ECONOMICS OF ADDICTION & DRUGS

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Second draft of the State of the Art Science Review for the Foresight Project on Brain Science, Addiction & Drugs.

February 2005.

Executive Summary

- There are many misconceptions about the consumption and control of illicit drugs, including that: drug users are unresponsive to price; controlling licit substance use may encourage young people to switch to illegal drugs; availability controls are likely to be more effective than measures to reduce demand. Economics provides both theories and empirical evidence to explore factors influencing current drug use, the costs to society of the harm they create and the cost effectiveness of different policy options. This review contains a brief overview of the economics of illicit drugs in three sections: economic theoretical models and their uses; empirical evidence on the size of the UK market, the economic costs of drug use and the factors influencing supply and demand; and the cost-effectiveness of policies. The final section sets out economic models of drug diffusion. This summary sets out results of this review in addressing the foresight questions.
- ***What will be the psychoactive substances of the future?*** Economists do not have the answer to this question but can provide insight into how the markets for different drugs may ebb and flow. In particular the importance of social factors is considered alongside economic incentives such as price and income to yield more comprehensive and complex models of current and future behaviours of both consumers and suppliers of drugs. An important aspect of this work is how the distinction between different groups in society may lead to different demands for policies, the richer groups being potentially more demanding of restrictions and different experience of problems, the poor generally bearing more of the costs of drug use. Other distinctions – for instance among age groups or cohorts – may call for cyclical or adaptive policies. The analysis of drug adoption also provides a way to translate the characteristics of future substances in terms of impact on the individual (e.g. onset and persistence of habit formation, spillover effects on cognition, productivity, taste for other drugs, decision making, etc.), social groupings (e.g. user group cohesion, stability and isolation, potentiation or attenuation of peer pressure and peer learning, etc.) and markets (e.g. gateway effects, height of entry barriers - including technological sophistication or control of key inputs, etc.) into future trajectories of use and effects. The models can also predict whether new drugs will drive out existing ones or find a niche in separated or polydrug-using clusters.

- ***What are the effects of using psychoactive substances?*** The economic impact of problem drug use is sizeable, with Class A drug users estimated to generate social costs of £12 billion in 2000. These effects are spread across individuals, families, communities and society more generally. The problematic user rather than the occasional user seems to be responsible for the majority of these costs but this may partly reflect data deficiencies, such as the difficulty of identifying regular drug use effects from the data or correcting over-sampling of problem drug user in impact surveys and under-sampling them in use surveys. Also, for novel drugs longer-term health and dependency impacts associated with such problematic use may take some time to emerge. Governments may need to adopt a precautionary approach to any drug with a dependence potential. The theoretical demand models also shed light on how

social groupings, information, economic constraints and policy affect drug use choices by affecting perceived costs and benefits, and by triggering simplified or myopic decision making. In addition, the models highlight the social character of dependence and of problems associated with use.

- ***What mechanisms do we have to manage the use of psychoactive substances?*** In a departure from conventional wisdom, both economic theory and empirical evidence suggest that drug prices influence demand. Also there are a number of complementary relationships between licit and illicit substances. This suggests policies can be devised to affect individual behaviour. Controlling supply has proved harder to implement and theoretical models highlight a number of reasons for the sometimes seemingly contradictory outcomes from the application of narrow policy options without an analysis of the complete market interactions. Policy effects may well be localised and insignificant in the short run, but much more substantial after network effects and societal evolution have taken hold. They should be measured in longitudinal terms. Where effective treatments exists, this approach has been shown to be cost-saving to society but the incentives for commercial firms to develop effective treatments for novel drugs may be lacking until serious and sizeable problems have begun to emerge. The analysis suggests that gateway and cross-drug effects are significant, but also potentially reversible so that policy should be both targeted on the most cost-effective drugs and patterns of use and adaptive to emerging evidence on changing prices and habits. Economics also suggests that drugn use follows punctuated and/or cyclical paths, and thus that policies should 'lead' or 'follow' the cycle. The analysis suggests that policies should be conceived and co-ordinated in terms of their effects on the decisions underlying the development of drugs markets and problems: prices, risks and perceptions of them; uncertainties regarding supplies, returns and quality; peer pressure and peer learning about drug 'reputations'; and contextual 'cues' that affect individual decisions in the face of policy and other constraints. Finally, the analysis suggests that policy should take account of and try to influence structures on both the supply and demand sides of the market, if only to avoid such 'rebound' effects as the social isolation of drug-using clusters or inadvertent support for suppliers' attempts to limit entry and enforce market discipline.

1 INTRODUCTION

The current consumption of both licit and illicit drugs is seen to have a range of economic impacts and there is general concern about costs arising both as a result of their use and from policy measures such as enforcement, education and treatment, put in place in an attempt to reduce these problems. However, economics has a set of tools whose application goes beyond simple valuing of the extent of the problem. This review aims to explore economics' role in explaining changes in drug use, predicting expected and unexpected impacts of policy changes and evaluating the overall worth of different policy options. In particular, can any of these tools help in the analysis of future trends, the impacts of new drugs and what potential policy levers to alter future drug use patterns?

Many economic tools and analyses are common to licit and illicit goods but illicit markets and their participants' behaviour - especially where addictive goods are concerned - do have some special features. Thus we take the economic analysis of licit drug markets as read and focus on illicit drugs. However, good data on illegal markets are hard to obtain and useful insights can be drawn from theory and empirical analysis of legal addictive goods such as alcohol or tobacco. Also, some studies have explored interactions among licit and illicit markets – in particular, whether changes in restrictions on the use of legal drugs such as alcohol and tobacco affects the demand for or supply of illicit goods. The review therefore reflects some of this wider literature.

The paper is divided into five further sections. Section 2 gives a brief overview of novel and specific models of addictive goods and their potential for explaining both drug use patterns and the impact of different policy options. Existing empirical studies of: the size of the UK market; the costs associated with drug problems; and factors that influence consumers and suppliers of illicit drugs; are reviewed in the third section and conclusions drawn regarding implications for future trends. The fourth section reviews the empirical literature on cost effectiveness of different policy instruments with a view to reaching indicative conclusions about future options.

These three sections bring together existing knowledge. The fifth section speculates about how embedding the most novel theories in social models could be more useful in exploring scenarios about the future diffusion of new and existing drugs and resulting consequences and policy options.

2. THE ROLE OF ECONOMIC THEORY IN EXPLAINING DRUG USE, ITS PROBLEMS AND THE POTENTIAL EFFECTIVENESS OF POLICIES.

2.1 The Basic Economic Model and its Application to Addictive Goods

Economics is built on demand and supply, determined by rational, informed (but constrained) choice and reconciled by markets. In making choices, rational consumers are expected to take all current and future costs and benefits of their actions into account. However, consumers generally are not expected to take account of: the impact of their actions on others; the external costs (or benefits) of their choices. External costs make market clearing consumption higher than is socially optimal. There is potential for government intervention to improve overall welfare, providing its costs do not exceed its benefits, by reducing external social impacts and/or helping economic agents to internalise them.

Addictive goods challenge this simple model in two ways. Most attention has focussed on the nature of choice and rationality. An extreme model of addiction would leave users without effective choices about thus insensitive to changes in economic circumstances of price or income. The rational addiction model (Becker and Murphy, 1988) explored below is an attempt to find a middle ground, suggesting how consumers can rationally pursue their welfare even if they are aware of the nature of dependence and how this may influence their future choices. The second issue is the role of information about potential future consequences of addictive substances, both existing and novel drugs with dependence potential. The risks of some licit drugs such as cigarettes may be relatively well known, but just how informed are consumers about risks of other licit drugs such as alcohol, illicit drugs that have been available for a number of years and novel drugs with an unknown risk potential?

If consumers are both aware of adverse consequences and not addicted, only if there was evidence of external costs would there be potential for government intervention to increase overall societal welfare - see Table 2.1. However, lack of information about adverse consequences creates a need to include some private costs in decisions about government intervention. It could be argued that 'non-rational' addicted consumers are not getting optimal utility from their consumption and therefore diverting productive resources could increase overall welfare. Clearly one issue raised by novel substances or indeed novel consumption patterns is the difficulty of estimating potential longer-term effects, particularly on individual health but also on dependence potential. The continuing debate about the potential effects of marijuana illustrates these difficulties. In a recent overview Pacula (2005) argues that accumulating evidence of the impact of marijuana on educational achievement translates into reduced future earnings as well as costs of treating health related consequences of those, albeit a small proportion, developing a dependency problem.

Table 2.1: Which costs count under different assumptions?

	Addicted	Not addicted
Unaware of adverse consequences	Private + external costs + production resources	Private and external costs
Aware of adverse consequences	External costs + ? (dependent on views of rationality of addiction)	External costs

Source: Buck et al, 1996

Table 2.2 illustrates a range of potential economic impacts of drug use and groups in society who may bear some of its costs. Within the economic model, costs falling on families and carers are often treated as "private" but the nature of dependence - particularly severe dependence - would suggest that normal models of agreed intra-household choice do not apply. A number of other issues influence the distinction

between private and external costs. The basic economic model takes an individualistic approach to consumption decisions. However, as explored in the rest of this review, economic models of collective behaviour take account of the interactions between individuals. This has some parallel in the debate about whose costs count. If individuals "care" about the impacts of drug use on others, this may affect social welfare and how societies value different consequences of addictive behaviour. In particular, what value is given by society to the risks of death from drug taking? Should part of this and other individual values form part of the "costs" of drugs to society that prompt government action? These economic models of whose costs count do not determine the choice and level of different government policies in different drug markets but they can help make explicit some assumptions being made in often-simplistic debates especially about the legal status of different drugs. They also provide a framework for scenario analyses to explore the potential impact on overall social welfare. The evidence that has attempted to put values to some of the internal and external costs of illicit drugs in the UK is reviewed in Section 3.

