Chapter 14
Are Spatial Variables Important? The Case of Markets for Multiple Drugs in British Bengal

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Abstract Results from the preliminary analysis of a dataset consisting of population-level statistics for opium and three forms of marijuana for districts in the province of Bengal in British India for the period 1908–1928 are presented. The findings shed light on the importance of geographic phenomena for the economic analysis of drug consumption, and on the economic characteristics of opium and marijuana consumption. Exploratory spatial data analyses reveal spatial clustering for a number of variables that are important for understanding drug consumption. In addition, there is evidence of substitutability between marijuana and opium, and within the three different forms of marijuana. Finally, the consumption of all four products is responsive to changes in their prices.

Introduction

This chapter explores the role of spatial aspects of drug consumption in the broader analysis of the economics of drug consumption and addiction. The aim of the overarching project of which this chapter is part is to advance our knowledge of the behavior of multiple drug-consuming populations. We do this with a series of analyses using a unique recently-discovered and extraordinarily rich and reliable dataset on the consumption of multiple addictive substances collected at a time when the consumption of these substances was legal. When it is collected and entered in its entirety, the dataset will contain annual statistics for a large number of districts from British India over an approximately three-decade period in the early 20th century. These data will include population-level information on the consumption and prices of alcohol (in multiple forms and at multiple proof strengths), opium, and cannabis in three separate forms, namely *charas* (hashish), *ganja*, and *bhang*. *Bhang* is the leaf of the marijuana plant, *ganja* consists of dried parts of the plant (including the bud with the THC-rich resin, THC being the acronym for tetrahydrocannabinol,

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the main psychoactive component of hemp drugs), and *charas* consists primarily or wholly of the THC-rich resin.[1] In addition, corresponding information on wages, the cost of living, taxation, and a variety of other pertinent economic and non-economic phenomena are being collected and entered. The above data are combined with historical spatial data for the districts for which they are available.

In this pilot study, the results of a preliminary analysis of a subset of the larger dataset are presented. These data consist of population-level statistics for opium and the three forms of marijuana for districts in the province of British Bengal for the period 1908–1928 (Fig. 14.1). This pilot dataset enables the pursuit of a number of lines of enquiry, of which the analysis of substitution and complementarity of opium and marijuana (in its three different forms) with each other and the

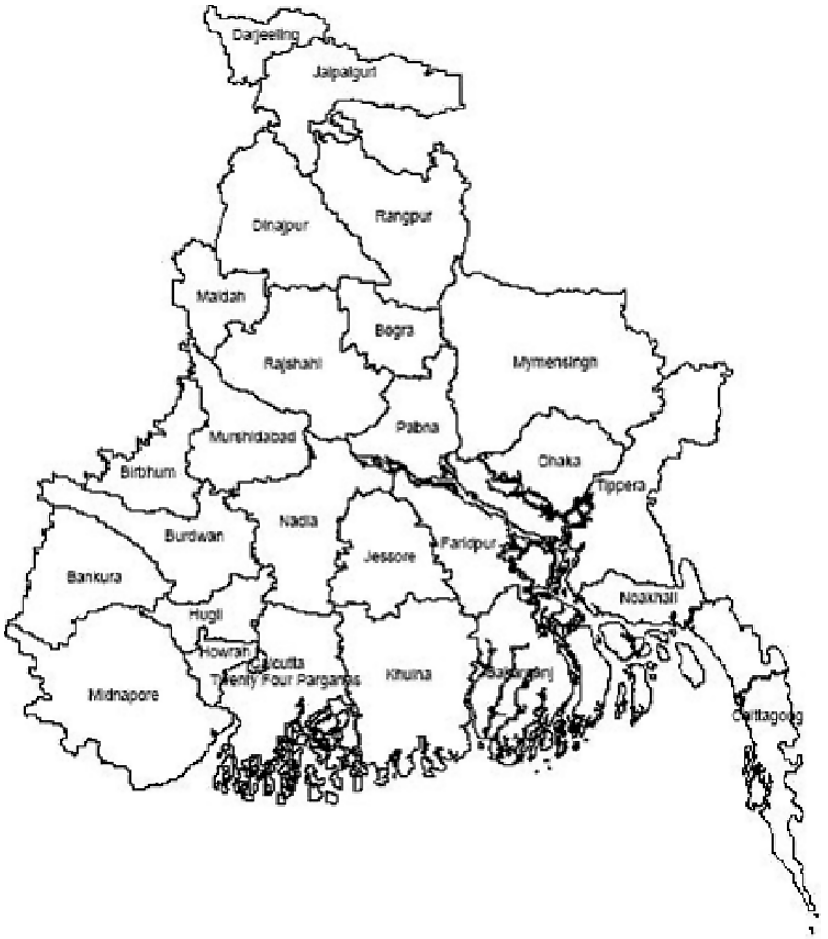

Fig. 14.1 Districts of Bengal in 1919

price sensitivity at the population level of marijuana and opium consumption in the presence of the other drugs is the focus of this study.

Spatial variables can play an important role in understanding the etiology of drug addiction for a variety of reasons. First, space is inherently important in understanding the consumption of most agricultural commodities. To cite just one case-specific example, because different parts of Bengal show differing degrees of suitability for the growth of wild and cultivated cannabis, the former of which was used as a substitute for the cannabis being sold by the government (for which the sales data are recorded), different districts of Bengal are likely to show differing degrees of price responsiveness of consumption of legal marijuana.[2] To the extent that marijuana was a substitute for opium, estimates of the price-responsiveness of opium may also be affected by the availability of wild marijuana, which depends on geography. Further, variations in other phenomena, measured or unmeasured, that may affect patterns of consumption also coincide with geography. One example is population; in keeping with the related literature on the economics of consumption of psychoactive substances, consumption is operationalized in per capita terms. Another example is inflation; the prices of the drugs are normalized for inflation in this study. To the extent that changes in population (because of epidemics, for example) and measures of inflation (because of the often localized nature of food shortages, for example) may vary systematically with geography, these considerations should be included in the analysis as well. A related reason for the inclusion of the spatial dimension in any model of drug consumption is the possibility of measurement error. In the case of Bengal, for example, Calcutta, one of the most urbanized and densely populated districts of Bengal, is bounded by a number of relatively sparsely populated districts. 24-Parganas, the district to the southeast of Calcutta, for example, consists primarily of the Ganges delta (also known as the Sunderbans), most of which is very sparsely populated. The majority of the population of 24-Parganas is concentrated in a relatively urbanized belt that borders Calcutta, giving a picture of the district that is not entirely accurate.[3] To some extent, including spatial variables can help to mitigate this inaccuracy. The aim of this chapter is to shed light on the importance of these and other geographic phenomena for the economic analysis of drug consumption.

