

Chapter 2

Literature Review

2.1 Introduction

Complementing research on recreational drugs in other disciplines, such as epidemiology, sociology, psychology and medicine, economists have investigated an array of issues related to drug consumption and its adverse effects. Their contribution to the drug debate has provided valuable insights and assistance to health professionals and policymakers towards the development of effective policies to contain drug use and minimise the associated harms.

The economic approach considers drug consumption within the context of individual consumer decision-making. This has led economists to examine policy tools that impact on the demand and supply of psychoactive drugs. Economic theories have been developed and examined empirically. The development of more sophisticated econometric tools and methods and improved quality of data in recent years have significantly enhanced drug analysis to provide a better understanding of drug consumption behaviour.

While there exists an exhaustive literature on licit drugs, research on illicit drug use has been rather sparse due to unavailability of data. Nevertheless, the last two decades have seen a growing number of economic studies on illicit drugs, most of which examined US data. Drug decriminalisation, or legalisation, has stirred significant discussion across many disciplines. Economists have been at the forefront of this debate and have provided important insights on the economic impact of criminal law enforcement regarding drug use.

This chapter carries out a selective review of the economic literature on drug use. It focuses on studies that have investigated the demand for drugs predominantly in the post-1980 period. Section 2.2 outlines the economic theory related to drug consumption. Section 2.3 surveys the literature on drug consumption, reviewing studies on licit and illicit drugs separately. Empirical evidence on cross drug relationships is examined in Sect. 2.4. Section 2.5 discusses the econometric methods used in the empiric and Sect. 2.6 raises a few data issues. Finally, Sect. 2.7

summarises the chapter highlighting some limitations in the literature and presenting scope for further research.

2.2 Economists' Formulation of Drug Consumption

Economic studies have made important contributions to the drug debate. The economic approach considers the demand for drugs as a result of the traditional consumer utility maximisation problem (see Pacula 1998b; Sickels and Taubman 1991). Individuals are assumed to derive utility from the consumption of a bundle of goods and services which can include substance use. They make decisions about choosing, purchasing and consuming the best combination of goods and services that maximise their utility subject to a budget constraint. The constrained utility maximisation yields demand equations for each of the commodities consumed. A substantial body of empirical research provides evidence that consumers' decisions to consume drugs are consistent with the economic law of demand: an increase in the price of a drug is expected to deter its consumption, and thus, its adverse consequences. Drug demand has been estimated using different types of data and measures of consumption, such as time-series data on national aggregate consumption and individual-level data from micro surveys.

The addictive nature of drugs has received extended attention in the drug literature. Until the mid-eighties, most studies focused on the habit formation, or reinforcement, aspect of addiction. This led researchers to explore the dynamic behavior of addictive goods' consumption using imperfectly rational addiction models (Strotz 1955) or myopic models of addiction (see Houthakker and Taylor 1970, Chapter 5). The imperfectly rational addiction model recognises the impact of past and current choices on future consumption decisions when an individual makes current choices, but argues that the individual changes his plan in the future. On the other hand, in the myopic model, current consumption decisions are backward-looking. They are influenced by only past consumption such that myopic drug users ignore any forward-looking intertemporal aspect of consumption when they determine the optimum quantity of drug consumption in the current period. Most of the earlier economic studies that modelled drug consumption assumed drug users to be myopic or imperfectly rational. This led them to believe that habit, or addiction, is not quickly abandoned such that drug users would not necessarily respond to expected price increases. There is a considerable amount of empirical evidence in support of habit formation in the literature (see Grossman et al. 1998a).

Becker and Murphy (1988) brought a new perspective to the analysis of addictive behaviour. They argue that addicts can also be forward-looking and rational such that the consumption of addictive goods can be analyzed in a standard rationally optimizing framework. In their model of rational addiction consumers take account of both past consumption, and future effects, of current consumption when making current choices. They believe that while utility rises from current consumption, long-run utility is lower because they are building up a stock of the addictive good

that has a negative marginal utility. Thus, their model assumes that individuals consistently maximize utility over their life cycle, taking into account past and future consequences of their choices. For instance, the decision to take drugs is based on present and future costs and benefits of consumption. The costs are related to the negative effects of drug use on health which are often realised in the longer run. The perceived benefits are usually immediately realised and might include relaxation, enhancement of concentration, stress alleviation, etc. To the extent that such costs and benefits are reflected in current and future prices, the latter can be used as instruments for past and future consumption. In contrast to the conventional wisdom that addictive goods are not price sensitive, they suggested that demand for an addictive good falls following a price increase, with a greater response to a permanent price increase in the long term than in the short term. A sizeable empirical literature has since evolved on rational addiction, examining and generally supporting the key empirical contention of the Becker and Murphy model on intertemporal complementarity (Becker et al. 1994; Chaloupka 1991; Grossman and Chaloupka 1998; Keeler et al. 1993). However, scarcity of intertemporal consumption data restricts the use of the rational addiction model as a standard approach to modelling the consumption of drugs.