Table 2.2 Economic impacts of drug use

Bearer of Cost	Examples of impact
Users	Premature death
	Loss of quality of life – mental and physical health; relationships; etc.
	Impact on educational achievement, training opportunities etc
	Excess unemployment and loss of life time earnings
Families/carers	Impact on children of users
	Transmission of infections
	Intergeneration impact on substance use
	Financial problems
	Concern/worry for users
	Caring for substance users or substance users' dependants
Other individuals directly affected	Victims of drink/drug driving and other accidents; substance related violence; substance related crime
	Transmission of infections from substance users

Bearer of Cost	Examples of impact
Wider community effects	Fear of crime
	Environmental aspects of drug markets – needles, effects of drug dealing in community etc.
Industry	Sickness absence
	Theft in the workplace
	Security expenditure to prevent substance related crime
	Productivity losses
	Impact of illicit markets on legitimate markets
Public sector	Health care expenditure
	Criminal justice expenditure
	Social care services
	Social security benefits

2.2 Addiction, choice and demand for illicit drugs

In essence, rational choice means that each actor has a feasible set of options – determined by constraints – that can be ranked according to preferences. Personal choices involve such matters as consumption (of licit and illicit goods and services) investment (in the form of savings, education, etc.) and supply (particularly labour supply and criminal activity). The points of analysis – where economics touches issues relating to psychoactive substances – involve:

- The preferences themselves –how past consumption affects preferences, the accuracy with which choices are assessed, the rate at which the future is discounted, preferences for investment and supply as well as consumption, consideration (if any) of externalities, etc.
- The feasible set – prices and income (returns to investment and supply activities)
- Income-generating activities
- The choice process – this includes time-consistency, the influence of context and cues, alternative models of 'addictive choice' and the handling of risk, uncertainty and incomplete information.

A variety of models explore individual choices to consume drugs and undertake other actions associated with drug-taking (such as crime). All these models establish connections between behaviour and economic influences (e.g. price, purity, etc.). But they differ in the nature of these connections, and thus in predictions regarding new drugs, and importantly policy impacts. They also differ in consistency with neuroscience, psychology and empirical evidence.

These models attempt to reconcile the economic basis for choice behaviour with a series of stylised facts about drug-taking and other forms of 'addiction.' Among the characteristics that such models should explain are:

- Users do not follow monotone behaviour patterns – they frequently abstain for short periods but relapse in the long run[1].
- Users often develop compulsive use patterns even when prolonged use reduces or reverses the hedonic benefits of drug-taking. This 'hedonic tolerance' is sometimes described as a series of unsuccessful attempts to recapture a remembered pleasure[2] or as a transfer of utility from the effects of drug-taking to the act itself.
- Both consumption and relapse are often triggered by contextual cues. Success in quitting is enhanced by a marked change of circumstance or acquaintances; conversely, heavy relapses can be triggered by a 'priming' exposure to even very small doses[3].
- Users often recognise their behaviour as a mistake, but see themselves as lacking self-control. In other words, they believe they would have been better off had they not taken drugs – in the past as well as the present and future, and even in the absence of learning.
- Users often resort to pre-commitment strategies to control their behaviour, for example by consuming other drugs that block or interfere with the pleasurable aspects of their drug of choice, or entering treatment or rehabilitation centres.
- Drug use responds to economic factors, such as price and information about the consequences of drug-taking, though the extent and timing of this response may be

[1] Goldstein (2001), O'Brien (1997), Trosclair *et. al.* (2002)
[2] Hyman and Malenka (2001)
[3] Goldstein (2001)

problematic. According to evidence produced in the rational addiction literature[4], there is evidence of forecasting as well – with users reducing current consumption to limit vulnerability to anticipated future price increases.

- Drug use is affected by the attention paid to consumption choices. For instance, recovering addicts can overcome temporary cravings if they are reminded of adverse effects at the time – even when they are well aware of these effects. Conversely, distractions that mask such knowledge (e.g. rave environments) can increase the likelihood of use[5].
- Finally, there are strong and systematic differences in patterns of use and response to environmental changes across different drugs, methods of administration and individuals.

Many models of addiction use – or modify – standard rational choice models. This section briefly describes some main variants and their implications for use of psychoactive drugs – and the response of such use and associated effects to market and policy changes.

The rational addict model (Becker and Murphy, 1988) asserts that drug use, like other behaviour, forms part of a solution to a global expected lifetime utility maximisation. Preferences (even time preference) may change in complex ways as a result of past behaviour, but the rational agent takes this into account by working backwards from all possible ends of life. In this view, drug taking is an individual problem in the absence of prohibition and the only societal problems arise from externalities. Drug-taking thus enhances welfare (at least *ex ante*) and externality problems can be dealt with by suitable government action.

This model does not imply that 'rational' addicts are happy with the choices they've made and the life they lead. Welfare improvements are only expectations, and many

[4] Gruber and Koszegi (2001)

[5] This suggests that attention-management strategies may be a useful adjunct to addiction therapies, and also that there is value in information-exchange activities even when the message is not 'new.' Of course, an overly-familiar message may not attract attention.

may well 'lose the gamble' they've undertaken. Nevertheless, on aggregate the 'winners' could compensate the losers and still have enough left over for a risk premium. In other words, these models are consistent with exogenous shocks and with state-contingent preferences[6].

The empirical predictions are quite strong. Users should: seek out the lowest-cost way of meeting their demand; discount the future geometrically at the same rate for drugs and for all other goods (with no 'preference reversal'); be risk-averse (because expected utility is concave); have no problems of self-command (doing things that they expect to regret); and thus have no need to "play games against their future selves" as Schelling (1980) puts it.

The model has been extended to account for observed behaviour (MacDonald, 2004). This includes the inclusion of learning and regret and endogenous determination of time preference. Experiments show that heroin produces higher rates of time preference (discounting) than other reinforcers. Ex-addicts report a fear of relapse, and treatment by managing contingencies is effective even when the monetary rewards are far smaller than the costs of the drug habit (Bretteville-Jensen, 1999).

Other models invoke time-inconsistent preferences – typically by biasing utility towards the present, for instance via hyperbolic discounting[7]. In such models, small, immediate rewards may be preferred to later – but more substantial – rewards for only a short period before they are available. Choices made in advance will tend to favour deferred rewards. Under these conditions, pre-commitment strategies that remove the power to revisit choices or mask cues that might raise the possibility of choice are in the individual's long-term interest. Individual strategies may be consciously economic (e.g. by limiting the discretionary spending power of vulnerable persons, social (by choosing a different group of friends or living situation) or cognitive (e.g. by making consumption choices more deliberate – and thus sensitive to scientific information – and limiting impulse purchases). Consumers may rationally demand

[6] Laibson (2001)
[7] O'Donaghue and Rabin (1999, 2000), Gruber and Koszegi (2001).

government action to reduce their choices. Becker et al (2004) recently extended this welfare analysis to suggest that restrictive policies, such as prohibition, could be preferred by the rich and that such policies' costs fall disproportionately on the poor.

These models are all based on changing individual preferences. A different approach considers changes in the way individuals perceive choice situations and translate preferences into actions. A simple and tractable approach, largely consistent with neurological science and the stylised facts above, incorporates different cognitive states, triggered by cues in the environment in ways that reflect past experience. In 'cold' states individuals take a wide range of information into account and behave in 'rational' ways, characterising decision problems using attention, foresight and memory. In 'hot' cognitive states individuals' decisions are simplified by ignoring some alternatives or consequences of the choices under consideration. Such 'shortcuts' are not inherently either irrational or suboptimal – the brain is a finite mechanism, and cognitive decisions can have substantial opportunity in terms of other decisions and activities. Hence, many repeated behaviours are reduced to routines chosen by rough-and-ready rules of thumb, backed by 'wake-up rules' that identify situations where explicit decisions are needed. These rules are, in general, products of experience and learning rather than design[8]. They are thus shaped by emotional states, which are in turn triggered by contextual cues shaped by prior experience (cue-conditioning). Applying these rules gives an attenuated form of learning, in which individuals may try to avoid cues associated with failed decisions, use precommitment to rule out dangerous alternatives, desensitise themselves to specific cues (or consequences) or develop self-management strategies for coping with emotional states[9].

Melioration models[10] analyse both utility and characterisation in an attempt to reconcile compulsive aspects of drug taking (consistent with a disease model of

[8] In particular, Barkow *et. al.* (1995) suggest that these rules were formed through processes that evolved in a world that differs systematically from ours in terms of which decisions can be made slowly and which require rapid responses.
[9] This approach can help to explain certain discrepancies in the rational model – for instance the gap between what people know and what they apparently believe (as inferred by their actions) and the gap between wanting and liking (Robinson and Berridge (2000)).
[10] Herrnstein and Prelec (1992), Heyman (2003).

addiction) and its responsiveness to prices, adverse effects, etc. (consistent with learning and rational addiction). The analysis is based on four observations. First, repeated consumption decreases future values of both the drug and competing activities. Second, the frequency of an activity depends on its *relative* attractiveness, so drug-taking that makes alternative behaviours less attractive can increase even if its own utility declines. Third, psychological experiments[11] suggest that reinforcement is relative to a frame of reference, which can change so as to favour sub-optimal choices. Fourth, local (global) frames of reference favour excessive (controlled) drug use.

