalization, decriminalization, and depenalization. Those terms are often misused. According to the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA), "decriminalization" comprises removal of a conduct or activity from the sphere of criminal law. Prohibition remains the rule, but sanctions for use (and its preparatory acts) no longer fall within the framework of the criminal law; "depenalization" means relation of the penal sanction provided for by the law. In the case of drugs, and cannabis in particular, depenalization generally signifies the elimination of custodial penalties.[1] This means that under the decriminalization framework, drug use and possession are still illegal but infractions to these prohibitions are to be treated in a noncriminal framework rather than through the criminal justice system. In contrast, in the depenalization framework, imprisonment is no longer imposed for drug usage and possession even though these remain a criminal offense, as other criminal sanctions such as police record, probation, or fines are still available. In this paper legalization is defined as the amendment of law to eliminate any sanction, criminal or administrative, associated with the possession, use, or distribution of any controlled drugs.

In the late 1980s and 1990s a growing population of intravenous heroin users became a major threat to public health in Portugal, where rates of heroin users were among the highest in Europe. During this period, the number of HIV infections and drug related deaths rose dramatically. In the mid'90s Portugal engaged

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[1] European Monitoring Centre for Drugs and Drug Addiction, "Illicit drug use in the EU: Legislative Approaches", 2005.

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in an intensive debate on alternative enforcement policies to deal with drug use and, in 1998, a panel of leading scholars and medical professionals presented a report with recommendations rooted in understanding drug dependency as a disease rather than a crime, proposing prevention, treatment, and reintegration programs as an alternative to prison. The recommendations of this panel of experts led to the adoption of the National Strategy for the Fight Against Drugs (NSFAD) in 1999 and encompass a new legal framework with the end of criminal sanctions for drugs users, the enforcement of law to reduce drug production and trafficking, and the expansion of policies and resources for the reintegration of drug users and treatment.[2]

This process culminated with the approval of the law decriminalizing the personal use and possession of illicit drugs on July 1, 2001 (Law 30/2000).[3] The new law applies to the use, possession, or acquisition of all drugs, including "hard" drugs, in quantities up to a ten day supply.[4] This policy change was also intended to reduce demand by promoting a health-driven drug policy and eliminating the stigma related to the criminal prosecution of drug users. In the Portuguese decriminalization framework, police can no longer arrest drug users but must refer them to the local Commissions for the Dissuasion of Drug Use (*Comissões para a Dissuasão da Toxicodependência*) (CDT) that decide the administrative or public order sanction to apply.[5] Severe criminal penalties are still applied to drug traffickers.

The discussion on the alternative legislative approaches to deal with the illicit drug economy presumes that drug decriminalization leads to an increase in the prevalence of drug use. However, the impact of the drug decriminalization policy on drug markets is not clear. Critics advocate that decriminalization leads to a perception of acceptability of illicit drug use and lowers costs of drug use as drug users face no criminal sanctions. In this case, if the supply side remains constant, meaning that traffickers and sellers face the same risks associated with drug trafficking, this would lead to higher prices.[6] On the supply side, and to the extent that demand remains constant, an effective enforcement of the drug law with the objective of fighting production and sale of drugs would also lead prices to increase. In the Portuguese case, the NSFAD comprised both the end of criminal sanctions for drug use and increased resources to fight drug trafficking. Therefore, the impact of the drug decriminalization policy on the market equilibrium depends both on demand and supply effects.

In this paper we shed further light on the impact of drug decriminalization on the illicit drug market by studying its impact on the price of illicit drugs. A primary reason to focus on the impact of the policy change on the price of drugs is the presumed effect of prices on use and consumption. From an economic viewpoint, the study of prices may provide insights on the impact of the drug decriminalization policy as a market clearing equilibrium results from the combination of prices and quantities. In fact, availability and prices of illicit drugs are often pointed as the main determinants of drug consumption.

The fear of increased usage and dependence due to softer law enforcement has been a critical argument in the discussion, but these concerns are to a large extent speculative as no unambiguous empirical evidence on the impacts of decriminalization on drug markets can be found in the literature. The current paper examines the dynamics of the illicit drugs market, focusing on the supply side of the market. To evaluate the impact of the policy change on prices we follow two empirical research routes. The first, is a standard difference-in-differences analysis which accommodates the presence of observed and unobserved heterogeneity and time effects. The second approach is the application of the Synthetic Control Method, which has the advantage of providing a systematic way of constructing a comparison group that best resembles the characteristics of the treated unit.

The results suggest that (retail) prices of cocaine and opiates did not decrease following the drug decriminalization policy which is in contradiction with the commonly held belief that softer drug law enforcement necessarily leads to lower prices. Empirical evidence regarding the Portuguese case suggests that the demand effect did not materialize in the post-decriminalization period and, therefore, this failure of prices to decrease may be explained by the boost in resources available to fight drug trafficking.

This paper is organized as follows: the second section presents related literature. The third section describes the data and the empirical methodology and discusses the results. The final section provides the conclusions.

Related literature

The discussion of policy toward illicit drugs commonly uses the metaphor of markets to explain the dynamics of use. Even though prices play a crucial role in the metaphor they have been overlooked in the empirical analysis and data collection. In fact, prices constitute a prominent indicator for understanding the effects of a policy change such as drug decriminalization. The sharp decline of the retail prices of hard drugs like cocaine and heroin in the last 20 years (see Costa Storti & De Grauwe, 2009a, 2009b) highlights the importance of studying the mechanisms beyond public policies aimed at reducing the supply of illicit drugs.