Another strand of the drug theory which has considered the intertemporal consumption of drugs is the gateway, or stepping-stone, theory pioneered by Kandel (1975). The gateway hypothesis suggests that there is a systematic progression or sequencing in drug use with soft drugs such as alcohol and cigarettes providing a gateway, or stepping stone, to marijuana and finally to the use of hard drugs such as cocaine and heroin. It postulates that the early onset of legal drugs causes individuals, in particular adolescents, to experiment with harder drugs later. A small literature has evolved on the gateway theory broadly underpinned by two key lines of arguments. On the one hand, the gateway effect is considered to be causal and generative where the use of soft drugs induces the consumption of hard drugs (Baumrind 1983). On the other hand, it is argued that the gateway effect is only predictive where the use of a soft drug helps predict the use of a hard drug without implying causality (O'Donnell and Clayton 1982). Until recently the gateway effect had been discussed mostly by non-economists, including epidemiologists, sociologists and psychiatrists. In recent years, economists have shown increasing interest in testing the gateway hypothesis. Notwithstanding the paucity of intertemporal data, a growing, but modest, body of theoretical and empirical economic literature has amassed on the gateway hypothesis (see Beenstock and Rahav 2002; Bretteville-Jensen et al. 2008; Degenhardt et al. 2010; DeSimone 1998; Pacula 1997; Pudney 2003; van Ours 2003).

2.3 Drug Consumption

Drug consumption has been examined using a variety of data and econometric methods. Most of the earlier studies used state or national time series data on *aggregate* consumption. The prime objective of those studies was to examine

price effects. The availability of *individual-level* data has, however, brought an improved understanding of consumer behaviour. The analysis of differential policy responses by demographic characteristics such as age, gender and ethnicity, along with the demographic differential effects themselves, has been very useful for the development of drug policies and other educational programs.

The main focus of economic demand studies has been on the price elasticity of demand. Economists argue that in addition to the monetary price of drugs, drug prohibition, or restrictions on availability, are also potential deterrents of drug use. By making purchases more difficult or illegal, restrictions on availability increase the full cost of drugs. A negative demand response to such restriction policies is thus predicted as another example of the law of demand.

In contrast to licit drugs, demand studies have focused very little on illicit drug use given that consumption data and price measures of illicit substances are generally difficult to obtain. In the absence of data on money prices, economists have often used the legal status of drugs, and/or fines and prison sentences for drug possession, as proxies for their full price. Decriminalisation which entails lowering, or eliminating, criminal sanctions against the use of illicit drugs is predicted to decrease the price of drugs. The literature has shown mixed evidence of the impact of such policies on drug consumption.

2.3.1 Licit Drug Consumption

In most countries and jurisdictions, the use of alcohol and tobacco is legal although some have restrictions on where drinking and smoking are allowed. Notwithstanding their legal status, various policies have been developed to contain their misuse. Economic studies have made important contributions to developing tobacco and alcohol abuse prevention policies. The literature has examined a host of licit drug policies including: taxes; restrictions on drinking and smoking in public places or on-campus; minimum legal drinking and smoking age; regulations limiting place and time to sell alcohol and cigarettes; enforcement of drunk driving laws; and label warning of the dangers of drinking and smoking. Given the long-standing legal status of tobacco and alcohol in most countries, there exists a more extensive and comprehensive set of data on the two drugs as compared to illicit drugs. In addition, self-reported surveys attract higher response rates for questions relating to licit drugs compared to illicit drugs as there is no fear of any adverse consequences. Also, drug-related information such as price, excise duties and fines imposed for drunk-driving are typically easily and cheaply obtained from public sources. Against this background, licit drug consumption has been extensively examined over the past couple of decades.

Alcohol

A large body of economic literature has developed over the last few decades on alcohol consumption. Again, most of the earlier research examined *aggregate* demand for alcoholic beverages. Of more interest to policymakers has been the prevalence of drinking, bingeing, and chronic heavy drinking, given that the adverse consequences of alcohol are mostly associated with excessive drinking. There has also been a particular interest in drinking patterns across certain demographic groups such as adolescents, young women in their child-bearing age and the unemployed. With the availability of individual-level data, several of these issues of interest have been examined empirically (for example, Hammer 1992; Sen 2003).

