The Changing Economy and Demography of Saskatchewan and its Impact on Crime and Policing

Phase III Report: Saskatchewan Crime Patterns and Determinants

Prepared by:

Stuart Wilson,
Department of Economics,
University of Regina

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Research Collaboration Project between the Royal Canadian Mounted Police "F" Division and the University of Regina's Collaborative Centre for Justice and Safety

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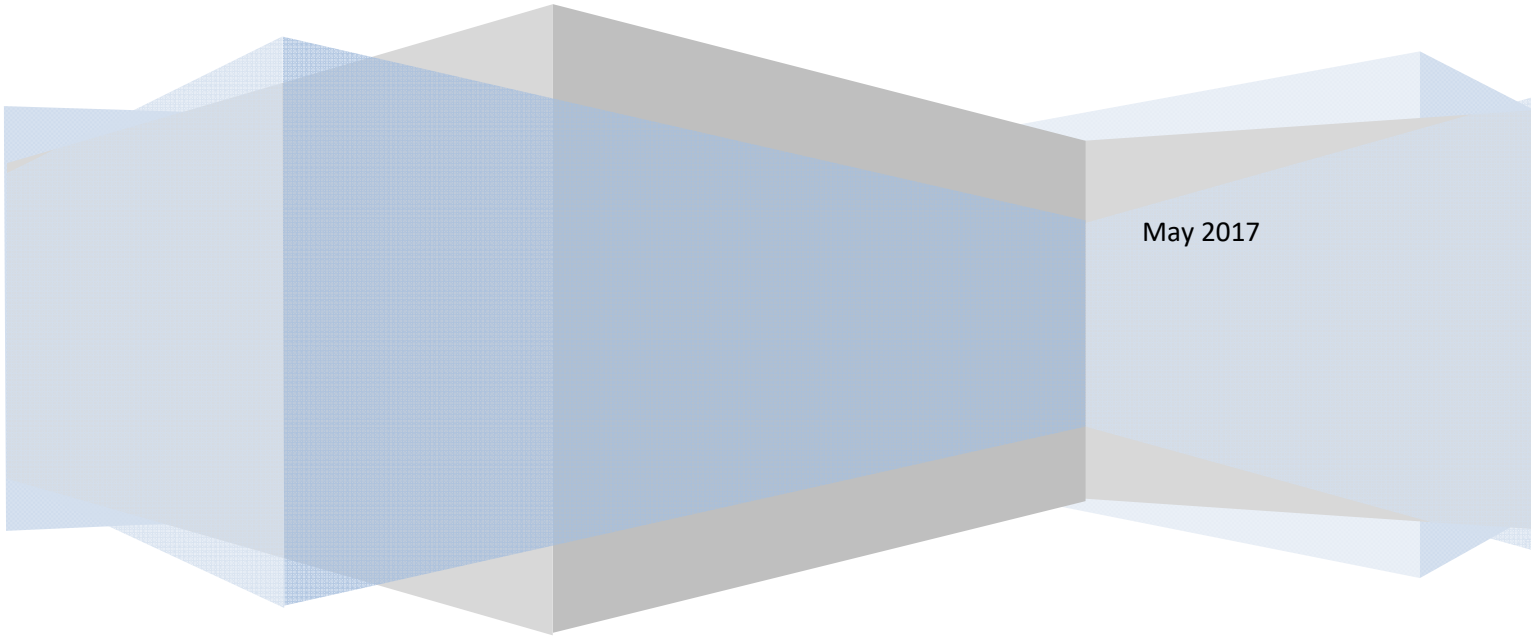

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Author Profile

Dr Stuart Wilson is an Associate Professor with the Department of Economics at the University of Regina. He earned his PhD in Economics from Queen's University at Kingston, and conducts research on the links between demographic change, public policy, public safety, savings and investment, and economic growth. Among his works are articles in the *Review of Economic Dynamics*, *Empirical Economics*, the *Journal of Community Safety and Well-Being*, and a chapter in the McGill-Queen's University Press book, *Canadian Immigration Policy for the 21st Century*. He teaches courses in macroeconomics, econometrics, population economics, and the economics of public safety at the University of Regina.

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Executive Summary

This report is the third preliminary report of a larger research project focusing on the changing economy and demography of Saskatchewan and its impact on crime and policing. The first report presented an overview of economic, demographic, policing, and crime trends over the last two decades in Saskatchewan and its ten major cities, with the additional context of developments in the other Prairie provinces, and in Canada as a whole. The second report provided a review of the literature on the theoretical and empirical determinants of criminal behaviour and crime. This report examines crime patterns in Saskatchewan and investigates their determinants, with a particular focus on demographic and economic influences.

Property crime rates rose from the 1960s to 1988 in Manitoba and Saskatchewan, and to 1991 in Ontario, Alberta and British Columbia. Afterwards, these rates started a trend decline. However, rates of property crime were subject to two exceptionally large one-period jumps after which property crime rates re-established the trend decline: in 1998 with the shift in reporting from UCR1 to UCR2 methodologies; and in 2003 with other changes in police-reporting practices. Among the **economic and demographic factors** examined, the estimation results provide evidence that declining property crime rates coincided with:

1. rising real household incomes per capita
2. increasing real per capita alcohol sales
3. declining unemployment rates
4. declining share of youth in the population
5. decreasing population movements, through
    a. decreases in the immigration rate
    b. decreases in the inter-provincial in-migration rate
    c. decreases in the interprovincial out-migration rate

The influences of the economic and demographic variables on rates of property crime in Saskatchewan have been found to be empirically important, and yet the results suggest that approximately sixty percent of the decline in the rate of property crime in Saskatchewan from 2003 to 2013 may be attributed to unexplained time trends, and province-specific factors. During this period, economic improvements in Saskatchewan coincided with declines in rates of property crime, but those economic improvements also coincided with increases in population movements which put offsetting upward pressure on the rate of property crime.

Rates of **violent crime** generally rose from the 1960s to the end of the twentieth century in Canada. Rates of violent crime have only recently been in decline, since 2000 in Ontario and Manitoba, since 2003 in Saskatchewan, since 2005 in BC and since 2008 in Alberta. The estimation results suggest that the decreases in the rate of violent crime were associated with:

1. decreases in the unemployment rate
2. decreases in real per capita alcohol sales
3. decreases in international and inter-provincial in-migration
4. increases in inter-provincial out-migration

However, changes in the economic and demographic variables available for this study were found to have offsetting effects and overall held very little influence on rates of violent crime in the five western provinces. All of the decline in the rate of violent crime in Saskatchewan from 2003 to 2013 may be attributed to undefined deterministic trends and province-specific factors. In addition, rates of violent crime were influenced by the shift from UCR1 to UCR2 reporting methodologies, with rates jumping by 27% in Saskatchewan, and up to 34% (in British Columbia) in 1998.

The crime rates of **breaking and entering**, **motor vehicle theft**, **fraud**, **homicide**, and of **robbery** were also examined in this study. The estimation results indicate that changes in four of these crime categories, the exception being motor vehicle theft, were all positively linked with changes in unemployment rates, and that changes in the proportion of youth in the population were positively related to changes in all five of these crime categories. It is important to note, once again, that economic and demographic factors available for this study ultimately had little impact on these crime rates. Strong unexplained forces appear to be driving changes in crime rates.

Over a shorter time period, from 1981 to 2011, the following **additional relationships** were found to hold empirically:

1. Housing price increases were linked to increases in property crime rates and were weakly linked to increases in violent crime rates.
2. Increases in income inequality were weakly linked to increases in violent crime rates.
3. Increases in rates of incarceration were linked to decreases in rates of violent crime.
4. Increases in police officer strength (officers per capita) were contemporaneously linked to decreases in violent crime, but linked to increases in crime rates in the following year.

These results (1, 2) suggest that housing price inflation and changes income inequality may affect the impoverished and influence criminal activity. In addition, these results (3, 4) suggest that incarceration may have deterrent and incapacitation effects on criminal activity, and that increasing police strength

may serve as an immediate deterrent on crime, but may cause a subsequent increase in crime rates through improved investigation and reporting.

Promising avenues for future research to help explain the as yet empirically unidentified forces include the investigation into changes in reporting and recording practices, the evolution of private security, the development and implementation of crime prevention initiatives, and cross-sectional analyses of crime rate variation at the police detachment regional level.

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1 Introduction

This report is the third report of the research project titled, *The Changing Economy and Demography of Saskatchewan and its Impact on Crime and Policing*, as part of the Research Collaboration Project between the Royal Canadian Mounted Police "F" Division and the University of Regina's Collaborative Centre for Justice and Safety. This research project aims to examine the socio-economic links to crime, identify how economic and demographic changes in Saskatchewan and its cities have influenced changes in crime rates, and to speculate how crime rates might evolve along with the economy and demography of the province.

The first report provided an overview of the economic and demographic changes that have occurred over the last two decades in Saskatchewan as a whole and in its ten major cities, and the coinciding changes in policing and crime rates (Wilson & Sagynbekov, 2014). After two decades of slow economic and population growth, the Saskatchewan economy shifted into a higher gear in 2006 in response to higher commodity prices. Saskatchewan experienced an export boom, increased resource exploration and development, a construction boom, and increased immigration and inter-provincial in-migration. The province benefitted with higher median incomes and reduced poverty rates. Crime rates have fallen since 2003, and yet are still among the highest in the country. Three cities in the province with above-average crime rates share the characteristics of low median incomes, high rates of poverty, and high proportions of aboriginal peoples with the characteristics of youthfulness, low educational attainment, low household income, high rates of unemployment, and high rates of poverty. Two cities in the province with above-average rates of violent crime and drug-related offenses share the characteristics of fast population growth and high median incomes. These facts were presented in the first report.

The second report provided a survey of the literature concerning the influences on criminal behaviour, with a particular focus on economic, demographic, policing, and justice system factors (Wilson, Sagynbekov, Pardy, & Penner, 2015). Theoretical influences on crime included economic factors such as levels of income, unemployment, inflation, poverty and inequality, as well as demographic factors such as population age structure, differences in family structures and in ethnicity, migration, and justice factors like punishment, policing, and crime prevention. Empirical studies found that criminal activity rose when inflation increased, and when employment opportunities for young unskilled men declined. There were mixed or weak results for links between crime and unemployment, poverty, and inequality. Youthfulness, the proportion of broken or lone-parent families, and the proportion of visible minorities were positively associated with criminal activity; however, these demographic characteristics tend to mask socio-economic factors such as poor employment outcomes, financial and social instability, poverty, and neighborhood disadvantages. Of justice system factors, when appropriately correcting for simultaneous effects, there is evidence suggesting that increases in police

size and resources, and severity of punishment and incarceration may reduce crime. One of the most important takeaways from the review was that it is important to use appropriate empirical methods given the data available, and to corroborate results with those from other studies in order to make valid inferences.

These reports served to motivate the current third report with the objective of identifying provincial crime patterns and their influences. Police-reported crime incident data are available starting in 1962, and a limited set of economic and demographic variables is available for the provinces dating back to the 1960s. Time series estimation methods are used on provincial data to investigate crime patterns for separate provinces, and panel techniques are used to jointly examine crime rates for the group of five western provinces from Ontario to British Columbia.

The results suggest that changes in economic and demographic variables coincided with changes in rates of property crime. More specifically, increases in real per capita incomes and in real per capita alcohol sales, and decreases in rates of unemployment, appeared as signs of improved economic prosperity, and coincided with declines in rates of property crime; decreases in the share of youth in the population, and decreases in population movements (international and inter-provincial migration) were also associated with decreases in rates of property crime. The results also suggest that, although some statistically significant links were uncovered, changes in economic and demographic variables had relatively little influence on changes in rates of violent crime. Economic and demographic change may help explain up to forty percent of the decline in the rate of property crime in Saskatchewan from 2003 to 2013, but none of the decline in the rate of violent crime over the same time period. The majority of change in these two rates is attributed to unidentified deterministic time trends and unspecified effects. The extension of the analysis to the five crime subcategories of breaking and entering, motor vehicle theft, fraud, robbery, and homicide revealed that decreases in the rates of these specified crimes coincided with decreases in unemployment rates and in the youth share of the population. However, the links between the individual crime rates and other economic and demographic variables either varied or were not statistically significant. This leads to questions regarding the aggregation of crime over types and making and extending inferences over various crime categories.

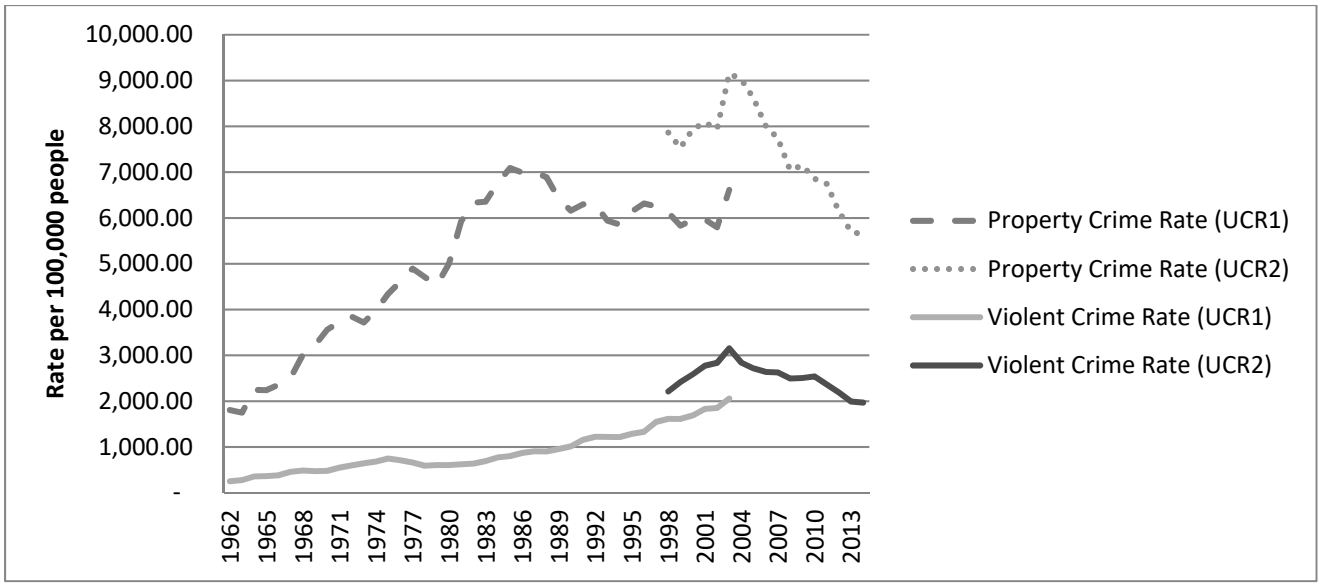
In section 2, the methodologies used in this report are presented. In section 3, the results for Saskatchewan using time series techniques are examined, and section 4 provides a comparative assessment of the economic and demographic influences on rates of property and violent crime in the five provinces. Section 5 presents results using panel estimation methods, and section 6 assesses the economic and demographic determinants of specified sub-categories of crime. Section 7 provides an overview of recent work explaining the international crime drop, as well as suggestions for further research. Section 8 concludes the report.

2 Modeling Crime Patterns and Demographic and Economic Determinants

Crime rates have exhibited distinct patterns of growth over the last fifty years. The rate of property crime in Saskatchewan rose from about 2,000 incidents per 100,000 residents to 7,000 in the mid-1980s, and then retreated to around 6,000 before it shifted upwards twice more recently – first with the change in police-reporting from UCR1 crime definitions and methodology to UCR2 crime definitions and methodology in 1998, and again in 2003 due to changes in police-reporting practices – before declining over the last decade.[1] The rate of violent crime trended upwards from 250 incidents per 100,000 residents in 1962, to 3,150 in 2003, and has since declined to just under 2,000 per 100,000 residents in 2014. Figure 1 presents the rates of property crime and of violent crime for Saskatchewan, from 1962 to 2014. These data are available from Statistics Canada and compiled from the Uniform Crime Reporting Surveys.

To identify and examine the economic and demographic influences on crime rates, time series methods will be used on data at the individual provincial level, and panel regression techniques will be used jointly for the four western Canadian provinces, Saskatchewan, Manitoba, Alberta, British Columbia, and for Ontario.

Figure 1: Crime Rates in Saskatchewan, 1962-2014



Sources: CANSIM Tables 252-0001 (1962-2003); 252-0051 (1998-2014); 051-0001 (population data).

[1] Please refer to Sections 2.3 and 7.2 for more information on reporting changes.

2.1 Time Series Methodology

In order to conduct meaningful econometric analysis, series must be in stationary forms. Most time series exhibit growth patterns and are either: (i) considered trend-stationary, meaning that these series grow with an underlying trend and deviations from that trend pattern are considered temporary; or are (ii) considered difference stationary, meaning that these series grow each period, but that one-period deviations in growth permanently affect the series.

Trend Stationary Series: $$y_t = \propto + \theta t + e_t;\ e_t = \rho e_{t-1} + u_t\ ;\ |\rho| < 1;\ u_t \sim iid \quad \text{(Eq 1)}$$

In the trend stationary case when the series is in its natural logarithmic form, the parameter θ is the estimate of the growth rate for the period in question. In the case where $|\rho| < 1$, the effects of shocks are transitory and not permanent, and the removal of the trend results in a stationary series. These series may be modeled in "levels" forms (i.e. without differencing). In the case where $|\rho| = 1$, the effects of shocks are permanent, the series has a unit root, is non-stationary, and must be differenced to achieve a stationary series (i.e. they may not be modeled in their levels forms). The term iid refers to independent and identically distributed residuals.

Difference Stationary Series: $$y_t - y_{t-1} = \Delta y_t = \varphi + v_t; v_t = \gamma v_{t-1} + u_t\ ;\ |\gamma| < 1;\ u_t \sim iid \quad \text{(Eq 2)}$$

In the difference stationary case, when the original series is in its natural logarithmic form, the parameter φ is the estimate of the growth rate.

2.1.1 Testing for Stationarity

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are performed to determine whether the series is stationary in levels, or has a unit root and is instead stationary in first differences. The ADF Test regression has the following form:

$$\Delta y_t = \propto + \delta y_{t-1} + \sum_{i=1}^{k} \Delta y_{t-i} + \theta t + u_t \quad \text{(Eq 3)}$$

The value for *k* is chosen to eliminate autocorrelation in the test regression. The null hypothesis being tested is that $\delta < 0$ when $\rho < 1$ in Eq 1, and generally used asymptotic critical values for the test statistic are obtained from Monte Carlo experiments (Dickey & Fuller, 1979; MacKinnon, 1991). The ADF test has been found to have low power in the presence of a large lag structure. Philips and Perron used the ADF test structure and used a non-parametric correction for autocorrelation with no lag structure in Eq 3. The critical values are the same as those used for the ADF test (Phillips & Perron, 1988).

2.1.2 Deterministic Components

The trend stationary series in Eq 1 has two deterministic components, the intercept $\propto$, and the time trend θt. This regression can be augmented to allow for shift parameters and different trends over different periods.

