



# The price elasticity of demand for heroin: Matched longitudinal and experimental evidence<sup>☆</sup>



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## ARTICLE INFO

### Article history:

Received 20 May 2014

Received in revised form 5 December 2014

Accepted 30 January 2015

Available online 9 February 2015

### JEL classification:

I10

C81

C91

### Keywords:

Elasticity

Heroin

Demand

Panel data

Experimental methods

## ABSTRACT

This paper reports estimates of the price elasticity of demand for heroin based on a newly constructed dataset. The dataset has two matched components concerning the same sample of regular heroin users: longitudinal information about real-world heroin demand (actual price and actual quantity at daily intervals for each heroin user in the sample) and experimental information about laboratory heroin demand (elicited by presenting the same heroin users with scenarios in a laboratory setting). Two empirical strategies are used to estimate the price elasticity of demand for heroin. The first strategy exploits the idiosyncratic variation in the price experienced by a heroin user over time that occurs in markets for illegal drugs. The second strategy exploits the experimentally induced variation in price experienced by a heroin user across experimental scenarios. Both empirical strategies result in the estimate that the conditional price elasticity of demand for heroin is approximately 0.80.

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<sup>☆</sup> The order of authorship is a hybrid of the conventions in medicine and economics, with the first author listed being the principal investigator, and the remaining authors being listed in alphabetical order. Support for this research by a grant from the National Institute on Drug Abuse (R21DA025859) is gratefully acknowledged. The funding source had no involvement in the conduct of the research. We wish to thank the editor and two anonymous referees for helpful comments and suggestions. We also wish to thank Rachel Atwater, Jacquelyn Booker, Ellen Ciesielski, Sean Sierra, and Venkataramana Yanamandra for outstanding assistance with this research. We also wish to thank Brendan Saloner and Dan Houser, and audiences at George Mason University, University of Texas at Austin, the Addiction Health Services Research Conference, and the 5th Biennial Meeting of the American Society of Health Economists for helpful comments. Prior to enrollment, study subjects provided written informed consent approved by the University of Connecticut Health Center Institutional Review Board. A Certificate of Confidentiality was obtained from the National Institute on Drug Abuse prior to initiating the study.

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<http://dx.doi.org/10.1016/j.jhealeco.2015.01.008>

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## 1. Introduction

Heroin abuse appears to be an increasingly significant problem in the United States. The number of past-year heroin users rose from 373,000 in 2007 to 620,000 in 2011 (as captured in the National Survey on Drug Use and Health (NSDUH) survey), and the number of people meeting criteria for heroin abuse or heroin dependence more than doubled during the same period, from 179,000 to 369,000 (Muhuri et al., 2013). More broadly, the overall cost of illicit drug use in the US is approximately \$200 billion per year, including crime, drug-related health care, and impact on productivity (NDIC, 2011).

One factor that partly determines drug use is price. Heroin prices have fallen, in particular: by some measures, inflation-adjusted (2010 dollars) typical prices of one pure gram of heroin fell from over \$1500 in the early 1980s, to \$400 in the early 2000s, and have continued to gradually fall since then (ONDCP, 2004, 2012; Kilmer et al., 2014). In contrast, one goal of many policy responses to drug abuse problems is to increase the price. Therefore, it is important to understand the price responsiveness

of drug consumption, otherwise known as the price elasticity of demand.

This paper reports estimates of the price elasticity of demand for heroin based on a newly constructed sample of information about regular heroin users. The newly constructed sample covers the period 2010–2012, and therefore is reflective of the recently low heroin prices, and other recent trends in heroin markets, including policies aiming to limit abuse of prescription opioid pain relievers, that may have shifted demand for heroin (Rudd et al., 2014; Muhuri et al., 2013). Although our focus in this paper is on the collection of high quality data, and the implementation of appropriate empirical strategies to estimate the elasticity of demand for heroin, incidental contributions include “updating” the earlier estimates of the elasticity of demand for heroin to account for these recent aspects of heroin markets.

Our newly constructed dataset concerns 120 regular heroin users, and matches longitudinal information about real-world heroin demand at daily intervals with the results of a demand experiment. We focus our efforts on collecting data from regular heroin users because they simultaneously account for much of heroin consumption, and are difficult to capture in general population surveys (Dave, 2008, 2006; van Ours and Pudney, 2006; Saffer and Chaloupka, 1999; Caulkins, 1995).