In light of the continuing interest in policies relating to the use of psychoactive substances in general and marijuana in particular, one cannot help but note the relative lack of systematic analysis of the economics of marijuana use. While a number of studies exist, some even based on reliable statistical data, that characterize the economic properties of other substances such as opium, tobacco, and alcohol, little is known about how populations of marijuana users respond to changes in the price of marijuana or in general economic conditions.[4] There is a good reason for this difference. Opium, for example, was sold in a number of Asian colonies (including the Netherlands Indies and Japanese Taiwan) in the late 19th and early 20th centuries under tightly controlled government-administered systems. Because these governments kept close tabs on quantities sold, sale prices, numbers of users, and other relevant data, they created statistically viable data sets that, with the development of the requisite methodologies, were ready to be analyzed, even though opium itself had been prohibited by the time these methods were developed.[5] Unlike opium,

however, the body of data on marijuana consumption is small. When it was legal in the early 20th century, governments paid scant attention to it, and neglected to follow its consumption in as great detail as they did that of opium. As a consequence, after it became illegal in the mid-20th century, precious little information about its economic properties was available to scholars for statistical analysis.

Late-colonial British India is an exception to this lack of attention to marijuana consumption. In 1893–94, the *Indian Hemp Drugs Commission Report* (Hemp Report) was published following over a year of detailed research on a variety of aspects of marijuana consumption in India.[6] The Hemp Report was written in response to questions regarding the legal status of marijuana and whether the then-legal drug should be made illegal. Following this report, in the early 20th century, detailed statistics on consumption, prices, and a variety of other significant variables were collected, which enable a careful examination of the economic properties of marijuana.

A secondary goal of this chapter is to provide some background into the consumption of marijuana and opium in late-19th and early-20th century British India in general and in undivided Bengal in particular. Using statistics from reports produced on the state of opium and marijuana consumption in Bengal in the early 20th century, we illuminate some of the questions that were being raised at the time, using econometric methods that were developed many decades later. A specific question that will be addressed is the significant issue of whether behavior in relation to the different forms in which hemp drugs were available at the time was the same and therefore, by implication, whether the categorical approach taken by the British government to keep the consumption of marijuana in *all* its forms legal was justified. Because the analysis is preliminary in the sense that we do not fully incorporate the spatial dimension, alcohol data, or wage data into the econometric analysis, we will limit our interpretations of the data, reserving more conclusive assertions for a series of future and more comprehensive studies.

In the early 20th century, the consumption of marijuana and opium was legal and widespread – from Asia to North America, these substances were being consumed under a variety of regimes, from the strictly government controlled to the laissez-faire. In a variety of Asian colonies, including the Dutch East Indies, British Malaya, Japanese Taiwan, and French Indochina, to name but a few, large quantities of opium and/or marijuana were being sold, usually through government-controlled markets for the benefit of government coffers. British India was no exception. A century later, at the beginning of the 21st century, the situation is changed. Marijuana, opium, and their derivatives are considered by many to be harmful, and their use is widely banned.

The remarkable turnaround in attitudes toward and laws pertaining to psychoactive substances over the past century has not diminished interest in their study, however. For one, there is irrefutable evidence that the consumption of these substances continues, perhaps even unabated. Some of these substances, including opium, are considered to be more addictive than others, such as marijuana, adding a layer of complexity to the notion of "substance abuse," a term that has come to be uniformly applied to the excessive use of any of these substances. Additionally, debates

continue about the advisability of maintaining the illegal status of some of these substances, and marijuana in particular. In fact, in some countries, as also in some states of the USA, the possession of small quantities of marijuana is no longer a criminal offense, and the partial or complete legalization of the substance is the subject of many a heated debate in a number of state legislatures.[7]

At the scientific level, opium and marijuana are interesting for a variety of reasons. Morphine, which is extracted from opium, is used worldwide as a painkiller in a variety of medical traditions, including the allopathic tradition. In the Ayurvedic system of medicine, marijuana and opium are ingredients in a long list of remedies for ailments ranging from the digestive to the sexual.[8] Because little is known about the interactions of these two drugs with each other, or about how addictive they are, however, it is difficult if not impossible in the current state of knowledge to weigh the pros and cons of using these substances or their derivatives. In the case of marijuana, for example, there is some debate about whether marijuana is addictive, and if so, to what degree it causes psychological and/or physical dependence. The econometric analysis of the behavior of populations that simultaneously consume both types of substances can shed light on some of these questions. In the following sections, we will lay out some of the background for political and social conditions under which opium and marijuana were being consumed in British India. Following this, we will present results of a preliminary and pilot analysis of the data for Bengal using exploratory geographic and econometric methods.

Historical Context: The Reports of the Late 19th Century

Background to the Marijuana "Problem": The Indian Hemp Drugs Commission Report

In 1893, the British Government commissioned a report on Indian "hemp drugs."[9] The goal of this exercise was to inform drug policy in India. Specifically, the question to be answered was whether the government should keep Indian hemp drugs legal for general (medicinal, recreational, and religious) use, as was the case at the time, or whether it should restrict consumption to only necessary uses such as medical therapies or, at the extreme, even ban them outright. The report originated as the result of pressure from British parliamentarians on the government in London to review its policy governing the sale of marijuana to its Indian subjects. Partly as a result of the influence of the religious (missionary) establishment in India, segments of which strongly opposed the free use of these substances, the issue was pressed until the report was commissioned.[10]

The resulting Hemp Report, published in 1894, was a painstakingly detailed analysis of the consumption of marijuana in India, including content on methods of cultivation of the hemp plant, the production of consumer products from the plant, the geography of its cultivation, the position of various forms of marijuana products in the cultural and social milieu of the time, and so on. Because it had

the advantage of being written at a time when the drug was legal, and for which plenty of data were therefore readily available, it is still considered to be a policy document of tremendous value.[11] While the Hemp Report does not contain data that are statistically viable, it is an excellent contextual foundation on which to build and interpret any statistical picture of marijuana consumption in late-colonial British India.

The Hemp Report concluded with the view that the sale of "hemp drugs" in British India was neither harmful nor culturally unacceptable. In fact, because the drugs had medicinal value, and had been in use for centuries in religious and cultural ceremonies, banning their use would have created disturbances in society, something that the authorities were keen to avoid. A scholar on the subject of the report, James Mills, has recently challenged the legitimacy of the recommendations of the Hemp Report on the grounds that it was written by a group of people who were intensely loyal to the British government.[12] Given the high stakes in the form of revenue losses that the government stood to incur should hemp drugs be banned, these individuals naturally advocated their continued legal sale. In sum, Mills argues, profit triumphed over principle, and marijuana continued to remain legal in the ensuing decades.

Background to the Opium "Problem": The Report of the Royal Commission on Opium, 1893–1895

A parallel development in the area of opium policy and the different interpretation that it has received makes for a very interesting comparison with the Hemp Report. This difference of interpretations also sets the stage for the analysis presented in the second half of this chapter.