These models differ in tractability, face validity, the clarity with which policy effects are rendered and the concreteness of their predictions. These models reinforce the potential role of price and other incentives, including enforcement, in patterns of use - predictions that would not hold in "non-rational" models. However, they also point to complex interactions of factors over time and can illustrate certain counter-intuitive phenomena. Also the economic basis for policy analysis need not be inconsistent with psychological and neuroscientific models of addiction

Theories of drug use tend to be somewhat generic, treating substances in the abstract. Of further interest is the relationship between different drugs. Some substitutability within classes of drugs (e.g. stimulants, depressants) may be expected. If prices of one depressive drug rose, consumers would switch to a lower price substitute. However, the empirical literature suggests more complementarity and there has been an observed rise in poly-drug use. Complementarity among drugs creates analytic problems for microeconomic analysis and can lead to equilibria that are inefficient, dominated by one or a few drugs, or that fail to exist at all.

A second phenomenon is the so-called "gateway effect[12] whereby initiation into one substance leads to the use of another. This suggests targeting patterns for enforcement activity; it may be more efficient to target the gateway drug (or activity) than the

[11] Heyman and Tanz, 1995
[12] DiNardo and Lemieux (1992), Chaloupka, Grossman and Tauras (1997), Pacula (1997)

eventual drug. However, 'rational addiction' models of polydrug abuse suggest that this effect could be reversed, depending on the relative attractiveness of either drug to novices user as well as any asymmetric spillover from using one drug to using another. Therefore, changes in relative alcohol and cannabis prices, for example, could lead to their changing places as gateway drugs to each other or to 'hard drugs.' Similarly, where peer group effects are important, gateway trajectories may differ among groups for purely fortuitous reasons.

2.4 Supply and markets

Supply side points of analysis involve:

- Underlying motivation – usually assumed to be profit maximisation, but others – e.g. political or ideological motivations – may require different treatment.
- Available 'technology' for turning inputs into output. Inputs include raw materials, labour, capital, etc., but also complementary activities such as (for illicit substances) money-laundering, intimidation of rivals, corrupt services and other means of managing law enforcement risk, etc.
- Investment.
- Financial constraints.

The 'supply chain' stretches from international or source-country supply, processing, transhipment and money-laundering markets to domestic wholesale and retail (even street-level) markets. At street level market level the separation of supply and demand breaks down; user/seller activity may best be modelled as a rational way to reduce the cost of obtaining drugs.

The supply chain can be analysed in terms of:

- Structure – in particular the degree and distribution of market-power both upstream and down. This measures the extent to which market players are able to control their environment, and thus the degree to which deep pockets or other forms of influence may immunise them from policy impacts or even allow them to exploit policy to limit competition.

- Conduct – suppliers of (especially illicit) substances have a range of strategies at their disposal. Many of these (e.g. predatory behaviour, use of violence, bribery, etc.) are of direct policy concern.

Drug markets have different supply-side and market dynamics from conventional markets and other illicit markets in terms of turnover, price and quality variability, violence, corruption and the extent of rents and social costs. Both illicit and licit drug markets are prone to concentration, but for different reasons and with different likely effects on deadweight loss, production efficiency and the pace of innovation. Unavailability of legal channels for dispute resolution may predispose illicit drug markets to violence and/or corruption. This is reinforced on both sides: law enforcement pressure may reduce incremental expected costs of violence in combination with drugs offences and costs of violent market regulation may make corruption more attractive.

The general tendency to concentration has some important drivers. For instance, law enforcement pressure may control new firms' entry and accumulation of 'learning economies.' In addition, it limits consumer search and thus temptations to renege on cartel agreements and *can* make punishments more credible. On the other hand, the threat of disruption at any level of the market makes one-to-one connections risky, so monopoly is, on the whole, less likely and less resilient than oligopoly.

The legal risks that inhibit price search also reduce the effectiveness of consumer recourse and reputations in promoting quality, so competitive forces may well produce low prices and variable quality. The conventions of supply (e.g. fixed prices for unobservable 'doses') mean that supply shocks are transmitted to those least able to bear them. This may magnify adverse health consequences.

Such detailed analysis of supply models can help explain many observed but seemingly contradictory outcomes of policy initiatives. Adequate models of supplier

behaviour are essential to mapping future consequences of existing and emerging drug markets.

2.5 Conclusions

What are the psychoactive substances of the future?

Economic models do not provide much insight into what potentially may be the substances of the future but may provide the framework to explore the both the factors that influence use and the relevance of different consequences to policy decisions. There is a growing literature on the dynamics of drug-taking behaviour and associated harms and optimal policies. The approaches can be divided between representations of individual drug-taking decisions and models of collective behaviour. Individual economic models have been expanded to cover many of the characteristics observed in addictive behaviour. They provide predictions about the impact of changes in prices and also provide some guidance as to the economic legitimacy of restrictive government policies. They also help explain some of the observed unanticipated consequences of policy actions. The potential to analyse these full ranges and interactions of policy changes, suggest an important role for economic modelling in future scenario analyses.

Existing collective models recognise the crucial importance of social interactions for intentions with regard to drugs and the eventual result of acting on those intentions. The prevalent form of collective modelling likens drug use to epidemic disease. Choices about drugs are strongly influenced by information and incentives from interactions with peer groups, educators, medical personnel, mass media, authority figures, etc. These influence all important arguments to the demand models: price expectations, beliefs about the likelihood and severity of risks, tastes for particular experiences, coping strategies for managing adverse effects or future behaviour and even the 'framing' of drug use decisions: what consequences are considered, how they are evaluated and weighted, how uncertainty (as well as risk) is incorporated, etc. But beyond this focus on social determinants of drug use lies a deeper issue; that drug use itself as a social ritual determines the social environment as much as it is determined by it. The importance of such an approach in exploring the patterns of drug adoption is explored in Section 5.

What will the future impact of psychoactive substance be?

Current economic models highlight uncertainty about the future impact of different illicit markets. The inherent instability of these markets can lead to health and other consequences for users, beyond the direct harms to individuals, families, communities and society in general from dependent drug use. However, chronic problems may only become apparent after consumption has been prevalent in a large enough group of the population for a long enough period of time. The emerging evidence on marijuana may or may not parallel the case of tobacco where, for example, the full health impact has only been fully measured some 50 years after the mass adoption of cigarette smoking (Doll et al, 2004). Economic theory gives some guidance on a precautionary principle for governments to follow, in that individuals may "rationally" demand some constraints on their behaviour.

What interventions will be available in the future?

The predictions from economic models are that consumers are likely to respond to changes in market incentives and be responsive to a number of different policy options but social factors are also important.

3. THE EMPIRICAL PICTURE

3.1 Data Issues

Finding data on illegal activities to test economic models will always be challenging. In addition, it has not been a tradition of economic research to test and re-test their models. New theoretical models and empirical estimates are sometimes presented without rigorous statistical testing, and without refuting previous theoretical models. This makes empirical economic evidence difficult to review systematically. Specific definition and measurement issues arise around prices and levels of use.

There is little reason to expect the law of one price to hold. Moreover, retail prices do not include such 'hedonic' components as search time or risks associated with obtaining or taking the drug, etc. Indeed, 'foresight' models do not include the 'entailed cost' of future consumption linked to today's purchase.

Measuring prices higher up the value chain – to ascertain supplier returns, cost incidence and other determinants of policy response and retail pricing – is complicated by complex contingent payment arrangements, money laundering costs, etc. A survey can be found at (Caulkins and Reuter, 1999); Table 3.1 shows a breakdown of US cocaine prices. A recent analysis taking account of some of these complexities suggests that black market prices of cocaine (heroin) are 2 to 4 times (resp. 6 to 19 times) the likely legal market prices in the US (Miron, 2003). However, prices and purity differ by drug, between Europe and the US and among European countries.

Certainly, illicit substances prices are high. On the demand side, one consequence (Kleiman (1997)) is that elasticities cannot safely ignore income effects. Also, an addict who responds to price increases by committing more crime is not showing inelastic demand but rather increasing discretionary income to pay the difference. Price changes should also significantly affect heavy users' behaviour – similar results have been found for alcohol users. While light users may respond to price increases by reducing consumption, heavy users may reduce other consumption (e.g. housing, food), committing more crime, etc. Price rises may move some across the boundary from light to heavy use (and criminal activity).

Table 3.1: Components of drug prices

Component	Percent of retail price
Wholesale (farmgate) price	1%
Importation[1]	12%
Retail labour[2]	13%
Higher-level labour	3%

Component	Percent of retail price
Seizure of drugs and assets[3]	8-11%
Money laundering costs	2-4%
Packaging, processing, inventory	4%
Compensation for prison risk[4]	24%
Compensation for violence risk	33%
Taxes	0%

Notes: 1 – differential between the source-country and landed price
2- Illegality forces substitution of costly labour for efficient capital equipment and requires extensive vigilance
3 – Based on seizures at all levels, evaluated at wholesale cost
4 – Incarceration valued at average income, measured by survey.

Source: Caulkins and Reuter (1998)

Many components – especially farm-gate prices – are so small that policies targeting them are unlikely to achieve much impact. Most costs are unmonetised risk compensation – so accounting profits are likely greatly to exceed economic profits. Hence, accounting losses will almost never induce exit. Also, differences in tolerance for non-monetary costs favour market domination by the less risk-averse (or even risk-seeking). Thanks to this adverse selection, supply-side policies that impose risk may have attenuated or perverse effects. Young, poorly-educated and violence-prone males are most likely to tolerate such costs; thus the association of violence and drugs may not wholly be due to the struggle for profit.

