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Precursors and Prices: Structuring the Quebec Synthetic Drug Market

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Abstract

Few analyses of basic elements of the synthetic drug market have been conducted, particularly in regard to its structural features. Synthetic drug's relatively recent classification as an illicit substance, coupled with its distinct clandestine characteristics, has hindered the development of reliable assessments of the market's structural features. Using information derived from 365 seized synthetic drugs, this study aims to reliably examine the structural attributes of Quebec's synthetic drug market by merging two approaches: drug composition and economic analysis. Findings for the drug composition analysis indicate that the market is composed of a high number of small structures, indicating a competitive and decentralized market. Providing complementary information, the economic analysis revealed that differential production costs and relations between traffickers influence price variations, depending on the region. These results emphasize the need to design policies that account for regional differences as well as reflect the competitive nature of the market.

Keywords

synthetic drugs, market structure, drug composition analysis, economic analysis, price determinants

Introduction

The production and export of synthetic drugs in Canada have garnered significant attention in recent years. Large border seizures and reports published by narcotics bodies have triggered a surge of interest, placing synthetic drugs at the forefront of national law-enforcement agendas and in the media spotlight. News sources, emphasizing a structured view of the market, have labeled Canada a "global drug lord" (Glenny, 2009) and drawn parallels between the Canadian synthetic drug market and highly organized Colombian drug enterprises (Godfrey, 2012). However, despite these allegations and the heightened attention accompanying them, few analyses of basic elements of Canada's synthetic drug market have been conducted, particularly in regard to its organizational characteristics and structural attributes. Further of the sparse set of studies, findings are often fragmented and contingent on multiple assumptions, only providing glimpses into the market's structure or even echoing discredited allegations. This current lack of validated information may be attributed to the paucity of innovative methodological tools available to assess the clandestine market, hindering the development of reliable analyses. Conventional

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analytical methods that rely on peripheral and direct players for insight are limited in markets where access to participants is rare. Attempting to narrow the gap between efforts to analyze the market and reliable methods to do so, innovative approaches have emerged that use properties of the drug market to analyze its structure. Adopting this model, the present study will conduct a drug composition and economic analysis using two fundamental elements of the market, seized drugs and prices, to provide an innovative and systematic assessment of the structural characteristics and organizational features of Quebec's synthetic drug market.

Despite their prevalence, few researchers have turned to the central component of the drug market, the drugs themselves as a unit of analysis. Drugs are frequently seized through law-enforcement procedures; however, given police and judicial mandates, their use often ends as a justification for arrest and court room evidence. With the aid of chemical extraction and systematic classification, these seized drugs can also serve another purpose: providing intelligence to gain insight into the structural and organizational attributes of the drug market. Using seized drugs, specifically drug composition data, as the basis of the current research, this study will analyze the composition and physical features of seized synthetic drugs in Quebec to assess the market's structure. In addition, drug prices, another component of the market, will be incorporated into the analyses to provide a comprehensive understanding of the market's internal dynamics.

Assessments of the Synthetic Drug Market

The necessity of innovative and reliable approaches to assess the synthetic drug market follows from the inconsistencies that have emerged from the sparse set of analyses. Recently, studies have advanced the notion that a few illicit enterprises control significant shares of Canada's synthetic drug market (Criminal Intelligence Service Canada [CISC], 2010; Royal Canadian Mounted Police [RCMP], 2010), contrasting with earlier research on crime groups that state they generally operate within ephemeral and competitive structures (Block & Chambliss, 1981; Gruppo Abele, 2003; Haller, 1990; Potter, 1994; Reuter, 1983). Many of the former allegations have been observed in reports published by Canadian national intelligence bodies. CISC in their 2010 Organized Crime Report claims that clandestine "super labs" have proliferated in Canada to meet the demands of consumer countries, including Australia and New Zealand. Also supporting these allegations is the RCMP Criminal Intelligence Division in their 2009 report on the Illicit Drug Situation in Canada. This report stated that not only are organized crime groups alleged to be in charge of "economic based laboratories" (covert laboratories whose goals are to make profits by responding to national and international demand), but comparatively speaking, they are present in higher numbers than "addiction-based labs" (smaller laboratories that are primarily for a consumer's personal supply; RCMP, 2010). These statements suggest that large organizations play an integral role in the market, responsible for supplying the bulk of consumer demand. Running these large laboratories to meet this wholesale demand requires a high degree of organization, encouraging a rigid and structured perspective of these criminal collectives.

However, these claims should be interpreted with caution, as much of the data and methods are undisclosed, preventing independent researchers from reviewing and evaluating how the results were obtained. Providing a glimpse into their methodology, the RCMP (2010) revealed that their findings rely primarily on seizure data. However, in addition to a lack of detail that was provided for this source (they only state that seizure data were used), seizure data have been criticized for not being valid indicators of drug markets due to their potential to fluctuate in response to factors that are not related to or actual changes in the drug market, such as a single, significant seizure or shifts in law-enforcement priorities (Bouchard et al., 2011). Variations in seizure data may indicate enhanced police targeting and funding, rather than increases in production,

informing us of police strategies, and thus the activities of these authorities, rather than actual market behavior.

In contrast to these reports, a recent multisite European study has emphasized that the synthetic drug market is likely competitive and transient (Gruppo Abele, 2003). Over a 3-year period, research teams analyzed three European synthetic drug markets: Barcelona (Montañes, Barruti, Pallarés, & Domínguez, 2003), Amsterdam (Blickman, Korf, Siegel, & Zaitch, 2003), and Turin (Massari, Mareso, Monzini, & Veglio, 2003). Applying a multifaceted approach that relied primarily on qualitative research tools, including interviews with police officers and drug traffickers, they established that many groups operated in a loosely structured, flexible, and decentralized market, with few barriers to entry or exit. Their research was highly valuable as two of the drug markets they observed were at different stages of development, allowing them to make distinctions and study structural variations. A young market, Spain, consisted primarily of small amateur labs that manufactured a relatively small amount of pills destined for local consumption (Montañes et al., 2003). In contrast, the Netherlands had developed into a more professionalized market that consisted of small groups and a network structure that relied on the outsourcing of specialists, such as chemists and individuals involved in the trade of precursors (Blickman et al., 2003). Regardless of the degree of professionalization, their research allowed them to determine that all three markets were highly adaptable and an "extremely fluid and multifaceted phenomena" (Gruppo Abele, 2003, p. 223).