In 1893, in response to pressures not dissimilar from those in the context of marijuana, the British parliament commissioned a report on the legal sale and taxation of opium in British India. The resulting *Report of the Royal Commission on Opium, 1893–95* (henceforth Opium Report) published in 1895, presented a thorough analysis of the consumption of opium in India, including content on methods of cultivation of the opium poppy, the production of consumer products from the plant, the geography of its cultivation, the position of various forms of opium products in the cultural and social milieu of the time, and so on.[13] Like the Hemp Report, because it had the advantage of being written at a time when opium was legal, and for which plenty of data were therefore readily available, it is still considered to be a policy document of great value. While the Opium Report does not contain data that are statistically viable, like the Hemp Report, it is an excellent contextual foundation on which to build and interpret any statistical picture of opium consumption in British India. Together with the Hemp Report, the Opium Report resulted in a variety of policy resolutions, the contents of which often found their way into local and regional laws.

The Opium Report concluded with the view that the sale of opium was neither harmful nor culturally unacceptable in British India. In fact, it asserted that opium had religious and medicinal value. A scholar on the subject of the report, John

Richards, has recently supported the findings of the report on the grounds that it was a justifiable attempt to keep the "cultural imperialism" of some of the more religiously-motivated and contextually ignorant British colonials at bay. In sum, he argues, preservation of Indian culture triumphed over imperialism, and opium continued to remain legal in the ensuing decades.[14]

A Comparison of the Hemp and Opium Reports

A striking feature of the marijuana and opium reports is the degree to which they resembled each other. Both reports were very thorough in the information they gathered – each report comes with half a dozen or so voluminous appendices including reams of testimony given by people involved, directly, or indirectly, with the consumption or trade of the substances.[15] The reports were published within a year of each other. They were commissioned as a parliamentary response to the same prohibitionist forces. Both commissions were dominated by, and the ensuing reports written by, British loyalists, who were likely cognizant of the significant potential losses from the prohibition of the substances. While Indians were represented on both commissions, they had little control over and say in the outcome of the reports. And both reports came to the same conclusion, i.e., the continued regulated (and heavily taxed and therefore profitable) sale of the substances to Indian subjects.

By contrast, the differences between the reports appear to be so small as to be almost superficial. One was about "hemp drugs," while the other was about opium, and one (i.e., the Opium Report) considered in more detail the foreign trade in the substance, while the focus of the other (the Hemp Report) was almost wholly domestic.[16] On a few other details too, the reports differed, but in form and spirit they were the same.

Far more striking than the similarities in the two reports are the differences in the interpretations that the two aforementioned scholars have provided of them. Mills rejects the conclusions of the Hemp Report on the grounds that it was motivated by financial considerations. Richards welcomes the conclusions of the opium report on the grounds that it rejected cultural imperialism in favor of a more culturally harmonious status quo. How is one to reconcile these two radically differing judgments of two reports that were so similar in tenor? The answer lies in a closer reading of the reports. In addition to providing a general if preliminary characterization of the economics of simultaneous marijuana and opium and consumption, in this chapter, we will focus on the Hemp Report and demonstrate, using econometric methods, the validity of this closer reading of the report.

The Indian Hemp Drugs Commission (hence Hemp Commission) consisted of a president (British), six members, three of whom were British and three Indian, and a British secretary. While the report concluded in favor of the maintenance of the legal regime, it contained dissenting opinions by two of the three Indian members (forming a majority of the Indians on the Hemp Commission).[17] These opinions are remarkable in that they showed a nuanced (and, as will be seen, relevant even in modern India) understanding of the position of marijuana in Indian society, and they

actually challenged the financial interests of the British authorities. If any pressure had been brought to bear on the Indian members of the Commission to fall in line with the recommendations of their British superiors, then it worked on only one of the three Indians, making the two notes of dissent all the more remarkable.

Both dissenting opinions drew distinctions among the different forms in which marijuana was consumed, namely *bhang*, *ganja*, and *charas*. While the Hemp Report had a tendency to pigeonhole the three major forms of marijuana under the broad heading of "hemp drugs," it made clear the fact that, while these substances were all derived from the same plant, they had differing effects on consumers. Both dissenters recommended the continued legal use of *bhang*, because it was the weakest form of the drug, it did not seem to have deleterious effects on its consumers, and it was widely used for medicinal and religious purposes. Both recommended the gradual and eventual prohibition of *ganja* and *charas* based on the view that these forms of "hemp drugs" were more harmful in their effects (no doubt due to their higher potency), were not widely used for religious purposes (unlike *bhang*), and their consumption was generally frowned upon in Indian society. They proposed gradual prohibition because of the negative impact that rapid prohibition would have on the part of the economy that benefited from the production of these drugs.[18]

The positions of the dissenters, whose opinions were arguably the most culturally nuanced and were, in addition, informed by the same facts as those that informed their British comrades on the Commission demonstrates the partial validity of Mills' position on hemp drug policy in British India. Mills is right to suspect the profit motive of the British – if profits were not part of the equation, then the stronger forms of the drug should have been banned, assuming that they were different from *bhang* in their effects on consumers.[19] Unfortunately, these (and *ganja* in particular) were precisely the forms of the drug that yielded the greatest profits to British coffers. In large swaths of India, *bhang* grew wild and, while it was considered, for good reason, to be of significantly inferior quality (in the sense of lower THC content) to cultivated *bhang*, it posed a potential threat to any hemp drug enterprise that depended solely on *bhang*. Because of the importance of the resin for the potency of the *ganja* and *charas* forms of the drug and the necessity to cultivate marijuana in order to derive high-potency *ganja* and *charas*, however, these two forms of the drug lent themselves much more to control, and hence to profit in a legal and controlled regime.[20] Little wonder then that the voices of two of the three Indian members of the Commission went unheeded.

The Richards argument applied to the hemp drugs context is also partially correct. The prohibitionist forces were being culturally imperialistic, at least to the extent that they advocated the prohibition of *all three* forms of the drug. If the members of the Commission, British and Indian alike, agreed on one issue, it was the maintenance of the legal status of *bhang*. Categorical prohibition would have altered this, imposing foreign norms on the indigenous culture, which is what Richards means when he uses the term "cultural imperialism" in the context of opium.[21]

Of course, the above analysis takes as given the assertions of the dissenting Indian majority on the Commission, i.e., that *ganja* and *charas* were different from *bhang*. This is not at all obvious, given that the intoxicating substance, namely THC, was present in all three forms of the drug. In the second part of this chapter, the question of whether *bhang*, *ganja*, and *charas* can be treated as different drugs from a behavioral perspective is taken up. The responses of consumption of these drugs to changes in their price and in the prices of the other drugs are estimated and summarized. If the drugs appear to be substantially different in their economic properties, then we have evidence (over and above the qualitative evidence with which they supported their dissenting views) in support of the distinction made by the dissenters on the Hemp Commission.