Example: $$y_t = \propto + \theta t + \alpha_1 D_1 + \theta_1 D_1 t + e_t \quad \text{(Eq 4)}$$

In this case, D_1 is a dummy variable, equal to 1 from t_1 to t_2, and 0 otherwise. The parameter $\propto$ is the intercept (shift parameter) for the sample, and $\propto_1$ is the additional shift parameter for the period from t_1 to t_2 . The parameter θ is the time trend parameter indicating the rate of growth for the whole sample, and θ_1 is the additional trend parameter for the period from t_1 to t_2 , which indicates the additional rate of growth (θ_1) above the rate (θ) for the sample. Additional shift and trend parameters may be included.

The difference stationary series in Eq 2 has one deterministic component, the average sample growth rate parameter φ. This form may be augmented to take into account additional deterministic components.

$$\Delta y_t = \varphi + \varphi_{t_1} D_{t_1} + \theta_2 D_1 + v_t \quad \text{(Eq 5)}$$

In this case, if D_{t_1} is a dummy variable equal to one at one point in time, at t_1, then the parameter φ_{t_1} indicates a one-time shift in the variable Δy_t , and a sustained shift in y_t over a portion of the sample, similar to shift parameter $\propto_1$ in Eq 4. The parameter θ_2 indicates a trend growth rate shift, sustained over the period from t_1 to t_2, and is similar to the effect of θ_1 in Eq 4. Additional shift and trend parameters may be included.

2.1.3 Multivariate Analysis

In the multivariate analysis, other variables thought to have explanatory power are added to the deterministic components in the regression.

$$z_t = \mu + D_t\gamma + X_t\beta + e_t; e_t = \rho e_{t-1} + u_t \; ; \; |\rho| < 1; \; u_t \sim iid \quad \text{(Eq 6)}$$

The parameter μ denotes the constant term in the regression equation, the vector D_t includes all other deterministic components, and the vector X_t includes all explanatory variables used in the regression.

2.2 Panel Analysis

There are cases where a time series may be too short to conduct reasonable individual econometric analyses. However, if several corresponding time series are available, these time series may be used to form a panel dataset. One of several advantages of model estimation using a panel dataset are “more informative data, more variability, less collinearity among the variables, more degrees of freedom and more efficiency” (Baltagi, 2005, p. 5). The cross-sectional variation in panel data increases the amount of variability in the data and reduces the degree and impact of collinearity amongst variables. Panel datasets increase the degrees of freedom and allow for more efficient parameter estimates.

To estimate the relationship between crime and the economic and demographic variables in the panel of five provinces, the following linear model is used:

$$z_{it} = \mu + D_t\gamma + X_{it}\beta + e_{it} \qquad \text{(Eq 7)}$$

X_{it} is a vector of j variables for i panels (in this case, i different provinces), D_t is a vector of deterministic variables including province-specific and time-dependent dummies, and e_{it} denotes the error term. In the case of a small number of panels with a relatively large number of cross sections (time periods), it is possible to use least squares procedures that provide panel-corrected standard errors for the estimates, and allow for heteroskedasticity, for first order autocorrelation, and for correlation of errors across panels at a given point in time (Cameron & Trivedi, 2010).

2.3 Available Data

Police-reported crime data are available starting in 1962, using the Uniform Crime Reporting Survey UCR1 definitions and crime categories. These data are made available by Statistics Canada from 1962 to 2003. Statistics Canada currently releases police-reported crime data under UCR2 coding. Changes from the UCR1 coding include more detailed offense categories, expanding from the three-digit coding in UCR1 to the four-digit coding in UCR2. Many offenses which were previously categorized in the "Other Criminal Code violations" category were appropriately re-categorized under UCR2 as violent or property crimes. The UCR2 data go back to 1998 and are considered as the official crime statistics. Statistics Canada has also released more comprehensive data using UCR1 methodology for the period from 1977 to 1997, with series similar to those released after 1997. For the purpose of this report, the UCR1 data will be used from 1962 to 1997, and the UCR2 data will be used from 1998 to 2014. The change in methodology at 1998, with a substantial jump in many police-reported crime rates in 1998 compared to 1997, is important to note and to treat appropriately in the econometric analysis.

The key economic and demographic indicators that are available starting in or before the 1960s are described in Table 1 along with the above-mentioned crime rates. These series are all available from 1967 to 2013 and are used to construct individual provincial time series analyses, and joint panel analyses. These data were chosen given the theoretical and empirical support for their inclusion in analyses. For a review of the literature on the theoretical and empirical influences on crime rates, please see Wilson, Sagynbekov, Pardy, & Penner (2015).

The data and methods used in this study are similar to those used by Bunge, Johnson, & Balde (2005), as are the data constraints. Their analyses focused on the four crime types of break and enter, motor vehicle theft, homicide, and robbery, over the 1962-2003 period, for Canada as a whole. This report serves as an extension of the work conducted by Bunge, Johnson, & Balde (2005), with a larger time period, and by looking at the impact of economic and demographic change on the individual provinces, and the five western provinces in a panel. The focus in Sections 3 through 5 is on the two major crime

groupings of property and violent crime. The focus in Section 6 is on the five crime categories of breaking and entering, motor vehicle theft, fraud, homicide, and robbery.

Table 1: Data Description

Symbol	Symbol for logarithmic form	Description	Sources
VCR	*vcr*	Provincial rate of violent crime, incidents per 100,000 residents as of July 1 of that year.	CANSIM Tables 252-0001 (1962-2000); 252-0051 (1998-2014); 051-0001
PCR	*pcr*	Provincial rate of property crime, incidents per 100,000 residents as of July 1.	CANSIM Tables 252-0001 (1962-2000); 252-0051 (1998-2014); 051-0001
Y	*y*	Real provincial household income per capita.	CANSIM Table 384-5000 (1962-2013)
π	N/A	The rate of city-linked provincial CPI Inflation (this is the CPI series in logarithmic form and in first differences).	CANSIM Table 384-5000 (1962-2013)
UR	*ur*	The provincial unemployment rate.	HSC Series D491-497 (1962-1965);CANSIM I CHASS I CHASS Labels D45076,45097,45118, 45139, 45160 (1966-1975) CANSIM Table 282-0002 (1976-2014)
OHP	*ohp*	Real value of provincial alcohol sales per capita.	CANSIM Table 183-0006
YSP	*ysp*	The provincial ratio of the population aged 15 to 24 as of July 1 that year divided by the population as of July 1 of that year.	CANSIM Tables 051-0001, 051-0026 (1962-2014)
IMP	*imp*	The provincial ratio of the number of international immigrants that year divided by the population as of July 1.	CANSIM Tables 051-0001, 051-0017 (1962-2014)
EMP	*emp*	The provincial ratio of the number of international emigrants that year divided by the population as of July 1.	CANSIM Tables 051-0001, 051-0017 (1962-2014)
INP	*inp*	The provincial ratio of the number of interprovincial in-migrants that year divided by the population as of July 1.	CANSIM Tables 051-0001, 051-0037 (1962-2014)
OUP	*oup*	The provincial ratio of the number of interprovincial out-migrants that year divided by the population as of July 1.	CANSIM Tables 051-0001, 051-0037 (1962-2014)

3 Crime Rates in Saskatchewan

The rates of property crime, and of violent crime, for Saskatchewan in this section will be examined using the methodology described in Section 2. The first step is to identify the stationary form of these crime rate series using unit root tests. ADF and PP tests were first conducted on the crime rate series in logarithmic forms to identify the type of transformation required to achieve a stationary series. The results for Saskatchewan are presented in Table 2. We may infer from these results that these series are integrated of order one, and are stationary in first differences – as growth rates in logarithmic forms. This will require the modeling strategy outlined in Eqs 2 and 6 in Section 2. These series will not be modeled in their levels forms.

3.1 Deterministic Components

Each crime rate series in growth rate form is examined using deterministic period dummies to account for sustained changes in average growth rates, and one-period dummies to account for one-time changes in growth rates. These dummies are constructed by examining the patterns in the original series themselves.

3.1.1 Deterministic Trends in the Rate of Property Crime

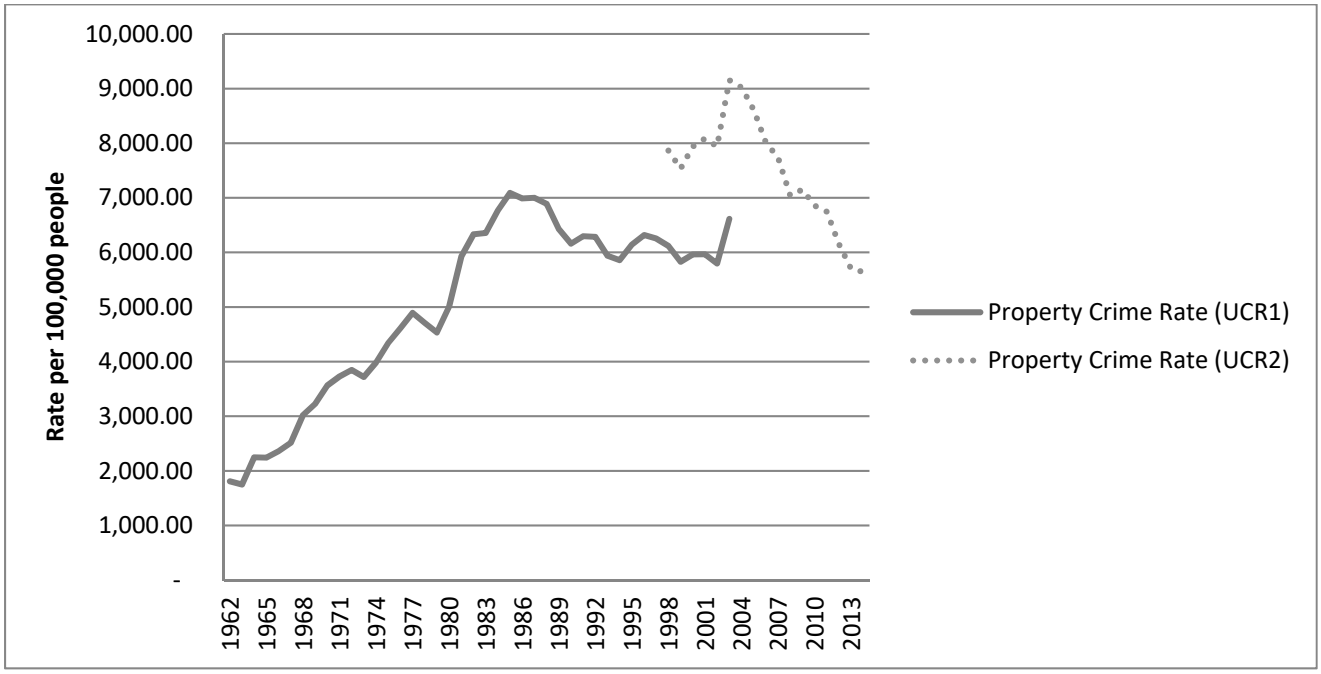
The Saskatchewan property crime rate is depicted in Figure 2. This series appears to show positive growth from 1962 to the late 1980s. A noticeable drop in the rate appears after 1988, with relatively little change in the rate until the shift to UCR2 reporting in 1998. This reporting change led to a substantial increase in the rate at that time. Following a dramatic increase in the rate in 2003, the rate begins a steady decline.

Table 2: Unit Root Tests, Saskatchewan, 1962-2014

Test	pcr 1963-2014	vcr 1963 -2104
ADF (levels)	-1.5798 (1)	-0.8692 (0)
PP (levels)	-0.9563 (1)	-0.8194 (1)
ADF (First Differences)	-1.7320 (6)	-3.9657 (2)
PP (first differences)	-4.6953 (1)	-7.7822 (1)
Inference	I(1)	I(1)

Asymptotic critical value at 10% significance level: -3.13.

Figure 2: The Property Crime Rate in Saskatchewan, 1962-2014



Sources: CANSIM Tables 252-0001 (1962-2003); 252-0051 (1998-2014); 051-0001 (population).

The first regression included deterministic dummies to account for both sustained and one-period changes in 1989, 1998, and 2003, and the regression results are presented in Table 3. Over the entire sample period from 1963 to 2014, the mean growth rate for the rate of property crime was 2.19% per year. The results presented in column 2 indicate that growth in the rate of property crime averaged 5.42% per year from 1962 to 1987. Then, the growth rate decreased by 6.50 percentage points, to an average of -1.08% from 1988 to 1997, and this change in growth was statistically significant. (Please note that these trend growth changes are additive given how these period dummies are defined.) The growth rate further increased by 1.33 percentage points over the 1998-2002 period to an average rate of 0.25% per year, and declined by 4.64 percentage points over the 2003 to 2014 period to an average rate of -4.39% per year; however, neither of these two more recent changes were found to be statistically significantly different from 0. So, there appeared to be a substantial change in the growth pattern of the rate of property crime following 1988, but no statistically significant sustained change in the rate of growth after 1998, nor after 2003. However, there were statistically significant one-period changes in the growth rate in 1998 and in 2003, by 22.7% and 18.6% respectively above the trend growth rates.

Table 3: Growth in the Rate of Property Crime – Regression Results

Regressors/Statistics	Δpcr 1963-2014	Δpcr 1963-2014
Constant	0.0542 (0.0116)***	0.0542 (0.0116)***
Dummy (1988-2014)	-0.0650 (0.0226)***	-0.0776 (0.0164)***
Dummy (1998-2014)	0.0133 (0.0349)	-
Dummy (2003-2014)	-0.0464 (0.0339)	-
Dummy (1988)	-0.0504 (0.0613)	-
Dummy (1998)	0.2270 (0.0650)***	0.2529 (0.0590)***
Dummy (2003)	0.1859 (0.0607)***	0.1654 (0.0590)***
R^2	0.4861	0.4563
Adjusted R^2	0.4176	0.4223
Mean	0.0219	0.0219
Standard error (sigma)	0.0581	0.0579
AR(1) t-stat	-0.3930	-0.1328
LM test (16 df)	9.615	7.884
Test for normality Jarque-Bera (2df)	18.804***	14.003***
Block F-test for Exclusion of Omitted Variables		0.8705 (3,45 df) p-value = 0.4634

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test).

The results in column 3 are the regression results when excluding statistically insignificant dummies. Those results indicate that the rate of property crime grew on average by 5.42% each year from 1963 to 1987, and then decreased by an average of 2.34% each year thereafter. In 1998, as a result of reporting changes from UCR1 to UCR2, the rate of property crime grew by an additional 25.29% over the annual rate of -2.34%, for an estimated 22.95% change over 1997-1998 from the deterministic components of the regression (i.e. excluding the random component of change). In 2003, the estimated rate of property crime grew by 14.20% from 2002, excluding the random component of growth. The deterministic components in the regression captured 46% of the variance in the growth rate over the period, indicating just over half of the variance is accounted for by unexplained shocks (or residuals in the model).

3.1.2 Deterministic Trends in the Rate of Violent Crime

The rate of violent crime is shown in Figure 3. The series exhibits an increase from 1962 to 2003 and then falls thereafter, and there is a substantial one-period jump in 1998 when UCR2 reporting is thereafter used. The same period dummies used above for the property crime rate series were used for the violent crime rate series, although the 1988 dummies were expected to have no impact. The estimation results are presented in Table 4.

The mean growth rate for the entire period (1963-2014) was 3.96%. However, the coefficients on the dummy variables indicate deterministic differences in growth rates over sub-periods. The constant term in column 2 indicates that the estimated average growth rate for the period from 1963 to 1987 was 5.19%. The estimated growth rate increased slightly by 1.14 percentage points to a rate of 6.33% over the 1988 to 1997 period, decreased by 0.30 percentage points to 6.03% average annual growth from 1998 to 2002, and then fell by 10.38 percentage points to -4.35% average annual growth from 2003 to 2014. However, of these estimates, only the constant term (indicating base growth over the entire period) and the coefficient on the dummy for the 2003 to 2014 period were statistically significant.

Figure 3: Violent Crime Rates in Saskatchewan

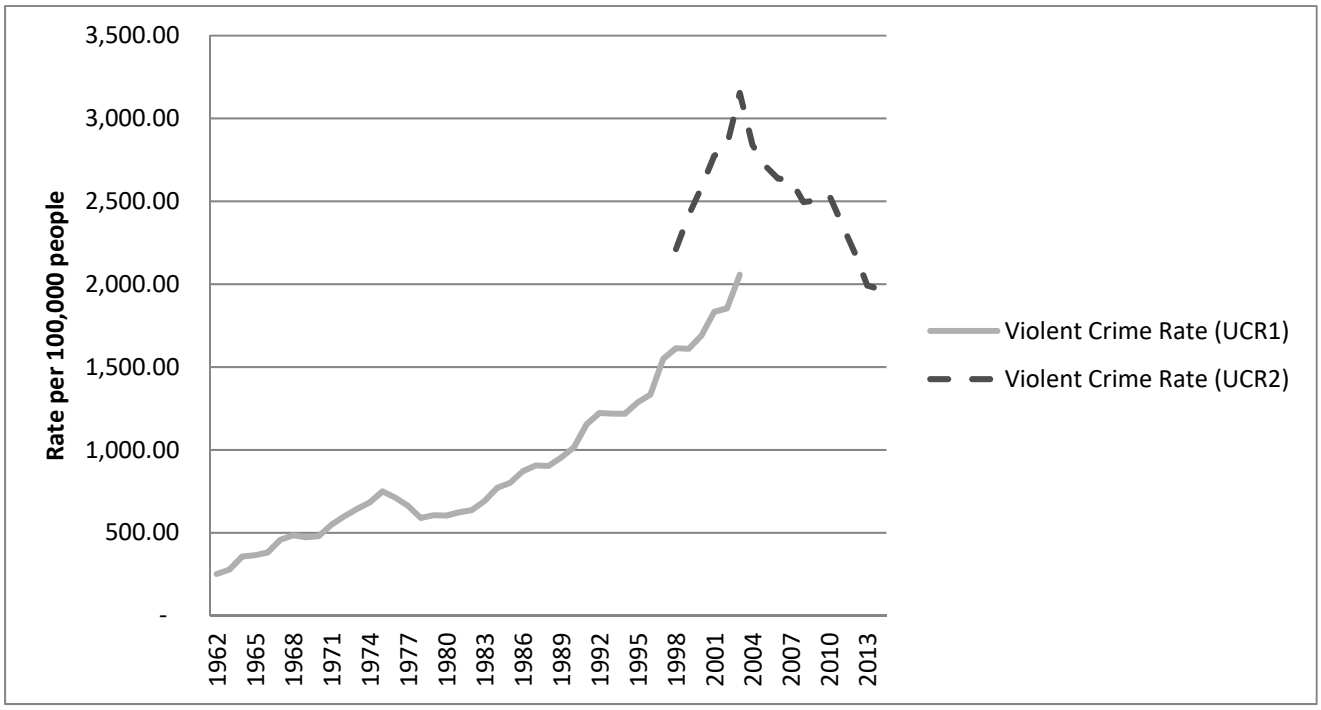


Table 4: Growth in the Rate of Violent Crime – Regression Results

Regressors/Statistics	Δvcr 1963 -2014	Δvcr 1963-2014
Constant	0.0519 (0.0170)***	0.0543 (0.0133)***
Dummy (1988-2014)	0.0114 (0.0322)	-
Dummy (1998-2014)	-0.0030 (0.0475)	-
Dummy (2003-2014)	-0.1038 (0.0462)**	-0.0978 (0.0279)***
Dummy (1988)	0.0603 (0.0624)	-
Dummy (1998)	0.2648 (0.0658)***	0.2667 (0.0579)***
Dummy (2003)	0.1757 (0.0625)***	0.1742 (0.0604)***
R^2	0.5471	0.5375
Adjusted R^2	0.4868	0.5086
Mean	0.0396	0.0396
Standard error (sigma)	0.0613	0.0600
$\hat{\rho}$	0.2907 (0.1327)	0.2918 (0.1326)**
Durbin's H test	0.6302	0.6689
Test for normality Jarque-Bera (2df)	5.5739*	4.3045
Block F-test for Exclusion of Omitted Variables		0.3204 (3,45 df) p-value = 0.8105

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test).