Economic demand studies have generally found evidence of a decline in alcohol consumption in response to demand restriction policies. Chaloupka (1993) carried out a survey of studies which assessed the sensitivity of alcohol use to price changes. He found considerable evidence that an increase in the price of alcoholic beverages could effectively reduce drinking. Pacula and Chaloupka (2001) reviewed studies which examined the impact of price and public policies on alcohol abuse. They concluded that addictive behaviour is sensitive to changes in the full price of drugs, where the full price of a drug reflects not only its monetary cost, but also health, legal and time costs involved in obtaining and using the drugs. More recently, Cook and Moore (2002) reviewed some studies which examined the impact of prices on alcohol use and abuse and alcohol-related problems. They also concluded that excise taxes on alcoholic beverages are effective at controlling alcohol consumption and therefore can be effectively used to promote public health. In addition, they found that other policies such as minimum purchase age, advertising restrictions, and fines and liability laws can also help curb alcohol use and its adverse consequences. Chaloupka et al. (2002) drew similar conclusions from a survey of studies that examined the impact of alcohol prices on drinking and heavy drinking by teenagers and young adults.

The impact of price and other alcohol policies on drinking usually varies by type of alcoholic drinks (Asplund et al. 2007; Clements and Johnson 1983; Nelson 1997; Selvanathan and Selvanathan 2004) and consumption levels (Cook and Moore 1993b; DiNardo and Lemieux 2001; Grossman et al. 1994, 1987; Kenkel and Manning 1996; Williams 2005). The next sections discuss these issues in more detail.

Demand for Beer, Wine and Spirits

Alcohol is consumed in heterogenous product forms. Anecdotal evidence suggests that the three broad alcoholic types—beer, wine and spirits—are consumed by quite different socioeconomic and demographic groups. These user groups, with some distinctive characteristics, exhibit different consumer behaviour. For instance, their price responses are quite different across the three alcoholic types. Generally beer consumption tends to be the least responsive to its price, whereas spirits, more

commonly used by young people, are the most price sensitive. The scarcity of data by specific alcoholic types has restricted economic analyses of beer, wine and spirits separately at individual level. Nonetheless, a few epidemiologists and health professionals have examined the association between demographic and personality traits and individuals' preference for particular alcohol types (see Klatsky et al. 1990; McGregor et al. 2003).

Most economic studies that have examined the demand for beer, wine and spirits individually have used aggregated time series data and a system-wide approach with again, a focus on price elasticities. From an extensive review of the economic literature on the relationship between price and the demand for the three beverages, Leung and Phelps (1993) concluded that the demand for beer was significantly price inelastic while those for wine and spirits were elastic. Similar evidence was found from an earlier survey by Ornstein and Hanssens (1985), but no reliable estimates were obtained for wine price elasticity. In contrast, a few studies have found all three types of alcoholic beverages to be price inelastic (Clements and Selvanathan 1987; Heien and Pompelli 1989; Nelson 1997) of which some have been examined using Australian data (for example, Clements and Johnson 1983; Clements and Selvanathan 1991; Selvanathan 1991).¹ Fogarty (2006); Gallet (2007) and Wagenaar et al. (2009) shed light on this disparate and conflicting literature by showing that most of the variations in the own price elasticity of demand estimates for alcohol could be related to demand specifications, data issues, estimation methods, the level of alcohol consumption, and the ethanol share in the beverages. The results on cross price responses have been equally conflicting in the literature. As a result, there is mixed evidence on the economic relationships across the three types of alcoholic drinks.

Heavy Drinking, Bingeing and Youth Drinking

Heavy drinking and bingeing are of particular interest to policymakers given the adverse outcomes they have on society. Several studies have examined the effect of alcohol policies such as taxes, drink driving laws and alcohol restrictions on heavy drinking and bingeing. In general, these studies have focused on youth drinking. Teenagers and young adults, prone to potentially risky behaviour (Gruber 2001; Markowitz et al. 2005), are of considerable concern to policymakers. Young people are more likely to indulge into heavy or binge drinking which results in a high incidence of motor vehicle fatalities and crime and violence across this segment of the population. Also of concern is the habit forming aspect of drinking—adolescent drinking appears to set the pattern for alcohol use in later life (see Cook and Moore 2001; French and Maclean 2006; Grossman et al. 1998b; Williams 2005). Finally, youth drinking can have some detrimental, and often irreversible, consequences in

¹However, using more recent Australian data, Selvanathan and Selvanathan (2004) has found the demand for spirits to be price elastic.

terms of health, human capital and social status (Cook and Moore 1993a; Dee and Evans 2003; Kenkel et al. 1994; Williams et al. 2003).