Although this report provides an extensive analysis of the synthetic drug market, the primary method to investigate the synthetic drug market by the Gruppo Abele was through the use of interviews with active, former, and indirect participants involved in the illicit trade. While this method provides a technique to learn more about the structure through insider accounts of the drug markets, these sources may only provide partial or misinformed accounts and thus may misrepresent the sphere and characteristics of the drug market as a whole. In addition, these methods primarily relied on data obtained at the retail level, not allowing us to observe the higher level, and thus more influential, actors in the market. To overcome these data limitations, quantitative data were also obtained and integrated into the study to examine the market, although to a lesser extent. The report concluded by emphasizing the necessity of conducting further studies on the market in this and other regional and global contexts.

Using an innovative method, drug composition analysis, the present study aims to resolve these discrepancies, while providing a focused analysis of the synthetic drug market in Quebec. The first method, drug composition analysis, is modeled off extensive research in Europe, particularly studies conducted by Dujourdy et al. (2003), Esseiva et al. (2007), Marquis et al. (2008), Weyermann et al. (2008), and Zingg (2005), which have examined the reliability of chemical extraction methods for drug composition data and the utility of this information in a drug intelligence context. Drug composition analysis is uniquely placed to derive information about the market, using the central component of the market, the drugs themselves as the unit of analysis. Taking information obtained from synthetic drug seizures, drug composition analysis examines the seized synthetic tablet's chemical makeup (the number and concentration of different substances present in the tablet) and physical properties (e.g., color and logo) to make inferences about the market's features. At the core of this method is the premise that each drug carries its manufacturer's signature, based on the "recipe" he or she used. Given the wide range of synthesis methods, an infinite number of cutting agents, and the endless colors and logos the drug can be pressed into, it is assumed that drugs produced by the same manufacturer carry the same profile and therefore can be identified through an analysis of the drug's chemical and physical characteristics. Thus, by linking and classifying drugs according to their similar characteristics (tablets with the same concentration of active substances and organic impurities or physical features), we can gain insight into the number and size of drug manufacturers in a given area, revealing the organizational characteristics and structural features of this market.

To accurately conduct a drug composition analysis, numerous characteristics of the synthetic drug market need to be taken into account when interpreting results. In particular, it is essential to note the two distinct steps in the synthetic drug manufacturing process: the pre-tabletting stage, which involves the chemical synthesis of the active substance, and the post-tabletting stage, the compression of the powder into tablet form. The first step, the pre-tabletting component of production, comprises the creation of the drug's chemical composition, including the active substance and organic impurities that are formed during synthesis as well as any cutting agents that are added to the final product (Milliet, Weyermann, & Esseiva, 2009). Following this step is the post-tabletting stage, which creates the physical appearance of the tablet and involves the compression of the powder into its final shape, determining the weight, diameter, logo, and other physical features of the tablet (Milliet et al., 2009). After this step, the samples remain static with no further changes to its structure until after purchase or seizure (Milliet et al., 2009). While some researchers have noted systematic and strategic links between a drug's composition and its logo suggesting that both steps are conducted by the same individuals or groups (Karch, 2011), it is essential to factor in these two stages when conducting a drug composition analysis, as they may be conducted in different locations and reflect separate actors.

A further method to analyze the synthetic drug industry is through an economic analysis. Drug prices are a valued research tool to analyze illegal drug industries, as they are a fundamental component of drug markets and can reveal the economic forces and factors at work in illicit enterprises (Caulkins & Baker, 2010; Caulkins & Reuter, 1996). Price data have been used extensively to inform drug policies and provide insight into drug markets, including the effectiveness of law-enforcement interventions (Caulkins & Reuter, 2010) and to monitor changes in the structure of the market (Rhodes, Hyatt, & Scheiman, 1994). These studies rely primarily on price oscillations over time to make inferences about changes in the drug market. However, to reliably use price data to analyze illegal drug markets, it is essential that the determinants of illicit drug prices are comprehensively understood; otherwise, we risk making faulty conclusions and attributing price fluctuations to unrelated factors. In addition, knowledge of the determinants of these price variations can provide information about the internal dynamics of the illicit market, revealing production costs, behavioral trends, market structure, consumer trends, demand and supply, and other factors that lead to the final setting of prices. As we know little about the synthetic drug market, we also know little about price variations therein and the factors that account for such price variations.

Determinants of Illegal Drug Prices

Multiple factors influence the amount that illicit drugs are sold for. Drug markets are influenced by the same economic rules as legal markets as well as unique factors associated with operating in an illegal market. Touching on the myriad of elements that can influence drug prices, it is important to note that drug prices are governed by similar market forces as legal commodities (Pietschmann, 1997; Reuter & Haaga, 1989; Ritter, 2006), complying with basic economic supply and demand principles (Ritter, 2006). In its most basic form, changes in the market are reflected in the supply or demand of a commodity, which subsequently affects its price. Price changes occur to restore market equilibrium, where supply equals demand, so as to regulate product shortages or excesses (T. J. Moore et al., 2005).

Furthermore, although drugs comply with some of the same principles as legal goods, current prices of illicit drugs are significantly higher than if they were sold in the legal market (Miron & Zwiebel, 1995; M. H. Moore, 1990; Reuter & Kleiman, 1986). To account for these price disparities are additional distinct factors, tied to their illegality, which also influence their retail price (Caulkins & Reuter, 1998). While operating in an illegal market reduces some costs associated with running an enterprise, additional risks are incurred by the product's criminality and

significantly increase risk expenses, including violence, risk of arrest, and judicial costs (Caulkins & Reuter, 1998). These additional risks significantly hike transaction costs and subsequently the drug's final retail price. Despite extensive studies on the determinants of drug prices, few have examined the factors that influence the retail cost of synthetic drugs. Knowledge of these factors can reveal information about the inner dynamics that characterize this clandestine market.

Analytical Scheme

Aiming to provide a reliable picture of the structural attributes of Quebec's synthetic drug market while working within the confines of the data, this study will proceed in three stages. First, a descriptive analysis using the drug composition data will provide an initial overview of the market, identifying links between drugs with shared characteristics and thus providing a detailed description of the market's structure. Second, building off these findings and using the same data, a cluster analysis will be conducted to statistically model these structural features by determining the optimal number and nature of clusters for all the seized drugs and will provide for the creation of a structural variable. Finally, the price data will be incorporated to examine how this structural variable and other market indicators influence price variations across the province. In sum, this multifaceted approach allows us to examine the industry at the retail level, through an analysis of price determinants, and the production level, through the composition of the drugs that manufacturers produce, providing for a comprehensive analysis of the market's features.