Preliminary Analysis of the Drug Data

Data Description

Prior to the statistical analysis of the data, an overview of the population and the consumption and price statistics pertaining to opium and marijuana in Bengal are presented. The current dataset includes price and consumption data for opium, *bhang*, *charas*, and *ganja* as well as other related variables for 27 districts over 21 years (1908–1928).[22] Because we are working with pre-partition Bengal the area covered currently straddles Bangladesh and the state of West Bengal in India.[23] The 27 districts are: Bakarganj, Bankura, Birbhum, Bogra, Burdwan, Calcutta, Chittagong, Dacca, Darjeeling, Dinajpur, Faridpur, Hooghly, Howrah, Jalpaiguri, Jessore, Khulna, Malda, Midnapore, Murshidabad, Mymensingh, Nadia, Noakhali, Pabna, Parganas, Rajshahi, Rangpur, and Tippera (see Figure 14.1 above). We currently have 525 total district year observations instead of $27 \times 21 = 567$ because we are missing all data for the years 1908–1910 for 14 districts. It should also be noted that we do not have any marijuana price data for these years (1908–1910). In terms of the price data, in most years, the retail price per unit weight (usually a *seer*), is provided for all the regions.[24] All prices are denominated in *rupees* and *annas*.[25]

Primary Variables

The first challenge is missing data for our primary variables, prices and consumption of the four drugs. Of the eight variables of interest (prices and consumption for opium, *bhang*, *charas*, and *ganja*), we have approximately 74% of the total possible data. We are missing consumption data for 50 *bhang* and 278 *charas* observations, and price data for 1 opium, 114 *bhang*, 318 *charas*, and 74 *ganja* observations. The missing consumption data for *bhang* and *charas* are assumed to be 0 (none officially consumed). Table 14.1 displays the summary statistics for drug consumption. *Ganja* consumption is highest by weight (and expenditure), followed by opium, *bhang* and *charas*. Table 14.2 displays the summary statistics for the

Table 14.1 Drug consumption descriptive statistics

	Minimum	First Quartile	Median	Third Quartile	Maximum	Missing Observations	Standard Deviation	Mean
Opium	77	513	842	1,617	32,010	0	3,352	1,916
Bhang	4	75	200	906	20,710	50	2,692	1,065
Charas	2	14	27	82	1,815	278	295	125
Ganja	274	1,481	2,010	3,344	22,560	0	3,291	3,149

Table 14.2 Drug price descriptive statistics

	Minimum	First Quartile	Median	Third Quartile	Maximum	Missing Observations	Standard Deviation	Mean
Opium	7,680	12,290	19,970	24,960	32,640	1	6,560	18,580
Bhang	576	1,440	2,880	3,840	3,840	114	1,249	2,621
Charas	7,104	14,590	17,280	23,040	30,720	318	6,058	18,860
Ganja	3,840	9,600	12,960	16,800	20,160	74	4,425	13,320

drug prices, adjusted for inflation. Opium and *charas* are the most expensive drugs, followed by *ganja* and *bhang*.

We balance the panel by estimating the missing values using seemingly unrelated regressions. Each dependent variable is estimated using a time trend with district specific slopes and intercepts. This process is equal to performing ordinary least squares in each district, regressing the dependent variable on a time trend. We estimate missing observations for the price of opium (1 obs), price of *bhang* (71 obs), price of *charas* (128 obs), price of *ganja* (51 obs), and the price of rice (76 obs), which is used as an index of inflation. Not all missing values are estimated. There are still missing values for *bhang* and *charas* prices in those districts that did not have any sales of these drugs. Specifically, Darjeeling has no *bhang* and *charas* price data and Jalpaiguri has no *bhang* price data for any year.

Other Variables

We estimate the district population in each year using the census population data in years 1891, 1901, 1911, 1921, 1931, and 1941.[26] This exercise is complicated by the global influenza epidemic that struck British India in 1918–1919. It is well-established that British India experienced the highest death toll of any country or territory as a result of this event. While estimates of the death toll in India vary widely, they are in the range of 12 million to 20 million, or approximately 50% of the worldwide figure.[27] Because the disease entered India through Bombay on the west coast of India, Bengal, in the eastern part of India, was not hit as hard as some of the western provinces. That said, the census data for 1911 and 1921, which provide the closest census population figures before and after the year of the epidemic, suggest that parts of Bengal were in fact severely affected by the disease. Specifically, Fig. 14.2a shows that 11 districts in the dataset experienced declines in

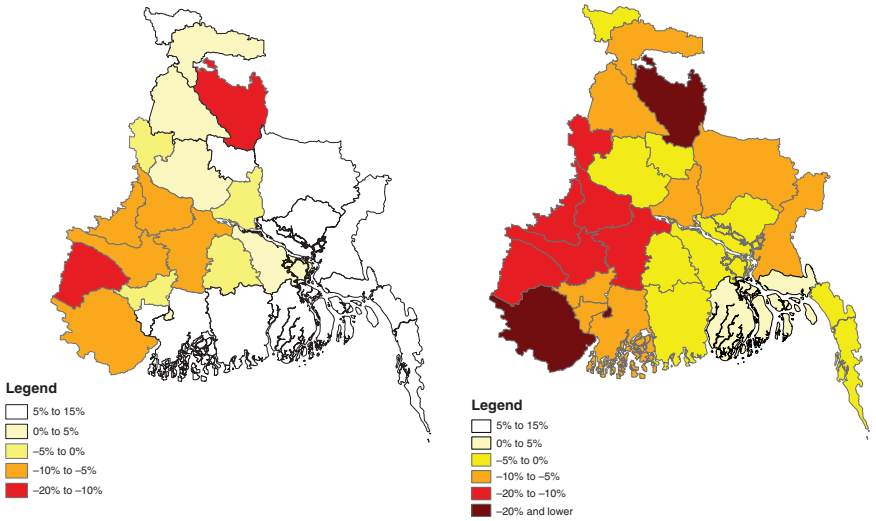

Fig. 14.2 (**a**) Percentage change in population in Bengal from 1911 to 1921 (census years straddling the influenza pandemic); (**b**) percentage change in population in Bengal from 1918 to 1919 (estimates for the influenza pandemic) (See also Plate 16 in the Colour Plate Section)

population over the entire decade. A number of additional districts show very slow rates of growth.

Therefore, our estimation procedure proceeds as follows. First, we assume an exponential rate of population growth, $P_{t+1} = P_t \times (1 + r)$, where r is the growth rate and t is the time period. Then, rather than assuming a constant growth rate for each district over the entire time frame, we allow for a structural break in the year 1919 to account for the influenza pandemic. We estimate a growth rate for each district before 1919 using the 1891–1911 census data and a growth rate after the pandemic using the 1921–1941 census data.[28] The growth rates are displayed in Table 14.3. These growth rates are used in conjunction with the census data to estimate the district population over all years. This exercise also enables us to estimate the drop in population between 1918 and 1919 as a result of the influenza epidemic. The results, displayed in Fig. 14.2b, appear to be consistent with the census data displayed in Fig. 14.2a. Finally, the rates of population growth (or decline) in Figs. 14.2a (1911–1921) and 14.2b (1918–1919) show strong evidence of spatial clustering, as demonstrated by the univariate Moran's I statistic, which is significant at the 1% level for both variables.