The longitudinal component of the dataset has information at the level of individual drug demand collected via an interactive voice response (IVR) telephone system: actual price and actual quantity at daily intervals. Our longitudinal data therefore compares favorably with other datasets used to estimate elasticities of demand for illegal drugs, many of which rely on possibly misleading aggregated price and/or consumption data, indicators and/or proxies for drug use rather than transacted quantity data, time-series or cross-sectional data rather than panel data, and/or focus on general population surveys that under-represent regular heroin users. In the rest of the paper, we refer to this as “the IVR data.” We review the literature, and possible concerns about prior estimates, in more detail later in the paper.

Subjects also participated in a laboratory experiment in which they were given varying amounts of imitation money and asked to make hypothetical drug purchases at varying drug prices.<sup>1</sup> In the rest of the paper, we refer to this as “the experimental data.”

We motivate our preferred empirical strategies by first estimating the elasticity of demand for heroin using the IVR data treated as a pooled cross-sectional dataset. This results in an estimated conditional price elasticity of demand for heroin that is approximately  $-1.05$ .<sup>2</sup>

In this paper, we tend to focus on the conditional elasticity of demand for heroin, because in the IVR data we exploit transaction-level price data that does not exist for a given individual on a given day in the absence of a transaction. We can estimate a participation price elasticity of demand for heroin based on the experimental data, which we find to be small: approximately  $-0.07$ .

One concern with the  $-1.05$  estimate of the conditional price elasticity of demand, which motivates our preferred empirical strategies, is the possibility that the price of heroin that an individual tends to experience is related to fixed factors that determine the quantity of heroin that individual tends to demand. In models of perfectly competitive markets, it is reasonable to assume that

the price that an individual experiences is the “market price” that is unrelated to the characteristics of that specific individual, justifying the credibility of (pooled) cross-sectional estimates of price elasticity. However, in the context of the market for illegal drugs, it is possible that individuals that have fixed characteristics that make them “high demand” users of heroin also are individuals that tend to experience lower prices of heroin. For example, it could be that “high demand” users have more ability and financial incentive to search for, negotiate, and/or otherwise acquire a low price for heroin, perhaps due to learning from experience or the share of income spent on heroin (Reuter and Caulkins, 2004; Galenianos et al., 2012).

If “high demand” users tend to experience lower prices of heroin, then the estimated elasticity based on (pooled) cross-section methods is biased. It is confounded by the fact that individuals that tend to experience high prices of heroin also tend to be those individuals that have low demand for heroin. By standard omitted variables bias arguments, that suggests that the demand for heroin is actually less price elastic than suggested by the estimate of  $-1.05$ .

We use two empirical strategies that address this concern. The first empirical strategy is a fixed-effects design based on the longitudinal IVR data, and exploits the idiosyncratic variation in price experienced by an individual over time. Even if, for example, “high demand” users tend to experience lower prices, because of the idiosyncratic nature of the market for illegal drugs,<sup>3</sup> they will occasionally experience higher prices. Our first empirical strategy estimates the elasticity of demand for heroin based on that within-individual idiosyncratic variation in price. The second empirical strategy is based on the experimental data, and exploits the experimentally induced variation in price experienced by an individual across experimental scenarios.

Therefore, the two different empirical strategies aim to estimate the elasticity of demand based on two different sources of exogenous variation in price. Both empirical strategies result in an estimated conditional price elasticity of demand for heroin that is approximately  $-0.80$ , with no evidence of an economically or statistically significant difference in elasticities across the two empirical strategies.

Since our two preferred empirical strategies result in similar estimates, our estimates provide some support for the external validity of the experimental method for estimating illegal drug elasticities. More generally, our estimates add to the recent discussion about the credibility of experiments in general as a tool to recover features of the “real-world” in economics (e.g., Levitt and List, 2007; Camerer, 2011; and further references cited therein). However, it is important to recognize the possibility that participation in the study affected the behavior of the subjects, as in a Hawthorne effect (e.g., Zwane et al., 2011). For example, it is possible that being surveyed about price and quantity of heroin increases the salience of price, possibly changing the responsiveness to price. Consequently, it is not necessarily clear how the subjects would have behaved in the real world in the absence of the survey, or in an experiment that did not directly follow the collection of the real world data. Potentially, an experiment that is run separately from collection of real world data would exhibit less external validity than our results

<sup>1</sup> Non-hypothetical choices are a better approximation of “true” preferences than are hypothetical choices (Chang et al., 2009), but we use a hypothetical choice experiment due to logistical and ethical considerations of providing drugs.

<sup>2</sup> The conditional elasticity of demand is the elasticity of demand conditional on non-zero demand.

<sup>3</sup> The market for drugs, and the associated idiosyncrasies compared to the classical “perfectly competitive” market, has been characterized throughout the literature. A few examples include: National Research Council (2001, 2010). In particular, street prices of drugs in a single market can show substantial variation over short time periods (Reuter, 1998; Weatherburn and Lind, 1997).

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