The one-period dummy variable for 1988 indicates that the growth rate in the rate of violent crime increased deterministically by 6.03% for that year, over and above the estimated average growth rate of 6.33% from 1988 to 1997; however, that one-period deviation was not statistically significant. The violent crime rate grew by an additional 26.48% in the single 1998 year. The coefficient of 0.1757 for the 2003 dummy indicates that the growth rate jumped by an additional 17.57% for that year only, above the average growth rate for the larger period. Overall, the first regression specification captured 55% of the variance in the growth rate over the period, indicating that just less than half of the variation in the growth rates of the rates of violent crime is accounted for by the regression residuals.

The results in the third column are the estimates obtained by eliminating the statistically insignificant dummies from estimation. These results led to the inferences that the average estimated growth rate in the violent crime rate was 5.43% for the period from 1963 to 2002, and it was -4.34% for the period from 2003 to 2014. There were also one-period increases in growth in the rate of violent crime of 26.67 percentage points in 1998 and of 17.42 percentage points in 2003, above their respective period average rates of growth.

3.2 Multivariate Analysis

In this section, the impact of changes in demographic and economic variables on the two crime rate series is explored. Provincial demographic data for population cohort shares, immigration, emigration, in-migration and out-migration patterns are available starting with or before 1962. Provincial economic data for city-linked inflation rates, real household income per capita, and real alcohol sales per capita are also available starting with or before 1962 to 2013. Unemployment rates for the provinces are available historically back to 1946, but only starting in 1966 for the individual Prairie Provinces, as unemployment rates are grouped for the three provinces before 1966.

3.2.1 The Rate of Property Crime

The regression results using the full set of demographic and economic variables, along with the deterministic variables, are presented in Table 5. The unrestricted regression results in column 2 suggest that changes in real household income per capita, inflation, and unemployment rates are all positively correlated with changes in rates of property crime in Saskatchewan. However, of these economic variables, only the link between changes in the unemployment rate is considered statistically significant with respect to changes in property crime rates at the 0.10 significance level.

The unrestricted regression results suggest that changes in the size of the youth population relative to the total population, changes in the rates of international emigration, and changes in the rate of interprovincial in-migration are positively correlated with changes in rates of violent crime, while changes in the rate of immigration, and in interprovincial out-migration are negatively associated with changes in the rate of violent crime. Of these demographic variables, only changes in the relative size of the youth population were statistically significant influences on changes in rates of property crime.

The restricted regression results are presented in column 3. The results suggest that: a 1% increase in the rate of unemployment is associated with a 0.13% increase in the rate of property crime; a 1% increase in real alcohol sales per capita is associated with a 0.36% decrease in the rate of property crime, and a 1% increase in the share of the youth population to the total population is associated with a 0.93% increase in the rate of property crime. The R^2 increased from 45.63% to 66.19% when these three variables were included along with the deterministic components, suggesting that almost one-quarter of the variation in the rate of property crime is explained by changes in these three economic demographic variables (this is a comparison of the result in column 3 of Table 3 to that in column 3 of Table 5). Block tests of exclusion for the excluded insignificant dummies, economic, and demographic variables produced a p-value of 0.77, and lead to the inference that these variables were not determinants of changes in rates of property crime.

Table 5: Growth in the Rate of Property Crime – Multivariate Regression Results

Regressors/Statistics	Δpcr 1967 -2013	Δpcr 1967-2013
Constant	0.0411 (0.0129)***	0.0425 (0.0106)***
Dummy (1988-2014)	-0.0567 (0.0227)**	-0.0589 (0.0145)***
Dummy (1998-2014)	0.0226 (0.0313)	-
Dummy (2003-2014)	-0.0352 (0.0296)	-
Dummy (1988)	0.0596 (0.0578)	-
Dummy (1998)	0.2222 (0.0555)***	0.2551 (0.0462)***
Dummy (2003)	0.1676 (0.0509)***	0.1668 (0.0461)***
Δy	0.0247 (0.1346)	
$\Delta \pi$	0.1706 (0.5718)	
Δur	0.1477 (0.0703)**	0.1264 (0.0482)**
Δohp	-0.3326 (0.2471)	-0.3631 (0.1905)*
Δysp	0.8433 (0.4540)	0.9281 (0.3701)***
Δimp	-0.0277 (0.0450)	
Δemp	0.0232 (0.0368)	
Δinp	0.0732 (0.0840)	
Δoup	-0.0685 (0.0672)	
R^2	0.7138	0.6619
Adjusted R^2	0.5753	0.6112
Mean	0.0188	0.0188
Standard error (sigma)	0.0468	0.0448
AR(1) t-stat	-0.2459	-0.0681
LM test (16 df)	10.129	11.060
$\hat{\rho}$	-	-
Durbin's H test	-	-
Test for normality Jarque-Bera (2df)	0.3787	0.0004
Block Exclusion F-Test		0.6243 (9,31 df); p-value = 0.7672

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test).

Table 6 uses the regression point estimates from Table 5 to decompose the estimated impact of changes in the economic and demographic variables on changes in the rate of property crime in Saskatchewan over the 2003 to 2013 period. These point estimates suggest that up to 18% of the decline in the rate of property crime in Saskatchewan between 2003 and 2013 may be associated with changes in the economic variables; most notably, the decrease in the rate of unemployment and the increase in per capita alcohol sales were each associated with about 10% of the decline in the rate of property crime. The results also suggest that up to 22% of the decline in the rate of property crime may be attributed to demographic change. In particular, the results suggest that the increase in immigration may account for 10% of the decline; however, the estimated impact of immigration was not statistically significant, and could very well have no impact whatsoever. The reduced-form equation estimates in column 3 of Table 5 suggest an explanatory role for changes in the proportion of youth in the population, and so it is possible that approximately 15% of the decline in the rate of property crime may be attributed to the decline in the proportion of youth in Saskatchewan.

Table 6: Decomposition of Changes in the Saskatchewan Rate of Property Crime, 2003-2013

Variable	Cumulative change	TS Regression coefficient (Table 5, column 2)	Percent contribution to overall change in the rate of property crime, 2003-2013	Contribution to change in the rate
Δy	0.3371	0.0247 (0.1346)	-1.77%	+61
$\Delta \pi$	-0.0060	0.1706 (0.5718)	0.20%	-7
Δur	**-0.3118**	**0.1477 (0.0703)**	**9.72%**	**-336**
Δohp	**0.1421**	**-0.3326 (0.2471)**	**9.98%**	**-345**
Δysp	**-0.0838**	**0.8433 (0.4540)**	**14.90%**	**-515**
Δimp	1.7523	-0.0277 (0.0450)	10.02%	-354
Δemp	-0.1740	0.0232 (0.0368)	0.84%	-29
Δinp	0.1368	0.0732 (0.0840)	-2.11%	+73
Δoup	-0.1188	-0.0685 (0.0672)	-1.71%	+59
Combined Impact: Economic variables			18.13%	-627
Combined Impact: Demographic variables			21.94%	-766
Deterministic Dummies and Residuals			**59.93%**	**-2,063**
Total			**100.00%**	**-3,456**

Note: Standard errors in parentheses.

3.2.2 The Rate of Violent Crime

The regression results using the full set of demographic and economic variables, and the deterministic variables from Table 4 are included in Table 7. The unrestricted regression results in column 2 suggest that changes in real household income per capita, inflation, unemployment rates, and real alcohol sales per capita are all positively correlated with changes in rates of violent crime in Saskatchewan. However, of these economic variables, only the effect of real alcohol sales per capita is considered statistically significant with respect to changes in violent crime rates at the 0.10 significance level. The unrestricted regression results also suggest that changes in the size of the youth population relative to the total population; changes in the rate of interprovincial out-migration are negatively correlated with changes in rates of violent crime; and changes in the rate of immigration, emigration, and in-migration are all positively associated with changes in the rate of violent crime. None of these demographic variables were found to have a statistically significant effect on rates of violent crime at the 0.10 significance level. However, the coefficients on the rates of immigration and of in-migration both had *t*-values in excess of 1, and are prime candidates for inclusion in subsequent regressions and testing; as variables are eliminated, the degree of multicollinearity decreases, the degree of precision in the estimates increases, and degrees of freedom in the estimation increase. Block exclusion tests were conducted on Δy, $\Delta \pi$, Δur, Δysp, Δemp, and Δoup, and yielded a p-value of 0.92, so that these variables were then eliminated in the subsequent regression.

Regression results of the first reduced model are presented in column 3. Autocorrelation was handled using the Cochrane-Orcutt estimation procedure and provided unbiased estimates of standard errors for the coefficients (in the presence of autocorrelation, the ordinary least squares standard error estimates are biased). The regression point estimates indicate that a 1% increase in growth in alcohol sales per capita may translate into a 0.3% increase in growth in the rate of violent crime, while a 1% increase in growth in the rate of in-migration may translate into a 0.1% increase in growth in the rate of violent crime. However, in both cases, the coefficients may be considered statistically insignificant at reasonable levels (the p-values for the coefficient estimates are 0.142 and 0.140 respectively).

The final reduced form results are presented in the fourth column. These results suggest that, aside from the deterministic changes in the rate of growth in the violent crime rate, only changes in the rate of international immigration had a statistically significant impact on changes in the rate of violent crime; the point estimate suggests that a 1% increase in the growth in the immigration rate increases the growth in the rate of violent crime by 0.1%. The R^2 increased from 53.75% to 67.34% when the growth rate in immigration was included as a regressor, and suggests that 13% of the variation in the rate of violent crime may be attributed to the variation in the immigration rate (see column 3 of Table 4, and column 4 of Table 7).

Table 7: Growth in the Rate of Violent Crime – Multivariate Regression Results

Regressors/Statistics	Δvcr 1967 -2013	Δvcr 1967-2013	Δvcr 1967-2013
Constant	0.0381 (0.0153)**	0.0543 (0.0130)***	0.0529 (0.0140)***
Dummy (1988-2014)	0.0329 (0.0269)	-	-
Dummy (1998-2014)	-0.0024 (0.0371)	-	-
Dummy (2003-2014)	-0.1399 (0.0351)***	-0.1222 (0.0275)***	-0.1213 (0.0294)***
Dummy (1988)	-0.0548 (0.0686)	-	-
Dummy (1998)	0.2698 (0.0659)***	0.2366 (0.0488)***	0.2681 (0.0466)***
Dummy (2003)	0.1567 (0.0604)**	0.2001 (0.0486)***	0.2024 (0.0496)***
Δy	0.0160 (0.1597)	-	
$\Delta \pi$	0.0982 (0.6788)	-	
Δur	0.0355 (0.0835)	-	-
Δohp	0.5634 (0.2934)*	0.3142 (0.2096)	-
Δysp	-0.3322 (0.5390)	-	-
Δimp	0.0769 (0.0534)	0.0768 (0.0403)*	0.1029 (0.0391)**
Δemp	0.0140 (0.0437)	-	
Δinp	0.0993 (0.0997)	0.0992 (0.0659)	
Δoup	-0.0459 (0.0798)	-	
R^2	0.7026	0.7065	0.6734
Adjusted R^2	0.5586	0.6625	0.6423
Mean	0.0352	0.352	0.0352
Standard error (sigma)	0.0556	0.0486	0.0500
AR(1) t-stat	1.0744	-	-
LM test (16 df)	12.458	-	-
$\hat{\rho}$	-	0.3835 (0.1347)***	0.4144 (0.1328)***
Durbin's H test	-	0.0030	0.1893
Test for normality Jarque-Bera (2df)	0.3263	1.5525	2.2875
Block F-test for Exclusion		0.3995 (9,31 df) p-value = 0.9219	2.3563 (2, 40 df) p-value = 0.1078

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test).

Table 8 presents the decomposition of changes attributable to the independent variables in the first unrestricted regression (Table 7, column 2). These estimates indicate that deterministic factors accounted for the decline in the rate of violent crime in Saskatchewan from 2003 to 2013. The results suggest that, all else equal, changes in the economic and demographic variables should have resulted in an increase in the rate of violent crime.

3.3 Saskatchewan Crime Patterns

The rates of property crime and violent crime in Saskatchewan both experienced trend increases from 1962 into the late 1980s, growing at average rates of 5% per year. The property crime rate fluctuated around 6,000 incidents per 100,000 residents through the late 1980s and early 1990s, while the violent crime rate continued to rise. Both rates jumped in 1998 with the change in police-reporting to the UCR2 methodology. The one-period increases were of the magnitude of 25% for the rate of property crime and 27% for the rate of violent crime in Saskatchewan. Another one-period jump occurred in 2003, as the rates of property crime and violent crime both jumped by 17%. Since 2003, both rates have been in decline, at an average annual rate of 2% for the rate of property crime, and at an average annual rate of 4% for the rate of violent crime.

Table 8: Decomposition of Changes in the Saskatchewan Rate of Violent Crime, 2003-2013

Variable	Cumulative change	TS Regression coefficient (Tables 6, column 2)	Percent contribution to overall change in the rate of property crime, 2003-2013	Contribution to change in the rate
Δy	0.3371	0.0160 (0.1597)	-1.20%	+14
$\Delta \pi$	-0.0060	0.0982 (0.6788)	0.09%	-1
Δur	-0.3118	0.0355 (0.0835)	2.41%	-28
Δohp	**0.1421**	**0.5634 (0.2934)***	**-17.37%**	**+202**
Δysp	-0.0838	-0.3322 (0.5390)	-6.02%	+70
Δimp	**1.7523**	**0.0769 (0.0534)**	**-29.32%**	**+341**
Δemp	-0.1740	0.0140 (0.0437)	0.52%	-6
Δinp	0.1368	0.0993 (0.0997)	-2.92%	+34
Δoup	-0.1188	-0.0459 (0.0798)	-1.20%	+14
Combined Impact: Economic variables			**-16%**	**+187**
Combined Impact: Demographic variables			**-39%**	**+453**
Deterministic Dummies and Residuals			**155%**	**-1,803**
Total			**100%**	**-1,163**

Several demographic factors were considered in the empirical analysis of crime rates. Of those factors, changes in the share of youth (15 to 24 years of age) in the total population were found to be linked with changes in the rate of property crime in Saskatchewan. The estimation results suggest that a 1% decrease in the youth share in the population was associated with a 0.9% decrease in the rate of property crime. Changes in violent crime were found to be linked with changes in the immigration rate in Saskatchewan. The results suggest that a 1% increase in the rate of immigration was associated with a 0.1% increase in the rate of violent crime.

Among the economic factors considered to be related to rates of crime, none were found to be associated with changes in the rate of violent crime, while changes in the unemployment rate and changes in real per capita alcohol sales were linked to changes in the rate of property crime. The results suggest that a 1% decrease in the unemployment rate was associated with a 0.1% decrease in the rate of property crime, while a 1% increase in real per capita alcohol sales coincided with a 0.35% decrease in the rate of property crime.

Decomposition methods were used to assess the strength of the associations between crime rates and the economic and demographic factors. The estimates suggest that changes in the youth share in the population were associated with a drop in the rate of property crime by 515 incidents per 100,000 residents; that changes in the unemployment rate were linked with a decline in the rate of property crime by 335 incidents per 100,000 residents; and that changes in per capita alcohol sales were associated with a drop of 345 incidents per 100,000 residents in the rate of property crime in Saskatchewan over the 2003-2013 period. The decomposition estimates also suggest that the rate of violent crime should have increased by 340 incidents per 100,000 residents with the increase in the rate of immigration, but other factors were strong enough to more than offset any potential increase in the rate of violent crime over the period from 2003 to 2013.

It is important to note that the demographic and economic factors identified in this study appear to have accounted for only one-quarter of the variation in growth of the rate of property crime, and about 15% of the variation in growth of the rate of violent crime. Approximately one-half of the variation in the growth of these two crime rates was attributed to unexplained deterministic trends, with the remainder due to unexplained shocks (residual "error"). These results identify a difficulty in analyzing crime rate trends with a limited set of available explanatory variables and in the presence of unexplained time-dependent trends. It was not possible, given the nature of the crime rate series, to uncover any relationships between variables in the levels form, which help explain long-term patterns.[2]

[2] Any modeling in levels form is questionable and may involve inferences based on spurious regressions. Engle-Granger cointegration analysis revealed no cointegrating relationships between crime rates and the explanatory variables. As a result, error-correction models and long-run relationships between the variables of interest were not estimated. Readers interested in error-correction models may refer to Seddighi, Lawler, & Katos (2000) and Wilson (2006).