The other variable of interest is the price of rice. Because Bengal was (and still is) a heavy rice consuming region, the price of rice is used as an indicator of the cost of living.[29] The rice price data are available annually at the district level. The variation in rice prices over time is clearly non-linear, with at least four inflection points. Therefore, we estimate the 142 missing instances of rice prices in the data set using a 5th degree polynomial. However, this model results in seemingly extraordinary estimates for prices in the later years (>1925). This aspect of the study will be

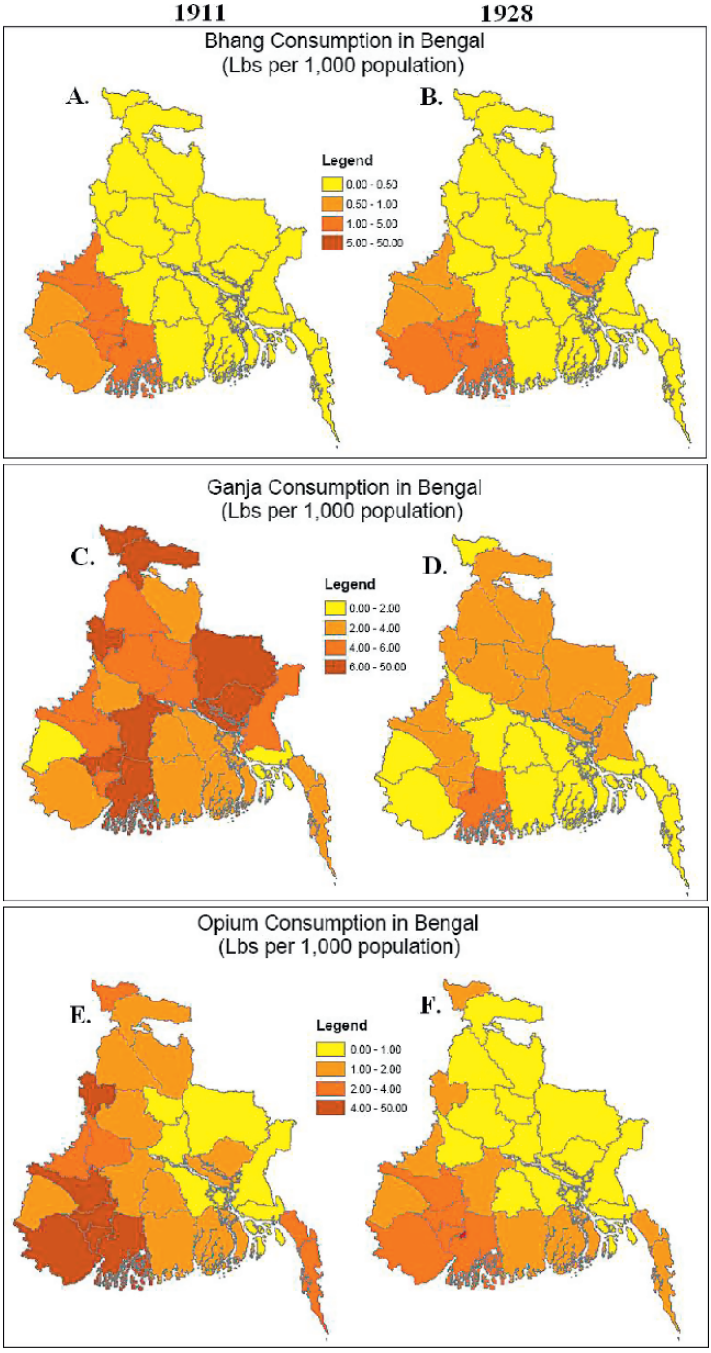

Fig. 14.3 (**a**) Bhang consumption in Bengal – 1911; (**b**) bhang consumption in Bengal – 1928; (**c**) ganja Consumption in Bengal – 1911; (**d**) ganja Consumption in Bengal – 1928; (**e**) opium consumption in Bengal – 1928; (**f**) opium consumption in Bengal – 1911 (Lbs per 1,000 population) (See also Plate 17 in the Colour Plate Section)

Table 14.3 Population growth rates before and after the 1919 influenza pandemic

	1918 and Before (%)	1919 and After (%)
Bakarganj	0.5	1.2
Bankura	0.3	1.2
Birbhum	0.8	1.0
Bogra	1.1	1.0
Burdwan	0.5	1.4
Calcutta	1.7	3.4
Chittagong	0.8	1.1
Dacca	1.1	1.5
Darjeeling	0.8	1.5
Dinajpur	0.7	0.6
Faridpur	0.6	1.3
Hooghly	0.3	1.2
Howrah	1.1	2.0
Jalpaiguri	1.4	0.5
Jessore	−0.4	0.7
Khulna	0.3	1.4
Malda	1.1	1.0
Midnapore	0.4	5.8
Murshidabad	0.4	1.3
Mymensingh	1.3	1.1
Nadia	−0.1	1.3
Noakhali	0.8	1.5
Pabna	0.2	1.0
Parganas	1.1	1.8
Rajshahi	0.3	0.2
Rangpur	1.6	0.7
Tippera	1.7	1.3

refined in future iterations. All nominal (i.e., Rupee-denominated) variables were adjusted for inflation using this variable.[30]

We now proceed to a spatial and econometric characterization of the data, with a focus on the figures for population and consumption of opium, *bhang*, *charas*, and *ganja*.

Models of Drug Consumption

As discussed earlier, the dissenting members of the Hemp Commission emphasized the distinct nature of the different forms of marijuana, namely *bhang*, *ganja*, and *charas*. As a consequence of this emphasis, their concluding opinions (to prohibit *ganja* and *charas* and to keep *bhang* legal) were at odds with those of the British-dominated majority on the Commission, which took a categorical (i.e., all or nothing) approach to the issue. Were the dissenters justified in treating *ganja* and *charas* differently from *bhang*? While there is substantial evidence that they were justified on religious and social grounds, the question of differences in the substances at a more basic behavioral level still stands. In particular, because all three forms of marijuana contain THC as the main psychoactive ingredient, it is possible that all

three forms produced similar behavior among users. The goal of this section is to analyze the data on the substances for evidence of differences and similarities. To this end, standard models of consumption of *bhang*, *ganja*, *charas*, and opium are estimated.

In keeping with the literature on how changes in prices affect the consumption of the drugs under study, we use per capita consumption data rather than aggregate consumption. Therefore, we normalize the consumption data by the estimated population in each district. Figure 14.3 shows per capita consumption of *bhang*, *ganja*, and opium for the start- and end-years (i.e., 1911 and 1928) for the pilot data used in this chapter. Table 14.4 demonstrates that there is evidence of spatial clustering of per capita consumption of the drugs under study, suggesting that geography may be important. Specifically, for half of the variables, Moran's I statistic suggests clustering and is statistically significant. In addition, other important variables such as population density and the percentage change in population during the influenza epidemic (1918–1919) show evidence of spatial clustering. These findings indicate in favor of modification of the econometric models for spatial phenomena in future iterations of this research.