Becker and Murphy (1988) present a model of rational addiction which implies that the consumption of addictive substances is likely to respond considerably to prices. Over the last decades some studies have focused on the price elasticity of demand of addictive licit substances, namely alcohol and tobacco. Becker, Grossman, and Murphy (1994) find substantial elasticity of demand for cigarettes in the short and long run (−0.4 and between −0.7 and −0.8, respectively). Similar elasticities of demand for alcohol are reported by Coate and Grossman (1988).

Subsequently, this research was extended to the illicit drugs market. Economists have been focused on the price sensitivity of drug use, often using the prevalence as dependent variable. van Ours (1995) uses data from the early twentieth century and estimates noticeable short- and long-run elasticities of demand for pre-World War II opium consumption in the Dutch East Indies (−0.7 and −1.0, respectively). Caulkins (1995) finds an elasticity of demand for cocaine between −1.5 and −2.0 for a very specific group of people, the arrestees. Saffer and Chaloupka (1999) find a price elasticity for the prevalence of heroin of −0.9 and for the prevalence of cocaine of −0.55. Grossman and Chaloupka (1998) find that cocaine consumption by American youth is very responsive to changes in its price. Also, the different legal approach to alcohol and marijuana is likely to explain different cocaine consumption among the U.S. states.

DiNardo (1993) investigates the relationship between law enforcement and the price of cocaine using U.S. data from the System to Retrieve Information from Drug Evidence (STRIDE)

[2] The NSFAD comprises a set of measures which includes the extension of the healthcare services network and the needles exchange programme, the increase in scientific research and specialist training, and the significant increase in the financial budget to deal with the drug problem.

[3] Until this legislative change, the use, possession, or production of illicit drugs for personal use were criminally punishable by up to 1 year in prison or a fine, even though drug users rarely faced criminal sanctions, in practice.

[4] According to Decreto-Lei no. 15/93, January 22, 1993 and Portaria no. 94/96, March 26, 1996, this amounts to 0.1 g heroin, 0.1 g ecstasy, 0.1 g amphetamines, 0.2 g cocaine or 2.5 g cannabis.

[5] Those commissions are three-member panels comprising social workers, lawyers, and medical professionals.

[6] An anonymous referee points to the complex dynamic nature of demand and supply as softer law enforcement on the demand side may lead supply to increase as a result of increased demand and, consequently, prices may fall.

collected by the Drug Enforcement Agency (DEA) and finds no significant evidence supporting the hypothesis that increased law enforcement is associated with higher prices and, therefore, with lower consumption of illegal drugs. Poret (2003) constructs a model of a vertically organized distribution of illicit drugs to show that the results of stronger law enforcement can be opposite to the desired ones, namely, the decrease in consumption of illicit drugs. This model helps to explain the failure of the "war on drugs" declared in the U.S. in the 1980s as the tougher law enforcement was not associated with either reduced supply or lower prices. According to Reuter (1997), "this failure of cocaine and heroin prices to rise with tougher enforcement is a major analytic and policy puzzle". Relatedly, Miron (2003) points the price decrease in the U.S. following the considerable increase in enforcement as inconsistent with the theory that increased enforcement should add costs and, therefore, increase prices. Caulkins and Reuter (1998) study the relation between drug policy and drug prices and find conflicting evidence with respect to the ability of policy to influence prices. Caulkins and Reuter (2010) examine how drug enforcement affects the price of drugs drawing on the risks and prices model presented in Reuter and Kleiman (1986). The risks and prices theory investigates how enforcement relates to prices by imposing costs on drug suppliers (namely, compensation for the risks of arrest). Under the static equilibrium model, decreased law enforcement in the supply side is associated with greater availability of drugs and reduced prices, which leads to higher illicit drugs use. However, within the dynamic model that allows for disequilibrium as a market moves toward a new long-run equilibrium, prices may fall and usage rates may increase even if enforcement is not softened.

Concerning the Portuguese decriminalization of illicit drugs, Hughes and Stevens (2010) advocate that it did not lead to higher drug use but did help to reduce the number of drug-related injuries, drug usage, and the criminal justice burden and costs. International comparisons show that the Portuguese levels of drug use are below the European average[7] and research focused on young and problematic drug users suggests that drug use has declined among the population most at risk (see Balsa, Vital, & Urbano, 2013; Gonçalves, Lourenço, & Silva, 2015; Hughes & Stevens, 2010). These figures contrast with the held belief that removing criminal sanctions inevitably leads to increased drug use. This evidence tallies with Reuter and Stevens (2007) who show that harsher punishment of drug users do not directly affect use rates.

Greenwald (2009) suggests that the new Portuguese drug policy has been "a resounding success". The data show that drug usage, the number of drug-related deaths, and the number of HIV and AIDS infected individuals among drug addicts decreased substantially in the post-decriminalization period. Meanwhile, a great deal of financial resources were allocated to treatment and prevention through the Commissions for Dissuasion of Drug Addiction. Tavares and Portugal (2012) find that the Portuguese decriminalization of drugs contributed to improve drug-related outcomes, namely, the number of offenses and drug-related deaths.