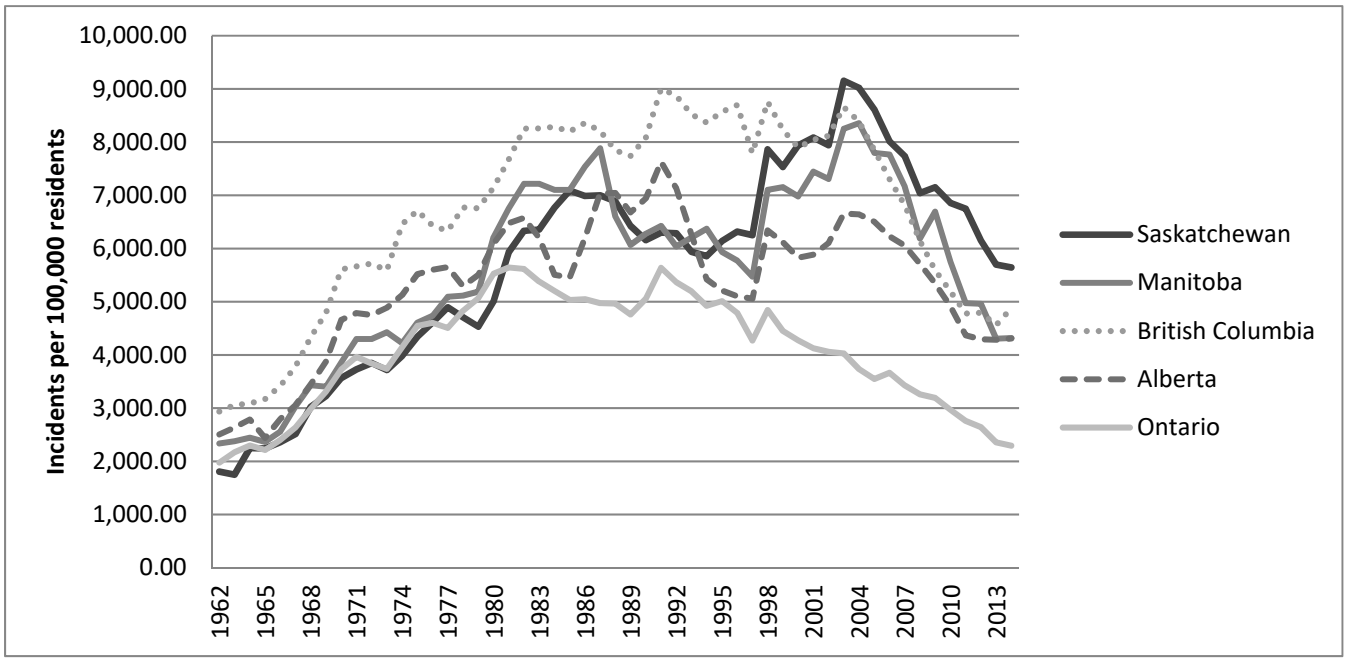
4 Crime Rates in a Comparative Context

The preceding section identified the rates of growth in crime rates of Saskatchewan, as well as some demographic and economic variables that appear to have some influence on the rates of property and violent crime in Saskatchewan since 1962. This section will proceed to compare the trends and influences of Saskatchewan crime rates with those of the four closest neighboring provinces: Ontario, Manitoba, Alberta and British Columbia.

4.1 Rates of Property Crime

The rates of property crime for Saskatchewan, for the other western provinces, and for Ontario are presented in Figure 4. For all five provinces, the rates of property crime rose from 1962 and into the 1980s. It appears that the rate for Ontario started to decline around 1983, with the exception of abrupt increases in 1991 and 1998 interrupting the pattern of decline. The rates for Saskatchewan and Manitoba continued to grow until 1987 and exhibited little trend during the 1990s. The rate for Alberta appeared to be more volatile during the 1980s, but continued to grow until 1992. The rate for British Columbia grew more slowly in the 1980s and peaked in 1992. The rates for all five provinces rose in 1998 with the shift to UCR2 reporting. For the four western provinces, the rate of property crime began a long-term decline after 2003.

Figure 4: Rates of Property Crime, Select Provinces, 1962-2014



The rates for the five provinces were empirically examined in the same manner as described in Section 3 with deterministic, economic, and demographic factors. Deterministic dummies for 1988 were used for Saskatchewan and Manitoba, while dummies for 1991 were used for Alberta, BC, and Ontario, to model the first apparent break in provincial crime rate trends. Dummies for 1998 and 2003 were used for all five provinces. The preliminary results using these deterministic dummies and the full set of economic and demographic variables are presented in Table 9. These results indicate the different influences on property crime rates in these five provinces.

4.1.1 The Influence of Economic Variables

Changes in real household income per capita were negatively related to changes in the rate of property crime in four of the five provinces, and only statistically significant in Alberta and British Columbia: a 1% increase in the growth of real income was associated with a 0.59% decline in the rate of property crime in Alberta, and with a 0.95% decline in the rate of property crime in British Columbia. Changes in the real value of alcohol sales per capita in the five provinces were negatively associated with changes in the rate property crime; however, none of those results was found to be statistically significant. Of the other two economic variables, increases in the rate of unemployment were associated with increases in the rate of property crime. In two of the five provinces, this relationship was statistically significant. A 1% increase in the rate of unemployment was associated with a 0.15% increase in the rate of property crime in Saskatchewan, and with a 0.16% increase in the rate of property crime in Manitoba. Changes in the rate of inflation were only linked to changes in the rate of property crime in British Columbia: a 1% increase in inflation was associated with a 1% increase in the rate of property crime in BC.

4.1.2 The Influence of Demographic Variables

Changes in the proportion of youth in the population had a statistically significant link to the rate of property crime in four of the five provinces; changes in the rate of immigration had a significant influence on the rate of property crime in two provinces, Manitoba and Alberta; and changes in the rate of in-migration were significantly associated with the rate of property crime in Alberta. Changes in the rate of emigration and out-migration had no statistically significant relationship with rates of property crime in any of the five provinces.

The estimated coefficients describing the relationship between changes in the relative size of the youth cohort and changes in rates of property crime ranged from 0.84 for Saskatchewan, to 1.63 in Ontario. The results suggest that a 1% increase in the share of the youth population was associated with a 0.84% increase in the rate of property crime in Saskatchewan, with a 1.15% increase in the rate in Alberta and BC, with a 1.36% increase in the rate in Manitoba, and with a 1.63% increase in Ontario.

Inflows of migrants into Manitoba and Alberta were associated with increases in the rate of property crime. A 1% increase in the immigration rate was associated with a 0.11% increase in the rate of property crime in Manitoba and with a 0.07% increase in the rate of property crime in Alberta, while a 1% increase in the rate of in-migration was associated with a 0.12% increase in the rate of property crime in Alberta.

4.1.3 Deterministic Components

A persistent decline in the rate of property crime began in 1988 in Saskatchewan and Manitoba, and in 1991 in Alberta, BC, and Ontario. The trend in the declining property crime rate was disturbed in 1991 with dramatic one-period permanent increases ranging from 12% to 19% in BC, Ontario and Alberta; these changes coincided with the 1991 recession. The declining trend was disrupted in all five provinces in 1998 by one-period permanent increases caused by the change from UCR1 to UCR2 reporting; the estimated impact of this reporting change on the rate of property crime ranged from 14% in BC to 28% in Manitoba. There was another one-period permanent change to property crime rates that occurred in 2003 in the four western provinces, with the impact ranging from a 12% increase in British Columbia, to a 17% increase in Saskatchewan; Ontario did not experience a statistically significant jump in its rate of property crime in 2003.

Table 9: Estimated Growth in the Rate of Property Crime

Regressors/Statistics	Δpcr Saskatchewan 1967-2013	Δpcr Manitoba 1967-2013	Δpcr Alberta 1967-2013	Δpcr British Columbia 1963-2013	Δpcr Ontario 1963-2013
Constant	0.0411 (0.0129)***	0.0527 (0.0159)***	0.0539 (0.0174)***	0.0573 (0.0129)***	0.0367 (0.0123)***
Dt1	-0.0567 (0.0227)**	-0.0625 (0.0275)**	-0.1112 (0.0330)***	-0.0756 (0.0255)***	-0.0508 (0.0204)**
Dt2	0.0226 (0.0313)	0.0173 (0.0369)	0.0490 (0.0446)	0.0133 (0.0334)	-0.0363 (0.0293)
Dt3	-0.0352 (0.0296)	-0.0655 (0.0313)**	-0.0080 (0.0409)	-0.0277 (0.0273)	0.0006 (0.0255)
D1	0.0596 (0.0578)	-0.0869 (0.0671)	0.1863 (0.0531)***	0.1192 (0.0496)**	0.1395 (0.0503)***
D2	0.2222 (0.0555)***	0.2755 (0.0680)***	0.2088 (0.0546)***	0.1377 (0.0552)**	0.2015 (0.0488)***
D3	0.1676 (0.0509)***	0.1373 (0.0603)**	0.12574 (0.0547)**	0.1167 (0.0480)**	0.0340 (0.0460)
Δy	0.0247 (0.1346)	-0.1897 (0.2987)	-0.5853 (0.3135)*	-0.9524 (0.3838)**	-0.5193 (0.4599)
$\Delta \pi$	0.1706 (0.5718)	-0.7476 (0.6385)	0.0034 (0.4974)	1.0093 (0.5479)*	0.4700 (0.4260)
Δur	0.1477 (0.0703)**	0.1586 (0.0716)**	0.0890 (0.0563)	0.0733 (0.0601)	0.0820 (0.0565)
Δohp	-0.3326 (0.2471)	-0.4577 (0.3358)	-0.1826 (0.1291)	-0.1280 (0.2730)	-0.1641 (0.2669)
Δysp	0.8433 (0.4540)	1.3604 (0.6444)**	1.1570 (0.4388)**	1.1503 (0.3464)***	1.6328 (0.4117)***
Δimp	-0.0277 (0.0450)	0.0956 (0.0445)**	0.0746 (0.0464)	0.0065 (0.0452)	-0.0267 (0.0390)
Δemp	0.0232 (0.0368)	0.0061 (0.0598)	-0.0602 (0.0518)	-0.0241 (0.0616)	-0.0842 (0.0580)
Δinp	0.0732 (0.0840)	0.1875 (0.1214)	0.1713 (0.0826)**	0.0479 (0.0872)	-0.0282 (0.0774)
Δoup	-0.0685 (0.0672)	-0.1574 (0.1059)	0.0126 (0.0817)	0.0235 (0.0809)	0.0698 (0.0794)
R^2	0.7138	0.7761	0.7641	0.7014	0.7518
Adjusted R^2	0.5753	0.6678	0.6499	0.5734	0.6455
Mean	0.0188	0.0111	0.0091	0.0086	0.0035
Standard error (sigma)	0.0468	0.0523	0.0477	0.0430	0.0396
AR(1) t-stat	-0.2459	-1.1783	-	1.3801	0.3269
LM test (16 df)	10.129	15.574	-	17.839	24.899
$\hat{\rho}$	-		0.3407 (0.1371)**	-	-
Durbin's H test	-		2.0285**	-	-
Test for normality Jarque-Bera (2df)	0.3787	0.4794	0.5405	1.0553	3.1849

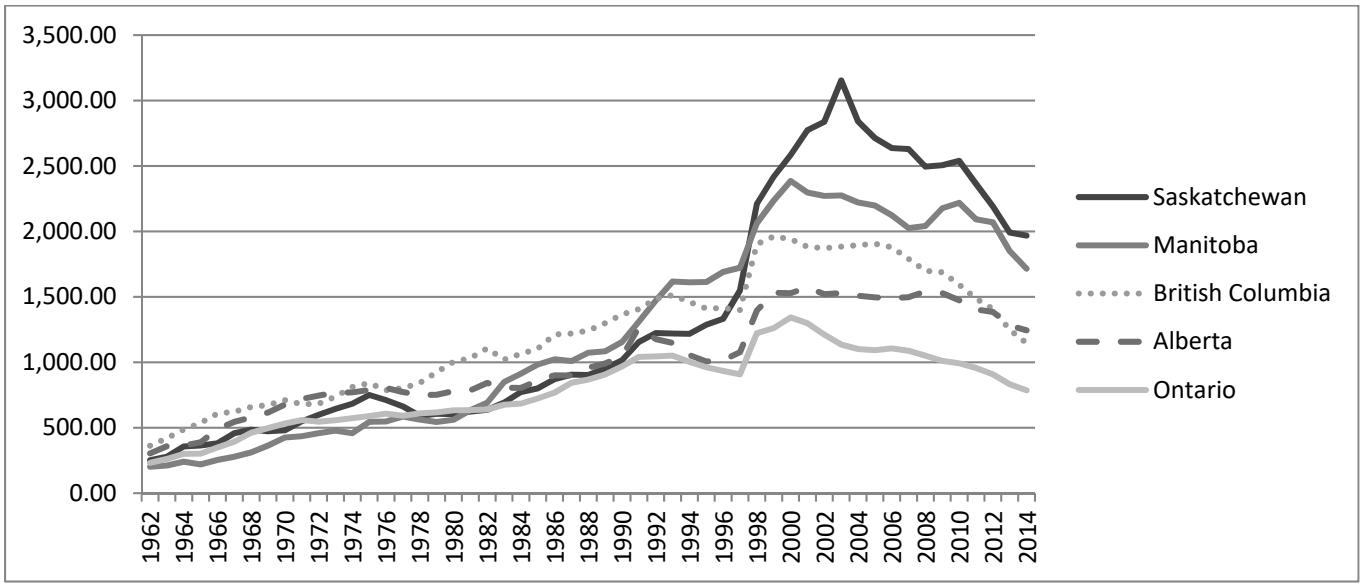
Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test).Deterministic Components: D1 – 1988 (Saskatchewan, Manitoba), 1991 (Alberta, British Columbia, Ontario); D2:1998 (all); D3 – 2003 (all); Dt1 – 1988-2013 (Saskatchewan, Manitoba), 1991-2013 (Alberta, British Columbia, Ontario); Dt2 – 1998-2013 (all); Dt3 – 2003-2013 (all).

4.2 Rates of Violent Crime

The rates of violent crime for the four western provinces and Ontario are presented in Figure 5. These rates generally rose into the early 1990s. In Alberta, the rate appeared to reach a peak in 1991 and then began a temporary decline until 1998. In Ontario and British Columbia, the rates began a periodic decline in 1993, lasting until 1998. For the most part, the rates of violent crime in Saskatchewan and Manitoba continued to rise through the 1990s. In 1998, the rates of violent crime in all five provinces rose abruptly with the shift from UCR1 to UCR2 reporting. The rate in Saskatchewan continued to climb and peaked in 2003, after which it declined to 2014. The rate in Manitoba reached its peak in 2000, and generally fell thereafter. In Alberta, the rate of violent crime held steady around 1,500 incidents per 100,000 residents, before falling from 2009 to 2014.The rate of violent crime in British Columbia held relatively steady in the early 2000s, then declined rapidly after 2005. In Ontario, the rate of violent crime followed a declining trend after 2000.

These trends in rates of violent crime are examined with respect to deterministic, economic and demographic factors. Deterministic dummies were used to identify possible break points: in 1988 in Manitoba and Saskatchewan; in 1991 for Alberta; 1993 for British Columbia and Ontario; 1998 for all provinces; 2000 for Manitoba and Ontario; 2003 for Saskatchewan; 2005 for British Columbia; and 2008 for Alberta. The preliminary regression results with the full set of economic and demographic variables are presented in Table 10.

Figure 5: Rates of Violent Crime, Select Provinces, 1962-2014



4.2.1 The Influence of Economic Variables

Changes in average household income and in inflation had no statistically significant influence on rates of violent crime in any of the five provinces. Changes in unemployment rates were associated with changes in the rate of violent crime in only Manitoba, and changes in real per capita alcohol sales occurred simultaneously with changes in rates of violent crime in two of the five provinces: Saskatchewan and Alberta. Economic variables had no apparent impact on the rate of violent crime in British Columbia and Ontario.

The regression results suggest that a 1% increase in the unemployment rate was associated with a 0.14% change in the rate of violent crime in Manitoba. A 1% increase in alcohol sales per capita was associated with a 0.56% change in the rate of violent crime in Saskatchewan, and with a 0.17% change in the rate of violent crime in Alberta.

4.2.2 The Influence of Demographic Variables

Changes in the rate of immigration were associated with changes in the rate of violent crime in two of the five provinces. The results suggest that a 1% increase in the rate of immigration was associated with a 0.06% increase in the rate of violent crime in Alberta, and with a 0.14% increase in the rate of violent crime in British Columbia. Changes in the rate of emigration had no statistically significant impact on rates of violent crime in any of the five provinces, nor did changes in rates of interprovincial in-migration. While changes in the rate of out-migration had no influence on rates of violent crime in four of the five provinces, a 1% increase in the rate of interprovincial out-migration was associated with a 0.14% decline in the rate of violent crime in Alberta. Changes in the relative size of the youth population influenced rates of violent crime in only one province: a 1% increase in the population share of youth was associated with a 1.24% increase in the rate of violent crime in Ontario.

4.2.3 Deterministic Components

The regression results indicate the extent of deterministic trends and one-period deviations across the sample for the five provinces. All provinces exhibited an upward shift in the rate of violent crime in 1998, and that upward shift was estimated at 14% in Manitoba, 18% in Alberta, 27% in Saskatchewan, 29% in Ontario, and 34% in British Columbia, when accounting for other economic, demographic and deterministic factors as well as periodic trends and random changes. Other periodic changes in the rates of violent crime differed between the five provinces, both in magnitude and statistical significance.

Table 10: Estimated Growth in the Rate of Violent Crime

Regressors/Statistics	Δvcr Saskatchewan 1967-2013	Δvcr Manitoba 1967-2013	Δvcr Alberta 1967-2013	Δvcr British Columbia 1963-2013	Δvcr Ontario 1963-2013
Constant	0.0381 (0.0153)**	0.0668 (0.0172)***	0.0270 (0.0178)	0.0417 (0.0108)***	0.0582 (0.0154)***
Dt1	0.0329 (0.0269)	0.0070 (0.0297)	-0.0608 (0.0321)*	-0.0591 (0.0264)**	-0.0698 (0.0314)**
Dt2	-0.0024 (0.0371)	-0.0413 (0.0398)	0.0418 (0.0363)	0.0185 (0.0315)	0.0469 (0.0511)
Dt3	-0.1399 (0.0351)***	-0.0491 (0.0338)	-0.0570 (0.0389)	-0.0478 (0.0232)**	-0.0738 (0.0469)
D1	-0.0548 (0.0686)	0.0360 (0.0724)	0.2475 (0.0360)***	0.0243 (0.0472)	0.0620 (0.0429)
D2	0.2698 (0.0659)***	0.1354 (0.0734)*	0.1820 (0.0363)***	0.3355 (0.0507)***	0.2880 (0.0504)***
D3	0.1567 (0.0604)**	0.0261 (0.0651)	0.0398 (0.0363)	0.0483 (0.0470)	0.1103 (0.0435)**
Δy	0.0160 (0.1597)	-0.3902 (0.3225)	0.1374 (0.2032)	0.1462 (0.3355)	-0.5698 (0.4775)
$\Delta \pi$	0.0982 (0.6788)	0.6278 (0.6895)	0.1758 (0.3184)	0.0684 (0.5109)	-0.0799 (0.3871)
Δur	0.0355 (0.0835)	0.1369 (0.0773)*	0.0357 (0.0364)	0.0685 (0.0580)	0.0148 (0.0502)
Δohp	0.5634 (0.2934)*	0.5051 (0.3626)	0.1696 (0.0822)**	-0.2255 (0.2572)	0.0934 (0.2340)
Δysp	-0.3322 (0.5390)	0.3457 (0.6958)	0.4070 (0.4310)	0.4688 (0.3171)	1.2403 (0.4823)**
Δimp	0.0769 (0.0534)	-0.0396 (0.0480)	0.0634 (0.0307)*	0.1354 (0.0413)***	0.0357 (0.0408)
Δemp	0.0140 (0.0437)	-0.0271 (0.0645)	-0.0032 (0.0318)	0.0275 (0.0570)	-0.0035 (0.0486)
Δinp	0.0993 (0.0997)	0.1437 (0.1311)	-0.0069 (0.0524)	0.0259 (0.0830)	-0.0354 (0.0690)
Δoup	-0.0459 (0.0798)	-0.0953 (0.1144)	-0.1370 (0.0547)**	0.0723 (0.0781)	0.0158 (0.0756)
R^2	0.7026	0.5639	0.8059	0.7782	0.7783
Adjusted R^2	0.5586	0.3529	0.7120	0.6832	0.6833
Mean	0.0352	0.0422	0.0204	0.0243	0.0251
Standard error (sigma)	0.0556	0.0564	0.0341	0.0399	0.0388
AR(1) t-stat	1.0744	0.2424	-	0.1227	-
LM test (16 df)	12.458	12.004	-	9.433	-
$\hat{\rho}$	-		0.6174 (0.1147)***	-	0.3572 (0.1308)***
Durbin's H test	-		0.1578	-	-2.0553**
Test for normality Jarque-Bera (2df)	0.3263	1.8967	0.9070	0.4868	1.9114

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test).Deterministic Components: D1t – 1988-2013 (Saskatchewan, Manitoba), 1991-2013 (Alberta), 1993-2013 (British Columbia, Ontario); D2t – 1998-2013 (all); D3t – 2000-2013 (Manitoba, Ontario), 2003-2014 (Saskatchewan), 2005-2013 (British Columbia), 2008-2013 (Alberta); D1 – 1988 (Saskatchewan, Manitoba), 1991 (Alberta), 1993 (British Columbia, Ontario); D2: 1998 (all); D3: 2000 (Manitoba, Ontario), 2003 (Saskatchewan), 2005 (British Columbia), 2008 (Alberta).