For each good, the model was written as a variant of

$$C_{it} = \alpha + \beta_1 \text{BHANGPRICE}_{it} + \beta_2 \text{GANJAPRICE}_{it} + \beta_3 \text{CHARASPRICE}_{it} + \beta_4 \text{OPIUMPRICE}_{it} + e_{it}$$

where C_{it} is natural logarithm of per capita consumption of *bhang*, *ganja*, *charas*, or opium in district i at time t, BHANGPRICE_{it}, GANJAPRICE_{it}, CHARASPRICE_{it}, and OPIUMPRICE_{it}, are the natural logarithm of the real price of *bhang*, *ganja*, *charas*, and opium and e_{it} is the random error term. α is the regression constant, and $\beta_1 - \beta_4$ were the coefficient estimates as written above. Because the markets were monopolized by the government, the issue of endogeneity of consumption does not arise.[31]

Table 14.4 Clustering patterns of drug consumption

Variable	Year	Moran's I	z-Score	Significance Level (0.01, 0.05, or 0.10)	Clustered or Dispersed
Opium consumption	1911	0.026	3.423	0.01	Clustered
	1928	0.074	5.439	0.01	Clustered
Bhang consumption	1911	−0.009	1.750	0.10	Dispersed
	1928	0.062	5.153	0.01	Clustered
Ganja consumption	1911	−0.036	0.135	Not significant	Neither
	1928	0.017	2.568	0.05	Clustered
Charas consumption	1911	−0.070	−1.912	0.10	Dispersed
	1928	−0.047	−0.412	Not significant	Neither

Consumption is measured in pounds per 1,000 population.

Preliminary Regression Results for the Pilot Data

As a preliminary step, two categories of models were estimated for each substance. These were fixed effects models and random effects models with district-specific effects. In each category, two models were estimated, one each with and without a time trend. Finally, these four models were estimated using a restricted dataset for which only those observations for which *bhang* and *charas* data were available were used, and a larger dataset for which all observations were used by dropping the prices of *bhang* and *charas* from the model. The results demonstrated that the fixed effects specification with a time trend is usually superior to other specifications.[32] The results of the regressions for opium, *ganja, charas*, and *bhang* are presented in Tables 14.5–14.8.

Table 14.5 Opium regression results (Fixed effects with time trend model)

Variable	Estimate	$Std.Error$	t-Value	Pr($>\|t\|$)
Intercept	67.79	6.29	10.78	0.00
Opium price	−0.70	0.10	−7.20	0.00
Ganja price	0.38	0.12	3.20	0.00
Charas price	0.13	0.11	1.14	0.25
Bhang price	0.03	0.04	0.73	0.47
Bankura	0.12	0.08	1.65	0.10
Birbhum	0.48	0.08	6.19	0.00
Burdwan	0.95	0.08	12.48	0.00
Calcutta	3.18	0.07	42.78	0.00
Dacca	−0.34	0.08	−4.51	0.00
Dinajpur	−0.25	0.08	−3.16	0.00
Hoogly	1.49	0.07	20.40	0.00
Howrah	1.29	0.08	16.46	0.00
Khulna	0.06	0.08	0.73	0.46
Malda	0.67	0.08	8.45	0.00
Midnapore	1.18	0.07	16.14	0.00
Murshidabad	0.23	0.08	2.93	0.00
Mymensingh	−1.29	0.08	−16.00	0.00
Nadia	0.09	0.08	1.19	0.24
24-Parganas	1.48	0.07	20.06	0.00
Rangpur	−0.51	0.08	−6.33	0.00
Year	−0.04	0.00	−11.95	0.00
Summary statistics				
Residuals	SE residual	0.22	DF residual	300
Regression	F-statistic (21,300)	311.60	p-value	0.00
N	N	322	N of FE	17
Specification	LR test	112.23	p-value	0.00
Fit	AIC	173.07	R^2	0.96
	BIC	199.49	Adj. R^2	0.95
	log Lik	−79.53		

Table 14.6 Ganja regression results (Fixed effects with time trend model)

Variable	Estimate	*Std.Error*	*t*-Value	Pr(¿—t—)
Intercept	59.40	5.89	10.08	0.00
Opium price	−0.09	0.09	−0.96	0.34
Ganja price	−0.22	0.11	−1.95	0.05
Charas price	0.04	0.11	0.41	0.68
Bhang price	0.09	0.04	2.42	0.02
Bankura	−0.18	0.07	−2.49	0.01
Birbhum	0.49	0.07	6.82	0.00
Burdwan	0.77	0.07	10.81	0.00
Calcutta	2.47	0.07	35.46	0.00
Dacca	0.72	0.07	10.14	0.00
Dinajpur	0.63	0.07	8.53	0.00
Hoogly	0.87	0.07	12.75	0.00
Howrah	0.83	0.07	11.28	0.00
Khulna	0.07	0.07	1.01	0.31
Malda	0.80	0.07	10.66	0.00
Midnapore	−0.12	0.07	−1.79	0.07
Murshidabad	0.37	0.07	4.89	0.00
Mymensingh	0.82	0.08	10.89	0.00
Nadia	0.31	0.07	4.28	0.00
24-Parganas	1.32	0.07	19.04	0.00
Rangpur	0.31	0.08	4.16	0.00
Year	−0.03	0.00	−11.25	0.00
Summary statistics				
Residuals	SE residual	0.21	DF residual	300
Regression	F-statistic (21,300)	146.70	p-value	0.00
N	N	322	N of FE	17
Specification	LR test	97.54	p-value	0.00
Fit	AIC	104.50	R^2	0.91
	BIC	130.92	Adj. R^2	0.91
	log Lik	−45.25		

Table 14.5, the opium model, shows an own-price elasticity of -0.7. This is consistent with earlier findings on opium price elasticities. There is also evidence that *ganja* and opium are substitutes. Further refinement of the models to include more observations and spatial and other variables such as wages will shed more light on this and other possible drug interactions.

Table 14.6 contains the results of the *ganja* model. The own price elasticity of *ganja* is low, at -0.22. Aside from this finding, little can be said about cross-price elasticities at this time aside from a small substitution effect from *bhang*. The results for *bhang* are shown in Table 14.7. The own-price elasticity of *bhang* is low, at -0.33. Table 14.8 summarizes the *charas* model. Because of the small quantities of *charas* being consumed in British Bengal and the correspondingly large fluctuations in consumption in percentage terms compared to opium, *ganja*, or *bhang*, these results should be interpreted with caution. *Charas* has a high own-price elasticity of -0.79, is a substitute for *ganja*, and complements *bhang*. We are currently collecting data for provinces in which *charas* consumption was relatively high, and expect that

Table 14.7 Bhang regression results (Fixed effects with time trend model)

Variable	Estimate	*Std.Error*	*t*-vValue	Pr(¿—t—)
Intercept	−179.10	19.09	−9.38	0.00
Opium price	−0.17	0.29	−0.59	0.56
Ganja price	0.18	0.39	0.47	0.64
Charas price	0.25	0.37	0.67	0.50
Bhang price	−0.33	0.13	−2.48	0.01
Bankura	1.00	0.20	5.07	0.00
Birbhum	2.40	0.19	12.46	0.00
Burdwan	2.48	0.20	12.70	0.00
Calcutta	4.79	0.18	26.46	0.00
Dacca	−0.58	0.19	−3.08	0.00
Dinajpur	−0.06	0.20	−0.29	0.77
Hoogly	1.22	0.18	6.63	0.00
Howrah	0.51	0.35	1.44	0.15
Khulna	0.90	0.20	4.58	0.00
Malda	1.23	0.31	3.97	0.00
Midnapore	−0.33	0.19	−1.71	0.09
Murshidabad	0.94	0.21	4.60	0.00
Mymensingh	0.07	0.35	0.20	0.84
Nadia	1.25	0.20	6.32	0.00
24-Parganas	1.64	0.18	9.03	0.00
Rangpur	−0.57	0.42	−1.37	0.17
Year	0.09	0.01	8.82	0.00
Summary statistics				
Residuals	SE residual	0.53	DF residual	216
Regression	*F*-statistic (21,216)	85.07	*p*-value:	0.00
N	*N*	238	*N* of FE	17
Specification	LR test	86.86	*p*-value	0.00
Fit	AIC	521.57	R^2-Squared:	0.89
	BIC	545.88	Adj. R^2-Squared	0.88
	log Lik	−253.79		

analyses of those data will yield more robust and perhaps different estimates of the price elasticity of *charas*.