The effectiveness of a price policy on adolescents' and young adults' drinking behaviour has been the subject of extensive debate among researchers and policymakers. The price sensitivity of youth drinking, problem drinking and drinking consequences have been examined by a number of economists using a variety of data sets over different time periods. While most studies have agreed that price increases result in a lower frequency of youth drinking and binge drinking (Chaloupka and Wechsler 1996; Coate and Grossman 1988; Laixuthai and Chaloupka 1993; Saffer and Dave 2006; Williams 2005; Williams et al. 2004), the magnitude of the effects has varied across studies. Coate and Grossman (1988) obtained a negative effect of price on youths' frequency of alcohol consumption: the impact being larger for frequent to fairly frequent drinkers as compared to infrequent drinkers. Chaloupka and Wechsler (1996) found that an increase in beer prices led to moderate reductions in both binge drinking and drinking among female youths, but had no effect on males. In contrast, Chaloupka and Wechsler (1996) and Williams and Mahmoudi (2004) found little impact of beer price on youth drinking or binge drinking. Chaloupka et al. (2002) argued that most of the disparities in youths' price response in the literature could be associated with the price measure. They claimed that college students' drinking often takes place at local bars that offer sharply discounted prices to attract college students, or in parties and other social and recreational occasions where alcohol is available at no charge. However, studies investigating youth drinking have generally used state level alcohol prices as a measure of monetary price and neglected the low-cost or no-cost drinking that occurs on frequent occasions.

Prohibition from selling to underaged adolescents has also been recognised as a coercive tool to contain alcohol consumption. Several studies have investigated the effect of the Minimum Legal Drinking Age (MLDA) on alcohol participation, the amount of alcohol consumption and alcohol-related consequences (for example, Coate and Grossman 1988; Dee 1999a; DiNardo and Lemieux 2001; Laixuthai and Chaloupka 1993; Pacula 1998b; Thies and Register 1993). Most of these studies concluded that an increase in MLDA reduces the prevalence of youth drinking, frequency of drinking and heavy drinking.

The use of alcohol restriction policies on campus has also been recognised as an effective means to contain drinking and excessive drinking among youths. Campus bans, restrictions on "happy hours" and on open cans, appear to be significant deterrents to young drinkers (see Chaloupka and Wechsler 1996; Williams 2005; Williams et al. 2005; Williams and Mahmoudi 2004). For instance, Chaloupka and Wechsler (1996) found that restrictions imposed on on-campus bars and the number of outlets selling alcoholic beverages within an institution's proximity, could be more effective in reducing binge drinking than beer taxes. In addition, they showed that more aggressive drink driving policies, such as increasing the probability of arrest and raising the penalties upon conviction for young drunk drivers, could reduce both drinking in general and binge drinking among males.

A study by Manning et al. (1995) appears to be the only one that has examined price responsiveness of alcohol demand for light, moderate and heavy drinkers on the *general population* as opposed to adolescents and young adults. It found that light and heavy drinkers were much less responsive to alcohol price than moderate drinkers. The study also examined how price influenced the pattern of consumption by considering the number of days of heavy drinking for a sample of heavy drinkers. Recognising the small sample size of heavy drinkers, they found such a drinking pattern to be less price responsive than overall drinking.

Tobacco

Over the past few decades, a fairly large economic literature has evolved on the demand for tobacco. The studies have been based on a variety of data and modelling techniques. While economic analyses have predominantly focused on the relationship between price and consumption of tobacco, several studies have examined the effects of other policy tools that can potentially curb tobacco consumption such as fines for smoking in public places, prohibition from selling to underaged and bans on self-service displays of cigarettes in shops (see, for example, Bardsley and Olekans 1999; Czar et al. 2001; Goel and Nelson 2005, 2006, 2012). Other studies have investigated the effects of advertising and promotional activities that encourage smoking (see Hu et al. 1995; Saffer 1998) while a small literature has examined the impact of anti-smoking advertisements or campaigns (Bardsley and Olekans 1999). With the advent of sophisticated econometric models and longitudinal survey data, there has also been a growing interest in recent years in investigating the factors that affect the initiation and cessation of smoking (see, for example, DeCicca et al. 2002; Jones 1994; Kidd and Hopkins 2004). Cigarette smoking has also been examined in the context of gateway theory to test for any gateway effect it may potentially have on the use of other harmful drugs (Beenstock and Rahav 2002; Degenhardt et al. 2010).

Most of the earlier studies have used time-series data aggregated at national or state level. However, in recent decades, economists have increasingly used individual-level data to examine issues that generally cannot be addressed using aggregate data. As in the case of alcohol, policymakers are more interested in the prevalence of smoking and the pattern of smoking, particularly across certain socioeconomic and demographic groups such as youths and the unemployed. The use of unit-level data has allowed them to estimate differential policy responses across those population groups of interest and examine demographic differentials effects useful for the development of public policies (Goel and Nelson 2005; Hersch 2000).

Cameron (1998) and Chaloupka and Warner (2000) and more recently Gallet and List (2003) reviewed the economic literature on cigarette consumption. They found that cigarette consumption was generally price inelastic although the estimates of the price elasticities varied across studies. They argued that most of the disparity in

the estimates of price elasticities resulted from sensitivity to model specifications, data issues and estimation methods.