Gonçalves et al., 2015 study the social cost of the NSFAD and document a significant reduction in the legal costs associated with criminal proceedings for drug-law offenses and a significant reduction in the number of consumption drug-law offenses (9 percent) in the period between 1999 and 2010, which is line with the health-oriented strategy of the policy change. On the other hand, the authors also estimate that police costs for detection of drug-law offenses increased in the case of the specialized police force responsible for major drug-law offenses (Polícia Judiciária) and decreased in the case of the non-specialized police forces. This is consistent with the significant increase in the number of trafficking offenses (47 percent) while the number of consumption-trafficking offenses increased only moderately (15 percent) in the period between 1999 and 2010. Hughes and Stevens (2010) use data on drug seizures and prices and find that the evolution of drug seizures in Portugal is in line with increased law enforcement rather than domestic market growth. This evidence suggests that the NSFAD's objective of fighting drug trafficking was not disregarded and worked through the shift of resources from low-level drug users to higher levels of the drug market.

Becker and Murphy (2013) argue that an alternative to the "war on drugs" policy declared by the U.S. is to follow Portugal's lead and decriminalize drug use while maintaining drug trafficking illegal. The decriminalization of drug use would reduce U.S. prison population since drug users cannot be criminally punished while promoting treatment of drug addicts.

Methods

Data description

We use a panel of 16 countries, including 15 European Union countries plus Norway, for the period between 1990 and 2010. We consider 2000 as the treatment year since, even though the decriminalization of use and possession of illicit drugs in Portugal entered into force on 1 July 2001, authorities started to apply the recommendations proposed by the National Strategy for the Fight Against Drugs before the legislative change. Therefore, we have 10 periods in the pre-treatment period and 11 periods in the post-treatment period. We study the impact of drug decriminalization on the retail prices of opiates and cocaine.

Figs. 1 and 2 depict the evolution of cocaine and opiates prices respectively, and at first glance, suggest that there are no discernible changes in the trends of cocaine and opiates prices after the policy change.

The illegal nature of the illicit drugs market explains the scarce data available and the difficulty in understanding how data were collected and how reliable they are. The information on prices was obtained from the United Nations World Drug Report (2012) and refers to the retail prices (street prices) measured in US$ per gram. The data source for drug prices for the European countries is the

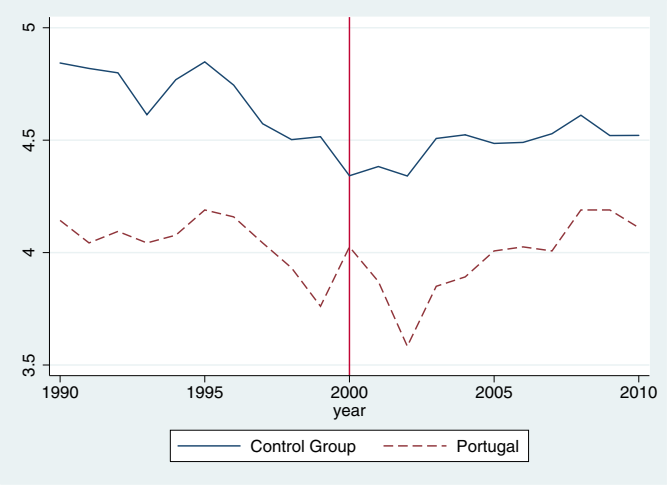

Fig. 1. Evolution of the logarithm of cocaine prices, 1990–2010. *Notes*: For detailed data definitions and sources see Table A1.

[7] European Monitoring Centre for Drugs and Drug Addiction, "Drug policy profiles – Portugal".

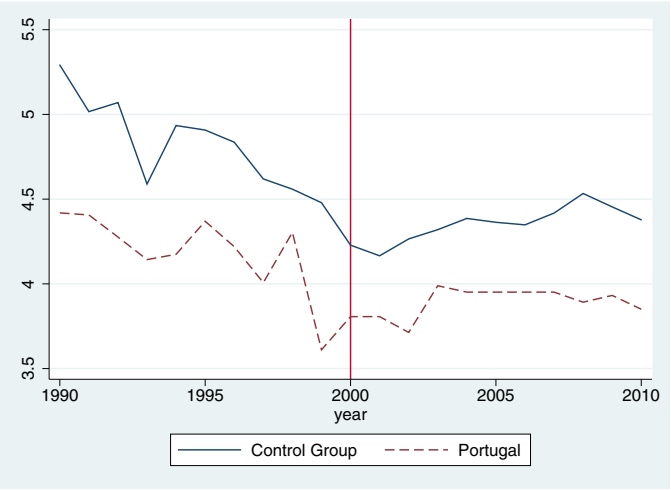

Fig. 2. Evolution of the logarithm of opiates prices, 1990–2010. *Notes*: For detailed data definitions and sources see Table A1.

Annual Reports Questionnaire developed by the Commission on Narcotic Drugs and is complemented with information from the European Monitoring Center for Drugs and Drug Addiction (EMCDDA) and Europol.[8] The EMCDDA data on prices come from different sources (police sources and surveys among drug users) and as a result, caution is required when using the data since the cross-country comparability may be compromised. However, even though data may be collected from different sources across countries there is no reason to believe that collection techniques have changed across countries, over time, or within country over time.

We include a set of control variables used to characterize the demographic, social, and economic environments of a country. This way, it is possible to find a counterfactual Portugal that best resembles Portugal in the pre-decriminalization period. The control variables used in the analysis are the (logarithm of) GDP per capita, the proportion of population aged from 15 to 24 years old, alcohol consumption, and the (logarithm of) number of seizures. The first two variables are intended to characterize the economic context, whereas the third is used to measure the importance of young population in the population structure. Alcohol consumption is also included in the estimation since it is sometimes referred to as a substitute for drug use and is often associated with drug environments. The control variable pertaining to seizures is understood as an indicator of the size of market supply.[9]

A detailed description of the variables and sources is in Table A1.