4.3 Limitations

Overall, the regressions for the five individual provinces suggest relationships between the rate of property crime and real incomes, the unemployment rate, the proportion of youth in the population, and the rates of immigration and in-migration. The results also suggest relationships between the rate of violent crime and the unemployment rate, real per capita alcohol sales, the youth share of the population, and rates of immigration and out-migration. However, these relationships are not statistically significant across all five provinces, and the set of economic and demographic variables appears to explain a small portion, between 15% and 25%, of the variation in the rates of property crime and of violent crime. Unexplained deterministic trends and one-period shocks appear to explain about half of the variation in these rates.

The province-specific regressions have two additional drawbacks: one relating to the degrees of freedom, and another due to multicollinearity. These regressions have low degrees of freedom given the number of periods in the study (46), the number of explanatory variables (9), and deterministic dummies (7). The low degrees of freedom make it difficult to consider lag structures and dynamic effects of the explanatory variables. Multicollinearity is also generally an issue as sets of the explanatory variables tend to move in similar directions over time. As examples, movements in real incomes are positively correlated with movements in inflation and in-migration, and movements in unemployment rates are negatively correlated with movements in real incomes, inflation, immigration and in-migration; the magnitudes of their correlation coefficients are between 0.2 and 0.7 among the five provinces in this study. In the presence of multicollinearity, parameter estimates are less reliable and standard errors are high. The problem of multicollinearity may be reduced by excluding some of the seemingly insignificant variables, but that may cause some of the remaining estimates to be biased due to the omission of important explanatory variables. In the next section, panel estimation methods which alleviate these challenges are used.

5 Panel Analysis

The regressions presented in the previous two sections were performed individually for the five provinces. In this section, panel methods are used collectively for the five provinces. Panel data provide several advantages over individual province-specific data. Among the advantages for this study are that panel data combine province-specific time-series data across five provinces to increase the amount of data, to improve the variability of the data across time and across the five provinces, to reduce the degree of collinearity between variables, and to increase the degrees of freedom and efficiency in the estimates (see Hsaio, 2003, and Baltagi, 2005). Panel methods were implemented using STATA. Panel unit root tests revealed that crime rates followed unit root processes, confirming the individual test results in Section 3.[3] The Prais-Winsten regression in STATA was used on the first differenced transformations of the crime rates in natural logarithms: to allow for first order autocorrelation and for correlation of errors across panels (the xtpcse command).[4] For a more detailed explanation of these panel estimators and estimation techniques, please see Cameron & Trivedi (2010).

5.1 Property Crime Rates

The panel regression results for the 1968 to 2013 period are presented in Table 11. Column 2 presents the regression estimates using the pooled least squares estimator with contemporaneous error correlation across provinces, with province-specific first-order autocorrelation, and with only a common constant term and no lagged independent variables. This model is identified as PCSE1 and provides an illustration of how much variation is accounted for by just the independent variables. The model results identified in column 3 as PCSE2 include province-specific constant terms, and province-specific one-period and shift dummies similar to those used in Section 4. The results in column 4 identified as PCSE3 are from the enhanced model with lagged independent variables. The modeling procedure provides a recognizable R^2 statistic identifying the proportion of variation explained by the independent and dummy variables.

[3] The analyses by Levitt (2001) and by Andresen (2013) did not account for the non-stationary time-series properties of crime rates, and did not examine the rates in first differenced form. This leads to questions about inferences from the results and whether the regression results are spurious. Bunge, Johnson, & Balde (2005) did account for the unit root properties of Canadian crime rates and modeled rates in the first-differenced forms.

[4] The generalized least squares method (xtgls) yielded results similar to those presented herein, but while the xtgls method produces more efficient standard errors in a well-specified model, it does not produce a convenient and universally recognizable R^2 statistic.

Table 11: Panel Estimates of the Growth in the Rate of Property Crime

Regressors/ Statistics	Δpcr 1968 -2013	Δpcr 1968 -2013	Δpcr 1968-2013
Estimation	PCSE1	PCSE2	PCSE3
Δy_t	-0.0376 (0.1565)	-0.0985 (0.0903)	-0.2130 (0.0852) **
Δy_{t-1}			-0.2061 (0.0874)**
$\Delta \pi$	0.4062 (0.4344)	0.1960 (0.2329)	-0.1966 (0.2382)
$\Delta \pi_{t-1}$			-0.0704 (0.2127)
Δur_t	0.1564 (0.0489)***	0.1333 (0.0266)***	0.1049 (0.0225)***
Δur_{t-1}			-0.0536 (0.0231)**
Δohp_t	-0.1675 (0.1280)	-0.2237 (0.0756)***	-0.1566 (0.0787)**
Δohp_{t-1}			-0.1656 (0.0730)**
Δysp_t	1.2102 (0.4564)***	1.1707 (0.2142)***	1.1493 (0.3899)***
Δysp_{t-1}			0.2909 (0.3927)
Δimp_t	-0.0128 (0.0384)	0.0376 (0.0202)*	0.0124 (0.0182)
Δimp_{t-1}			0.0534 (0.0167)***
Δemp_t	-0.0261 (0.0373)	-0.0198 (0.02117)	-0.0064 (0.0189)
Δemp_{t-1}			0.0237 (0.0200)
Δinp_t	0.1126 (0.0637)*	0.0800 (0.0361)**	0.0916 (0.0314)***
Δinp_{t-1}			0.0504 (0.0301)*
Δoup_t	-0.0218 (0.0586)	-0.0103 (0.0322)	0.0003 (0.0285)
Δoup_{t-1}			0.0598 (0.0283)**
$\hat{\rho}$ (ON; MB; SK; AB; BC)	0.21; 0.10; 0.11; 0.37; 0.32	-0.03; -0.23; 0.06; 0.38; 0.18	0.02; -0.20; 0.08; 0.27; 0.04
Deterministic Dummies	Only a common constant term	YES (35)	YES (35)
R^2	0.1880	0.6862	0.7326
Test βs(second lags – t-2) = 0			χ^2 (9) =7.37 (p-value = 0.5991)

Notes: Standard errors in parentheses; *, **, and *** denote that the estimate is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test).

The results in column 2 without province-specific dummies are presented for the model with first-order autocorrelation in the residuals. These results suggest that contemporaneous changes in income, in per capita alcohol sales, and in the rate of international immigration, international emigration, and inter-provincial out-migration, are negatively related to changes in property crime rates; however, none of these relationships was found to be statistically significant. Contemporaneous changes in rates of inflation appear to be positively related to changes in property crime, but this relationship is also statistically insignificant. The model estimates do suggest that there are statistically significant positive contemporaneous relationships between changes in rates of property crime, changes in the rate of unemployment, changes in the proportion of youth in the population, and changes in rates of inter-provincial in-migration. The estimated fit of the model is poor, with an overall R^2 of 0.19; this indicates that the explanatory economic and demographic variables used in the regression explain a very small portion of the variation in the growth rate of the rate of property crime over the sample.

The results in the column denoted as PCSE2 are from the regression with the full set of deterministic dummies included in Section 4. The coefficient estimates are similar to those without dummies but with greater precision in the standard error estimates, with the exception of a statistically significant negative relationship between changes in rates of property crime and changes in per capita alcohol sales, and of a statistically significant positive relationship between changes in rates of property crime and changes in rates of international immigration. The model with deterministic dummies yields an R^2 of 0.69, capturing a much higher percentage of the variation in the growth rate of the rate of property crime from its sample mean.

The results with lagged dependent variables in column 4 (PCSE3) indicate much more complex dynamic effects of changes in the explanatory variables than can be described in previous models. Contemporaneous and lagged changes in incomes and in per capita alcohol sales have reinforcing negative and statistically significant effects on changes in rates in property crime. Contemporaneous changes in unemployment rates have a positive and statistically significant impact on changes in rates of property crime, while lagged changes in unemployment rates have a negative and statistically significant impact on changes in rates of property crime. With the inclusion of lagged dependent variables, the model results indicate positive and statistically significant relationships between changes in rates of property crime and lagged changes in the rate of inter-provincial in-migration, of immigration, and of inter-provincial out-migration.

From these results, we may make a series of inferences regarding the relationships between rates of property crime in the five Canadian provinces and these economic and demographic variables. We may infer that decreases in rates of property crime coincided with and followed increases in per capita incomes and in per capita alcohol sales. The results suggest a complex counteracting relationship between unemployment rates and property crime: rates of property crime increased with contemporaneous increases in the unemployment rate, but the impact of those increases was reduced

by past increases in the unemployment rate. We may also infer that there was little impact of changes in inflation on property crime rates.

The results suggest that decreases in the proportion of youth in the population coincided with decreases in rates of property crime. Lagged changes in the proportion of youth in the population had a reinforcing (positive) effect, although statistically insignificant. We may also infer from the results that migration movements both in and out of the provinces had a dynamic and positive impact on rates of property crime: increases in property crime coincided with and followed increases in rates of immigration, in-migration, and out-migration.

Table 12 provides a decomposition of the changes in the explanatory variables to gauge their estimated impact on changes in the rate of property crime for Saskatchewan from 2003 to 2013. The results suggest that up to 45% of the recent decline in the rate of property crime in Saskatchewan may be attributed to cumulative changes in the economic variables, while rising per capita income in Saskatchewan individually appears to account for more than one-quarter of the decline in the rate of property crime. The results suggest that the cumulative impact of the demographic variables would have caused a minimal increase in the rate of property crime over the 2003 to 2013 period. Individually, the decrease in the proportion of youth in the Saskatchewan population may account for up to 24% of the decline in the rate of property crime (or a decline of 839 incidents per 100,000 population), while over the same period, the results suggest that the increase in the rate of international immigration may have resulted in an increase in the rate of property crime by 25% (or 865 incidents per 100,000 population), all else equal. The majority of the decline in the rate of property crime cannot be attributed to any of the economic and demographic variables used in the regressions, but rather to deterministic trends and unexplained variation.

5.2 Violent Crime Rates

The results from the panel regressions for rates of violent crime in the five provinces are presented in Table 13. The results in column 2 are from the regression without the deterministic dummy variables. These results indicate that the economic and demographic variables provide very little predictive power in explaining changes in violent crime rates in the western provinces and Ontario, accounting for only seven percent of the variation from its mean, as indicated by the R^2 statistic. The inclusion of the deterministic dummies, as shown in column 3, raises the explanatory power of the model measurably, although the forces underlying these deterministic trends are unfortunately unexplained.

Table 12: Decomposition of Changes in the Saskatchewan Rate of Property Crime, 2003-2013

Variable	Cumulative change in variable (in natural logarithms)	PCSE3 regression coefficient from Table 9	Percent contribution to overall change in the rate of property crime, 2003-2013	Contribution to overall change in the rate of property crime, 2003-2013
Δy_t	0.3371	-0.2130 (0.0852) **	15.15%	-523
Δy_{t-1}	0.3248	-0.2061 (0.0874)**	14.12%	-488
Combined Impact: Δy			**29.27%**	**-1,011**
$\Delta \pi$	-0.0060	-0.1966 (0.2382)	-0.25%	9
$\Delta \pi_{t-1}$	-0.0096	-0.0704 (0.2127)	-0.14%	5
Combined Impact: $\Delta \pi$			**-0.39%**	**13**
Δur_t	-0.3118	0.1049 (0.0225)***	6.90%	-238
Δur_{t-1}	-0.1929	-0.0536 (0.0231)**	-2.18%	75
Combined Impact: Δur			**4.72%**	**-163**
Δohp_t	0.1421	-0.1566 (0.0787)**	4.70%	-162
Δohp_{t-1}	0.1808	-0.1656 (0.0730)**	6.32%	-218
Combined Impact: Δohp			**11.01%**	**-381**
Δysp_t	-0.0838	1.1493 (0.3899)***	20.31%	-702
Δysp_{t-1}	-0.0646	0.2909 (0.3927)	3.96%	-137
Combined Impact: Δysp			**24.27%**	**-839**
Δimp_t	1.752	0.0124 (0.0182)	-4.58%	158
Δimp_{t-1}	1.816	0.0534 (0.0167)***	-20.46%	707
Combined Impact: Δimp			**-25.04%**	**865**
Δemp_t	-0.1740	-0.0064 (0.0189)	-0.23%	8
Δemp_{t-1}	0.1434	0.0237 (0.0200)	-0.72%	25
Combined Impact: Δemp			**-0.95%**	**33**
Δinp_t	0.1368	0.0916 (0.0314)***	-2.64%	91
Δinp_{t-1}	0.2522	0.0504 (0.0301)*	-2.68%	93
Combined Impact: Δinp			**-5.32%**	**184**
Δoup_t	-0.1188	0.0003 (0.0285)	0.01%	0
Δoup_{t-1}	-0.2352	0.0598 (0.0283)**	2.97%	-103
Combined Impact: Δoup			**2.97%**	**-103**
Combined Impact: Economic variables			**44.61%**	**-1,542**
Combined Impact: Demographic variables			**-4.07%**	**+141**
Deterministic Dummies and Residuals			**59.46%**	**-2,055**
Total			**100%**	**-3,456**

Table 13: Panel Estimates of the Growth in the Rate of Violent Crime

Regressors/ Statistics	Δvcr 1968 -2013	Δvcr 1968 -2013
Estimation	PCSE1	PCSE2
Δy	-0.0042 (0.1405)	-0.0078 (0.0903)
$\Delta \pi$	0.3167 (0.3873)	0.1727 (0.2065)
Δur	0.0705 (0.0436)	0.0552 (0.0232)**
Δohp	0.1915 (0.1193)*	0.1658 (0.0703)**
Δysp	0.2573 (0.4759)	0.2206 (0.1939)
Δimp	-0.0105 (0.0350)	0.0417 (0.0188)**
Δemp	0.0020 (0.0321)	0.0081 (0.0199)
Δinp	0.1060 (0.0575)*	0.0563 (0.0311)*
Δoup	-0.0168 (0.0540)	-0.0561 (0.0311)*
$\hat{\rho}$ (ON; MB; SK; AB; BC)	0.35; 0.47; 0.49; 0.32;0.26	0.33; 0.15; 0.28; 0.22; -0.02
Deterministic Dummies	Only a common constant term	YES (35)
R^2	0.0709	0.6449
Test βs(first lags – t-1) = 0		χ^2 (9) =12.00 (p-value =0.2130)

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test).

Changes in per capita real incomes and inflation did not appear to have any statistically significant influence on changes in violent crime rates. However, changes in unemployment rates and changes in real per capita alcohol sales had statistically significant influences and are positively related to changes in violent crime rates. The results suggest that a 10% increase in the rate of unemployment (for example from 5.0% to 5.5%) was associated with a 0.56% increase in the rate of violent crime (for example, from 1,500 to 1,508 incidents per 100,000 residents). The results also suggest that a 10% increase in real per capita alcohol sales was associated with a 1.7% increase in the rate of violent crime. Among the set of demographic variables specified in the regressions, changes in the rate of international immigration, and changes in the rate of interprovincial in-migration appear to be positively and statistically significantly associated with changes in rates of violent crime in the panel, while changes in the rate of interprovincial out-migration appear to be negatively and statistically significantly associated with changes in rates of violent crime in the panel. The results suggest that a 10% increase in the rate of immigration was associated with a 0.4% increase in the rate of violent crime, that a 10% increase in the rate of in-migration was associated with a 0.6% increase in the rate of violent crime, and that a 10% increase in the rate of out-migration was associated with a 0.6% decrease in the rate of violent crime.

Table 14 indicates how the estimates may be interpreted in light of changes in the explanatory variables in Saskatchewan from 2003 to 2013. The economic and demographic variables have very little explanatory power and provide little insight into how economic and demographic change has affected changes in violent crime rates over the past four decades as shown in Table 13, and since 2003 as shown in Table 14. As examples, the change in the unemployment rate from 5.6% in 2003 to 4.1% in 2013 was only found to correspond to a decline in the rate of violent crime by 44 incidents per 100,000 residents, while changes in the rate of immigration, from 17 to 97 per 100,000 residents corresponded with an increase in the rate of violent crime by 185 incidents per 100,000 residents. Unexplained deterministic trends, one-period shifts, and residual "error" appear to account for the decrease of 1,163 incidents per 100,000 residents in the rate of violent crime from 2003 to 2013. Unlike the case for the investigation of changes in the rate of property crime, further exploration revealed no significant effect of lagged explanatory variables on the rate of violent crime. A block test of exclusion was performed on the regression with lagged independent variables; it generated an insignificant test statistic, so the results in column 3 show only contemporaneous effects of the independent variables on changes in the rates of violent crime. The demographic and economic variables available for use over the 1967 to 2013 period had little impact on rates of violent crime for the five Canadian provinces.

Table 14: Decomposing Changes in the Saskatchewan Rate of Violent Crime, 2003-2013

Variable	Cumulative change in variable (in natural logarithms)	PCSE2 regression coefficient from Table 11	Percent contribution to overall change in the rate of violent crime	Contribution to overall change in the rate of violent crime
Δy	0.3371	-0.0078 (0.0903)	0.57%	-7
$\Delta \pi$	-0.0060	0.1727 (0.2065)	0.23%	-3
Δur	**-0.3118**	0.0552 (0.0232)**	**3.74%**	**-44**
Δohp	**0.1421**	0.1658 (0.0703)**	**-5.12%**	**60**
Δysp	-0.0838	0.2206 (0.1939)	4.02%	-47
Δimp	**1.7523**	0.0417 (0.0188)**	**-15.89%**	**185**
Δemp	-0.1740	0.0081 (0.0199)	0.31%	-4
Δinp	0.1368	0.0563 (0.0311)*	-1.67%	19
Δoup	**-0.1188**	-0.0561 (0.0311)*	**-1.45%**	**17**
Combined Impact: Economic variables			**-0.58%**	**6**
Combined Impact: Demographic variables			**-14.68%**	**170**
Deterministic Dummies and Residuals			**115.26%**	**-1,339**
Total (2003-2013)			100%	-1,163

5.3 Extensions

An expanded set of explanatory variables is available from 1981 to 2011. Variables include those used previously, and measures of male youth employment rates, inequality, poverty, relative incomes, and the number of police officers and incarceration rates per 100,000 residents, which have been thought to influence crime. The additional variables are described in Table 15. The panel estimation results for changes in property and violent crime rates using the expanded dataset are presented in Tables 16 and 17.