The second problem is determining consumption patterns. Except for tobacco, almost all drugs have highly asymmetric consumption following the "Pareto 80:20 law" – 80% of consumption accounted for by 20% of the population. Heavy users who account for most demand and its attendant problems are likely to be under-sampled in population surveys, and data and analysis are almost certain to be dominated by light or occasional users. However, convenient samples of problem drug users such as those arrested or seeking treatment are not representative either. Such samples may "over-represent" problems and consumption (see discussion by Pudney in Bramley-Harker, 2001).

3.2 Size of the UK Illicit Drug Market

An obvious first empirical estimate is the size of the UK illicit market. However, few research studies are available. Bramley-Harker (2001) took data from arrestees. The NEW-ADAM data provided the data on problem drug use prevalence and estimated expenditure. Population surveys were used to estimate numbers of occasional users. The results suggest that in 1998 a regular heroin user spent about £16,500/ year on all drugs and a regular crack user £21,000. Occasional users' estimated expenditure (£1.9 billion) was much lower than regular users' (£4.7 billion). The total estimate for the UK market (£6.6 billion) while sizeable, is still smaller than alcohol expenditure for the same year (£32 billion). The NEW-ADAM data point to a surprisingly high number of crack cocaine users but the overall figure was similar to a previous ONS estimate based on seizure data (between £4.3 billion and £9.9 billion - Groom et al., 1998).

3.3 Measuring the impact of illicit drug use

Economic models distinguish between private costs of drug use and externalities borne by others in society. Estimating economic impacts of drug use is very demanding on data and there are major gaps in the UK information available (Culyer et al, 2002). Some large international studies have attempted to estimate external costs of illicit drug use in comparison to those from licit drugs. In general, the costs of illicit substances, while substantial, are smaller than alcohol and tobacco costs. They are generally dominated by crime, health and productivity costs associated with problem drug users.

3.3.1 Individual impacts

There is a general lack of UK data on personal impacts (good or bad) and their valuation. Some data are available on mortality, morbidity and loss of earnings, including epidemiological data on premature mortality from different legal and illicit drugs. Tobacco accounts for the largest number of premature deaths at 106,000/year in the UK (Twigg et al, 2004), alcohol accounts for 22,000 in England (Rannia, 2003) and illicit drugs between 1000 and 3000 (ACMD, 2000). However, tobacco deaths tend to occur at a later age than those from alcohol or illicit drugs. In terms of life-years, the percentages lost to alcohol and tobacco are approximately equal and far

greater than loss from illicit substances. Such analyses are not generally adjusted for levels of consumption.

There is an economic question as to how to value such loss of life. Most existing studies focus on loss of a productive resource in terms of lost earnings. The Department of Transport uses willingness to pay to value loss of life from road traffic accidents; the most recent value is £860,380 for each premature death in 2003 prices whereas loss of productive worth is valued at £451,110 (Department of Transport, 2004). Studies do not generally adjust for lost quality of life, although it is clear that the health of problem drug users is well below population norms (estimated at about 0.2 of a quality adjusted life year per person - UKCBTMM Project Group, 2004). The National Institute for Clinical Excellence currently uses a minimum valuation of £20,000 for each QALY (NICE, 2004).

The considerable literature relating substance use and individual earnings is not conclusive. In part, this is because individual productivity, particularly in the UK, is not closely linked to individual earnings. Also, empirically it is difficult to control for the simultaneous impacts of higher income on consumption and of high consumption on earnings. More robust evidence is emerging on the impact of substance use, especially problem use, on overall employment (for example, MacDonald and Shields, 2004). US research also highlights the impact of early substance misuse on educational attainment. These two factors could suggest substantial impacts on the lifetime legitimate earnings of substance misusers. Pacula (2005), for example, suggests that early marijuana use may reduce future earnings by 2%.

3.3.2 Externalities

Few empirical studies attempt empirical estimates of families' concerns or direct impacts on e.g. lost earnings of carers. Rather, empirical studies include some public sector resource costs. For example, care of problem Class A drug users' children was estimated to cost £63 million and health care for neonates £4.3 million per year in England and Wales for 2000 (Godfrey et al, 2002).

Workplace costs of all drugs are of considerable interest but hard to quantify (Godfrey and Parrott, 2005). Some drugs consumed in or close to working time have a direct impact on productivity. Some workers may feel stimulants help productivity, although long term productivity impacts of most drugs remain unproven. Previous excess use can also lead to workplace problems. These potential effects can alter drug users' behaviour as they attempt to get desired effects in leisure time while ensuring they are fit for work. The long-term impact of such poly-drug use is also largely unknown. Drug use not only affects individual workers and their employers but colleagues as well - drink or drug related accidents are the most obvious example. Data on such workplace impacts are not easy to obtain.

Most empirical attention has been given to public sector impacts of different substances. The most recently published costs of Class A drug use in England and Wales are reproduced in Table 3.1. Estimates for premature death were calculated using willingness to pay. However, premature death is not a large component of class A drug use costs, which are dominated by crime costs (88% of the total). Also, in contrast to alcohol estimates problem drug users account for almost all estimated cost (99%). However, this study could not find data to estimate the potential impacts of drug driving or workplace drug use. Costs for different types of drug user varied substantially with young recreational users estimated to cost £36 per user, older regular users £3 per user in contrast to the much larger estimate of £35,500 for each problem drug user.

Table 3.1 Costs of Class A Drug Use in England and Wales, £ million, 2000.

Item	Cost
Health care	0.35
Premature death	1.02
Workplace/Drug Driving	No data available
Other social	0.06
Crime	10.56
Total	12.00

Source: Godfrey et al, 2002

3.4 What factors influence illicit drug demand?

3.4.1 Own Price

While limited in number and mainly US-based, most published studies find significant relationships between price and consumption of marijuana, heroin and cocaine (see reviews in Pacula and Chaloupka, 2001; Godfrey, 2001; and Saffer and Chaloupka, 1999a). Available studies suggest that rising prices of any of these drugs will reduce drug use but there are some differences in the size of the effects between studies. For example, heroin price elasticity ranged from –0.27 to –1.5 and cocaine from –0.44 to –2.5, although estimates for most drugs centre around –1.0. Most studies use population survey data. The research also gives some support to the rational addiction model.

Two more recent studies (Dave, 2000a and b) used drug arrestee and hospital admission data. Again, price was found to significantly affect heroin and cocaine use, although estimated price elasticities were lower (between –0.1 and –0.3) than the population studies. Similarly Bretteville-Jensen and Sutton (1996) and Bretteville-Jensen (2003) used data from more problematic users and found significant price impacts for Norwegian data. Interesting in these studies was a division between users and user/dealers, with user/dealers having lower price elasticity. Animal and human experimental studies confirm these findings on the impact of price for both occasional and regular users (Petry and Bickel, 1999; Sumnall et al, 2004)

It is difficult to draw conclusions from the available literature about relative price effects across different groups of the drug using population. Recent work suggests that pregnant users are price sensitive (Corman et al, 2004), with a $10 increase in pure cocaine price estimated to reduce use between 12 and 15%.

There are some parallels to the study of licit drug demand, where more data has led to a focus on the impact of price on different aspects of behaviour, particularly the starting and stopping of different drugs. With licit drugs, prices across different

brands or types of the same drug can be explored. Patterns tend to be complex with brand-conscious consumers tending to adopt patterns of behaviour within age cohorts but also proving price sensitive within these patterns.

3.4.2 Cross- price elasticities

Of particular policy interest is the impact of changes in the price of one drug on the consumption of others, particularly across the licit-illicit divide. Several studies attempt to explore such cross price effects. In particular, studies have considered the relationship between prices and restrictive policies affecting alcohol and marijuana consumption. Studies have generally been based on US youth population surveys (see review in Williams et al, 2004). The majority of these studies found complementarity between these two drugs, suggesting that restrictions or higher prices on alcohol will reduce both drinking and marijuana consumption. Similar findings have been found for Australia (Cameron and Williams, 2001). However, these studies have some inconsistencies, the complementarity being stronger in younger age groups than ethnic minorities or women, although the latest study found a similar relationship for college students (Williams et al, 2004).

Other studies examine relationships between cigarettes and marijuana; cocaine and marijuana, alcohol and heroin and alcohol and cocaine (Chaloupka et al, 1999; Farrelly et al, 1999; Saffer and Chaloupka, 1999a). All found complementarities.

A related issue is the gateway hypothesis of a set pathway from one drug to another. The evidence is currently inconclusive.

3.4.3 Income

As discussed above, the relationship between drug use and income is complex especially for problem users who may finance use through criminal and drug dealing activities. Bretteville-Jensen and Sutton (1996) estimated an income elasticity of 0.47 from their survey of non-dealing heroin users in Norway, suggesting income increases will increase drug use. They also found that drug users reduced illegal income when legitimate income (from work or social benefits) rose.

3.4.4 *Enforcement*

Many demand studies also explore the impact of street level enforcement on drug demand, to test whether changing use or low-level dealing penalties or decriminalisation of possession also affects use by changing the effective price. The results have been mixed, partly due to data difficulties. Policies themselves may be influenced by use levels. There also seems to be some difference between older populations where decriminalisation has an effect and younger populations where no such effects have been found (Pacula and Chaloupka, 2001)

More recent studies, which have attempted to control for such effects, tend to find more positive policy impacts. Desimone and Farrelly (2003), for example, found that increases in either cocaine or marijuana arrest probabilities decreased demand for both drugs for both adult and juveniles in the US. By contrast, Williams (2004) found that Australian marijuana decriminalisation only increased use among males over 25, but did not affect young males or females.

