2019 MCM
Problem C: The Opioid Crisis

Background: The United States is experiencing a national crisis regarding the use of *synthetic* and *non-synthetic opioids*, either for the treatment and management of pain (legal, prescription use) or for recreational purposes (illegal, non-prescription use). Federal organizations such as the Centers for Disease Control (CDC) are struggling to "save lives and prevent negative health effects of this epidemic, such as opioid use disorder, hepatitis, and HIV infections, and neonatal abstinence syndrome."[1] Simply enforcing existing laws is a complex challenge for the Federal Bureau of Investigation (FBI), and the U.S. Drug Enforcement Administration (DEA), among others.

There are implications for important sectors of the U.S. economy as well. For example, if the opioid crisis spreads to all cross-sections of the U.S. population (including the college-educated and those with advanced degrees), businesses requiring precision labor skills, high technology component assembly, and sensitive trust or security relationships with clients and customers might have difficulty filling these positions. Further, if the percentage of people with opioid addiction increases within the elderly, health care costs and assisted living facility staffing will also be affected.

The DEA/National Forensic Laboratory Information System (NFLIS), as part of the Drug Enforcement Administration's (DEA) Office of Diversion Control, publishes a data-heavy annual report addressing "drug identification results and associated information from drug cases analyzed by federal, state, and local forensic laboratories." The database within NFLIS includes data from crime laboratories that handle over 88% of the nation's estimated 1.2 million annual state and local drug cases. For this problem, we focus on the individual counties located in five (5) U.S. states: Ohio, Kentucky, West Virginia, Virginia, and Tennessee. In the U.S., a *county* is the next lower level of government below each state that has taxation authority.

Supplied with this problem description are several data sets for your use. The first file (MCM_NFLIS_Data.xlsx) contains drug identification counts in years 2010-2017 for narcotic analgesics (synthetic opioids) and *heroin* in each of the counties from these five states as reported to the DEA by crime laboratories throughout each state. A drug identification occurs when evidence is submitted to crime laboratories by law enforcement agencies as part of a criminal investigation and the laboratory's forensic scientists test the evidence. Typically, when law enforcement organizations submit these samples, they provide location data (county) with their incident reports. When evidence is submitted to a crime laboratory and this location data is not provided, the crime laboratory uses the location of the city/county/state investigating law enforcement organization that submitted the case. For the purposes of this problem, you may assume that the county location data are correct as provided.

The additional seven (7) files are zipped folders containing extracts from the U.S. Census Bureau that represent a common set of *socio-economic factors* collected for the counties of these five states during each of the years 2010-2016 (ACS_xx_5YR_DP02.zip). (Note: The same data were not available for 2017.)

A code sheet is present with each data set that defines each of the variables noted. While you may use other resources for research and background information, THE DATA SETS PROVIDED CONTAIN THE ONLY DATA YOU SHOULD USE FOR THIS PROBLEM.

[1] Centers for Disease Control website, (https://www.cdc.gov/features/confronting-opioids/index.html), accessed 4 September 2018.

Problem:

Part 1. Using the NFLIS data provided, build a mathematical model to describe the spread and characteristics of the reported synthetic opioid and heroin incidents (cases) in and between the five states and their counties over time. Using your model, identify any possible locations where specific opioid use might have started in each of the five states.

If the patterns and characteristics your team identified continue, are there any specific concerns the U.S. government should have? At what drug identification threshold levels do these occur? Where and when does your model predict they will occur in the future?

Part 2. Using the U.S. Census socio-economic data provided, address the following questions:

There are a good number of competing hypotheses that have been offered as explanations as to how opioid use got to its current level, who is using/abusing it, what contributes to the growth in opioid use and addiction, and why opioid use persists despite its known dangers. Is use or trends-in-use somehow associated with any of the U.S. Census socio-economic data provided? If so, modify your model from **Part 1** to include any important factors from this data set.

Part 3. Finally, using a combination of your **Part 1** and **Part 2** results, identify a possible strategy for countering the opioid crisis. Use your model(s) to test the effectiveness of this strategy; identifying any significant parameter bounds that success (or failure) is dependent upon.

In addition to your main report, include a 1-2 page memo to the Chief Administrator, DEA/NFLIS Database summarizing any significant insights or results you identified during this modeling effort.

Your submission should consist of:

- One-page Summary Sheet,
- One- to Two-page memo,
- Your solution of no more than 20 pages, for a maximum of 23 pages with your summary and memo.
- Note: Reference list and any appendices do not count toward the 23-page limit and should appear after your completed solution.

Attachments:

2019_MCMProblemC_DATA.zip - Includes seven zip folders and the NFLIS_Data file.

ACS_10_5YR_DP02.zip
ACS_11_5YR_DP02.zip
ACS_12_5YR_DP02.zip
ACS_13_5YR_DP02.zip
ACS_14_5YR_DP02.zip
ACS_15_5YR_DP02.zip
ACS_16_5YR_DP02.zip
MCM_NFLIS_Data.xlsx

Glossary:

analgesic – pain relieving medication

county – (in the U.S.) an administrative or political subdivision of a state; a region having specific boundaries and some level of governmental authority.

heroin – an illegal, euphoria producing, highly addictive analgesic drug processed from morphine (a naturally occurring substance extracted from the seed pods of certain varieties of poppy plants).

non-synthetic opioids – a class of drugs made from extracting chemicals in opium leaves, e.g. morphine, codeine, heroin.

opioids – pain relieving drugs that are often highly addictive

socio-economic factors – factors within a society that describe the relationship between social and economic status and class such as education, income, occupation, and employment.

synthetic opioid – man-made opioids