Sources of Synthetic Drug Tablets

This study relies on 365 synthetic drugs that were obtained through a project commissioned by the Canadian government in response to concern over increased use of synthetic drugs. In partnership with the provincial and municipal police forces in the province Quebec, a sample of seizures made by law-enforcement agencies in Quebec between June 2007 and 2008 were analyzed by Health Canada who extracted and systematically classified the synthetic drugs based on their chemical composition (active substance and cutting agents) and physical features (score, color, and logo). Among these tablets, there were four major active substances (3,4-methylenedioxy-*N*-methylamphetamine [MDMA], 3,4-methylenedioxyamphetamine [MDA], methamphetamine, and amphetamine), and more than 40 adulterants, cutting agents, and/or by-products of the chemical reactions. The wide range of tablets with different chemical compositions was also consistent with their physical characteristics, which contained a high number of different logos (n = 122) and colors (n = 12). All the synthetic drugs in this sample were seized in nine different areas across the Quebec province: Abitibi-Temiscamingue, Bas Saint-Laurent, Cote-Nord, Estrie, Gaspesie, Mauricie, Montréal, Outaouais, and Quebec. This information provides us with valuable information on potential regional differences and a more representative picture of the Quebec province, reflecting small remote regions and densely populated urban centers.

Additional information regarding the context and details of the seized drug in this sample was also supplied from law-enforcement investigative files, which included whether the drug trafficker was selling his or her product as ecstasy or speed, irrespective of the actual composition and the retail price of the drug (all in Canadian dollars). The majority of drugs were sold as speed (n = 244; 66.8%) and under one quarter as ecstasy (n = 88; 24.1%). Prices of these drugs ranged from a minimum of CAN$2 and CAN50¢ to a maximum of CAN$20 with the majority being sold for CAN$10 ($n$ = 133). As prices were obtained only for 261 of the drugs, this subsample comprises the economic analysis. The prices obtained in this seizure closely resemble prices of ecstasy in other Western regions across Europe. The 2011 Annual Report by the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) stated that in the majority of countries, ecstasy retail prices varied between EUR4 and EUR9, and Schifano, Corkery, Deluca,

Oyefeso, and Ghodse (2006) observed that the average price of a tablet in 2003 cost approximately £5.30 in the United Kingdom (Schifano et al., 2006).

Profiling Quebec's Synthetic Drug Market

Providing a model to utilize drug composition data is extensive research that has examined statistical methods to determine cutting points for whether drugs originate from the same production batch (Anderson et al., 2007; Dujourdy et al., 2003; Esseiva, Dujourdy, Anglada, Taroni, & Margot, 2003; Esseiva et al., 2007; Esseiva, Gasté, Alvarez, & Anglada, 2011; Marquis et al., 2008; Weyermann et al., 2008; Zingg, 2005). According to these studies, the Pearson correlation has consistently been determined to be the most reliable method to determine cutting points at which drugs with shared characteristics came from the same manufacturer. In these studies, researchers linked drugs based on detailed information, including the quantity and concentration of each substance present in each tablet (Anderson et al., 2007; Esseiva et al., 2003; Weyermann et al., 2008; Zingg, 2005). However, contrary to this research, the data in the present study do not provide the percentage of each ingredient, only yielding information on the substances present in each tablet and not their respective concentration, precluding us from adopting the Pearson correlation. This level of chemical analysis was not integrated into the data that were shared with us, and it was exceptional that we were able to receive any information in regard to the composition of the tablets. Accounting for the differences in data, the analysis procedures were adapted accordingly, substituting the Pearson correlation with two distinct methods—a network analysis and a cluster analysis. Although these two methods perform the same assessments (they both organize the drugs into groups according to shared properties), they were both incorporated in an effort to mitigate the limitations inherent in each method and to provide a more detailed analysis of the drug market.

The first method, network analysis, permitted a detailed view of the drugs' compositions and physical attributes and how they were directly connected according to these features. It permitted us to link each feature of a tablet, whether physical or chemical, with all of the 365 other tablets in the sample. This contrasted with the cluster analysis, which could not capture this level of detail, as the high variation in chemical and physical drug profiles and the low frequencies reported for much of the drugs traits required that variables be regrouped into larger categories or eliminated entirely. Despite providing less detail, the cluster analysis was incorporated to provide a statistical validation of the relationships found in the network analysis. Furthermore, it also created a dependent variable that reflects the structural features of the market. Thus, within the framework of this study, the cluster analysis served a statistical objective, aforementioned, while the descriptive network analysis served to provide a detailed analysis into the number of distinct profiles, and thus insight into the structure of the market.

Linking the Seized Drugs

Network analysis has been extensively applied in the field of criminology to examine the relational ties between actors, including organized crime groups (McIllwain, 1999) and terrorist cells (Krebs, 2002), to provide information about market structure. Although traditionally used with individuals, this study will use seized drug cases as the unit of analysis. This substitution is based on the aforementioned premise that a seized drug serves as a manufacturer's signature, and is therefore reflective of the producer. Thus, the market structure will be assessed by examining the "ties" between each tablet based on the drug's shared chemical and physical characteristics. The network analysis proceeded in a number of steps (UCINET was the main software used). First, all the data for the physical (logo and color) and chemical characteristics (active substance and cutting agents) for the 365 drugs were input into a table, according to whether they shared one or

more of these defining features with another tablet in the sample. Thus, if two tablets shared three of the same characteristics (e.g., both contained methamphetamine, diphenhydramine, and had a smiley logo), they were linked across the table with the number three. This method not only allowed us to group the tablets according to shared features but also permitted us to examine the strength of the relationship between tablets.

From the analysis, 80 different chemical compositions were identified among the 365 seized synthetic drugs, each tablet a different combination of the active substance(s) and/or cutting agent(s). The most popular tablet in the sample contained methamphetamine and caffeine (n = 100), comprising 27.4% of all seized synthetic drugs. Other popular profiles included MDMA (n = 18), MDA (n = 19), and methamphetamine (n = 27). The wide range of tablets with different chemical compositions was also consistent with their physical characteristics, which contained a high number of different logos and colors. Of the different logos in the sample, the most popular were a symbol of a "star" and "on star," which both, individually, accounted for 3.8% (n = 14) of all drugs. The drugs were 1 of 12 different colors, the most prevalent being white (n = 224). A drug's logo and color rarely indicated the drug's chemical composition; tablets with the same physical characteristics frequently represented two different drugs. The largest group of tablets that shared identical physical and chemical attributes consisted only of six tablets. Further deception was also detected in the synthetic drug market through an examination of the contents of the drugs sold as ecstasy or speed. Only 43% of the drugs sold as ecstasy and 66% of the drugs sold as speed contained the active substance that they were being sold as. This deception in the synthetic drug market is commonly observed, as toxicoepidemiologic monitoring of illegal street drugs has shown that substances marketed as ecstasy or speed can contain a wide variety of compounds and frequently do not contain the active ingredient (Cole, Bailey, Sumnall, Wagstaff, & King, 2002; Parrott, 2003; Spruit, 2001).