In addition to the findings discussed earlier, Table 14.5–14.8 demonstrate further possible evidence of the importance of space in understanding the economics of consumption of *bhang*, *ganja*, *charas*, and opium. Specifically, the majority of the district fixed effects are statistically significant, suggesting the possibility that geographic variables may be an important addition to the models. For this additional reason, the results should be interpreted with caution, pending further broader and deeper analyses of these and additional data, which we expect will be forthcoming soon.

The preliminary analysis suggests that *bhang*, *ganja*, and *charas* (and opium, for that matter) elicited very different behavioral patterns. These patterns are summarized in Table 14.9. First, different forms of marijuana show differing degrees of own-price responsiveness. Second, there is no symmetry of substitution effects, which one would expect if the different forms of marijuana were being consumed in the same manner and for the same reasons. For example, while the price of *ganja* is significant and positive in the *charas* consumption model, the price of *charas* is

Table 14.8 Charas regression results (Fixed effects with time trend model)

Variable	Estimate	*Std.Error*	*t*-Value	Pr(¿—t—)
Intercept	32.50	10.03	3.24	0.00
Opium price	−0.17	0.16	−1.07	0.29
Ganja price	0.82	0.19	4.33	0.00
Charas price	−0.79	0.18	−4.41	0.00
Bhang price	−0.23	0.06	−3.60	0.00
Bankura	1.57	0.12	13.29	0.00
Birbhum	1.70	0.12	13.97	0.00
Burdwan	2.39	0.12	19.94	0.00
Calcutta	4.82	0.12	41.21	0.00
Dacca	1.33	0.12	11.18	0.00
Dinajpur	−1.38	0.12	−11.17	0.00
Hoogly	2.53	0.11	22.11	0.00
Howrah	2.71	0.12	22.02	0.00
Khulna	0.64	0.12	5.20	0.00
Malda	−1.53	0.13	−12.16	0.00
Midnapore	2.08	0.12	18.06	0.00
Murshidabad	0.32	0.13	2.51	0.01
Mymensingh	−0.82	0.13	−6.49	0.00
Nadia	1.03	0.12	8.54	0.00
24-Parganas	2.86	0.12	24.65	0.00
Rangpur	−1.52	0.14	−11.08	0.00
Year	−0.02	0.01	−4.13	0.00
Summary statistics				
Residuals	SE residual	0.35	DF residual	294
Regression	F-statistic (21,294)	360.30	p-value	0.00
N	N	316	N of FE	17
Specification	LR test	120.77	p-value	0.00
Fit	AIC	359.90	R^2	0.96
	BIC	386.19	Adj. R^2	0.96
	log Lik	−172.95		

not significant in the *ganja* consumption model. The complementarity effects are, likewise, far from uniform. In sum, there is a clear evidence in support of the implicit assumption in the dissenting notes in the Hemp Report that *bhang*, *ganja*, and *charas*, although originating from the same plant (i.e., hemp) and containing THC as the main psychoactive substance, were qualitatively different in their usage and impact on users.

Future Research Directions

In a variety of ways, this is a pilot study. The dataset that will ultimately be used to analyze relationships between the consumption of the various drugs sold in British India will be larger in numbers of observations and in geographic scope than this dataset. Second, additional variables including wage or income data will be used

Table 14.9 Summary of the properties *of Bhang, Ganja, Charas*, and Opium

Property	Substance			
	Cannabinoids (increasing strength, from left to right)			Opioid
	Bhang	*Ganja*	*Charas*	Opium
Own-price responsive	Yes**	Yes*	Yes***	Yes***
Substitute A†	None	*Bhang***	*Ganja****	*Ganja****
Substituted B†	*Ganja***	*Charas****, *Opium****	None	None
Complement A‡	None	None	*Bhang****	None
Complemented B‡	*Charas****	None	None	None

"None" may indicate an inconclusive result that will be sharpened by analysis of the expanded dataset.

***Parameter estimates significant at the 1% level.

**Parameter estimates significant at the 5% level.

*Parameter estimates significant at the 10% level.

† The price of the 'row' drug is significant in the model of consumption of the 'column' drug.

‡ The price of the 'column' drug is significant in the model of consumption of the 'row' drug.

in future analyses. Further, based in part on the findings of this pilot study, which show a strong spatial character for some of the key variables in the analysis, we will include spatial considerations in final econometric models to be estimated using the expanded dataset. Many additional concepts, which are not discussed here for lack of space, can be analyzed using these data, including (1) the addictiveness (using economic models of addiction) of each of these substances in a multi-substance setting using legal data, (2) the price sensitivity at the population level of marijuana, alcohol, and opium consumption in the presence of different combinations (these vary depending on the province being studied) forms and strengths of the same and other substances, (3) the analysis of differential behavior depending on the strength of some of these substances (such as alcohol based on alcohol content and cannabinoids based on form, each of which has a different potency (i.e., *charas* vs. *ganja* vs. *bhang*)), and (4) whether the consumption of one or more substances or forms of substances tends to systematically precede in time the consumption of one or more of the other substances or forms of substances.

Conclusion

In this chapter, using a small pilot dataset and simple econometric models, a simple and perhaps obvious but nevertheless significant point has been demonstrated in the context of marijuana. The preliminary evidence indicates that drugs containing the same basic psychoactive substance can, depending on their form and content, produce very different effects on the consumer. This is, furthermore, manifested in econometrically identifiable behavior. For this reason, the tendency of the

British authorities to pigeonhole all forms of marijuana into one legal category was arguably counterproductive from a consumer welfare perspective. In advocating the continued legal sale of *bhang* but the prohibition of *ganja* and *charas*, the Hemp Commission dissenters were making nuanced judgments about behavior and their culture.[33] Their judgments are amply validated by the fact that, after India won her independence over 50 years after they penned their dissenting opinions, policy toward marijuana gradually evolved to the point that it is now legal only in the *bhang* form and illegal in the *ganja* and *charas* forms.