Difference-in-differences estimator

The empirical model that we use to analyze the impact of drug decriminalization on illicit drugs prices is a difference-in-differences (DID) model with controls for country observed and unobserved heterogeneity and for time effects that are assumed in the baseline model to be common across countries.

Consider the following model specifications:

$$\log y_{it} = \alpha_i + \lambda t + \beta \text{Port}_i + \gamma \text{After}_t + \delta \text{Port}_i * \text{After}_t + \mathbf{x}'_{it}\boldsymbol{\beta} + \varepsilon_{it} \quad (1)$$

and

$$\log y_{it} = \alpha_i + \lambda t + \beta \text{Port}_i + \gamma \text{Spline}_t + \delta \text{Port}_i * \text{Spline}_t + \mathbf{x}'_{it}\boldsymbol{\beta} + \varepsilon_{it} \quad (2)$$

where $i = 1, \ldots, N$ designates each country in the sample and the subscript t designates time. Port_i is an indicator variable for the treatment group, Portugal, and After_t is a dummy variable for time equal to one in the post-treatment period. The variable Spline_t is defined as equal to zero in the pre-treatment period and equal to $(t - 1999)$ in the post-treatment period. The parameter δ is the one of main interest and measures the treatment effect. The dependent variable $\log y_{it}$ represents two possible outcomes: (the logarithm of) opiates and cocaine prices. The vector $\mathbf{x}_{it}$ comprehends a set of time-varying observable individual characteristics and $\boldsymbol{\beta}$ is a vector of coefficients. The term α_i denotes a full set of country dummy variables, t is a linear time trend and ε_{it} is a zero mean disturbance term capturing all other omitted factors.

The model specification formulated in (1) accounts for a level shift in the price of drugs implied by the drug decriminalization policy while the model in (2) seeks to detect whether there was a shift in the slope of the price series.

Estimation of the model presented above can be done using standard estimation methods to deal with the presence of individual-specific effects. Wooldridge (2002) suggests estimation of this model applying the within estimator, provided that the policy change is strictly exogenous.

One of the most common problems associated with the difference-in-differences estimation is the presence of an individual-specific time trend, so that the treatment and the control groups follow different time trends. If that is the case, the difference-in-differences estimator can be biased. According to the series plotted in Figs. 1 and 2 it seems reasonable to assume that there are no systematic differences in the time trends between the two groups in the pre-treatment period. In order to fully account for the possibility of unobserved temporary individual-specific effects we estimate our baseline model using country-specific time trends. In this case, the estimated models are given by the following equations:

$$\log y_{it} = \alpha_i + \lambda_i t + \beta \text{Port}_i + \gamma \text{After}_t + \delta \text{Port}_i * \text{After}_t + \mathbf{x}'_{it}\boldsymbol{\beta} + \varepsilon_{it} \quad (3)$$

and

$$\log y_{it} = \alpha_i + \lambda_i t + \beta \text{Port}_i + \gamma \text{Spline}_t + \delta \text{Port}_i * \text{Spline}_t + \mathbf{x}'_{it}\boldsymbol{\beta} + \varepsilon_{it} \quad (4)$$

where λ_i represents a country-specific time trend.

Results

The estimation results based on the model specifications defined in Eqs. (1) and (2) are reported in Tables 1 and 2. The former presents the results concerning the prices of opiates and the latter the prices of cocaine. All columns report fixed-effects estimates controlling for differential trends. Columns (1), (2), and (3) report fixed-effects estimates using a common time trend while the estimates in columns (4) and (5) were obtained considering a country-specific time trend.

According to the estimates in columns (1) and (2) in Table 1 we can conclude that the treatment effect, measured by the parameter δ, is positive and statistically significant, meaning that the prices of

[8] In the particular case of Portugal, and since 2002, data on prices of cocaine and opiates refer only to traffic and traffic-use market.

[9] As noted by an anonymous referee, the number of traffic-related drug law offenses could be a more close indicator of drug trafficking. However, data on drug law offenses provided by the EMCDDA covers different concepts, varying considerably across countries. Drug law offenses usually refer to offenses such as drug production, trafficking, and dealing as well as drug use and possession for use. Perhaps, in the Portuguese case, drug use and possession are not criminal offenses but are included in these data.

Table 1
Effect of drug decriminalization on prices of opiates.

	Prices of opiates				
	(1)	(2)	(3)	(4)	(5)
After	−0.240**	−0.288**			
	(0.086)	(0.117)			
After*Port	0.191**	0.382**		0.136	
	(0.068)	(0.149)		(0.090)	
Spline			0.095***		
			(0.019)		
Spline*Port			0.034		0.029
			(0.020)		(0.048)
Alcohol Consumption		0.057	0.0009	0.031	0.026
		(0.041)	(0.035)	(0.078)	(0.082)
Young Population		0.063	0.032	0.109*	0.112
		(0.040)	(0.036)	(0.061)	(0.066)
Log GDP per capita		−1.667*	−1.045	−4.241***	−4.058**
		(0.846)	(0.671)	(1.250)	(1.389)
Log Heroin Seizures		−0.025	0.043	−0.009	−0.009
		(0.038)	(0.030)	(0.050)	(0.051)
Observations	285	248	248	248	248
Adjusted R^2	0.348	0.381	0.426	0.469	0.469
Common Time Trend	Yes	Yes	Yes	No	No
Country-Specific Time Trend	No	No	No	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the logarithm of opiates prices. The sampling period goes from 1990 to 2010. The variables alcohol consumption, percentage of young population, (logarithm of) number of drug seizures, and (logarithm of) GDP per capita are introduced as control variables in columns (2), (3), (4), and (5). A common time trend is included in columns (1), (2), and (3) and a country-specific time trend is considered in columns (4) and (5). Fixed effects estimates with robust standard errors clustered at country level in parentheses. Detailed data definitions and sources given in the appendix.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

Table 2
Effect of drug decriminalization on prices of cocaine.