To characterize the structure of the network and examine the overall connectivity, two cohesion analysis tools, density and clustering coefficient, were conducted. Density provides an overall analysis of the degree of connectivity of a network between subjects, while the clustering coefficient identifies the degree of local clusters in the network, examining the degree of connectivity between one tablet to all the tablets directly linked to it. Both methods are recommended to be applied as group size may influence the clustering coefficient, with larger samples reducing the coefficient (Hanneman & Riddle, 2005). This sample contained high connectivity with a density at 61% and a clustering coefficient at 83%. Accounting for these high densities was that most tablets could be linked based on one or two shared characteristics. In this sample, most drugs contained either methamphetamine (n = 208) or caffeine (n = 222), with these two ingredients also representing the drug category with the greatest frequency (methamphetamine and caffeine tablets consisted of 27.4% of all seized tablets). However, outside of this large group of tablets, most drugs that contained methamphetamine or caffeine also contained additional adulterants (e.g., diphenhydramine or dimethylsulfone), making it distinct from the others. Further distinguishing tablets from one another were the wide array of physical characteristics. Although the majority of tablets in this sample were white, there were 122 different logos for the 365 tablets. Therefore, even though many drugs shared some similar chemical characteristics, few also shared the same physical appearance. When the drug's physical and chemical features were looked at collectively, there was high variability between tablets, with only 48 drugs (13%) possessing identical characteristics with one or more tablets. This high variability in physical and chemical characteristics was also observed within each region.

The Structural Features of the Market

To statistically model the relationships identified in the network analysis, a two-step cluster analysis was conducted. To reliably use this method, the first step required us to narrow the long list

of variables to only those with higher frequencies and to create larger categories. It was determined that the chemical variables' values would be regrouped according to quality, allowing for the preservation of some detail of the data, while variables that described the physical characteristics of the synthetic drugs with low frequencies had to be eliminated, as they could not be assimilated into larger categories. For the regrouping of the chemical variables, quality was determined based on the drug's level of purity—whether the synthetic tablet only contained active stimulant ingredient(s) (amphetamine, methamphetamine, MDMA, or MDA) or whether its purity had been contaminated with cutting agent(s). After consulting toxicology and pharmacology reference books, these criteria permitted the identification of three groups: Grade A, Grade B, and Grade C drugs (Barceloux, 2012; Ebadi, 2008)—Grade A drugs were considered the highest quality drugs, consisting only of the active ingredient (e.g., MDMA); Grade B drugs, were deemed medium quality drugs, consisting of one active ingredient and one or more cutting agents (e.g., MDMA and caffeine); and Grade C drugs, the lowest quality tablets, composed exclusively of one or more cutting agents (e.g., caffeine). Ten drugs were excluded from the analysis, as they did not meet the criteria (e.g., one tablet solely contained psilocybin, the active ingredient found in mushrooms). To ensure the correct classification of the seized drugs into their appropriate categories, they were also verified by a professor of pharmacology at the Université de Montréal. However, given that the data did not provide information about the concentration of each substance, caution should be exercised when interpreting these groups, as it is possible that a tablet designated as a Grade A drug has a very low purity consisting of 95% cutting agent and 5% active ingredient. Based on the above classification, synthetic drugs in the Quebec market consisted primarily of Grade B drugs ($n = 227$), followed by Grade A drugs ($n = 71$) and Grade C drugs ($n = 57$).

Second, it was necessary to narrow the more than 107 values that characterize the physical and visual characteristics of synthetic drugs (each a descriptor of the drug's quality, color, or logo) down to variables that had a frequency of three or more. Only 7 of the drugs' possible 12 colors and 20 of the 93 logos were included. The rational for choosing only a fraction of all the colors and logos was empirical, as all variables had to have a sufficient number of cases ($n = 3$) to effect a reliable analysis. Given the above considerations, the clustering variables include the following: the drug's quality (Grade A, Grade B, and Grade C drugs), color (white, blue, yellow, mauve, orange, pink, and green), and logo (*bomb, capsule, heart, couche tard, e, lightning bolt, star, kärv, mercedes, MSN, on star, pepsi, pinup, 7up, playboy, puma, shell V power, transformers, versace*, and *no logo*).

All the variables, physical and chemical were incorporated into a two-step cluster analysis, allowing the software to select the optimal number of clusters. These clusters were then verified through a direct comparison with the findings obtained from the descriptive analysis to ensure consistency and validity between groups. In addition, a chi-square analysis was conducted to determine the goodness of fit of each variable incorporated in the cluster. Originally, the cluster analysis had been designed to distinguish between the two stages of production, pre-tabletting, the synthesis of the drug, and post-tabletting, the pressing of the drug into its final shape, allowing us to distinguish and make comparisons between these two production stages. However, preliminary analysis demonstrated that the high number of logos and colors with low frequencies precluded us from conducting a reliable cluster analysis for the drug's physical features. Even when the variables with insufficient cases were eliminated from the analysis, the high number of dichotomous variables did not permit a reliable cluster analysis and any further removal of variables hindered the interpretation and validity of the results. Given the inability to capture the differences between the two stages of production through a cluster analysis, the two characteristics were combined for an overall analysis of the tablets' features.

Incorporating the grouped list of variables into the two-step cluster analysis, four distinct clusters emerged. Findings were similar to the descriptive analysis, with a wide array of physical

Table 1. Distinctions Between Clusters.