The regression results in Table 16 for the growth rate in property crime rates are generally comparable to those presented in Table 11, within the confidence intervals of the estimated coefficients for the variables that appear in both samples. Changes in per capita incomes, inflation, and per capita alcohol sales all appear negatively associated with changes in the rate of property crime. Changes in unemployment rates also had a relationship with changes in property crime rates; the contemporaneous relationship is positive (increases in unemployment rates are contemporaneously associated with increases in property crime rates), while the lagged impact of unemployment rates is negative. These inferences were also made from the results presented in Table 11 for the longer time period but with the smaller set of explanatory variables. The relationship between changes in property crime rates and changes in the youth population share was positive and statistically significant, and the effect of changes in rates of immigration on property crime rates was positive but marginally statistically significant.

The results in Table 16 indicate that, of all the additional variables, only changes in housing prices were associated with changes in rates of property crime. Changes in house prices have a statistically insignificant contemporaneous negative relationship, but a statistically significant positive lagged relationship with changes in the rate of property crime. This leads to the inference that, all else equal, a one-period increase in housing prices is associated with a small contemporaneous decrease in property crime rates, but that crime rates in the next period will rise: a 10% increase in the rate of housing price inflation (e.g. from 3.0 percent to 3.3 percent), was associated with a contemporaneous decrease in the rate of property crime by 2.2% (e.g. from 6,000 to 5,868 incidents per 100,000 residents), and a lagged increase in the rate of property crime by 5.1% (e.g. from 5,868 to 6,167 incidents per 100,000 residents), all else equal. This suggests a time delay in the relationship between house price inflation and the effect on criminal behaviour, and that rising housing costs may be presenting motivation for members of low income households to engage in property crime, while also reflecting an increasing opportunity through increased prosperity of the average household.

Table 15: Description of Additional Data, 1981-2011

Symbol for logarithmic form	Description	Sources
myer	Male Youth Employment Rates	CANSIM Table 282-0002 (1976-2014)
gini	Income Inequality – Adjusted after-tax income Gini	CANSIM Table 206-0033 (1976-2013)
lir	Proportion of individuals in low income households	CANSIM Table 202-0802 (1976-2011)
ay2	Second Quintile average real income (2011 dollars)	CANSIM Table 202-0701 (1976-2011)
ry24	Relative average income (second quintile over fourth quintile)	CANSIM Table 202-0701 (1976-2011)
hpi	Housing CPI (for housing inflation)	CANSIM Table 326-0021 (1979-2014)
incr	Provincial incarceration rate (per 100,000 adults)	CANSIM Table 251-0005 (1979-2014, fiscal year end basis)
pr	Police Officers per 100,000 population	CANSIM 254-0001 (1976-1997), 254-0002 (1998-2014)

The regression results for changes in the rate of violent crime are presented in Table 17. The results uncover some dynamic effects between the variables of interest which were not apparent with the longer dataset. In particular, the results in the second column (PSCE1) in Table 17 lead to the inference that changes in income and in inflation were negatively associated with changes in violent crime rates, whereas those variables had no statistically significant relationship in the longer dataset. There is a strong positive relationship between changes in violent crime rates and changes in per capita alcohol sales over both periods. The relationship between the youth share of the population and violent crime rates appears to be contemporaneously positive, but appears to be negative with a one-period lag to the following period, fully compensating for the previous effect. Another relationship of note is the negative association between changes in violent crime and lagged changes in emigration rates which was not uncovered with the longer dataset.

Table 16: Additional Growth Rate Panel Regression Results – Property Crime Rates

Regressors/ Statistics	Δpcr 1982 -2011	Δpcr 1982-2011
Estimation	PSCE1	PSCE2
Δy_t	-0.2610 (0.1456)*	-0.1905 (0.1166)
Δy_{t-1}	-0.0187 (0.1576)	-0.0049 (0.13080
$\Delta \pi$	-0.6003 (0.3583)*	-0.3767 (0.3278)
$\Delta \pi_{t-1}$	-0.2358 (0.3461)	-0.1549 (0.2818)
Δur_t	0.0448 (0.0478)	0.0673 (0.0322)**
Δur_{t-1}	-0.1166 (0.0562)**	-0.0622 (0.0323)*
Δohp_t	-0.3373 (0.1329)**	-0.4189 (0.1147)***
Δohp_{t-1}	-0.1119 (0.1070)	-0.1818 (0.0943)*
Δysp_t	1.8646 (0.6728)***	1.6703 (0.6163)***
Δysp_{t-1}	0.0004 (0.5582)	0.2239 (0.5324)
Δimp_t	0.0283 (0.0271)	0.0309 (0.0253)
Δimp_{t-1}	0.0104 (0.0261)	0.0202 (0.0229)
Δemp_t	-0.0114 (0.0257)	-0.0071 (0.0228)
Δemp_{t-1}	0.0621 (0.0303)**	0.0485 (0.0289)*
Δinp_t	0.0652 (0.0429)	0.0626 (0.0388)
Δinp_{t-1}	0.0413 (0.0425)	-0.0081 (0.0355)
Δoup_t	0.0464 (0.0378)	0.0358 (0.0349)
Δoup_{t-1}	0.0359 (0.0447)	0.0269 (0.0382)
$\Delta myer_t$	-0.0549 (0.1407)	
$\Delta myer_{t-1}$	-0.2472 (0.1558)	
$\Delta gini_t$	-0.0668 (0.1543)	
$\Delta gini_{t-1}$	-0.1897 (0.1392)	
Δlir_t	0.0111 (0.0634)	
Δlir_{t-1}	0.0656 (0.0561)	
$\Delta ay2_t$	-0.0541 (0.2139)	
$\Delta ay2_{t-1}$	0.0376 (0.2221)	
$\Delta ry24_t$	0.2687 (0.2145)	
$\Delta ry24_{t-1}$	0.2226 (0.2120)	
Δhpi_t	-0.2047 (0.3250)	-0.2186 (0.2989)
Δhpi_{t-1}	0.5550 (0.3113)*	0.5104 (0.2538)**
$\Delta incr_t$	-0.0315 (0.0581)	
$\Delta incr_{t-1}$	-0.0412 (0.0593)	
Δpr_t	0.0717 (0.1113)	
Δpr_{t-1}	0.1031 (0.1086)	
$\hat{\rho}$ (ON; MB; SK; AB; BC)	-0.31;-0.19; -0.12; 0.14; 0.02	-0.25; -0.26; -0.08; 0.16; 0.06
Deterministic Dummies	YES (35)	YES (35)
R^2	0.8088/0.3231	0.7971
Test for omitted variables		χ^2 (14) =10.10 (p-value=0.7551)

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test)

Table 17: Additional Growth Rate Panel Regression Results – Violent Crime Rates

Regressors/ Statistics	Δvcr 1982 -2011	Δvcr 1982 -2011
Estimation	PSCE1	PSCE2
Δy_t	-0.2484 (0.1260)**	-0.1917 (0.1228)
Δy_{t-1}	-0.3624 (0.1355)***	-0.3244 (0.1300)**
$\Delta \pi$	-0.1780 (0.3414)	0.0640 (0.3178)
$\Delta \pi_{t-1}$	-0.6177 (0.2890)**	-0.5865 (0.2775)**
Δur_t	0.0234 (0.0395)	-0.0070 (0.0265)
Δur_{t-1}	-0.0608 (0.0388)	-0.0616 (0.0277)**
Δohp_t	0.4545 (0.1199)***	0.4562 (0.1025)***
Δohp_{t-1}	0.0910 (0.0907)	0.0744 (0.0860)
Δysp_t	2.5472 (0.5909)***	2.3690 (0.5661)***
Δysp_{t-1}	-2.7334 (0.6099)***	-2.4914 (0.5927)***
Δimp_t	0.0104 (0.0236)	0.0106 (0.0235)
Δimp_{t-1}	0.0105 (0.0230)	0.0059 (0.0217)
Δemp_t	0.0300 (0.0247)	0.0206 (0.0238)
Δemp_{t-1}	-0.0614 (0.0239)***	-0.0590 (0.0235)**
Δinp_t	-0.0229 (0.0381)	-0.0138 (0.0357)
Δinp_{t-1}	0.0626 (0.0393)	0.0374 (0.0361)
Δoup_t	-0.0181 (0.0338)	-0.0387 (0.0331)
Δoup_{t-1}	0.0542 (0.0365)	0.0571 (0.0359)
$\Delta myer_t$	0.0631 (0.1146)	
$\Delta myer_{t-1}$	-0.0063 (0.1107)	
$\Delta gini_t$	0.2465 (0.1325)*	0.1758 (0.1191) ~~
$\Delta gini_{t-1}$	0.0086 (0.1153)	0.0505 (0.1024) ~~
Δlir_t	-0.0268 (0.0445)	
Δlir_{t-1}	0.0465 (0.0449)	
$\Delta ay2_t$	0.0003 (0.1677)	
$\Delta ay2_{t-1}$	0.0134 (0.1744)	
$\Delta ry24_t$	0.2505 (0.1847)	
$\Delta ry24_{t-1}$	0.0848 (0.1587)	
Δhpi_t	0.2500 (0.2575)	0.2251 (0.2516) ~~
Δhpi_{t-1}	0.4537 (0.2592)*	0.3790 (0.2181) ~~
$\Delta incr_t$	-0.1029 (0.0489)**	-0.0879 (0.0472)*
$\Delta incr_{t-1}$	-0.1512 (0.0480)***	-0.1512 (0.0453)***
Δpr_t	-0.1058 (0.0985)	-0.0878 (0.0993)
Δpr_{t-1}	0.2042 (0.0977)*	0.2030 (0.0992)**
$\hat{\rho}$ (ON; MB; SK; AB; BC)	0.06; 0.48; 0.08; 0.10; -0.21	0.08; 0.45; 0.14; 0.07; -0.28
Deterministic Dummies	YES (35)	YES (35)
R^2	0.8575/0.3668 (a) no deterministic dummies except a common intercept	0.8503
Test for omitted variables		χ^2 (8) = 7.37 (p-value=0.4969)

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test); ~~ denotes the paired coefficients are jointly statistically insignificant at the 90% confidence level.

Among the new variables introduced, changes in inequality (as measured by the Gini coefficient), changes in housing prices, changes in police officer strength, and changes in incarceration rates appeared to have statistically significant relationships with changes in violent crime rates. The results led to the inferences that increasing inequality and increasing housing prices were linked to increases in violent crime rates. The results also suggest that increases in incarceration rates were linked to decreases in rates of violent crime, perhaps indicating deterrent and incapacitation effects of incarceration. The possibility of simultaneity bias is thought to be low since one would expect a decrease in crime would simultaneously be linked to a decrease in incarceration.

The results linking changes in police officer strength to rates of violent crime suggest a contemporaneous negative link and a deterrent effect of policing on crime, but the lagged effect of changes in police officer strength was positive and over-compensating for the prior deterrent effect. The estimates suggest that a 10% increase in the number of police officers per 100,000 residents was associated with an immediate 1% decrease in the rate of violent crime, but an increase in the next period by 2%. A possible explanation is that perhaps there was an increase in victim-reporting and/or police investigation activities leading to increased crime reporting as a result of an increase in the police force. The existing literature suggests that increased police officer strength may serve as a deterrent, but also increased policing activity may result in more investigations.[5]

A disadvantage with the results from the second dataset is that the degrees of freedom are relatively low due to the smaller sample size and the increase in the number of explanatory variables. Further exploration of these results and estimation with more panels and over a longer period of time is warranted.

5.4 Summary of Regression Results

In this section, panel methods were used to assess the links between crime rates, and economic and demographic factors. Panel methods were used on the dataset which included the list of variables used in Section 3 over five western provinces, from 1967 to 2013, and are now compared to the individual time-series results for Saskatchewan over the 1967-2013 period as presented in Section 3. Additional comparisons to the panel regression results using the second dataset, which included an expanded list of variables for the five provinces, but over the shortened 1981-2011 period, will also be made here.

5.4.1 Property Crime

The panel results presented in section 5.1 indicated that decreases in rates of property crime were linked with decreases in unemployment rates and this link was also uncovered in the individual time-series regressions in Section 3 (and the coefficient estimates are similar, within their confidence bounds). The panel regressions using the shorter time period but with the expanded list of variables,

[5] See Wilson, Sagynbekov, Pardy, & Penner (2015: Section 3).

also indicated a statistically significant link between rates of property crime and unemployment; however, the contemporaneously positive effect was more than offset by the lagged negative effect. The literature does not point to a well-defined relationship between unemployment and crime, with some studies showing evidence of a positive link and opportunity effects, while other empirical work supports the motivation effect with a negative relationship between the two variables. This study provides some support for a dominating motivational effect with a decrease in crime coinciding with improvements in employment opportunities over the 1967-2013 period.[6]

The finding that a high proportion of crime is committed by individuals dependent and under the influence of alcohol and drugs has led to the hypothesis that alcohol consumption and crime are positively linked (Pernanen, Cousineau, Brochu, & Sun, 2002). For the time period of this study, changes in real per capita alcohol sales were negatively related to changes in rates of property crime in the two panels and in the individual Saskatchewan time-series. Real per capita alcohol sales growth was positively correlated with growth in per capita incomes and was negatively correlated with unemployment rates (the large sample panel correlation coefficients are 0.19 and -0.22 respectively), and so real per capita alcohol sales appear to move in tandem with economic conditions, and property crimes are reduced during good economic conditions and with increases in per capita alcohol sales. This inference is supported by the negative link between changes in per capita incomes and changes in rates of property crime uncovered in Section 5.1.

Decreases in the youth share of the population were associated with decreases in the rate of property crime; this link was also uncovered in the individual time-series regressions in Section 3, and the panel regressions in Section 5.3 over the shortened time period. The age-crime curve with the high number of crime incidents committed by youth is well-established in empirical studies. These results support the evidence that a high proportion of property crime is committed by youth.[7]

The panel methodology revealed additional relationships between the variables in the study and property crime, with the advantage of the larger panel dataset of five provinces. Decreases in (international) immigration, and decreases in (interprovincial) in- and out-migration were associated with decreases in the rate of property crime. However, these forces offset others as improvements in the economy tend to be associated with increasing immigration, in-migration, and out-migration; as an example, in the case of Saskatchewan, from 2003-2013, these demographic forces did indeed cancel others out as shown in Table 12. The panel regression over the shorter period uncovered an additional relationship between changes in housing prices and rates of property crime, with increases in housing prices linked to increases in rates of property crime. These results may be viewed as supporting the inferences of many empirical studies about the link between inflation and relative deprivation, on

[6] Please refer to Wilson, Sagynbekov, Pardy, & Penner (2015: Section 3.1.2).
[7] Please see Wilson, Sagynbekov, Pardy, & Penner (2015: Section 3.2.2).

property crime, but in this analysis, the link was through housing prices and not through overall prices.[8] Generally, however, the majority of changes in the rates of property crime were attributed to unexplained forces (about 60% as presented in Tables 6 and 12).

5.4.2 Violent Crime

The individual time-series regression results for Saskatchewan presented in Section 3.2.2 suggested that increases in per capita alcohol sales were associated with increases in the rate of violent crime. These links were confirmed by the panel estimates over the same period (Section 5.2), and over the shortened time period (Section 5.3). Alcohol consumption and violent crime are thought to be positively linked, with rates of spousal abuse higher in households with heavy drinkers, and intoxication causing impaired behaviour and violent crime (Field, 1990; Cook & Moore, 1993; Johnson, 2001). In addition, a positive link between changes in the rate of immigration and changes in the rate of property crime was found in the individual Saskatchewan time-series estimation results in Section 3.2.2, and in the panel model results in this section.

The panel results suggested other links between the economic and demographic variables and rates of violent crime. The panel results presented for the 1968-2013 period indicated a statistically significant positive link between the unemployment rate and the rate of violent crime, while the results for the shorter time period suggest a statistically significant but negative link between these two variables. The shortened panel regression results presented in Section 5.3 also suggest that increasing income, increasing rates of emigration, increasing rates of incarceration, and decreasing income inequality were linked with decreases in rates of violent crime.

There is evidence of differing links between some of the economic and demographic variables and the aggregate rates of property crime and of violent crime. In the next section, five major crime sub-categories are examined separately in panel regressions in an attempt to identify differences and as an extension of the work done by Cook & Zarkin (1985), Devine, Shelley, & Smith (1988), and more recently by Bunge, Johnson, & Balde (2005).

[8] See Wilson, Sagynbekov, Pardy, & Penner (2015: pp. 21-23).

6 Panel Methods Applied to Specified Crime Rates

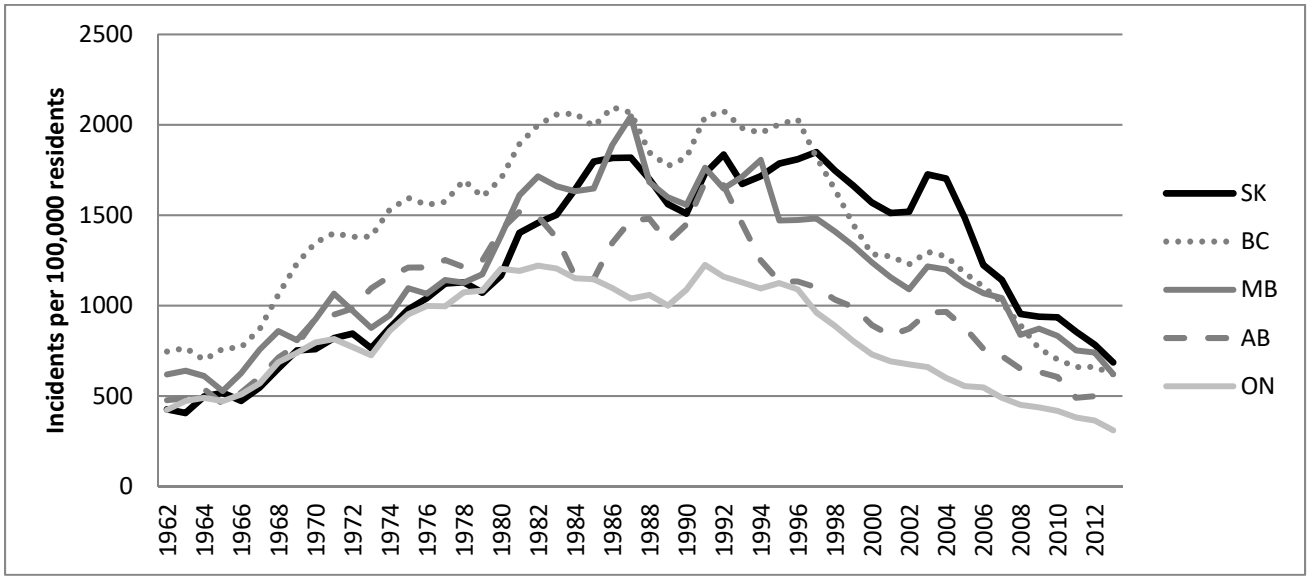
The rates of property and violent crimes are aggregates of various crimes in their categories. Within the category of property crimes were three key sub-categories described and discussed in the Phase I Report (Wilson & Sagynbekov, 2014): breaking and entering; motor vehicle theft; and fraud. The three sub-categories of violent crime, (assault 1, assault 2, and sexual assault 1), and the crime category of drug-related offenses were also specifically examined in the Phase I report. Unfortunately, the data for several of these crime categories are not available prior to 1983 (assaults) or prior to 1977 (drug offenses). Homicide and robbery rates are available back to 1962 and will be examined in this section, along with the property crimes of theft, breaking and entering, and fraud, using panel regression techniques to determine whether or not the available economic and demographic variables are associated with changes in these five sub-categories of crime.