	Prices of cocaine				
	(1)	(2)	(3)	(4)	(5)
After	−0.166***	−0.160***			
	(0.031)	(0.036)			
After*Port	0.125***	0.253***		0.066	
	(0.028)	(0.070)		(0.045)	
Spline			0.052***		
			(0.017)		
Spline*Port			0.021*		0.033
			(0.011)		(0.027)
Alcohol Consumption		0.056**	0.016	0.076*	0.071*
		(0.023)	(0.018)	(0.036)	(0.038)
Young Population		−0.003	−0.015	0.054	0.058
		(0.026)	(0.024)	(0.040)	(0.038)
Log GDP per capita		−1.272**	−0.796*	−1.281*	−1.097
		(0.551)	(0.407)	(0.689)	(0.735)
Log Cocaine Seizures		0.045**	0.064***	0.057	0.059
		(0.019)	(0.021)	(0.035)	(0.037)
Observations	285	245	245	245	245
Adjusted R^2	0.258	0.364	0.419	0.437	0.439
Common Time Trend	Yes	Yes	Yes	No	No
Country-Specific Time Trend	No	No	No	Yes	Yes
Country Dummies	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is the logarithm of cocaine prices. The sampling period goes from 1990 to 2010. The variables alcohol consumption, percentage of young population, (logarithm of) number of drug seizures, and (logarithm of) GDP per capita are introduced as control variables in columns (2), (3), (4), and (5). A common time trend is included in columns (1), (2), and (3) and a country-specific time trend is considered in columns (4) and (5). Fixed effects estimates with robust standard errors clustered at country level in parentheses. Detailed data definitions and sources given in the appendix.
* $p < 0.1$.
** $p < 0.05$.
*** $p < 0.01$.

opiates are higher in Portugal than they would have been in the absence of the drug decriminalization policy. The results reported in column (4) account for a level shift in the prices of opiates considering a country-specific time trend and, therefore, the treatment effect is calculated comparing the prices of opiates for Portugal in the before-after periods. In this particular case, the treatment effect is positive but not statistically significant. The estimates reported in columns (3) and (5) regarding the impact of the drug decriminalization policy on the slope of the price of opiates series suggest that the treatment effect is positive but not statistically significant. Therefore, we failed to find convincing evidence supporting the hypothesis of a slope change in the trend of the price of opiates.[10]

Concerning the impact of the policy change on the price of cocaine, the results in columns (1), (2), and (3) of Table 2 suggest that the treatment effect is positive and statistically significant. The estimates reported in columns (4) and (5) that account for country-specific time trends suggest that the treatment effect is positive but not statistically significant. Again, if anything, the drug decriminalization policy contributed to higher prices.

These results suggest that the drug decriminalization did not generate lower drug prices, if anything, the prices of opiates and cocaine were higher than they would have been in the absence of the policy change. According to economic theory, the fact that prices did not decrease can be explained by increased drug demand driven by the abolition of criminal sanctions for a constant supply, or by higher drug-law enforcement on the supply side. The evidence on drug usage rates suggests that demand did not increase and, therefore, these higher prices may be explained by the enhancement of the Portuguese police activity fighting trafficking.

Synthetic Control Method

In this section we apply the Synthetic Control Method (SCM) proposed by Abadie and Gardeazabal (2003) and Abadie, Diamond, and Hainmueller (2010). This method allows for the construction of a "synthetic" control region, which is a convex combination of countries that best resemble the relevant economic and social characteristics of Portugal before the implementation of the drug decriminalization policy in 2001. It is then possible to compare the evolution of prices of cocaine and opiates between Portugal and the "counterfactual" Portugal.

This comparative case study method addresses the problem of subjective comparison group selection by using a data-driven procedure to construct suitable comparison groups. The comparison group will be a weighted combination of the potential comparison countries obtained using observable and measurable characteristics. According to this method, the characteristics of the treated unit before the treatment period can be better approximated by a combination of comparison units than by any comparison unit alone.

An important advantage of the SCM relative to the standard difference-in-differences estimation method is that it accommodates the possibility of time-varying unobservable heterogeneity. Also, the SCM makes explicit the relative contribution of each potential comparison country to the counterfactual of interest, and the similarities between the country of interest and the set of available control countries.

How to construct the synthetic control group

To summarize the SCM we closely follow Abadie, Diamond, and Hainmueller (2012). Let J denote the number of available control units comprising the "donor pool" and consider, without loss of generality, that only one unit is exposed to treatment, so that we have a sample of $J + 1$ units. Assume that the dataset is a balanced panel spanning T time periods and that the sample includes T_0 pre-intervention periods and T_1 post-intervention periods.

Then the synthetic group is defined as a weighted average of the available units in the donor pool. Consider a vector of weights **W** which represents a potential synthetic control for the treated unit. The authors propose to choose the value of **W** based on the observation of the characteristics of the treated unit that are best approximated by the characteristics of the synthetic control.[11]

Let Y_{jt} denote the outcome of unit j at time t (say, the price of illicit drugs), Y_1 the vector of post-treatment information for the treated unit (say, Portugal), and Y_0 the matrix that contains the post-intervention values for the control units. The SCM aims to estimate the effect of the treatment, that is, the difference between the post-intervention outcomes between the treated unit and the synthetic control. Then, the SCM estimator:

$$Y_{1T} - \sum_{j=2}^{J+1} w_j^* Y_{jt} \tag{5}$$

gives the treatment effect as a difference between the outcome for the treated unit (price of illicit drugs in Portugal after decriminalization) and the outcome for the synthetic control obtained as a convex combination of units in the donor pool (predicted price of illicit drugs for the artificial Portugal).