3.4.5 *Information*

Pacula et al (2000) investigate the impact of perceptions of drug related harm on marijuana consumption in the US. They found that the perception of harm had increased and these changed perceptions reduced demand. In Sweden it was found young people may overestimate longer term health risks of licit drugs such as alcohol and tobacco (Lundberg, 2003) but be unaware of some shorter term impacts, consistent with some theoretical models.

3.4.6 Social factors

Most empirical models are based on individual data and models. There have been attempts to explore some peer effects and an interesting study of college drinking in the US suggests that changing the demographic mix in a college has a direct impact on the rate of problem drinking (Wechsler and Kuo, 2003).

3.5 Empirical evidence on supply behaviour

There is a much smaller economic literature on suppliers' behaviour. The literature has focussed on the impact of enforcement expenditure on market outcomes and this literature is briefly reviewed in the following section. As suggested above, it may be difficult to influence retail prices by untargeted interdiction policies. Theory would suggest considerable scope for profit and market concentration. Caulkins et al (1999) found profit margins in US markets varying from 50 to less than 10%. In exploring potential supply and demand interactions, Saffer and Chaloupka (1999b) did find that police drug control spending affects supply as well as demand.

Conclusions

What will the future impact of psychoactive substance be?

What can be learnt from the estimates of illicit drug market size and the value of associated problems? Regular (and often problematic) users dominate spending and problems created. However, this may simply reflect current drugs of misuse or lack of knowledge of longer-term impacts. Even with marijuana, the emerging evidence is that the costs are associated with problem use, either impeding youth schooling or later when dependence emerges. However, not enough is known about regular users and the impact of their use in the workplace or in situations such as driving that are risky both users and the rest of society.

Tobacco costs are more evenly spread and patterns of alcohol drinking are related to a complex set of problems related to both acute and chronic use.

What interventions will be available in the future?

Economic evidence on demand suggests that consumers of illicit drugs respond to incentives in a similar way to other goods and services. Prices and regulations affect demand for both licit and illicit drugs. In general, drugs are complementary, so relaxing policies on any one drug may increase the consumption of all substances. In particular, concerted policy to change sentiment among emerging cohorts does seem to have the potential to shift demand.

While these economic and policy factors shouldn't be ignored, social factors influencing preferences are likely to play a large part in determining overall consumption patterns. Demographic shifts may influence consumption in the short term although globalisation and diffusion of habits mean that trends in use spread across populations. We have less evidence about suppliers' behaviour but markets seem to adapt to changing preferences.

There is limited evidence on the differential impact of factors across income groups. However, potential differential impacts and demand for interventions across both income groups and generational cohorts raises interesting future scenarios. Current evidence points to a similarity of demand and supply factors across different drugs, indeed there has been a growth of polydrug use among consumers and some evidence of suppliers becoming more concentrated on this demand.

4. COST EFFECTIVENE MANAGEMENT OF SUBSTANCE MISUSE

Economists use economic evaluation techniques to compare the costs and consequences that occur in different policy scenarios. Current evidence is briefly reviewed for enforcement; treatment approaches; workplace policies and school based information as may be relevant to the UK.

4.1 Enforcement

In the UK as in most other countries, interventions designed to reduce the availability of drugs take a substantial share of drug policy expenditure. Recent years have seen a sizeable increase in expenditure on treatment and currently the share of enforcement has fallen from over 50% in 2001 to below 40% (Godfrey et al, 2005).

Demand studies as discussed above suggest that increasing the probability of arrest may impact on demand. The supply literature suggests that availability measures only have a limited impact on the overall size of the market (see review in MacDonald, 2004). For example, no evidence was found to suggest a major police initiative had an impact on drug use or prices in London (Best et al, 2001). Models of the cost-effectiveness of availability compared to treatment approaches have consistently suggested that treatment would provide better value for money than enforcement.

However, combining more sophisticated modelling with the time of social model of demand and drug diffusion suggest that relative cost-effectiveness of policies may vary over the diffusion of a new drug of misuse (Behrens et al, 1999).

4.2 Treatment

Reviews of drug treatment and rehabilitation, mainly for heroin users, suggests that treatment saves society far more than it costs (Cartwright, 2000; McCollister and French, 2003). Most of the empirical studies have been undertaken in the US but a number of UK studies have suggested that UK treatment does have similar benefits (Coid et al, 2000; Gossop et al, 1998) with a reduction in social costs of about 9 to 15 times the spending on drug treatment in the two years following treatment(Godfrey et al, 2004). Increases in the numbers of problem drug misusers in community based methadone treatment of about 10,000 a year over the next five years is likely to reduce the social costs of drug misuse by between three and four billion pounds (Godfrey et al, 2005). These additional treatment entrants could be channelled from enforcement activities and policies such as arrest referral schemes, and other criminal justice interventions although research on the cost effectiveness of this route into treatment is limited.

While such studies have provided evidence on the overall worth of increasing levels of treatment, there is far less economic evidence on the comparative worth of different treatment approaches. While a number of studies have recently been completed or underway (e.g. UKCBTMM Project Group, 2004) this is an important area for future research.

For the future, there is considerable scope for the development of pharmacotherapies and psycho-social approaches. Effective treatments are likely to have a good cost effectiveness profile given the high social costs associated with problem drug users. Similarly novel approaches that reduced the potential development of dependence could also be worthwhile. However, the history of securing resources for heroin addiction suggests that it may be difficult to secure investment in such treatments.

4.3 School based and other prevention policies

Reviews of the effectiveness of school-based programmes have suggested that such preventive activities are both costly and ineffective. However, there is some evidence that young people are more generally influenced by perceptions of harm and the search continues for more effective interventions. Caulkins et al (1999) indicate that if effective school-based interventions can be devised, they could also prove to be cost-effective despite the high resources required to deliver such programmes.

4.4 Interventions in the workplace

Drug misuse could have various impacts in the workplace as suggested in Section 2 and 3. This is also an area where there are commercial interests in devising tests and policies for employers. However, the evidence of the cost-effectiveness of such policies in reducing drug use is very limited. In particular, drug testing of employees may be a useful selection devise for employers, selecting employees with a range of characteristics such as risk aversion rather than controlling the use itself (Godfrey and Parrott, 2005). As a setting it does provide an opportunity for treatment interventions, which could provide some payback for employers.

Conclusions - *What interventions will be available in the future?*

Evidence for current drugs of abuse provide a mixed picture. There are no simple policy solutions to reduce demand and given that this demand will respond to changing market conditions, policy initiatives may have to be commensurate with these changes and external factors such as globalisation.

Dependent individuals have generally be shown to have the highest social costs and treatment for such individuals has been shown to be cost saving for society. There is considerable scope for devising novel treatments however the incentives for developing this business is limited given the nature of the area. It is not surprising that the commercial response to drug taking has focussed on devising interventions for employers.

5 PATTERNS OF DRUG ADOPTION

An important part of the growing literature on the dynamics of drug-taking is a theoretical treatment of collective behaviour, calibrated to empirical data.

These models of collective behaviour display common phenomena with greater or lesser fidelity, including:

- S-shaped adoption paths
- Cascade or 'herd behaviour'
- 'punctuated' paths of long periods of slow and localised change separated by brief periods of profound or discontinuous adjustment
- path-dependence or hysteresis (locally irreversible change) and
- cycles.

Everingham and Rydell (1994) present a simple model of market dynamics based on a division between poor, heavy users of a drug and light users who may be poor or rich. These groups have potentially different elasticities with respect to price, information, etc. Poor heavy users can finance their purchases through legitimate work, property crime or drug sales to rich users. Considering only the latter, a fall in rich users' demand will constrain the income – and consumption – of poor heavy users. But if their drug use reduces their legitimate income, the need to increase drug sales activity may bid down drug prices. The same analysis suggests that legal sanctions may increase the attractiveness of short-term employment in drugs markets relative to e.g. education.

More recent models[13] take account of the twin forces of contagion (promoting drug use) and prior observation (deterring it). Endogenously-influenced forces pulling in opposite directions, can easily lead cycles.

[13] E.g. Behrens, et. al. (1999 and 2002).

It is possible to extend this view in several directions. 'Contagion' from non-users can discourage drug use, as policies aimed at decreasing the social acceptability of drug use recognise. Second, the force of contagion (in either direction) is opposed by cohesion with social contacts.

A third factor, as Behrens, et. al. (2002) point out, is that drug reputations reflect both current use and memories or prior observation of heavy users. This is analogous to the 'stock of addiction' variable in rational addiction models – with the significant difference that its present value may respond negatively to past increases. In addition, recent experiences that depress the 'reputation' of a drug may switch to a positive impact as the experience recedes, consistent with psychological evidence that compulsive addicts try to recreate 'that first fine careless rapture[14].' .

Individual preferences for drug use may also display unobserved – or partially observed – heterogeneity. Individuals observe each other's actions, not underlying tastes. This by itself can generate multiple equilibria and cycles[15]. Moreover, people differ in proximity and the salience or persuasiveness of their experience. Changes in collective behaviour reflect the structure, strength and direction of societal ties. Indeed, networks depend on behaviour; one justification for standard epidemiological models of drug adoption is that addicts gradually form networks consisting almost entirely of other drug users. In the beginning, this involves some recruitment of existing social contacts – marking the contagious phase. Eventually there are few left to infect. This slows propagation by limiting 'outside' contacts, but – by embedding users in like-minded groups – reduces 'benign contagion' from non-users and may increases the 'infectiousness of contact with non-users. This is consistent with evidence that successful quitting typically involves a change of acquaintances.