The empirical analyses in this section may be viewed as an extension of the analyses performed by Bunge, Johnson, & Balde (2005). However, there are some major differences between the two studies to note: (i) this study uses data from 1967 to 2013 under both UCR1 and UCR2 reporting methodologies, whereas the prior study used data from 1962 to 2003 under UCR1 reporting; (ii) this study uses individual provincial data in a panel format, whereas the prior study used aggregate data for Canada as a whole; (iii) this study uses an expanded set of variables, including per capita incomes, and international and inter-provincial migration movements; (iv) this study allows for all relevant and available variables to be included in the analysis rather than reducing the list by prior testing; (v) this study allows for structural breaks and time trends in the crime rate data; and, (vi) this study allows for lagged effects of explanatory variables, and autocorrelated residuals, instead of moving average representations of the residuals. As a result of different datasets and modeling strategies, the two sets of results are not directly comparable, but they are both informative.

6.1 Breaking and Entering Rates

Rates of breaking and entering for the five provinces over the period from 1962 to 2013 are depicted in Figure 6. In general, these rates were increasing from 1962 into the mid-1980s, then varied around a process with little or no trend, then followed a downward trend during the 1990s. There was also a one-period jump around 2003 after which the rates continued their downward trend. To capture these trend changes, province-specific shifts and one-period dummies for 1984, for 1998, and for 2003 are used for the five provinces, along with the province-specific constant terms. The panel estimation results are presented in Table 18, column 2.

Figure 6: Breaking and Entering Rates, Select Provinces, 1962-2013



The results for the growth in the rate of breaking and entering indicate a contemporaneous negative correlation between breaking and entering rates and per capita incomes: as the growth in real per capita incomes increased, the growth in the rate of breaking and entering decreased. Decreases in the growth in rates of breaking and entering were contemporaneously correlated with decreases in growth of the unemployment rate, and were correlated with contemporaneous and lagged increases in per capita alcohol sales. These economic impact results seem to suggest that rates of breaking and entering may be reduced during good economic conditions, perhaps indicating that some perpetrators of these crimes have less economic need to commit these crimes during good times and may find gainful employment in the legal labour market.

The results suggest that rates of breaking and entering were positively related to changes in population movements. Migration movements may provide more opportunities to commit crimes, with more people moving into and out of the province; perhaps both types of migrants serve as potential victims or perpetrators at the right opportunity. In particular, growth in immigration rates and in-migration rates were associated with growth in rates of breaking and entering, and these relationships were statistically significant. The results also indicate a statistically significant and positive relationship between changes in the relative size of the youth population and changes in rates of breaking and entering. When the proportion of the youth population was declining, rates of breaking and entering were also decreasing. By way of comparison, Bunge, Johnson, & Balde (2005) concluded that breaking and entering rates for Canada as a whole from 1962 to 2003 were positively associated with changes in the rate of inflation (not confirmed in this study), and by changes in the proportion of youth aged 15 to 24 in the population (confirmed in this study).

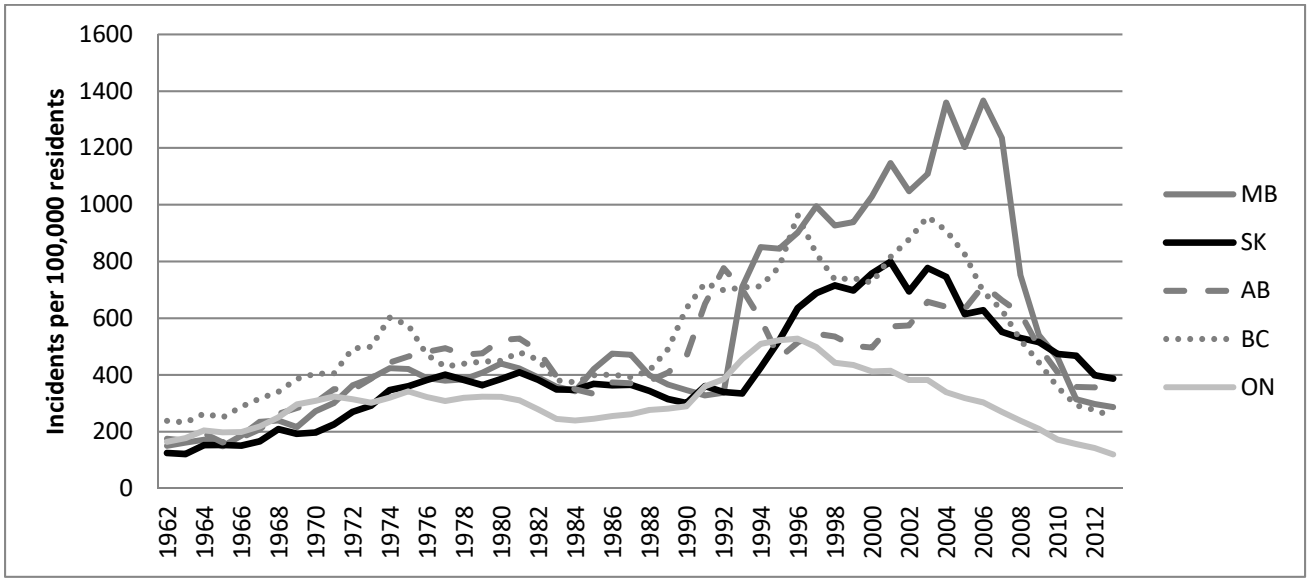
The R^2 statistics presented at the bottom of the table are for the model with the set of deterministic dummy variables first, then for the model with only a common constant term. The second statistic in the pair indicates how much variation from the mean in the growth of the crime rate may be explained by variation in the economic and demographic variables alone, which is quite low, at 21%. As with the previous estimation results presented in this report, most of the variation in changes in crime rates remained unexplained, either through unexplained deterministic trends, or through unexplained "error" variation.

The decomposition of changes in the rate of breaking and entering over the 2003-2013 period for Saskatchewan, using the estimates from Table 18, are presented in column 2 of Table 20. These estimates suggest that economic change could help explain up to 22% of the decline in rates of breaking and entering in the province, translating to a 224 point decline in the rate. Overall demographic change was associated with little of the decline in the rate of breaking and entering, with changes in the share of the youth population and changes in the rate of immigration having offsetting effects on the rate in Saskatchewan from 2003 to 2013.

6.2 Motor Vehicle Theft Rates

Motor vehicle theft rates for the five provinces are depicted in Figure 7. The rates for these provinces moved together until the 1990s. The rate for Manitoba began a strong increase around 1993, and then plummeted after 2008. The rate in Saskatchewan appears to have experienced a rise starting in 1994, and then a trend decline after 2003. Alberta experienced a sharp one-period jump in the rate in 1991, and then experienced a slow rise until 2006 and a drop thereafter. The rate in BC rose until 1974, then varied with little trend until 1988 from which a general trend increase continued until about 2003, albeit with sharp deviations; the rate in BC then declined from 2003 to the end of the study period. The rate of motor vehicle theft in Ontario appears to meander with a general rise into the mid-1990s, and a trend decline emerges after 1996. In the panel regressions, province-specific dummy variables were used for these various potential break points.

Figure 7: Motor Vehicle Theft Rates, Selected Provinces, 1962-2013



The panel regression results are presented in Table 18 (column 3). Of the economic variables, only lagged changes in the unemployment rate were statistically significantly correlated with changes in rates of motor vehicle theft, curiously in a negative fashion: increases in last period's unemployment rate were correlated with decreases in the rate of motor vehicle theft. The coefficient estimates for the remaining economic variables were statistically insignificant. A statistically significant and positive link between inflation and rates of motor vehicle thefts was identified in the empirical work by Bunge, Johnson, & Balde (2005), but not in this study. The results indicate that a decreasing proportion of youth in the total population was correlated with decreases in the rate of motor vehicle theft. The results also indicate that rates of emigration had a contemporaneous and statistically significant positive correlation with rates of motor vehicle theft, so that increasing rates of emigration coincide with increasing rates of motor vehicle theft.

Changes in the economic and demographic variables had little power in explaining the variation in changes in the rate of motor vehicle theft, as indicated by an R^2 of 0.17 when deterministic dummies were excluded in the panel regression. Table 20 indicates that 90% of the decline in the rate of motor vehicle theft in Saskatchewan from 2003 to 2013 may be attributed to unexplained trends and residuals. It is hypothesized that these unexplained forces include security and crime prevention initiatives introduced and implemented over the last few decades. As an example, the Manitoba Auto Theft Task Force promoted vehicle immobilizers and addressed joyriding by youth offenders. As indicated in Figure 6.2, car theft declined considerably between 2007 and 2013 in Manitoba (Manitoba Auto Theft Task Force, 2009).

6.3 Fraud Rates

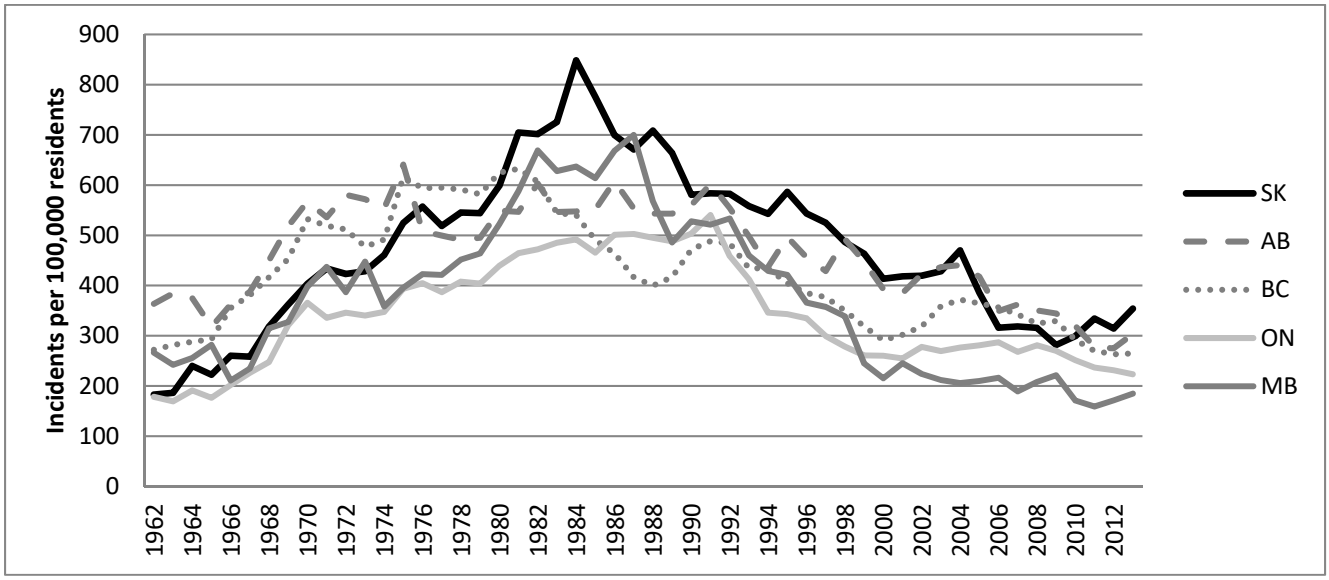
Provincial rates of fraud are shown in Figure 8. The rates appear to rise to 1984 and fall thereafter, with a bump around 2003. The rate for Manitoba appears to rise to 1988 and then decline, with a trend change in 2000 to a slower rate of decline. In Alberta, the rate of fraud rose until 1991, with marked volatility during the 1980s, and then declined with a temporary jump around 2003.The rate of fraud in BC appears to rise until 1981, then starts to decline with temporary increases around 1991 and 2003. For Ontario, the figure suggests an increase in the rate of fraud until 1991, with a trend decline thereafter, but that trend decline appears to dissipate around 1998. The estimation procedure will include province-specific trend shifts and one-period changes for these specified years.

The estimation results presented in column 4 of Table 18 indicate that there were statistically significant correlations between income growth and growth in the rate of fraud, and between changes in unemployment rates and changes in rates of fraud. Declining rates of fraud were associated with lagged increases in per capita incomes. Declining rates of fraud were also associated with contemporaneous decreases in unemployment rates, although the effect was reduced by lagged increases in unemployment rates; this suggests that increasing rates of fraud were highly correlated with a sudden shift in labour market conditions, from falling unemployment to rising unemployment the next period.

Changes in demography were statistically significantly correlated with changes in rates of fraud. In particular, contemporaneous increases in rates of immigration and in rates of emigration were associated with decreases in rates of fraud, while contemporaneous increases in rates of inter-provincial in-migration were associated with increases in rates of fraud. However, the direction of those associations was reversed when their lagged values were considered in two cases. Changes in rates of out-migration and changes in the youth population were both positively associated with rates of fraud, but were statistically insignificant.

The calculations in Table 20 suggest that economic and demographic change had a strong impact on changes in fraud rates. Economic conditions might explain most of the decline in the rate of fraud in Saskatchewan from 2003 to 2013, with much of the effect flowing through changes in per capita incomes. Changes in migration movements might help explain almost one-quarter of recent changes in the Saskatchewan fraud rate. Unexplained deterministic trends and residuals would otherwise have resulted in upwards movements in the Saskatchewan rate of fraud.

Figure 8: Fraud Rates, Selected Provinces, 1962-2013



6.4. Homicide Rates

Homicide rates, (which include murder, manslaughter and infanticide), for the five provinces from 1962 to 2013 are depicted in Figure 9. For the most part, it appears that the rates increased from 1962 to about 1977, then started a slow decline to around 1998, when the provincial rates fluctuated more widely from each other. The homicide rates for Ontario were the lowest of the five provinces, and while those for Manitoba and Saskatchewan were generally comparable to those of Alberta and BC before the turn of the century, they were noticeably higher in the more recent period.

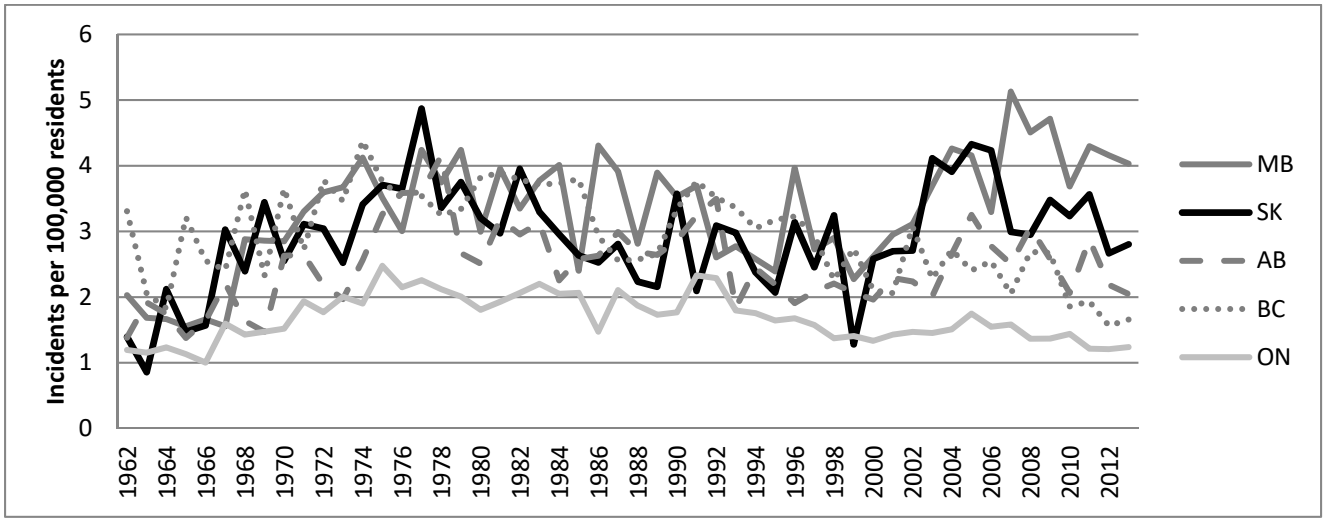
The panel regression estimates for changes in homicide rates are presented in column 2 of Table 19. These estimates are from the model with no deterministic dummies, with only a common intercept. Province-specific intercepts, and one-period and shift dummies variables for 1977, 1998, and 2003 were all statistically insignificant. The R^2 statistic indicates that economic and demographic variables help explain very little movement: only 13%, in the homicide rates for these five provinces over the study period.