Variable	Cluster 1 (%)	Cluster 2 (%)	Cluster 3 (%)	Cluster 4 (%)	χ^2 significance
Grade A	100.0	0.0	0.0	0.0	.000
Grade B	0.0	99.0	100.0	0.0	.000
Grade C	0.0	1.0	0.0	99.0	.000
Bomb	0.0	3.0	2.9	0.0	.252
Capsule	1.4	1.0	0.0	7.0	.006
Heart	4.0	3.0	0.0	0.0	.060
Couche Tard	5.6	0.0	3.6	1.7	.151
e	8.5	0.0	0.0	0.0	.000
Lightning Bolt	1.4	1.0	2.9	0.0	.479
Star	1.4	11.0	2.9	0.0	.001
Kärv	0.0	1.0	2.9	0.0	.242
Mercedes	0.0	0.0	3.6	0.0	.043
MSN	0.0	5.0	0.0	0.0	.002
On Star	4.0	0.0	6.6	1.7	.058
Pepsi	5.6	0.0	1.4	0.0	.026
Pinup	4.0	2.0	5.0	0.0	.281
Playboy	0.0	0.0	8.8	0.0	.000
Puma	0.0	4.0	1.4	0.0	.105
7up	0.0	0.0	3.6	0.0	.043
Shell V Power	2.8	0.0	2.9	0.0	.224
Transformers	1.4	6.5	0.0	0.0	.003
Versace	4.0	1.0	0.7	0.0	.147
No logo	12.6	21.4	0.0	7.0	.001
White	59.1	4.3	100.0	64.2	.000
Blue	5.6	14.1	0.0	5.3	.000
Yellow	1.4	10.8	0.0	8.9	.000
Mauve	1.4	11.9	0.0	0.0	.000
Orange	4.2	9.7	0.0	8.9	.003
Pink	18.3	32.6	0.0	3.5	.000
Green	2.8	9.7	0.0	1.7	.001

characteristics being shared among a high range of drugs with different compositions. The most distinctive feature that divided each cluster was its quality. One cluster grouped Grade A drugs, two grouped Grade B drugs, and one grouped Grade C drugs, permitting us to assess which logos and colors are most likely to be associated with drugs of different quality. This was further supported by the chi-square statistic used as an estimate of the goodness of fit of the structural model. All results for the quality and the tablet's color were determined to be significant, while some of the logos (*bomb, heart, couche tard, lightning bolt, kärv, on star, pinup, shell V power*, and *versace*) did not meet the statistical significance. Table 1 demonstrates the division into four clusters and the characteristics of each drug according to the categories. The findings from the cluster analysis can be summarized as follows.

Cluster 1, or Grade A drugs (consist only of the active substance), possessed a high number of different logos, the most popular being the letter "*e*" (8.5%), followed by *couche tard* (5.6%) and *pepsi* (5.6%). Other drug logos included *capsule, heart, lightning bolt, star, versace, pinup, on star*, and *shell V power*. However, all logos that characterized Grade A drugs were also shared with drugs of lower quality, with the exception of the logo "*e*," which was observed exclusively within Grade A drugs. Furthermore, all possible colors present in the sample were observed

among Grade A drugs; the most popular being white (59.1%), followed by pink (18.3%) and blue (5.6%). Thus, a drug's logo and color is rarely indicative of the drug's quality. While some logos and colors have a higher likelihood of being associated with Grade A drugs, they may also represent a different quality drug.

Turning to Cluster 2, Grade B drugs also contained a high number of different logos, with the most popular being *star* (11%). Many of the same logos as Grade A drugs were shared with Grade B drugs, including *capsule, heart, lightning bolt, star, pinup, transformers*, and *versace*. In addition, Grade B drugs could be any of the seven possible colors (white, blue, yellow, mauve, orange, pink, and green). However, in contrast to Grade A drugs, the most popular colors among Grade B drugs were pink (32.6%), mauve (11.9%), and yellow (10.8%).

The second and third clusters were composed exclusively of Grade B drugs, having been divided between the two clusters. However, the second group of Grade B drugs was distinct from the first in that it was composed exclusively of white pills. Furthermore, an analysis of their chemical compositions demonstrated that the second group of Grade B drugs were composed primarily of methamphetamine and caffeine, while the first group of Grade B drugs comprised a high number of different chemical profiles. Both clusters also shared many of the same logos, including *bomb, lightning bolt, star, kärv, pinup, puma*, and *versace*. However, the most popular logos in the third cluster were *playboy* (8.8%) and *on star* (6.6%).

The fourth cluster, Grade C drugs, had a low number of logos consisting only of four different logos in total: *capsule* (7%), *couche tard* (1.7%), *on star* (1.7%), or *no logo* (7%). The few logos present in this cluster may be explained by the fact that many logos were excluded from the cluster analysis, as they had too low of a frequency. Similar to the first two clusters, Grade C drugs contained all possible colors, with the exception of mauve. The most popular color was white (64.2%), distantly followed by yellow (8.9%) and orange (8.9%). Across the descriptive and the cluster analyses, consistency is found in the large overlap of shared characteristics between drugs. For the remainder of the article, these cluster groups will be referred to according to their quality, for example, either as Grade A drugs, Grade B colored drugs, Grade B white drugs, or Grade C drugs.

Factors That Influence Synthetic Drug Prices

Following the regrouping of variables into clusters, an ANOVA was conducted to examine the influence of the structural variable and the marketing variable (whether the drug was being sold as ecstasy or speed) on the drug's price. First, an ANOVA was conducted on the entire province to provide a comprehensive portrait of price determinants at the provincial level. Following this, a second comparative analysis was conducted using two separate ANOVA tests to compare the determinants of drug prices in Montréal ($n = 108$) to the rest of Quebec ($n = 153$), allowing for insight into geographical variations of price determinants. These two regions were selected based on the number of seizures made in each area required to effect reliable comparisons.

Quebec

Based on the outcome of the ANOVA for Quebec's synthetic drug prices, one can understand that there is a statistically significant difference between prices for both the cluster variable ($p < .05$) and whether it was sold as ecstasy or speed ($p < .01$). Both these variables account for 10% of synthetic drug price variation for the Quebec province. A larger effect resulted in whether it was being sold as ecstasy or speed ($F = 8.417$) in comparison with the cluster variable ($F = 3.354$). The interaction effect between the cluster and marketing variable was not statistically significant ($p > .05$).

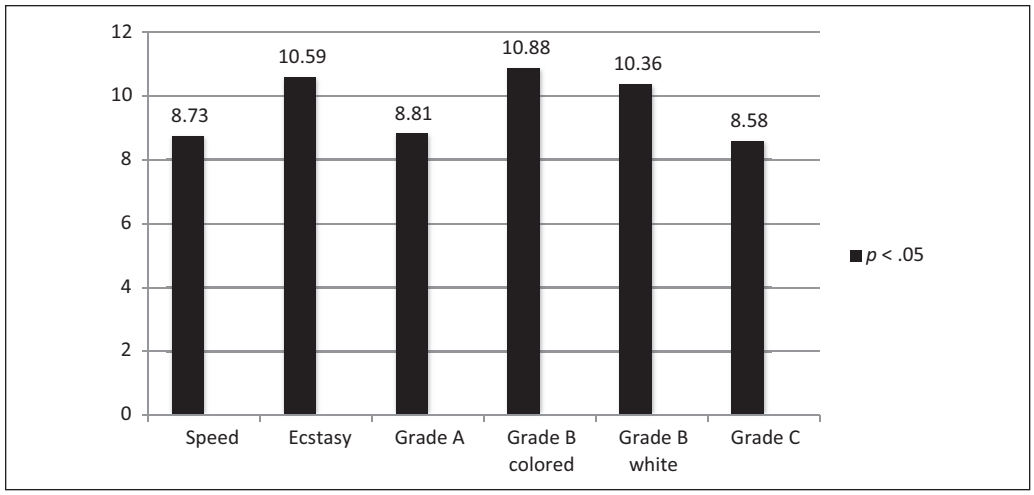

Figure 1. Price determinants of synthetic drugs for the Quebec province.