Abadie and Gardeazabal (2003) argue that this factor model allows controlling for time-varying unobserved heterogeneity affecting either the outcome of interest or the effect of the determinants on the outcome of interest. The reasoning goes as follows: if the synthetic control unit is able to closely resemble the behavior of the treatment unit in the period before the intervention, then differences in the outcome variable between the treatment unit and the synthetic control unit after the treatment can be interpreted as a result of the treatment itself.

Results

The outcomes of interest are the prices of opiates and cocaine. The predictors of illicit drug prices considered in the analysis for Portugal and the 14 potential control countries in the donor pool, X_1 and X_0, respectively, include alcohol consumption, the proportion of young population, and the logarithm of GDP per capita. These variables are averaged over the period from 1990 to 1999 and augmented by adding three lagged illicit drug prices (1990, 1995, and 2000). This allows for a better fit of the synthetic control group.

Using the techniques described above we analyze the impact of the drug decriminalization policy followed by Portugal on the prices of opiates and cocaine. The synthetic counterfactual is obtained from a convex combination of the available countries in the donor pool as explained above.

The results regarding the predictors of prices are shown in Table A4 and reveal a close fit between Portugal and the synthetic counterpart. The weights of each country in the donor pool in the synthetic Portugal are reported in Table A3 and indicate that the pre-treatment Portugal is best resembled by a convex combination of France, Germany, Italy, and Netherlands regarding the price of opiates, and Belgium and Netherlands regarding the price of cocaine. Zero or almost zero weights are assigned to the other donor pool countries.

Figs. 3 and 4 show the trends in the prices of opiates and cocaine for Portugal and the synthetic Portugal for the period between

[10] Please note that, in the case of Portugal, the inclusion of country specific trends does not capture the price behavior during the post-decriminalization period because such change is, by definition, condensed in the coefficient of the spline function.

[11] A more formal and detailed description can be found in Abadie and Gardeazabal (2003) and Abadie et al. (2010).

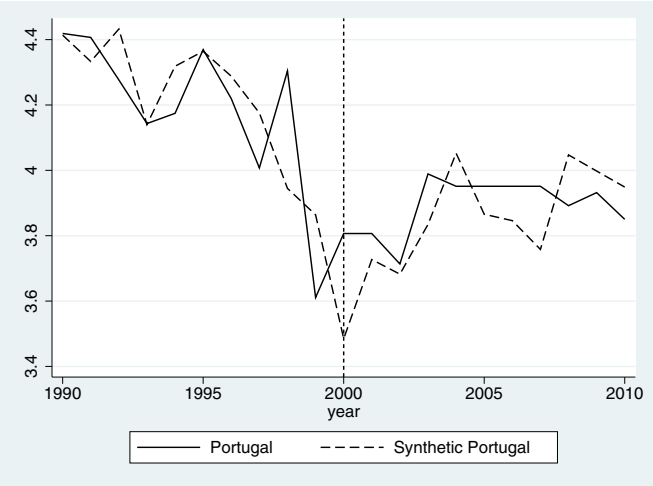

Fig. 3. Trends in the logarithm of opiates prices: Portugal vs. synthetic Portugal. *Notes*: The synthetic Portugal is obtained through a convex combination of Austria (0.001), Belgium (0.004), France (0.186), Germany (0.257), Ireland (0.001), Italy (0.096), Netherlands (0.450), Spain (0.003), and United Kingdom (0.001). For detailed data definitions and sources see Table A1.

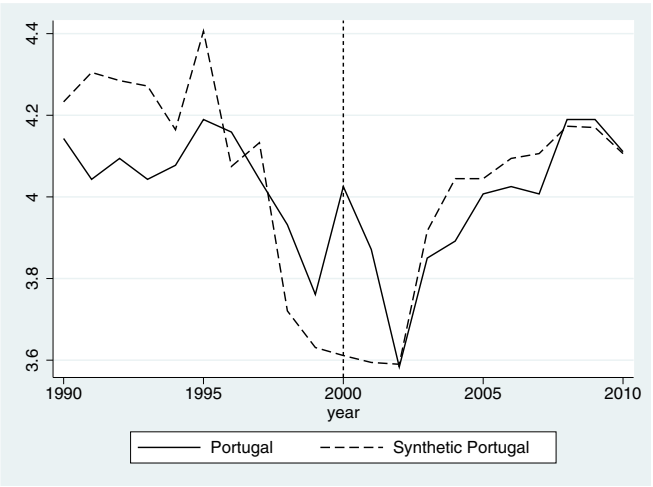

Fig. 4. Trends in the logarithm of cocaine prices: Portugal vs. synthetic Portugal. *Notes*: The synthetic Portugal is obtained through a convex combination of Belgium (0.225) and Netherlands (0.775). For detailed data definitions and sources see Table A1.

1990 and 2010, respectively. We can see that the synthetic Portugal closely resembles Portugal in the pre-treatment period.[12] The results suggest that no major divergence between Portugal and the synthetic counterpart can be found after the implementation of the drug decriminalization policy in 2000. These findings are in line with the difference-in-differences estimates of the spline term reported in columns (3) and (5) of Tables 1 and 2.