[14] A similar effect could be obtained simply by attaching a positive weight to the first experience and using negative discounting

[15] A series of control-theoretic models that take account of age distributions (e.g. Almeder et al, 2004) and interemporar drug supply decision (e.g. Feichtinger and Tragler (2002)) also produce cyles and multiplicity.

We present below a simple series of adoption models from drug taking decisions in a social context to joint evolution of behaviour and social structure.

5.3 Theoretical modelling of drug adoption patterns

Treating drug adoption as a social phenomenon, sheds light on the progress and likely outcomes of both new drug introduction and policy efforts to control use or adverse effects. The models in this section slightly extend the epidemiological literature, but in ways consistent both with individual addiction models and evidence on the growth, spread and decline of drug 'epidemics.'

The underlying ideas are that drug decisions are influenced by:

- Individual tastes
- Drug-taking prevalence and the strength of 'peer pressure' and
- Perceptions of risks and costs.

The models take account of the impact of direct and indirect observation on peer pressure and risk assessment as well as 'objective' information. The structure and strength of those connections – and even the underlying taste for the drug – are influenced by drug use. A simple chain of models captures these phenomena – at least qualitatively – and many features noted in Section 2, while remaining tractable enough for scenario studies and policy simulations.

5.4 A simple model with one drug and a large, fully connected population

The first model incorporates: unobserved and heterogeneous tastes; price, risk information, legal and societal disincentives; 'peer pressure'; and drug use among the peer groups. There is uncertainty about others' tastes but people make the choices they intend. This essentially static model shows multiple equilibria and can be used as the basis for dynamic analysis (illustrated in the discussion).

We begin with the decision to consume a single drug; the individual's relative utility for drug use is:

$$U_i(\theta_i, \bar{\pi}, \nu, \rho, \Gamma) = \theta_i[1 + \nu\pi_i(\Gamma)] - \rho \qquad \textbf{(1)}$$

where:

θ_i	The individual's intrinsic taste for the drug
ν	Peer - pressure effect : social pressure or social drug consumption
ρ	Anticipated price/risk : health, legal, workplace, social, purchase price, etc.
$\vec{\pi} = (\pi_1, ..., \pi_n)$	The vector of drug use prevalence across the population
Γ	The social network : a set of connected pairs (i, j)
$\pi_i(\Gamma)$	Drug prevalence among i's network neighbours - $\{j : (i, j) \in \Gamma\}$

This model makes very strong symmetry assumptions, uses a particularly simple reduced form and is limited to "rational addiction" in the sense that only preferences change – though it departs from the standard model in taking account of others' consumption. The purpose is to demonstrate that some unexpected qualitative features can arise in a simple setting.

In the simplest model, everyone is connected to everyone else and the population is large enough so that each experiences the general level of prevalence π. Because tastes differ all do not all make the same choice; the drug will be consumed by those with sufficient taste for the experience: $\theta_i \geq \theta^*$, where the critical value of taste satisfies:

$$\theta^*[1+\nu\pi] = \rho \qquad \textbf{(2)}$$

If taste is distributed between q_- and q_+ according to cumulative distribution F ($F(\theta)$ is the proportion whose taste does not exceed θ), $\pi = 1 - F(\theta^*)$, so:

$$1 - F^{-1}(\pi) = \frac{\rho}{[1+\nu\pi]} \qquad \textbf{(3)}$$

In a second version of this model, expected price/risk is influenced by learning from others. This utility function is:

$$U_i(\theta_i, \vec{\pi}, \nu, \rho, \Gamma) = \theta_i[1+\nu\pi_i(\Gamma)] - \rho(1-\beta\pi_i(\Gamma)) \qquad \textbf{(4)}$$

where β measures peer – learning. The equilibrium condition is:

$$1 - F^{-1}(\pi) = \frac{\rho(1+\beta\pi)}{[1+\nu\pi]} \qquad \textbf{(5)}$$

Figure 1 shows the (common) left hand side of equations 3 and 5, plotted with their right-hand sides[16]

[16] For the case F = cumulative normal with mean -5 and variance 5, $\rho = 20$; $\nu = 6$.

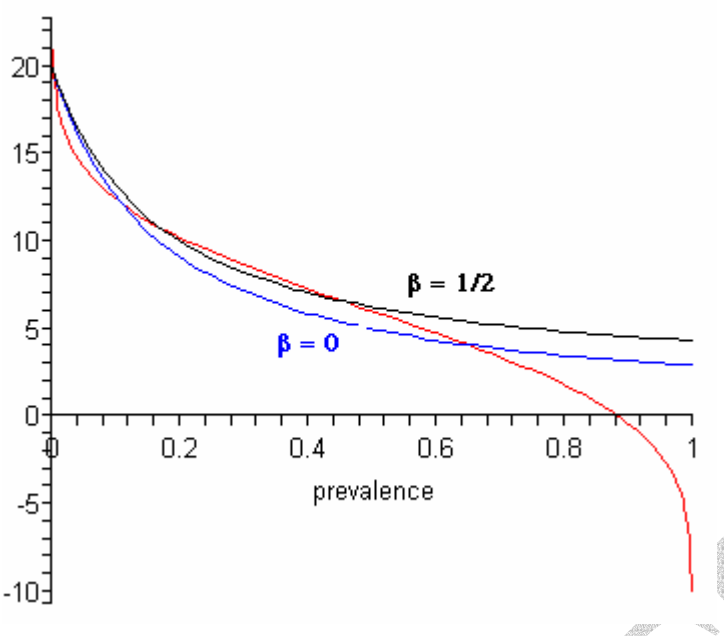

Figure 1: sample plot of equilibrium prevalence in simple model

This shows multiple equilibria and that *stable* equilibrium prevalence falls as peer learning about price/risk becomes more important.

For some values there is a unique equilibrium. The actual structure of the results also depends on the range of tastes:

$$\rho > (1+\pi)\theta_{-} \quad (6)$$

$$\theta_{+} > \rho \quad (7)$$

Condition (6) says that the lowest preference person would not take the drug even if all his peers did; (7) says that the preference person would consume even if none of his peers did. For the (unbounded) Normal distribution bothhold trivially.

If both conditions hold, the multiple equilibrium situation shown in Figure 1 is possible. If neither holds, there is likely to be a unique equilibrium.

Figure 2 shows the structure of the equilibrium set as a function of price/risk and peer effects.

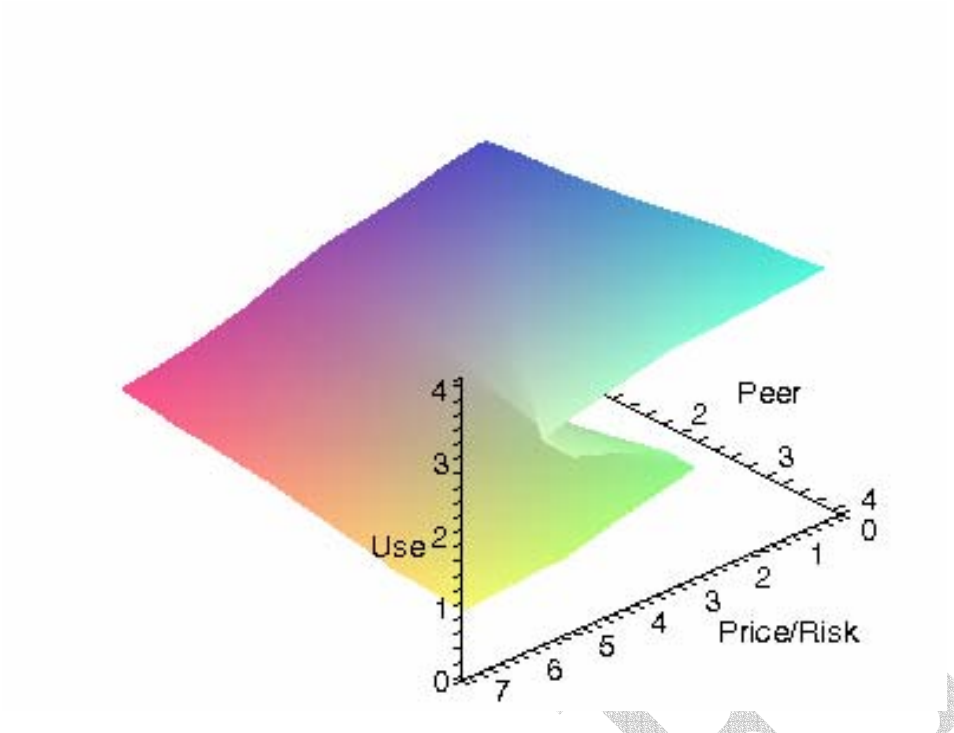

Figure 2: multiple equilibria in the drug adoption model

Stronger peer effects produce multiple equilibria; catastrophic jumps and S-shaped paths. The model becomes more interesting with endogenous changes in the peer and price/risk effects. Drug use may reinforce an individual's tendency to pay attention to his or her peer group. Although network structure is fixed, individual's ties to users may strengthen as a result of his own use or if increasing social isolation introduces social considerations into primarily hedonic or utilitarian drug use decisions This can move the individual into the multiple-equilibrium part of the diagram and reinforce choices. The behaviour of individuals with similar tastes and price/risk perceptions might diverge as peer effects strengthen.

More striking effects come from endogenous changes in perceived price/risk. If users' experience and close acquaintance with heavy users increase these perceptions (e.g. through increased expenditure needs and negative observations) and *vice versa* for non-users, the model implies anticlockwise cycles in drug prevalence. As with memory-contagion models, these cycles may be localised and optimally addressed by policy that 'follows the cycle.'