In recent years, with the development of the rational addiction model and the availability of longitudinal data, a small number of studies have made attempts to model cigarette demand considering the addiction aspect of its consumption (for example, Becker et al. 1994; Chaloupka 1991; Chen and Lin 2012; Gruber 2000; Keeler et al. 1993; Sung et al. 1994; Suranovic et al. 1999). Findings across most of these studies have been consistent with the hypothesis that smoking is addictive and that farsighted smokers reduce their current consumption because of expected increase in future prices.

Youth Smoking

Youths' smoking has been a matter of considerable concern to public health officials and policymakers given the pandemic use of cigarettes in this segment of the population, and its adverse implications in terms of habit formation and long-term health consequences. The earliest of the studies that used individual-level data showed important differential effects in terms of age (Lewit and Coate 1982; Lewit et al. 1981). In particular, these studies found an inverse relationship between age and price responsiveness, at least in the short run. The weak price sensitivity among adults was associated with the addictive nature of smoking. Presumably, long-term adult smokers who get addicted to smoking are less likely to adjust to price changes than youths. They also found that price did not only reduce youth smoking directly but also indirectly through its impact on peer smoking. Chaloupka and Wechsler (1997) contributed to this discussion by arguing that a stronger response by youths is a result of a larger fraction of their disposable income being spent on smoking and a higher future discount rate given their present-oriented attitude. In another study, Emery et al. (2001) investigated whether adolescents' price responsiveness varied by smoking experience. They found that experimenters were not as sensitive to price changes as established smokers were.

Several recent studies on teenage and young adults' smoking using individual-level data have reinforced the evidence of youths' price sensitivity (see Chaloupka and Wechsler 1997; Czart et al. 2001; Goel and Nelson 2005; Harris and Chan 1999; Tauras and Chaloupka 1999). A small body of literature has also examined the effectiveness of tobacco control policies in deterring youth smoking (Chaloupka and Grossman 1996; Chaloupka and Wechsler 1996; Evans and Huang 1997; Tauras and Chaloupka 1999; Wasserman et al. 1991). Workplace smoking bans, restrictions on smoking in public places and limits on smoking in schools have been found to reduce smoking prevalence and intensity while other restriction policies such as minimum legal purchase age and restrictions on vending machines appeared to have little impact on youth smoking. There is also some evidence of differential policy response across demographic groups. Chaloupka and Pacula (1999) and Farrelly et al. (2001a) found price responses to vary by demographic characteristics such as age, ethnicity and socioeconomic background. Chaloupka and Pacula (1999)

estimated significant differences by race in youths' responsiveness to tobacco control policies while Goel and Nelson (2005) found male smokers to be more responsive to indoor smoking restrictions than females.

2.3.2 Illicit Drug Consumption

Illicit drugs impose heavy social and economic burdens on society in terms of negative externalities including the cost of health care and lost productivity. However, due to data unavailability, very little was known until recently on illicit drug use and the impact of drug policies on their consumption. In recent decades, data on illicit drug use have been collected through various surveys although fear of consequences is argued to result in potential underreporting (Del Boca and Noll 2000; Kim and Hill 2003). In addition, unlike licit drugs, price information on illicit drugs are not typically collected and recorded in a systematic way. Nonetheless, a small body of literature has evolved in the last few decades examining the consumption of marijuana. More recently, the demand for some other illicit drugs such as cocaine, heroin and opium has also been examined.

Marijuana is the most commonly used drug after tobacco and alcohol, particularly among youths. Its illicit status has been a subject of continuing debate over past decades. Decriminalisation/legalisation of marijuana entails lowering/eliminating criminal sanctions against the use and possession of small amounts of the drug. A few countries or jurisdictions within some countries such as the US, UK, Portugal, Belgium and Australia have decriminalised or legalised the criminal status of marijuana arguing that prohibition laws do not discourage its use but rather impose substantial financial costs on society at large. They further argue that criminalising the soft drug, widely popular among young people, groups it with other more harmful hard drugs. As a result marijuana users face a greater risk of exposure to sellers of harder drugs and to consumption of harder drugs. On the other hand, opponents contend that marijuana decriminalisation or legalisation decreases the drug's non-pecuniary value and therefore increases its consumption. This discussion has motivated researchers to investigate the effectiveness of removing or softening prohibition laws on marijuana consumption. In earlier studies, the criminal status of marijuana was often used as a proxy for its monetary price in the absence of price information.