Figure 1 presents the results of the ANOVA. A few unanticipated relationships were borne out of the data for the cluster variable. Grade B colored drugs and Grade B white drugs sold for the highest prices: Grade B colored drugs sold on average for CAN$10.88, and Grade B white drugs, for CAN$10.36. In contrast, Grade A drugs sold for approximately CAN$2 less (CAN$8.81). In addition, the differential in prices between Grade A and Grade C drugs were marginal with Grade C drugs selling for a similar price as Grade A drugs, at CAN$8.58.

Furthermore, it was also found that drugs sold as ecstasy cost approximately CAN2$ more than if they had been sold as speed (respectively, CAN$10.59 vs. CAN$8.73). This may support that drug users are inclined to trust dealers and pay higher prices based on information derived from these players. Supporting this is the fact that ecstasy is deemed to be more expensive to produce than methamphetamine (Karch, 2011) and a better quality drug, involving more elaborate production methods and higher skilled manufacturers.

Montréal

ANOVA results for cases within the Montréal region indicated that there was a significant difference between prices depending on whether it was being sold as ecstasy or speed ($F = 4.456$, $p < .05$). However, in contrast to ANOVA results for the entire Quebec province, the results sustained that the cluster variable was not statistically significant at the .05 level ($F = 1.693$, $p > .05$). Thus, the drug's quality did not play a role in influencing the drug's price in Montréal. The marketing variable, whether it was being sold as ecstasy or speed, explained 14.3% of synthetic drug price variation in the Montréal region. Consistent with the ANOVA for the province, ecstasy was sold for a higher price (CAN$11.17) and speed for approximately CAN$2 less (CAN$9.36). Consequently, we may also conclude that in Montréal, drug users may be more inclined to trust the dealer and pay higher prices based on information derived from these players (see Figure 2).

The Province of Quebec Outside Montréal

For comparative purposes, an ANOVA was also conducted to examine the determinants of prices for the rest of Quebec outside Montréal. The results of the ANOVA sustained that there was a

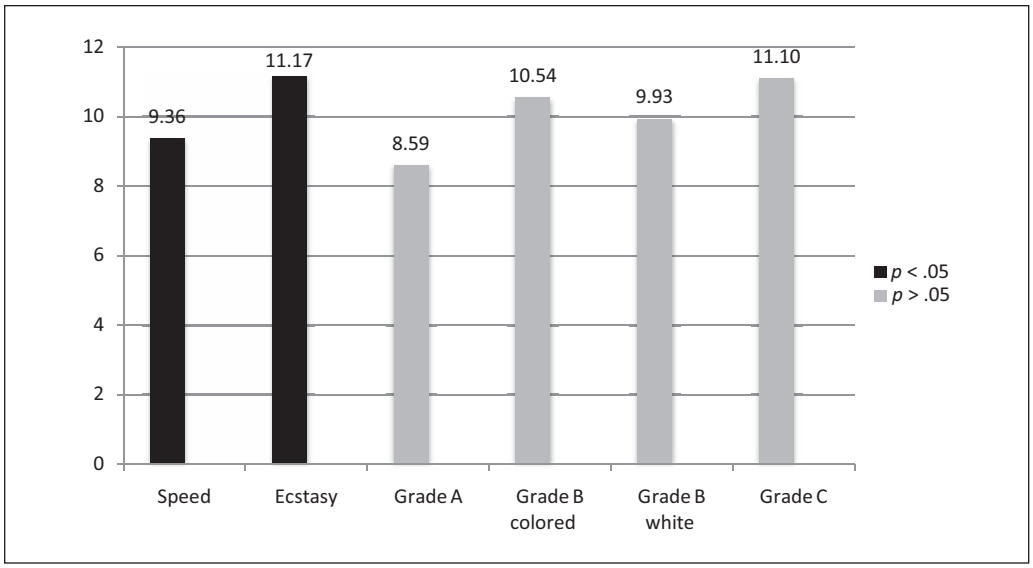

Figure 2. Price determinants of synthetic drugs in Montréal.

significant difference, albeit weak, between prices for the cluster variable ($F = 2.708$, $p < .05$), but not for the marketing variable ($F = 2.367$, $p > .05$). In this analysis, the cluster variable explained 10.1% of synthetic drug price variation for the region. In contrast to all of Quebec, Grade A drugs were the most expensive outside of Montréal (CAN$10.65). Consistent with all of Quebec, Grade A and Grade C drugs were similar in price, Grade C drugs being sold on average for CAN36¢ less (at CAN$10.29). In contrast, Grade B drugs were sold for the lowest prices; Grade B colored drugs for CAN$8.49 and Grade B white drugs for CAN$7.47, as displayed in Figure 3.

Discussion

The present study was designed to empirically assess structural features of the synthetic drug market by examining links between seized synthetic drugs and their price determinants. The first analysis demonstrated that a high number of different drugs are present in the market, potentially indicating a high number of manufacturers. The second investigation confirmed that a drug's composition and whether the trafficker markets the drug as ecstasy or speed can marginally influence its price, depending on the region. This study obtained divergent results for Montréal in comparison with the rest of Quebec; outside of Montréal prices were only influenced by quality, while prices in Montréal were only influenced by whether it was marketed as ecstasy or speed.