5.4.1 Welfare

Total welfare can be expressed as:

$$W = (1+\nu\pi)\int_{\theta^*}^{\theta_+} \theta f(\theta) d\theta - \rho(1-F(\theta^*)) \qquad (8)$$

Using $\pi = 1-F(\theta^*)$ to eliminate the critical taste parameter θ*, we get:

$$W = (1+\nu\pi)\int_{1-F^{-1}(\pi)}^{\theta_+} \theta f(\theta) d\theta - \rho\pi \qquad (9)$$

This implicitly normalises the welfare of non-users to 0, takes no account of welfare decreases (mistakes) associated with drug-taking beyond those modelled with price/risk and does not model different *levels* of individual consumption – only population prevalence. The model only implies multiple equilibria for given values of price/risk and peer effects, so we can plot welfare as a function of these parameters and drug taking:

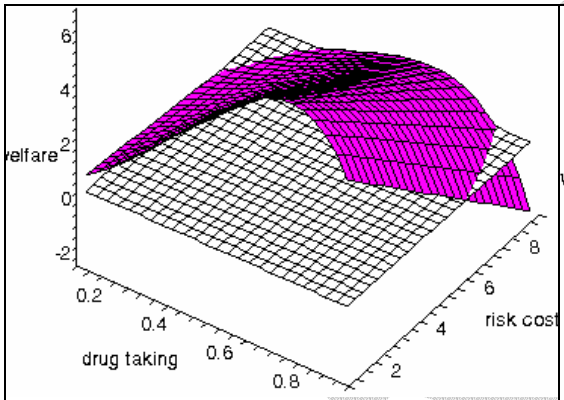

Figure 3: prevalence, price/risk and welfare

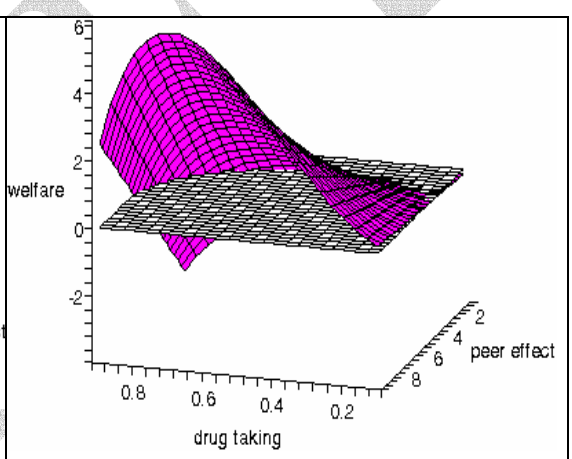

Figure 4: prevalence, peer pressure and welfare

A few other phenomena can tractably be handled by simple variants of this model. One concerns information about prevalence and price/risk. If individuals rely on general rather than direct experience, users will be a representative sample of the taste distribution. In one sense, the results are broadly similar – roughly S-shaped time-paths of adoption or remission, with 'catastrophic' jumps when peer effects are large. However, the behavioural response to policy changes may be different – in the absence of peer effects an increase in perceived price/risk will have much less effect than in the 'strategic' model, but if peer effects are large, increases in price/risk will always reduce prevalence, while in the strategic model modest price/risk increases may increase prevalence.

5.5 A dynamic model with fixed tastes

Treating drug use as conventional behaviour sheds light on the interaction of drug use choices and social contacts. This dynamic model is based on the twin phenomena of cohesion with one's reference group and contagious 'heterodox' behaviour. The underlying possibilities are based on the previous model; choice dynamics reflect in addition the stylised facts of addictive behaviour in Section 2 – including the possibility of mistakes. A first model examines formation and welfare properties of 'conventional' behaviour for a given social pattern; the next subsection combines this with evolving social linkages.

From eq. (4), the payoffs to drug-taking choices between any two socially-linked individuals are:

Table 1: the simple 2-player drug use game

		Player 2 takes drug: Yes	Player 2 takes drug: No
Player 1 takes drug	Yes	$(\theta_1(1+\nu)-\rho(1+\beta), \theta_2(1-\nu)-\rho(1+\beta))$	$(\theta_1-\rho,0)$
	No	$(0, \theta_2-\rho)$	$(0, 0)$

Consider a network of individuals making repeated choices over time. We assume the following dynamics:

- At any moment, each person has a certain probability of re-examining his choice
- S/he will try to adopt the best reply to neighbours' choices and will succeed with probability 1-μ
- With probability μ, s/he will make the 'wrong' choice.

This defines a Markov process on the population's drug-taking behaviour $\bar{\pi}$. An individual will wish to adopt the drug if 'most' of his neighbours do:

$$\pi_i(\Gamma) \geq {(\rho - \theta_i)}\big/{(\theta_i \nu - \rho\beta)} \qquad (10)$$

To begin, we assume that all people have the same tastes (θ) for, and that every person is connected to everyone else. The limit of this distribution will be a single

behaviour, which will involve low (only experimental) drug-taking if and only if abstinence is *risk dominant*:

$$\theta < \rho(2+\beta)/2+\nu \tag{11}$$

Abstinence is socially efficient if

$$\theta < \rho(1+\beta)/1+\nu \tag{12}$$

In this model:

- *If peer pressure is stronger than peer learning ($\nu > \beta$) abstinence is stable when it is optimal, but may be stable even when suboptimal*
- *If peer pressure is weaker than peer learning ($\nu < \beta$) abstinence is optimal when it is stable, but may be optimal even when unstable*
- .This provides some simple policy prescriptions. Because optimality here ignores externalities, stabilising abstinence may be desirable in broader circumstances. Policy can affect perceived price/risk by: conventional law enforcement cost- or risk-imposing strategies that target users; action against dealers that makes price, quality or availability more uncertain; education – especially peer reinforcement of risk information. Policy can also affect peer-pressure through e.g. youth policy. It is even possible – through provision of localised health care, law enforcement or price/purity information – to alter the strength of the peer-learning effect β.

Ignoring the dynamics of social interaction, a 'rational addiction' policy would have to alter these parameters to the point where

$$\theta < \rho \min\left\{1, \frac{1+\beta}{1+\nu}\right\} \tag{13}$$

This involves strictly more policy intervention unless the peer-pressure effect (ν) *exactly equals* the peer-learning effect (β) – but these are at least in part susceptible of policy intervention!

If peer pressure dominates peer learning, it is easier to make abstinence stable, achieving the desired result through non-cooperative evolution. Otherwise, it is easier to make abstinence optimal (among users), achieving the desired result through cooperative (or bargaining) means.

Speed of convergence to the stable outcome depends – in this model at least – on the frequency with which choices are revisited and the fidelity with which they are realised. This directly reflects the cue-conditioned cognition model (see Section 2). The dynamics can also be adapted for asymmetry between quitting and relapse – changing rates of onset or recovery but not the ultimate stable state.

Risk-dominant behaviour will eventually prevail in any symmetric network. Other 'geometries' can have clusters or pockets of drug use in an abstinent population – or *vice versa.* Clustering (small worlds of individuals all of whose friends are likely to be friends of each other) –is more likely in certain groups, and has two effects on adoption. It slows propagation, but within groups peer effects are likely to be very strong. These impacts are borne out by empirical experience and suggest further forms of educational and youth policy intervention.

When tastes differ the analysis becomes more complicated, but some general observations can be made. Even with relatively few 'high-taste' individuals, a cluster can 'tip' into drug-taking if the proportion is large enough (though it may well take more than one 'rotten apple'). Vulnerability is reduced if those with middling tastes for the drug have many outside connections to others with low to middle tastes or in clusters with relatively few high-taste individuals. The same holds for abstinence in populations where high taste is prevalent.

Adoption or remission are, in general, neither uniform nor monotone. Beyond the stochastic aspects, a given cluster may 'get stuck' for a long period external changes trigger rapid change. Policy interventions, whether global or localised, do not produce a constant stream of effects but instead have tipping points and delayed impacts that must work through the network as a whole before producing observable changes. On the other hand, the impacts when they come may well be profound.

5.6 Endogenous Tastes and Structures

The previous sections treated tastes (θ_i) and structure (Γ) as fixed. Neither assumption is likely to survive contact with the real world. While the detailed analysis is as yet incomplete, its broad outlines suggest some policy implications.

Network analysis has already developed a treatment of endogenous structures based on chance encounters: unlinked parties may form a link if each benefit off by doing so. Links dissolve if either party wishes to end the association. This defines a Markov process – this time on societal structures – whose limiting outcomes may be considered 'stable.' One simple application would hold drug-taking behaviour constant; stable and efficient networks are likely to differ sharply This may be desirable if individuals take insufficient account of externalities (involving other people, times or random consequences). It also suggests that even well-informed and foresightedly rational individuals might fail to form 'optimal' social contacts.

To gain deeper insight, it is desirable to combine these models – to let drug-taking behaviour and social interactions change on the same time-scale. Such models *can*, under the right conditions, reconcile efficiency and stability and produce lower drug use. But this is not inevitable.

One would expect drug adoption to increase the proportion of high-taste individuals among a given person's contacts, and ultimately to increase clustering as individuals sharing a common link are brought into contact. At the same time, links with low-taste individuals – at least non-users – may fall away. This fits heroin users' life-cycle contagion patterns, with straightforarwd implications for crime rates, treatment effectiveness and external costs. Policies that enhance clustering – e.g. by driving users underground – can have two, opposed effects. The first is to reduce the chances and depth of contact between experienced drug users and non-users. The second is to make such contacts more 'dangerous' because the individual making contact with such a cluster is more likely to be influenced by the drug user than vice versa. In addition, under policy and societal conditions that knit drug using clusters tightly

together, drug use provides a ready-made entrée to a tightly-knit cluster, which may be attractive to members of more scattered groupings.