The first economic study that examined marijuana consumption was conducted by Nisbet and Vakil (1972) but was based on a small sample collected from one single US institution. Since the 1990s, several studies have modelled the demand for marijuana using nationally representative survey data, but mostly in the US. Cross-state variation in marijuana decriminalisation along with the monetary price of marijuana have been used to capture the full price effect of the drug. Findings on the impact of marijuana decriminalisation have generally been mixed. With the exception of Chaloupka et al. (1999a) who found an increase in consumption following decriminalisation using a sample of youths, studies which have focused

on adolescents and young adults have generally found no significant impact of decriminalisation on marijuana consumption (see DiNardo and Lemieux 2001; Pacula 1998b; Thies and Register 1993; Williams 2004; Williams and Mahmoudi 2004). On the other hand, studies which have examined the impact of decriminalisation on the general population have found evidence of an increase in marijuana consumption (for example, Cameron and Williams 2001; Damrongplasit et al. 2010; Saffer and Chaloupka 1998, 1999; Zhao and Harris 2004). Saffer and Chaloupka (1998) pointed out some important differential effects of decriminalisation with respect to ethnicity. A few other studies have also investigated the impact of marijuana decriminalisation on adverse consequences of drug use, such as traffic fatalities and medical emergencies (see Chaloupka and Laixuthai 1997; Model 1993).

More recently, a small number of studies have addressed the demand for cocaine (Chaloupka et al. 1999b; DeSimone and Farrelly 2003; DiNardo 1993; Grossman and Chaloupka 1998; Saffer and Chaloupka 1998, 1999), all of which have focused on adolescents and young adults. With the exception of DiNardo (1993), all others found cocaine demand to be price sensitive. DeSimone and Farrelly (2003) observed a price response only among adults but not juveniles. There exist even fewer studies on heroin (see Dave 2006; Saffer and Chaloupka 1998, 1999; van Ours 1995) or opium (van Ours 1995) consumption.

A small body of literature has examined the effect on illegal drug use, of drug policies such as fines and jail sentences for possession, arrests rates and police enforcement (see DeSimone and Farrelly 2003; Farrelly et al. 2001b, 1999; Williams 2004). Chaloupka et al. (1999b) found that while sanctions for sale, manufacture or distribution of cocaine and marijuana had little impact on young cocaine and marijuana users, increased sanctions for their possession discouraged the use of both drugs. However, the magnitude of the estimates implied that very large increases in monetary fines were required to achieve meaningful reductions in use. Farrelly et al. (2001b) and DeSimone and Farrelly (2003) found evidence that higher fines for marijuana possession and increased probability of arrest decreased the probability of marijuana consumption among youths. A few studies have also examined the demographic differential effects related to illegal drug use, highlighting the impact of factors such as age, gender, education and ethnicity (Cameron and Williams 2001; Pudney 2004; Saffer and Chaloupka 1998; Williams and Mahmoudi 2004). Saffer and Chaloupka (1998) pointed out that the demographic pattern for marijuana use was rather similar to that of alcohol but different from those of cocaine and heroin.

2.4 Cross-Drug Relationships

The use of a drug cannot be considered in isolation from other drugs given that their consumption is potentially related. It is often argued that drug policies intended to discourage the use of one drug can also impact on the use of other related drugs.

For example, increases in the minimum legal drinking age or higher alcohol excise taxes, intended to deter alcohol consumption can signal societal disapproval for all drugs, not only alcohol. Similarly, advertisements to promote the use of one drug can also increase the use of their economic complements but discourage the use of their economic substitutes. This has led researchers to investigate the nature of economic relationships among the various drugs. Such findings have been potentially useful to policymakers to anticipate policy effects of one drug on the use of other closely related drugs and thus better coordinate drug policies. For instance, if cigarettes and alcohol are economic complements, public policy needs to check consumption of only one drug to reduce consumption of both.

Economic relationships between commodities are central to microeconomic consumer theory. They are determined using the sign of the cross price derivatives derived from Hicksian demand functions. Where individual-level drug data have been examined using discrete choice models, the economic relationships between drugs have been determined directly using the signs of the cross price coefficients or marginal effects. The literature has shown conflicting findings on economic relationships across drugs. Dee (1999a) examined the relationship between youth alcohol and cigarette consumption and found the two legal drugs to be economic complements. Similar results were obtained by Cameron and Williams (2001) and Zhao and Harris (2004) for the broader population while Goel and Morey (1995) found the two drugs to be substitutes in consumption. On the other hand, Picone et al. (2004) observed that cigarettes and alcohol are economic complements for those individuals who consider drinking or smoking as a source of pleasure or a stress reliever, but the two drugs act as economic substitutes for social drinkers and smokers. Decker and Schwartz (2000) found mixed evidence on the relationship between alcohol and cigarettes where both drugs were found to be substitutes in levels of consumption but an increase in alcohol price led to lower smoking participation.