Evidence of a Competitive Market

Given the high density reported in the UCINET findings, it may be argued that due to the similarities between profiles and higher frequency of some profiles over others, a few manufacturers have a significantly larger market share than others. Although this inference follows from the logic expressed above, the ubiquity of these ingredients and the high number of different combinations of these ingredients in this sample causes us to lean toward an alternative interpretation. First, the most prevalent profile and substances in the sample consist of two very common ingredients, methamphetamine and caffeine. Given the ease with which caffeine can be obtained and

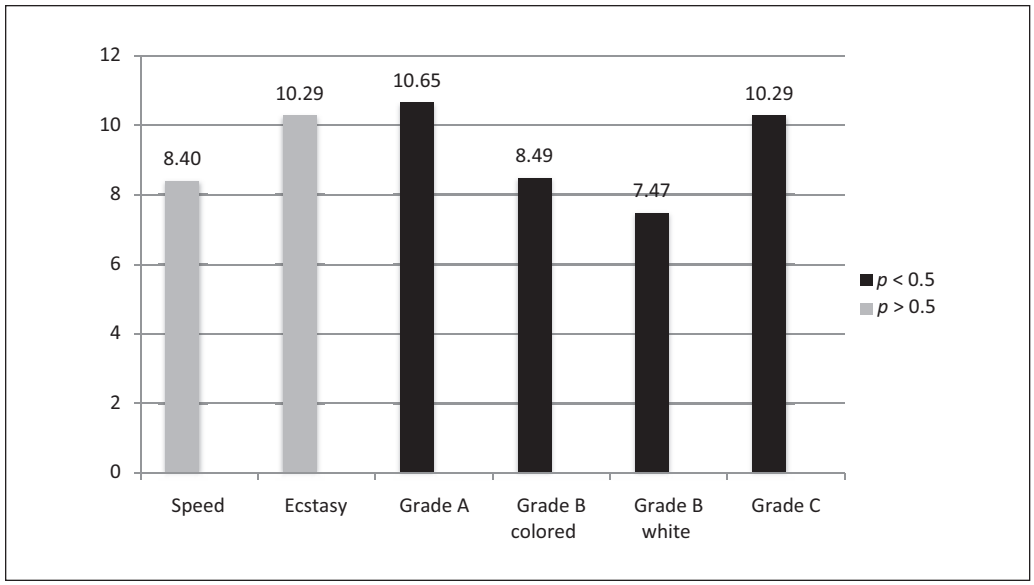

Figure 3. Price determinants of synthetic drugs for the Quebec province outside of Montréal.

that most synthesis procedures aim to produce methamphetamine, it is likely that multiple manufacturers are producing a similar product that contains both these ingredients, indicating multiple synthetic drug producers. These findings are further supported by the descriptive analysis, which demonstrated the high number of different profiles, which was consistently reflected across regions. However, due to the small sample sizes per region, it is important to emphasize that tablets seized in each region may reflect only a small subset of local production.

Further supporting a competitive market, of the drugs that share the same chemical makeup, few of these also possess the same physical characteristics. Very few tablets shared the same physical and chemical features with another tablet. Assuming that the manufacturers consistently press their tablets with the same logo, this supports the earlier conclusion that there are a high number of drug manufacturers. Previous research suggests that manufacturers may be unlikely to use multiple different logos, as logos may be strategically used to build brand loyalty among their consumer base (Karch, 2011). As consumers begin to associate a logo with a high quality drug, it is suggested that they will attempt to obtain drugs with that same logo the following purchase (Karch, 2011). However, concern should be exercised, as logos may be duplicated by others to deceive consumers into believing they have purchased a higher quality product or simply separate actors producing the physical features of the tablet in the post-tabletting phase of production.

It is also important to note a further limitation with these interpretations. As the drug composition data in this sample lack detailed information only providing us with information on the contents of each tablet and not the respective concentration of each substance, we risk inferring that all tablets that contain MDMA and caffeine came from the same production batch when in fact each tablet has different quantities of each substance, which would indicate multiple manufacturers. To minimize this possibility, all physical and chemical features of the tablet were taken into account when making links between drugs that came from the same origin. Thus, drugs that shared the highest number of characteristics also had the highest likelihood of originating from the same manufacturer. The data source used in this study is in contrast to research conducted by Esseiva et al. (2003), Esseiva et al. (2007), and Zingg (2005), who performed highly sophisticated extraction

methods that recorded precisely the amount of each substance present in the seized drug, providing more accurate links between drugs with shared characteristics.

In addition to the aforementioned limitation, this study hinges on a few principle assumptions, the primary being the premise that manufacturers consistently use the same recipe and methods. Very little research has explored the synthetic drug market and it has not been established that manufacturers repeatedly produce the same tablets. Given this, we risk concluding that there are multiple producers operating in the synthetic drug market in cases where there are a large number of distinct profiles present, when in fact it may be a single producer altering his or her manufacturing process.

Price Analysis Discussion

Moving to the price data, the drug's quality, as determined by the cluster variable, was deemed to have a statistically significant, albeit weak, effect on prices for the province as a whole and for the region outside Montréal. However, this cluster variable exerted a different effect on prices for these two geographical areas. When Montréal was excluded from the analysis, drugs of higher quality were sold for higher prices, with the exception of Grade C drugs (drugs with no active ingredient were more expensive than Grade B drugs). Although initially counterintuitive that lower quality drugs are more expensive, given research has demonstrated that cocaine users perceive low prices to be indicative of poor quality (Evrard, Legleye, & Cadet-Taïrou, 2010), it is logical that traffickers in efforts to deceive customers would sell these drugs at elevated prices. However, in contrast, when examining Quebec as a whole, medium quality drugs (Grade B drugs) are sold for the highest price, followed by high quality (Grade A drugs) and low quality (Grade C drugs). It is notable that higher quality is associated with higher prices only in the province of Quebec when Montréal is excluded, and that prices are not correlated with a drug's quality within the Montréal market.

Trafficker–Consumer Relations

This contrast between Montréal and the rest of Quebec may be attributed to two scenarios: the market structure and differential production costs. In regard to the market structure outside of Montréal, prices may be influenced by a drug's quality due to trafficker–consumer relations. Traffickers in attempts to obtain return customers have provided reliable, valuable information about their products to increase trust and future sales. Although it is unlikely that a trafficker will disclose to a user that a drug contains no active ingredient, traffickers may accommodate users by presenting drugs at different prices depending on what they can afford, leaving the decision with the user on whether to purchase a higher or lower quality drug. In contrast, in Montréal, fewer incentives may be in place for traffickers to develop a strong customer base through trusting relationships, as there may be a higher demand for drugs and therefore traffickers may be less inclined to obtain a regular clientele, with new customers always looking to buy the product. Indeed, the notion that "there's a sucker born every minute" may be more in tune with a dense urban population that makes it more difficult for consumers to keep suppliers in check.