Figs. 5 and 6 depict the yearly gaps in the prices between Portugal and the synthetic Portugal. They suggest that, if anything, the treatment effect seems to be positive, meaning that prices were on average higher than the ones that would have been charged in the absence of the drug decriminalization policy. An inference analysis based on falsification tests is provided in the appendix section.

[12] The fact that opiates prices and, particularly, cocaine prices start increasing before 2000 may be an anticipation effect as the NSFAD was adopted in 1999.

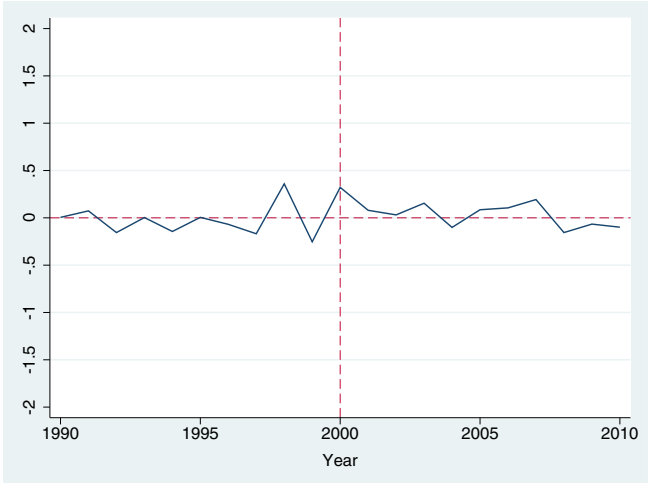

Fig. 5. Logarithm of opiates prices gap between Portugal and synthetic Portugal. *Notes*: For detailed data definitions and sources see Table A1.

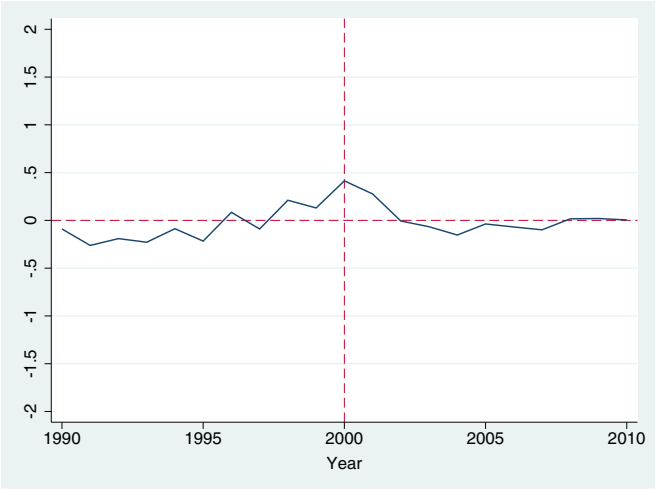

Fig. 6. Logarithm of cocaine prices gap between Portugal and synthetic Portugal. *Notes*: For detailed data definitions and sources see Table A1.

Conclusions

The existing forms of drug liberalization have been hotly debated over the past years in several countries, especially in the United Kingdom. However, the public debate is couched mostly in speculation, due to the lack of empirical evidence on these matters.

In this study we recognize the importance of drug demand indicators but we focus our analysis on the supply side. To the best of our knowledge this is the first study that investigates the role of the drug decriminalization process in illicit drug prices.

With this analysis we contribute to the drug policy debate by empirically assessing the impact of the Portuguese drug decriminalization (which occurred on 1 July 2001) on drug prices. We find that (retail) prices of cocaine and opiates did not decrease following the drug decriminalization. Therefore, drug decriminalization seems to have caused no harm through lower illicit drugs prices, which would lead to higher drug usage and dependence. This evidence contrasts with the commonly held belief that drug decriminalization would necessarily lead to a dramatic increase in usage rates.

According to these results, softer drug law enforcement regarding illicit drug consumers does not inevitably lead to lower

prices. In the 1980s the United States started to pursue a harsher drug law enforcement by increasing sanctions associated with drug-related crime. During this period consumption did not decrease and contrary to expectations street prices fell (Basov, Jacobson, & Miron, 2001). The US stringent criminalization policies are a response to increased supply and aims at reducing consumption. The combination of the two may explain why prices did not increase and instead decreased in result of the rising enforcement. Kleiman (2009) write that "Perhaps it is time to confess that, under the current U.S. conditions, drug law enforcement has a very limited capacity to raise the prices and reduce the availability of mass-market drugs, and thereby to reduce the extent of drug abuse". Our results are in line with this failure of the "war on drugs" to link higher prices with increased toughness. In the Portuguese case, decreased toughness on the demand side did not contribute to lower prices but if anything to higher prices than the ones that would have been observed in the absence of the drug decriminalization policy.

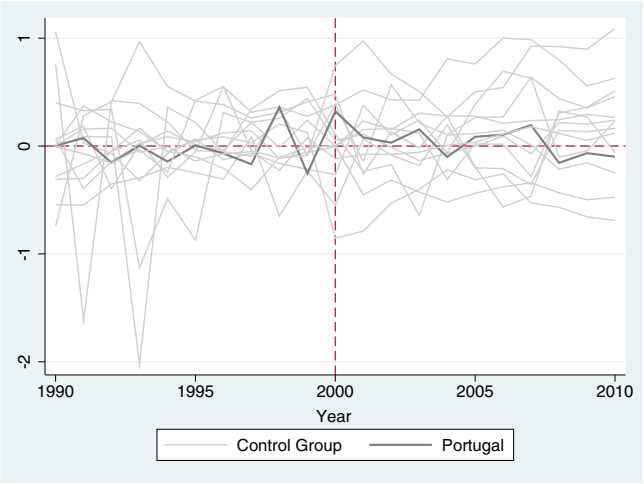

Fig. 7. Logarithm of opiates prices gaps in Portugal and placebo gaps in the control countries. *Notes*: For detailed data definitions and sources see Table A1.