Policymakers have been particularly concerned about the unintended effect that legal drug policies can have on the use of illicit drugs which are much harder to regulate. There has also been concern that decriminalising a soft drug such as marijuana may result in an increased use of harder drugs such as cocaine and heroin. Several studies have examined the economic relationship of marijuana with *alcohol* (Cameron and Williams 2001; Chaloupka and Laixuthai 1997; DiNardo and Lemieux 2001; Farrelly et al. 1999; Model 1993; Pacula 1998a,b; Saffer and Chaloupka 1998, 1999; Thies and Register 1993; Williams and Mahmoudi 2004; Williams et al. 2004; Zhao and Harris 2004); *cigarettes* (Cameron and Williams 2001; Farrelly et al. 2001b, 1999; Zhao and Harris 2004); *cocaine* (DeSimone and Farrelly 2003; Saffer and Chaloupka 1998, 1999; Thies and Register 1993); and *heroin* (Saffer and Chaloupka 1998, 1999). While there seems to be ample evidence that marijuana is an economic complement for tobacco, cocaine and heroin, studies that have examined the relationship between marijuana and alcohol have yielded mixed results. Most of the earlier studies that have used the legal status of marijuana as a proxy for its price have found marijuana to be a substitute for alcohol. However, the more recent ones which have also accounted for the monetary price of marijuana

and which are based on more recent data, have found evidence of complementarity between the two drugs.

The conflicting findings in the literature on cross drug relationships arise for several reasons. Pacula (1998a) attributed them predominantly to the potential endogeneity of control variables such as income, education and marital status; the lack of monetary prices in the estimation of demand equations; and the estimation of drug consumption in isolation. DiNardo and Lemieux (2001) also made an attempt to explain the conflicting results across studies. They attributed these differences broadly to the inclusion of potentially endogenous regressors, model specifications and sampling errors. Saffer and Chaloupka (1999) suggested that the conflicting findings across studies on the effect of marijuana decriminalisation could be attributed to the age of the cohorts being considered.

2.5 Econometric Approaches

The literature shows that studies which have examined drug consumption at an individual-level have mostly used discrete choice models. The use of such models has been driven by the categorical nature of the consumption data obtained from surveys. The decision to participate in drug consumption has generally been estimated using Probit or Logit models (see Cameron and Williams 2001; Chaloupka and Laixuthai 1997; Chaloupka et al. 1999b; Chaloupka and Wechsler 1996; DeSimone and Farrelly 2003; Farrelly et al. 1999; Saffer and Chaloupka 1998; Sen and Wirjanto 2010). Where researchers have estimated categorical levels of drug consumption, Multinomial Logit or Ordered Probit models have predominantly been used (Chaloupka and Wechsler 1996; Coate and Grossman 1988; Laixuthai and Chaloupka 1993; Williams et al. 2005). A few studies have modelled drug demand using two-part models where, in the first stage the decision to participate in drug use is estimated using a Probit/Logit model and in the second stage, the conditional amount of drug consumed is estimated using some form of linear regression model for continuous measures of drug use (Chaloupka et al. 1999a; Farrelly et al. 2001b; Manning et al. 1995; Pacula 1998b) and Ordered Probit models for categorical measures (Williams 2004). A few others have estimated tobit-type models to account for data censoring (Pacula 1998a; Thies and Register 1993; Williams 2005) or instrumental variable methods to address endogeneity issues (Dee 1999b; Picone et al. 2004).

Most economic studies on drugs have used a univariate approach, estimating drug consumption equations individually. However, this approach ignores the potential cross-commodity correlations across various drugs for the same individual that are potentially induced through unobservable characteristics such as personal tastes, addiction and risk-taking attitudes. Those few studies that have used multivariate techniques to estimate drug consumption (DiNardo and Lemieux 2001; Williams et al. 2004; Zhao and Harris 2004) have mostly focused on marginal probabilities of drug use, failing to fully explore the multivariate aspects of the model. The most

attractive feature of these multivariate models is that they can be used to model joint and conditional probabilities. For instance, the multivariate models provide information such as how being a smoker increases the probability of consuming marijuana or how being a hard drug user relates to a very high probability of marijuana use. The estimation of policy effects and other socioeconomic and demographic differential effects on such joint and conditional probabilities can provide important policy information, in particular on multiple or polydrug² use.

2.6 Data Issues

Until the 1980s most studies that examined the relationship between price and drug consumption were based on time-series aggregated data. Individual level surveys appeared to be very scarce at the national level and were mostly conducted on a small scale in localised areas. The late 1980s and early 1990s saw the first studies that examined drug use using nationally representative individual-level survey data. These came predominantly from the US, most of which focused on a particular segment of the population, mainly youths and young adults. Cross-sectional and longitudinal surveys, such as the National Health and Nutritional Examination Survey (NHANES), the Monitoring the Future (MTF) survey and the National Longitudinal Survey of Youth (NLSY), were the few early sources of individual-level data providing information on drug use in the US.³

It is generally argued by researchers that studies which use individual-level data yield more precise estimates of price elasticities given that they consist of individual amounts of drug consumed by subjects. Studies based on individual-level data and time series aggregate data have often produced inconsistent results. Leung and Phelps (1993) observed that studies based on unit-level data estimate a much higher price response than those which use annual time-series data, mainly because they can capture differential price responses of individuals from various demographic groups.