A second useful extension is endogeneity of tastes. It is perfectly feasible to make tastes a function of past consumption behaviour. This is consistent with the individual models of addiction in which preferences change (e.g. the rational addiction models), but has not been explored here.

5.7 Polydrug models

The model given above concentrates on a single drug. There is no difficulty in principle in extending this to the case of multiple or combined drug use. While space does not permit a comprehensive treatment, two interesting phenomena can be treated. Consider different 'drugs' (k = 1,,,K), where some may involve combinations (to handle complementarities easily). The utility function generalises to:

$$U_i(\theta_i, \vec{\pi}, \nu, \rho, \Gamma) = \sum_k \left[\theta_i^k \left[1 + \sum_{k'} \nu_k^{k'} \pi_i^{k'}(\Gamma) \right] - \rho^k \left(1 - \sum_{k'} \beta_k^{k'} \pi_i^{k'}(\Gamma) \right) \right] \qquad \textbf{(14)}$$

where

θ_{ii}^k	Individual i's intrinsic taste for drug k
$\nu_k^{k'}$	The peer - pressure effect of drug k' prevalence on taste for drug k
ρ^k	Anticipated price/risk for drug k
$\vec{\pi} = (\pi_1^1, ..., \pi_n^K)$	The vector of drug use prevalence across drugs and population
$\beta_k^{k'}$	Peer learning effect of observing drug k' use on price/risk of drug k
$\pi_i^k(\Gamma)$	Prevalence of drug k among i's network neighbours

Under suitable assumptions, 'diagonal' outcomes will survive – if peer effects are strong enough then cohesion will stabilise homogeneous behaviour. The Markov analysis used in Section 5.5 can be adapted as follows: as before, individuals have random chances to re-evaluate their behaviour and succeed with some probability, resulting in a Markov process whose limiting distribution defines the stable outcomes. In the single-drug model, the population would drift away from one pattern if enough people made 'mistakes' – by choosing the other. Here, there are more possibilities, and thus various ways in which a group could change from one state (say abstinence) to another (say heroin use):

- A sufficient proportion could experiment with heroin use to cause the others to change by peer pressure;
- A sufficient proportion could experiment with another drug to make heroin a 'best reply' to the mixed behaviour of the group;
- A sufficient proportion could experiment with another drug (say crack) to tip the group into its use, from which heroin use could be reached by a 'smaller' step.

In the formal analysis, the stability of a transition from one outcome to another is measured by the smallest number of 'mistakes' required to follow one of the above paths. The stable outcomes are those which are easiest to fall into and hardest to fall out of. This model produces the following types of result:

- There are situations where the transition from abstinence to stable drug use runs through another drug – this is an example of a gateway effect, and depends as much on the network structure of users as on physiological complementarities between the intermediate and eventual drugs.
- There are situations of stable polydrug abuse – again, these can arise purely through societal interactions. When asymmetric or endogenous networks are incorporated, polydrug clusters can arise through the connection (or coalescence) of different drug-using clusters.
- The trajectories and stable states depend on cross-drug peer and learning effects, so that they can be reversed by policies (or information) that change relative prices, risks, social acceptability, etc. thus leading to 'fashion' cascades (e.g. 'heroin chic.')
- Policy affects can be attenuated: a policy that inhibits one route into adoption of a particular drug may simply displace the dynamics to the next 'shortest' route.

The same model can be used to simulate the impacts of introducing (or withdrawing) drugs.

5.8 Conclusions

The models discussed in this section show that the implications of a wide range of policies and types of drugs and drug use can be handled in a unified way. Three

particular advantages are: that the models treat drugs in functional and social terms and thus have minimal dependence on scarce and poor-quality empirical data; the models are consistent with the full range of demand (and, potentially, supply models); and the models capture societal interactions in a flexible but transparent way and thus help bridge the gap between individual models of conventional microeconomics (and some psychological and physiological models) and collective models coming from sociology and criminology.

The models do not, by themselves, shed light on the psychoactive substances of the future, but they do shed light on how the characteristics of such substances and incumbent patterns of use will influence which potential substances are taken up and what the impacts are likely to be. However, the abstract nature of the models means that they are more suited to scenario exploration than prediction; they are best used in conjunction with scenarios to put flesh on the narrative bones, add colour and detail and provide a link between 'rounds' of scenario interaction.

In addition to the impacts associated with the prevalence of drug use, these models can shed light on induced changes in social structures. Such changes – in particular the formation of 'small worlds' around drug use – can be profoundly important in determining a range of other societal outcomes, including e.g. implications for non-drug crime, health, education and workplace productivity.

The models also suggest a wide range of interventions – in particular, they identify

- Interventions aimed directly at the evolution and spread of drug behaviours
- Interactive effects of e.g. law enforcement, informative and treatment interventions; and

A dynamic view of policy intervention that shows how to make policies 'follow the cycle' and also how to achieve better results by exploiting network dynamics (e.g. by making optimal outcomes stable) and the potential for cooperative progress within the affected community (by making stable outcomes optimal).

5.7 For the future

The economic evidence and modelling surveyed in this section is perhaps more useful for exploring the future than for predicting it. In particular, it offers a range of inputs for scenario-based exploration. A scenario, in this context, is a partially-specified description of a possible future which can be used to draw out hidden implications of current knowledge and data; explore the logical consistency of findings based on different data, perspectives and methods; integrate a range of different policy options and objectives; explore how key stakeholders are likely to respond to unfolding challenges; and increase the validity and clarity with which future options and developments are understood.

In itself, a scenario is based around four main elements.

- Key uncertainties –important aspects of the future that are either unknown at present or unknowable in the sense that they have not yet happened
- Relationships – the linkages between different key variables and parts of the system
- Levers – the policy and strategic options that will act through these relationships
- Measures – the terms in which system behaviour is described and evaluated

Further aspects include descriptive details (esp. facts and figures) and a narrative thread. There are so many possible futures that descriptions tend to be either confusing or banal. A scenario should encapsulate a single idea or possibility and convey it clearly and convincingly. This idea may involve a specific mechanism (e.g. the importance of learning or social interaction to drug adoption, the implications of cue-conditioning or self-strategising or gateway and polydrug interactions), a novel policy lever (e.g. the conscious use of uncertainty-generating strategies to ‘steer’ individual decisions or market evolution, targeting policies to specific substances, market segments or user groups or policies that ‘follow the cycle’) or new measures (e.g. measures of the structural characteristics of drug supplies, estimates of rents and value-added, estimates of the distribution of use across groups).

Scenario exploration can follow one or both of two routes: 'forecast' analysis, which starts from the present and tries to identify possible 'landing places' and their likelihood and desirability; and "backcasting" analysis, which starts from a desired (or feared) future and works out what must have happened in order to realise it. The useful results are: identification and prioritisation of key areas of uncertainty – those whose resolution might make a difference to policy choices; highlighting key relationships – those whose operation might lead to efficiencies or unintended consequences; policy sets – policy combinations, priorities and contingent strategies; and relevant measures – indicators or measurements derived from existing data or newly collected, together with an understanding of what they do and do not tell us.

In this setting, the empirical results surveyed above can be used to produce coherent starting points for constructing the basic elements and to add convincing colour to the narrative thread that explains the main idea.

The theoretical models, by contrast, can be used to illustrate qualitative features (e.g. diffusion patterns, cycles, multiple equilibria) or to make quantitative predictions. In scenario exploration, they can be used in the initial description to produce graphic or other illustrations of spillovers and other effects to help link the various parts of the narrative and draw attention to holistic consistency. They can also be used in an iterative exploration of the scenario – when users suggest alternative policies or resolutions of key uncertainties, or highlight alternative mechanisms or measures, calibrated theoretical models can be used as a visualisation tool. Finally, they can be used to produce quantitative measures to aid in policy evaluation – though not (given data and econometric limitations and the profound gaps between the measured past and the explored future) in specific detail. In this context, the models can be used in 'exploratory' mode (generating many 'nearby' alternatives) for analysing the robustness of conclusions to both quantitative and qualitative uncertainties. For instance, the adoption models point to the robustness of multiplicity and its associated discontinuous jumps and cycles and suggest that e.g. policy interventions designed to affect peer pressure and peer learning may change the structure of equilibrium or the

rate of convergence – and thus the ability of policy and community action to 'catch up' with developments.

More concrete observations can be made in terms of the demand and supply aspects of drug use. On the demand side, economic evidence supports the importance of choice and thus the relevance of 'economic' variables relating to: individual beliefs about risks attached to drug use; price and income effects; the impact of supply, price and quality uncertainty; the interaction of drug use with education and health; and the importance of peer effects and learning in conveying and appropriately reinforcing good decisions. On the supply side, the evidence suggests that targeting of specific drugs, market locations and levels, key players and supplier strategies (e.g. money-laundering or the use of violence) can play a key role in changing the performance of drugs markets. It also suggests reasons why the possibility of user/dealers at the local level may be important for the ability of policy to discourage drugs trafficking by imposing costs, how supply uncertainty may affect prices, qualities and market efficiency and whether the prevalence of minimally-refined agricultural products (e.g. the 'big 3' of heroin, cocaine and cannabis) is likely to be threatened by 'high-tech' alternatives.

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