Appendix A. Inference using SCM

The SCM does not allow us to use standard statistical inferences to assess the statistical significance of the estimated coefficients as the number of units in the comparison group are usually small. However, Abadie and Gardeazabal (2003) propose using falsification tests, which the authors call "placebo studies", to perform alternative quantitative inference. The idea is to apply the SCM to each country in the donor pool (akin to permutation tests) and see if the estimated effect in the treatment unit is of greater magnitude relative to the units where intervention did not take place. If those (false) treatment effects are of similar or greater magnitude as the estimated effect for the treated unit, then our results could be compromised.

The results of the placebo studies are shown in Figs. 7 and 8.

When the drug policy change is artificially and randomly assigned to countries in the donor pool where the drug policy did not in fact change, we find estimates of larger or similar magnitude to the ones obtained for Portugal. This evidence is consistent with the lack of systematic differences in the trends of opiates and cocaine prices for Portugal and its synthetic counterpart after the drug decriminalization policy.

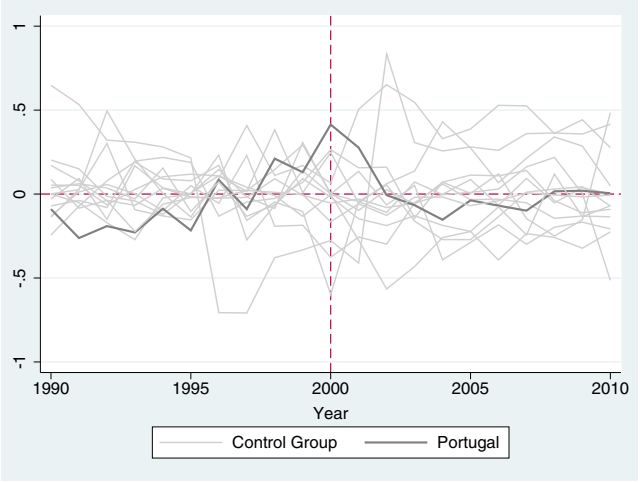

Fig. 8. Logarithm of cocaine prices gaps in Portugal and placebo gaps in the control countries. *Notes*: For detailed data definitions and sources see Table A1.

Table A1
Data description and sources.

Variable	Description	Source
Price of Opiates	Measured as the logarithm of the retail price (street price) of opiates, US dollars per gram	UN World Drug Report (2009)
Price of Cocaine	Measured as the logarithm of the retail price (street price) of cocaine, US dollars per gram	UN World Drug Report (2009)
GDP per capita	Measured as the logarithm of the constant 2005 GDP per capita measured in US dollars	OECD (National Accounts Data)
Unemployment Rate	Total unemployment as a percentage of total labor force	International Labor Organization
Young Population	Proportion of population aged between 15 and 24 years old	EUROSTAT
Alcohol Consumption	Liters consumed per capita by individuals aged above 15 years old	OECD Health Data
Heroin Seizures	Measured as the logarithm of the number of heroin seizures by law enforcement agencies, namely police, customs officials, and national guard.	EMCDDA
Cocaine Seizures	Measured as the logarithm of the number of cocaine seizures by law enforcement agencies, namely police, customs officials, and national guard.	EMCDDA

Table A2
Countries included in the sample.

Country
Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom

Table A3
Country weights in the donor pool for synthetic Portugal.

	Prices of opiates	Prices of cocaine
Austria	0.001	0.000
Belgium	0.004	0.225
Denmark	0.000	0.000
Finland	0.000	0.000
France	0.186	0.000
Germany	0.257	0.000
Ireland	0.001	0.000
Italy	0.096	0.000
Luxembourg	0.000	0.000
Netherlands	0.450	0.775
Norway	0.000	0.000
Spain	0.003	0.000
Sweden	0.000	0.000
United Kingdom	0.001	0.000

Table A4
Predictor's balance for prices of opiates and prices of cocaine.

Variables	Prices of opiates		Prices of cocaine	
	Treated	Synthetic	Treated	Synthetic
Alcohol Consumption	14.63	11.31	14.63	10.19
Young Population	15.96	13.43	15.96	13.60
Log GDP per capita	9.79	10.21	9.79	10.25
Log Opiates Seizures	7.89	7.88		
Log Opiates Prices 2000	3.81	3.48		
Log Opiates Prices 1995	4.37	4.36		
Log Opiates Prices 1990	4.42	4.41		
Log Cocaine Seizures			6.67	7.21
Log Cocaine Prices 2000			4.03	3.61
Log Cocaine Prices 1995			4.19	4.41
Log Cocaine Prices 1990			4.14	4.23
RMSPE	0.1674		0.1722	

Notes: All predictors are averaged for the period 1990 to 1999. Detailed data definition can be found in Table A1. The Root Mean Square Prediction Error (RMSPE) is a measure of goodness of fit and measures the fit between the trends of the outcome variable for Portugal and its synthetic counterpart. $\text{RMSPE} = \sqrt{\frac{1}{T_0}\sum_{t=1}^{T_0}\left(Y_{1T} - \sum_{j=2}^{J+1} w_j^* Y_{jt}\right)^2}$.

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