Studies that use state or national data can only provide average (per capita) or total drug consumption. However, very often policymakers are interested in examining the prevalence of consumption and heavy drug consumption. Such issues cannot be addressed using aggregated state or national level data. In addition, unit-level data allow policymakers to examine price responses and policy effects which may potentially vary across a sub-population by demographic characteristics such as

²Wilkinson et al. (1987) define polydrug users as “users of a variety of psychoactive substances, either concurrently or sequentially”. These can include licit and/or illicit drugs.

³The NHANES has been conducted since the early sixties on all segments of the US population. The MTF was first introduced in 1975 and collects data on American secondary school students, college students, and young adults while the NLSY is a longitudinal survey which first begun in 1979 and collects information on American teenagers and young adults.

age, gender and ethnicity. For instance, it is useful to find out whether the beneficial effects of a tax increase or some other drug policy, will be shared equally by all or whether specific policies are required to curtail drug abuse in certain sub-population groups. Blanket policies that fail to take into account such differences are very likely to prove ineffective and economically inefficient. The estimation of socioeconomic and demographic differential effects also provides vital information for designing anti-drug campaigns and educational programs. In particular, such information can help develop more efficacious counseling services and information services by targeting those population groups where drug use is more prevalent.

However, using individual-level data does have some limitations. They are typically obtained from cross-sectional surveys which measure individuals' drug consumption at the time of the survey. As such, price elasticity does not reflect individuals' response to a change in price but rather the effect on consumption resulting from a variation in alcohol prices across various states or geographical areas where individuals within the same state or geographical area face the same price. However, since individual-specific price information are rarely available, state level data are commonly used in such studies. Theoretically, the use of panel data addresses this problem but given that the time dimension of panel data is usually small, the variation in prices is likely to be insufficient to accurately measure price elasticities.

The reliability of self-reported surveys has often been questioned in the literature. Self-reported surveys have some inherent measurement errors and often tend to understate actual consumption (see Dave 2004; Harrison and Hughes 1997; Hoyt and Chaloupka 1994; Skog 1992; Wechsler and Kuo 2000). In addition, national surveys do not usually consider consumption by the homeless and prison inmates who generally have a high incidence of drug use and may potentially behave differently from the population at large. In fact, these individuals are much more likely to be hardcore users than those selected at random from the non-institutionalised population.

2.7 Summary

Economic research can make valuable contributions to drug policies and intervention programs by disseminating their research findings to policymakers, health professionals and consumers. This chapter has reviewed some of the theoretical and empirical economic literature on drugs focusing on studies that have modelled their consumption. The empirical literature on licit and illicit drug consumption is reviewed separately, examining the effects of drug policies and demographic factors. Cross-drug relationships are then discussed in the light of empirical evidence gathered from the literature. Finally, the chapter gives a brief discussion of issues related to data and modelling approaches, highlighting the importance of using individual-level data and multivariate techniques to examine drug consumption.

The above review has often showed conflicting and disparate findings across studies. Thus, further investigation of drug issues is required using more comprehensive drug data and enhanced modelling techniques that would provide additional empirical evidence or reinforce existing findings. In addition, most of these findings are based on US data and may be inappropriate to formulate policies for the Australian population given disparity in tastes and demographic factors.

The literature review also shows that there is an abundance of studies on licit drugs. In contrast, research on illicit drugs is sparser mainly due to data unavailability. Notwithstanding the growing popularity of other illicit substances such as cocaine, heroin, and amphetamines, the majority of illicit drug studies have focused on marijuana. This book investigates a selection of licit and illicit drugs using a comprehensive drug data set and advanced econometric techniques. The case of Australia is an interesting one for several reasons. Firstly, the availability of a rich dataset and price information enables to explore economic relationships across the various legal and illegal drugs, findings which are a first in the literature. Moreover, the study provides a good understanding of the various socioeconomic and demographic factors that are associated with a range of drugs including heroin and amphetamines, which have not quite been explored in the literature. Secondly, Australia is among the few countries in the world which has decriminalised the use of marijuana, albeit a recent experience. The findings in this book thus contribute to the small body of evidence on the effect of decriminalisation on drug use. Thirdly, Australia has a good record of success in tobacco control with a gradual decline in the smoking rate over the years. A battery of anti-smoking policies have been implemented across the years including a gradual increase in cigarette taxation. This study investigates the effectiveness of price policies with regard to smoking. Finally, per capita consumption of alcohol in Australia is among the highest by world standards. Australia also has a drinking culture that is similar to that of the U.S. with a high number of people, in particular teenagers, engaging into excessive drinking. This study investigates the relationship between drinking patterns and earnings, looking specifically at binge drinking behaviors.

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