Production Costs

The discrepancy on how the drug's quality influences prices in different regions may also be explained by looking at production costs. Research on illicit drug markets has stated that a drug's quality rarely influences its final price when production costs are insignificant, forming only a fraction of the retail price (Reuter & Caulkins, 2012). For example, in the heroin market, the drug's retail value is marked up by 99% from its wholesale cost in the country of origin (Caulkins

& Reuter, 1998). Applying this to the present study, quality may be more inclined to be associated with a drug's cost outside of Montréal because production costs are high (e.g., precursors may be purchased in smaller quantities and thus cost more) and play a larger role in influencing the drug's final price. Thus, synthetic drug manufacturers in the Montréal region may operate out of larger laboratories and therefore acquire precursors in bulk, wholesale quantities, resulting in considerable cost reduction. As supported by the above inferences in regard to trafficker–consumer relations, drug demand may be higher in this large metropolitan area, which is reflected in the low accountability between dealers and users. Thus, producers faced with larger demand may be inclined to obtain and produce drugs in large quantities, reducing associated production costs. That large production facilities may be located in a dense urban city contrasts with the cannabis market. Large expanses of land are generally required to produce wholesale quantities of cannabis, and thus, production facilities are more likely to be located in vast, isolated expanses of land in rural areas. In contrast, synthetic drug production requires relatively little space to produce significant output, allowing for a greater mobility and the opportunity to set up near consumer markets.

Stage of Market Development

That the structure and distinctive features of Montréal's synthetic drug market is different from the rest of Quebec was also supported by the results of the marketing variable. Although whether it was being sold as ecstasy or speed influenced the price in Montréal, it did not exert a statistically significant effect for the rest of Quebec. Thus, consumers in Montréal were more likely to rely on what the drug trafficker stated about the drug, than the drug itself. This finding is consistent with other studies on illegal drug markets (cannabis, cocaine) that demonstrate the perceived quality of the drug is dependent on the information that is provided by the drug seller (Evrard et al., 2010; Lakhdar, 2009). This may be indicative of the presence of many first-time transactions between dealers and sellers or may reflect the demographics of the consumers, with many new users. Novice consumers have little information (e.g., dealer's reputation, familiarity with the drug) to rely on when making a first purchase and may not be able to distinguish between different "highs," therefore indiscriminately purchasing drugs regardless of the price. As a buyer becomes a regular user and his or her education about the drug increases, he or she may develop the knowledge for what to look for, who to buy it from, and the expected subjective effects. Thus, these more experienced users may obtain quality drugs through the contacts they make and the repeated use of the drug.

Further supporting this is the "Expected Purity Hypothesis," developed by Caulkins (1994), which states that a key factor that influences drug prices is consumers' perceptions of the drug's potency. Given that drugs are "experience goods," purchasers are often unable to assess their quality until after consumption (Caulkins, 2007; Reuter & Caulkins, 2004). Thus, consumers unable to evaluate the drug's quality may rely on other factors, such as the drug trafficker's reputation and statements, to calculate the quality and hence the price they will pay.

However, these analyses are not entirely satisfactory, as the inferences about relationships between suppliers and consumers are based on the assumption that the drug seller knows the true quality of the drug, and is therefore aware that the consumer is being wrongfully manipulated. There is evidence in other drug markets that suppliers deceive traffickers further down the chain about the drug's quality to increase their respective profits (Reuter & Caulkins, 2004). In this sense, the retail dealer is likely as misinformed as the consumer in regard to the commodity's quality. A further limitation in this study is that due to the shortcomings of the data, it was not possible to examine all price determinants of synthetic drugs. Thus, confounding factors may be at play in setting these prices. Prices may be set according to the relations between a trafficker and a consumer; closer relationships justifying a lower price and unknown purchasers, a higher

price. In addition, a major problem in using price data is that prices fluctuate in regard to quantity discounts, with higher prices associated with smaller purchases and lower prices with bulk purchases (Caulkins & Padman, 1993). The present data did not detail the amount of the drug that was purchased at each sale not allowing us to account for this factor. Thus, more research is necessary to confirm the relationships between prices and structural dynamics.

Location of Transactions

We may also make inferences about Quebec's synthetic drug market based on an analysis of the price variation. Generally, retail drug transactions are standardized and are made in rounded dollar amounts. This finding has been documented in illegal drug markets across many countries (Wendel & Curtis, 2000). Standardized drug prices generally result as drug sales are conducted quickly to avoid police detection. Producing change prolongs this process and consequently increases the risk of exposure to law enforcement (Reuter & Caulkins, 2012). However, we note that in Quebec's synthetic drug market, many drugs are sold for prices that may require the production of change (e.g., CAN$2.50, CAN$7.50). This allows us to infer that some synthetic drug transactions may be conducted in private locations, where law-enforcement detection is diminished and the luxury of making change can be permitted. This finding is also supported by the Gruppo Abele (2003) research that found many synthetic drug purchases were made in private dwellings.

Conclusion

This study aimed at bridging a knowledge gap about the structural features of the synthetic drug market and factors that influence synthetic drug prices. The results of the analysis, albeit with limitations, provide support for a competitive perspective of the drug market. These findings closely follow that of earlier research that states illegal crime groups operate within ephemeral and competitive structures (Block & Chambliss, 1981; Gruppo Abele, 2003; Haller, 1990; Potter, 1994; Reuter, 1983). What can be cautiously inferred from the data in this study may assist authorities in designing more intelligence-led and proactive programs to effectively target drug manufacturers. This is particularly relevant given the lack of research to date on the synthetic drug market and the priority that the Canadian government has accorded to combat the synthetic drug industry. For resources to be effectively allocated, programs should be designed that reflect the reality of the synthetic drug market in the Quebec province, and to take into account variations in market characteristics according to region.

Although the limitations of the available data do not allow for validation of the market structure, they do illustrate the distinct characteristics of this market and the value of applying innovative methodological frameworks. This approach aligns with literature that has encouraged innovative analyses for assessing illicit markets:

> Although data presently available does not allow for model validation . . . nevertheless [it] illustrates the richness of possible behaviours of markets for illicit drugs and the value of being open to models built up from the special properties of those markets, rather than merely importing standard analysis and conclusions. (Caulkins & Reuter, 2006, p. 2)

In markets where research and data sources are scarce, the value of approaching an illicit market from another method enriches our understanding and provides new models to validate findings, rather than repeatedly using familiar methods that leave us with the same fragmented conclusions. Triangulating the findings of studies with other sources augments the validity of results and provides a comprehensive understanding of illicit markets. To enhance the reliability of the findings, this study would benefit from a qualitative analysis that assessed production

methods and synthetic drug producers' behaviors in addition to more detailed information regarding seizures, including the concentration of substances in tablets, which can be used to validate links between manufacturers at a more detailed level and provide greater understanding of this market traditionally hidden from the purview of researchers. The benefits of using synthetic drug profiles, including more effective police techniques and an enhanced understanding of market features, make this a method that should be diligently pursued by researchers and enforcement organizations to effectively target and understand the intricate processes that underlie the illegal synthetic drug market.

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