In historical context, the *Indian Hemp Drugs Commission Report* is a remarkable document. It contains a wealth of information on many aspects of marijuana production and use in British India. This information suggests that a nuanced approach to the management of the consumption of hemp drugs in British India would have been preferable to the categorical (and financially motivated) approach taken by the British-dominated majority on the Commission. Ultimately, the outcome of the *"Hemp Report"* holds a cautionary message that is paralleled in similar historical works on other substances.[34] Governments can, for financial or other reasons, pursue policies relating to addictive substances and activities that may suboptimal in the sense that, given their social and cultural milieus, they are overly liberal or restrictive.

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Notes

1. For detailed definitions and descriptions of the three main different forms of marijuana studied in this chapter, see the *Indian Hemp Drugs Commission Report*, henceforth "Hemp Report" [Kaplan (1969) reprint], p. 59. For research into the potency of marijuana, see Mikuriya and Aldrich (1988).
2. In this chapter, the terms "cannabis" and "marijuana" are used interchangeably to refer to all three forms of the drug. Where a specific form (i.e., *bhang*, *ganja*, or *charas*) is discussed, the specific term for that form is used.
3. Figure 14.1 shows the districts of Bengal. Because Bengal in the early 20th century was part of British India, it had not been partitioned by the British into Bangladesh and the state of West Bengal in India. Hence, the data being analyzed in this study straddle the modern countries of Bangladesh and India.
4. For opium, see Van Ours (1995), Liu et al (1999), and Chandra (2000). For tobacco and alcohol, there is a much larger literature, typified by such studies as Becker, Grossman, and Murphy (1994), Chaloupka (1991), Goel and Morey (1995), and Grossman et al. (1998). Most of the marijuana studies to date rely on individual level self-reported data that are,

in most cases, highly unreliable themselves. For data quality issues and problems relating to the economics of marijuana use, see the data descriptions in Cameron and Williams (2001), Chaloupka, Grossman, and Tauras (1999), Desimone and Farrelly (2003), DiNardo and Lemieux (1992), Nisbet and Vakil (1972), Pacula (1998), Thies and Register (1993), and Williams (2004).

5. Cigarettes and alcohol are, by contrast, legal in a number of countries. Hence, economists have been able to analyze the impact of price (and therefore tax) changes on these substances using recent data. It should be noted in the context of opium that no spatial models of opium consumption have been estimated to date. This is a gap in the literature that will hopefully be filled as part of this project.
6. See Indian Hemp Drugs Commission (1894).
7. A series of recent events illustrates the currency and importance of this debate, and demonstrates the need for an understanding of the behavior of drug-consuming populations in a regime of legalization. In June 2005, for example, the House of the Rhode Island General Assembly voted 57-10 in favor of legalizing marijuana for medical uses. Following a veto by Governor Carcieri, the Senate overrode the veto with a 28-6 vote. At the time the first draft of this chapter was being prepared, and pending a similar expected overriding vote by the House, Rhode Island's status as the 11th state to legalize marijuana for medicinal use was imminent. At the same time, the U.S. Supreme Court ruled that "state laws sanctioning medical marijuana use provide no defense against enforcement of federal anti-drug laws by federal agencies" (Lader 2005). And, as these legal events were unfolding, a report entitled "The Budgetary Implications of Marijuana Prohibition" (Miron 2005) demonstrating the significant budgetary benefits of marijuana legalization, and arguing for the inclusion of this economic consideration in any comprehensive debate on the pros and cons of legalization, was published.
8. See, for example, Pandey (2005).
9. "Hemp drugs" were defined as the drugs produced from the *cannabis sativa* or *cannabis indica* plant [*Hemp Report*, Kaplan (1969) reprint, pp. 16–17].
10. For a summary of the origins of the Indian Hemp Drugs Commission, see Mills (2005).
11. The number of hits on any leading search engine on the worldwide web in response to a search for the title of the report is testimony to this. The report has, at one point or another, also been cited in most national-level debates on the (il)legal status of marijuana, and continues to be so.
12. Mills (2005), concluding paragraph. See also Mills (2003).
13. See Great Britain Royal Commission on Opium (1894–1895).
14. Richards (2002), pp. 418–420.
15. The Indian Hemp Drugs Commission, for example, took testimony from 1,193 witnesses [*"Hemp Report"*, Kaplan (1969) reprint, p. 12].
16. As a source of export revenues, opium was far more important than "hemp drugs." Among the beneficiaries of this trade were China, the Dutch East Indies, French Indochina, and Siam.
17. For these dissenting opinions, written by Raja Soshi Sikhareshwar Roy and Lala Nihal Chand, see the notes appended to the end of the report. [*"Hemp Report"*, Kaplan (1969) reprint, pp. 363–477].
18. *"Hemp Report"* [Kaplan (1969) reprint], p. 379 (Roy) and *"Hemp Report"* [Kaplan (1969) reprint], p. 436 (Nihal Chand).
19. In a later section, this assertion will be tested.
20. The most THC-rich resin is found on female marijuana plants that have not had a chance to produce seeds. In order to ensure this, an elaborate process of eliminating male plants from any plantation in its early stages to prevent pollination and, therefore, seed production, had to be undertaken. This could only happen in controlled and cultivated circumstances. For details in the historical context, see *"Hemp Report"*, pp. 59–84.
21. Richards (2002), p. 420.
22. Data sources will be provided on request.

23. In 1947, Bengal was partitioned into East Pakistan (later Bangladesh) and Indian (West) Bengal.
24. The units of weight used in British Bengal were as follows: 1 *maund* = 40 *seers* and 1 *seer* = 2.057 pounds.
25. Prior to the introduction of the metric system in independent India, one *rupee* consisted of 16 *annas*.
26. See India Census Commissioner (1891, 1901, 1911, 1921, 1931, 1941).
27. Patterson and Pyle (1991), pp. 14–15.
28. We do not use the census data for the censuses prior to 1891 because of questions about their reliability.
29. See Bengal, Department of Agriculture (1920). This is standard practice in the economic history of rice-consuming Asia. See, for example, Mansvelt and Creutzberg (1978).
30. While daily nominal wages obtained from quinquennial wage surveys for the years 1911 and 1916 could be interpolated for the other years in the decade and used as indicators of income, we plan to obtain additional wage data before including this economic variable in the analysis. Missing wage data have not been estimated due to the extreme care that must be taken given the high numbers of missing observations.
31. A similar (implicit) assumption is made by scholars who have analyzed opium data in colonial Asia [Van Ours (1995), for example].
32. For example, with only one exception (the bhang model with fixed effects and no charas price), the time trend was statistically significant. Further, the bhang and charas prices are usually significant in the models in which they were included. Therefore, in this chapter, we will focus on the fixed effects models with the time trend using the restricted dataset so that bhang and charas prices are included in the analysis.
33. This nuanced approach is not unlike the approach adopted in some countries in South America, in which the coca leaf, which contains psychoactive substances, is legal, while its much more powerful and dangerous derivative, cocaine, is prohibited.
34. Rush (1990), Trocki (1990), and Chandra (2000), for example, demonstrate the willingness of governments to pursue profit over principle in the matter of drug policy in historical context.