Table 18: Panel Estimates – Growth in the Rates of Selected Property Crimes

Regressors/ Statistics	Breaking and Entering Δber 1968 -2013	Motor Vehicle Theft $\Delta mvtr$ 1968 -2013	Fraud Δfr 1968-2013
Estimation	PCSE	PCSE	PCSE
Δy_t	-0.2844 (0.1452)*	0.1410 (0.1803)	0.0207 (0.1585)
Δy_{t-1}	-0.0058 (0.1427)	-0.1571 (0.1721)	-0.4352 (0.1576)***
$\Delta \pi$	0.0347 (0.4033)	0.3537 (0.4961)	0.5095 (0.4531)
$\Delta \pi_{t-1}$	-0.1386 (0.3939)	-0.3432 (0.4445)	0.5809 (0.3983)
Δur_t	0.1457 (0.0392)***	-0.0052 (0.0471)	0.1527 (0.0442)***
Δur_{t-1}	-0.0214 (0.0417)	-0.1310 (0.0508)***	-0.1113 (0.0458)**
Δohp_t	-0.1705 (0.1266)	0.0625 (0.1658)	0.0088 (0.1506)
Δohp_{t-1}	-0.2032 (0.1218)*	-0.1196 (0.1544)	-0.1171 (0.1390)
Δysp_t	1.5591 (0.6405)**	1.9095 (0.7725)**	0.5647 (0.6988)
Δysp_{t-1}	-0.4938 (0.6814)	-0.3648 (0.7913)	-0.0877 (0.7070)
Δimp_t	0.0020 (0.0337)	0.0445 (0.0381)	-0.0994 (0.0346)***
Δimp_{t-1}	0.0832 (0.0305)***	-0.0129 (0.0364)	0.0497 (0.0322)
Δemp_t	-0.0260 (0.0326)	0.0905 (0.0405)**	-0.0951 (0.0350)***
Δemp_{t-1}	0.0473 (0.0338)	-0.0441 (0.0420)	0.0427 (0.0364)
Δinp_t	0.1069 (0.0562)*	0.0018 (0.0661)	0.1285 (0.0570)**
Δinp_{t-1}	0.0330 (0.0538)	0.0883 (0.0671)	0.0021 (0.0580)
Δoup_t	0.0043 (0.0480)	-0.0160 (0.0589)	0.0480 (0.0503)
Δoup_{t-1}	0.0741 (0.0493)	0.0098 (0.0608)	-0.0254 (0.0508)
$\hat{\rho}$ (ON; MB; SK; AB; BC)	-0.14; -0.14; -0.06; 0.26; 0.13	0.47; -0.03; 0.02; 0.12; 0.17	-0.15; -0.19; -0.05; -0.14; 0.11
Deterministic Dummies	35 as noted in text	25 as noted in text	27 as noted in text
R^2 (with dummies / without dummies)	0.5515/0.2229	0.5975/0.1746	0.4781/0.2475
Test βs(t-2 lags) = 0	χ^2 (9) =7.64 (p-value = 0.5710)	χ^2 (9) =11.68 (p-value = 0.2321)	χ^2 (9) = 6.97 (p-value = 0.6402)

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test); ~~~ denotes the coefficients are jointly statistically significant at the 99% confidence level, but not individually at the 90% level. Two R^2 statistics are presented for each regression: the first is for the regression with the complete set of dummy variables as identified in the text, and the second R^2 statistic is for a regression without dummy variables except for the common constant.

Figure 9: Homicide Rates, Selected Provinces, 1962-2013



Decreases in homicide rates were contemporaneously associated with increases in per capita income, per capita alcohol sales, and inflation, and with decreases in unemployment rates. However, the lagged effects of these variables were all reversed from the contemporaneous effects. This suggests that the impact of these variables was strongest when there was a sudden reversal of fortunes from a growing economy to a declining economy. The results presented by Bunge, Johnson, & Balde (2005) suggest a positive contemporaneous link between homicide rates and unemployment like those presented here; however, they found a positive contemporaneous link between homicide and alcohol sales per capita, while in this study the positive link was with a one-period delay. Five out of eight of the coefficient estimates for the economic variables were statistically insignificant, and the decomposition estimates in Table 20 suggest that economic changes may have pushed up the homicide rate nominally, by 4% in Saskatchewan from 2003 to 2013.

Only one of the contemporaneous or lagged demographic variables was found to have a statistically significant correlation with rates of homicide: contemporaneous changes in in-migration rates. Table 20 also suggests little role for demographic change in explaining the decline in homicide rates in Saskatchewan since 2003. Unexplained forces other than the economic and demographic forces included in the empirical estimation were at work influencing the trend decline in homicide.

6.5 Robbery Rates

Figure 10 presents the rates of robbery for the five provinces from 1962 to 2013. There was a sustained decline in the robbery rate in BC after 1998, and an increase in the growth rate of robbery in Saskatchewan starting from 1994. There is evidence of a shared trend decline across all five provinces in the last few years of the sample, starting around 2007. The panel model included province-specific intercepts, one-period and shift dummies for 2007, as well as one-period and shift dummies for Saskatchewan in 1994 and for BC in 1998.

The results presented in Table 19, column 3 suggest that, among the economic variables, only contemporaneous changes in the rate of unemployment were statistically significantly (and positively) associated with changes in robbery rates. Among the demographic variables, only lagged changes in the rates of inter-provincial in-migration were positively correlated with robbery rates, suggesting that increased inter-provincial in-migration corresponded to increased robbery rates in the next period. By comparison, only changes in inflation were positively linked with changes in robbery rates in Canada by Bunge, Johnson, & Balde (2005). As with most of the previous crime rate regressions, the economic and demographic variables had relatively little impact on changes in crime rates, helping to explain less than a quarter of the variation in growth of robbery rates; most of the variation in the rates was unexplained. This is also confirmed by the decomposition estimates presented in Table 20, which suggest that only 24% and 20% of the decline in robbery rates in Saskatchewan over 2003-2013 could be linked to economic and to combined economic and demographic changes experienced by the province respectively.

Figure 10: Robbery Rates, Selected Provinces, 1962-2013

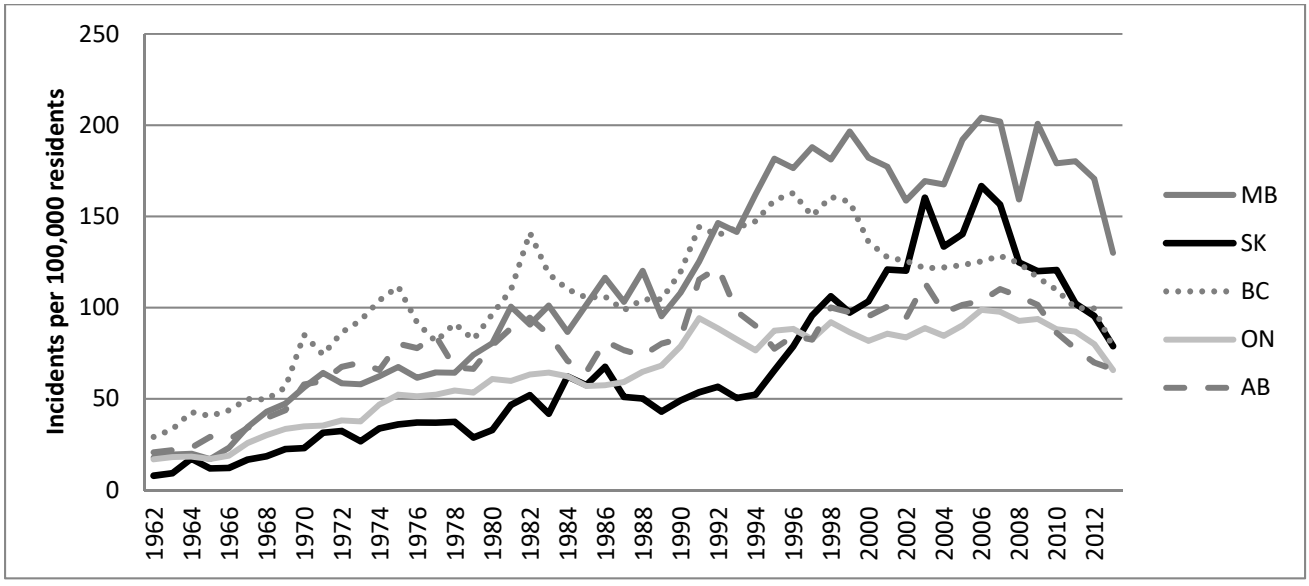


Table 19: Panel Estimates – Growth in the Rates of Selected Violent Crimes

Regressors/ Statistics	Homicide Δhr 1968-2013	Robbery Δrr 1968-2013
Estimation	PCSE	PCSE
Δy_t	-0.6140 (0.4197)	0.1234 (0.2703)
Δy_{t-1}	0.7693 (0.4263)*	-0.2646 (0.2689)
$\Delta \pi$	-0.5821 (1.0630)	0.6701 (0.6781)
$\Delta \pi_{t-1}$	0.7112 (0.9347)	0.5862 (0.5860)
Δur_t	0.2201 (0.0931)**	0.2657 (0.0612)***
Δur_{t-1}	-0.0756 (0.0938)	-0.0335 (0.0635)
Δohp_t	-0.5995 (0.3676)	-0.0510 (0.2194)
Δohp_{t-1}	0.6417 (0.3349)*	-0.1769 (0.2045)
Δysp_t	0.5898 (1.5737)	0.5127 (1.0287)
Δysp_{t-1}	0.4817 (1.6694)	0.1963 (1.0647)
Δimp_t	-0.0030 (0.0754)	-0.0402 (0.0518)
Δimp_{t-1}	0.0705 (0.0710)	0.0539 (0.0485)
Δemp_t	0.0606 (0.0870)	-0.0384 (0.0553)
Δemp_{t-1}	-0.0732 (0.0867)	0.0045 (0.0547)
Δinp_t	0.2458 (0.1369)*	0.0776 (0.0905)
Δinp_{t-1}	-0.0373 (0.1344)	0.2610 (0.0861)***
Δoup_t	-0.1379 (0.1274)	0.0236 (0.0835)
Δoup_{t-1}	0.0725 (0.1314)	0.0752 (0.0861)
$\hat{\rho}$ (ON; MB; SK; AB; BC)	-0.44; -0.50; -0.61; -0.21; -0.56	0.02; -0.33; -0.23; -0.23; -0.19
Deterministic Dummies	None – 35 as noted in text jointly insignificant and eliminated except a common constant χ^2 (34) =21.29 (p-value = 0.9561)	19 as noted in text
R^2	0.1348	0.3843/0.2211
Test βs(t-2 lags) = 0	χ^2 (9) =8.52 (p-value = 0.4828)	χ^2 (9) = 8.33 (p-value = 0.5016)

Notes: Standard errors in parentheses; *, **, and *** denote coefficient is statistically significantly different from zero at the 90%, 95% and 99% confidence levels (two-tailed test); two R^2 statistics are presented in the third column – the first is for the regression with the complete set of dummy variables as identified in the text, and the second R^2 statistic is for a regression without dummy variables except for the common constant.

Table 20: Decomposition of Changes in Growth of Selected Crime Rates for Saskatchewan, 2003-2013

	Contribution to overall change in the rate of:				
Variable – Combined Impact of:	Δber (2003-2013)	$\Delta mvtr$ (2003-2013)	Δfr (2003-2013)	Δhr (2003-2013)	Δrr (2003-2013)
Δy	**-110.165**	-1.954	**-52.422**	**0.147**	-5.090
$\Delta \pi$	1.257	0.643	-3.363	-0.011	-1.106
Δur	**-46.535**	**15.045**	**-10.196**	**-0.185**	**-8.766**
Δohp	**-68.716**	-7.131	-7.773	**0.105**	-4.504
Δysp	**-111.260**	**-76.324**	-16.246	-0.275	-6.384
Δimp	**174.203**	30.520	**-32.738**	0.419	3.150
Δemp	12.743	**-12.350**	**8.845**	-0.072	0.841
Δinp	**25.853**	12.597	**7.063**	**0.083**	**8.774**
Δoup	-20.212	-0.226	0.107	-0.002	-2.352
Economic variables	-224.160	6.603	-73.755	0.056	-19.467
Demographic variables	81.327	-45.784	-32.970	0.153	4.028
Deterministic Dummies and Residuals	-896.806	-350.855	32.034	-1.521	-66.000
Total	-1,039.639	-390.036	-74.691	-1.312	-81.438
	Percentage Contribution to the **overall decline** in the rate of:				
Variable – Combined Impact of:	Δber (2003-2013)	$\Delta mvtr$ (2003-2013)	Δfr (2003-2013)	Δhr (2003-2013)	Δrr (2003-2013)
Δy	**10.60%**	0.50%	**70.19%**	**-11.17%**	6.25%
$\Delta \pi$	-0.12%	-0.16%	4.50%	0.86%	1.36%
Δur	**4.48%**	**-3.86%**	**13.65%**	**14.07%**	**10.76%**
Δohp	**6.61%**	1.83%	10.41%	**-8.03%**	5.53%
Δysp	**10.70%**	**19.57%**	21.75%	20.96%	7.84%
Δimp	**-16.76%**	-7.82%	**43.83%**	-31.97%	-3.87%
Δemp	-1.23%	**3.17%**	**-11.84%**	5.48%	-1.03%
Δinp	**-2.49%**	-3.23%	**-9.46%**	**-6.30%**	**-10.77%**
Δoup	1.94%	0.06%	-0.14%	0.18%	2.89%
Economic variables	21.56%	-1.69%	98.75%	-4.27%	23.90%
Demographic variables	-7.82%	11.74%	44.14%	-11.65%	-4.95%
Deterministic Dummies and Residuals	86.26%	89.95%	-42.89%	115.92%	81.04%
Total	100%	100%	100%	100%	100%

Notes: Boldfaced text denotes figures derived from point estimates statistically significant at the 0.10 significance level; negative percentages reflect an increase in the rate of crime, not a decrease.

6.6 Assessment

The estimation results indicate that changes in two of the three major property crime rates (the exception being motor vehicle theft), and changes in the two categories of violent crime are all positively linked with changes in unemployment rates. The estimation results also show that changes in the proportion of youth in the population were positively related to changes in all five of these crime categories. However, the links between these five crime rates and the other economic and demographic factors differ. And since different crime categories are associated with socio-economic factors in different ways, it is naturally difficult to get conclusive and informative results on the socio-economic factors influencing aggregate rates of crime (as examples, total violent crime and total property crime). There are differing impacts, motives, and opportunities involved in different crimes.

For the five crime types, the R^2 statistics varied between 0.13 and 0.25 when no deterministic dummies were included. As with the previous estimation results presented in this report, most of the changes in crime rates remained unexplained, either through unexplained deterministic trends, or through unexplained "error" variation. This is also confirmed with the decomposition results in Table 20 which suggest that most of the drop in these crime rates in Saskatchewan over the 2003 to 2013 period remain unexplained and are the result of other forces.

What are these other forces? We do know that the quality of crime data used by researchers is affected by reporting and recording practices of victims and the population, and by the police. We know that the effectiveness of aggregate studies will be limited by the quality and availability of variables thought to influence crime rates, and that some variables may have changeable impacts on crime rates depending on circumstances (for example, economic conditions may present opposing motivational and opportunity influences on criminal behaviour), and have different effects on different crime types. Empirical work is unable to identify many forces that affect crime rates and criminal behaviour. The next section identifies and reviews some recent work which attempts to explain the international decline in crime rates, and presents avenues for future research.

7. Explaining Trend Changes in Crime Rates and Areas for Future Research

The econometric results presented in this report indicate that movements in economic and demographic variables available in Canadian time-series may help explain a small proportion of changes in rates of property and violent crime over time at the provincial level. The expansion of the number of potential explanatory variables was possible only with a reduction in the period of study due to data limitations, and the results indicated that there may be other variables that help explain changes in crime rates. However, the role of the unexplained trend and shift changes over time remained strong, indicating that there are other unidentified forces at work influencing the patterns in rates of crime over time. In this section, possible explanations for these trend and shift changes are briefly discussed and relate specifically to changes in security, social tolerance, and police recording practices. Directions for future work involve examining these issues, as well as performing cross-sectional analyses of crime in jurisdictions at the sub-provincial level at census dates because time-series data are not available at sub-provincial levels of aggregation.

7.1 The long-run decline in crime and the recent crime boom and drop

A body of work which has been recently garnering attention in the criminology literature attempts to explain the long-run decline in crime rates in the period leading up to the mid-Twentieth Century, to explain the increase in crime rates from the 1950s to the 1990s, and also to explain the more recent crime drop (and resumption of the long-run decline) that has been experienced by many industrialized nations. Research on this theme has been presented in a 2014 thematic volume of the journal, *Crime and Justice*, and in a collection of essays published as *the International Crime Drop* (van Dijk, Tseloni, & Farrell, 2012).

In the preface to the 2014 volume of *Crime and Justice*, Tonry (2014a) wrote, “important historical work convincingly showing that homicide rates in Europe have been declining for many centuries, and that rates of all offenses fell from the early 1800s through the 1950s in some Western countries, was published only recently and not widely known among non-historians.” Tonry (2014b) summarized the historical literature, pointing to the works of Gurr (1981), Eisner (2003) and others, which indicated that homicide rates were falling in England, from rates in excess of 20 per 100,000 residents in the thirteenth century, to rates around one per 100,000 in the nineteenth century, and that this decline was similarly experienced in Finland, Sweden, Norway, the Netherlands, Germany, and Switzerland. Explanations for the long-run historical decline revolved around the evolution of government and state institutions, including professional policing, the criminal justice system, and public education, and the evolution of economic systems, particularly the effects of the Industrial Revolution with specialized factories. Individuals became socialized towards common norms and co-operation, which increased individual discipline and self-control (Tonry, 2014b: 13-14). That crime rates in cities tended to be

lower than those in rural areas reinforced the thinking that urbanization and industrialization contributed to the long-run decline in crime (Eisner, 2003:105-6; Tonry, 2014b: 49-51).

Across developed countries, crime rates rose from the 1960s into the 1990s. This period has been characterized as one with major demographic and economic changes. The dramatic demographic changes of this period include the baby boom followed by a decline in fertility, the decline in rates of marriage, the rise in female labour force participation, and the increase in life expectancy. The Western world also moved into a post-industrial phase with major and frequent changes in the structure of national economies, and in the labour market (Tonry, 2014a, b). There were major changes occurring around the world, with decolonization, equal rights movements, and migration (Fukuyama, 1999). In the US, much recent attention has been placed on changes in policing and imprisonment to explain changing rates of crime during this period.

In many countries, victim reporting rates for non-homicidal violent and sexual crime increased in the 1970s and 80s, and appear to have exaggerated the increase in violent crimes when compared to victimization surveys. In addition, police-reported crime incidents have increased as a result of changes in police practices (as examples, increased professionalism and electronic record-keeping). During the latter years of the twentieth century, social and community tolerance for criminal offenses declined dramatically, and those social forces materialized through increased victim, public and police reporting, and, particularly in the US, more arrests, prosecutions, and sentences (Blumstein & Beck, 1999). More assaults have been classified as serious and more minor assaults have been recorded by police, when they would not have been earlier, as a result of changes in societal attitudes, a corresponding change in police practices, and more attention placed on minor crime by politicians (Britton, Kershaw, Osbourne, & Smith, 2012). Farrell, Tilly, & Tseloni (2014) also emphasized the role of increasing consumerism and more portable consumer goods and valuables, combined with more empty homes with both spouses in the workplace and children in schools, fueling increases in property crime. Responses to these changes took time, as household and auto security, and intensive crime prevention measures, became more widespread in the 1990s.

In the mid-1990s, crime rates began to decline in most developed countries. Levitt (2004) surveyed the literature which attempts to explain the dramatic drop in police-reported crime, as well as the drop in survey-reported victimization. He listed the set of examined factors he concluded from the evidence as having little or no role in the US crime drop in the 1990s: strong economic growth; demographic changes of aging, reduced fertility, and growth in ethnic diversity; improved policing practices; increased gun control; authorized concealed carry of weapons; and, increased use of the death penalty. He then proposed the list of factors which he concluded as explaining the drop in US crime: increased number of police officers; higher rate of imprisonment; decline in the crack cocaine epidemic; and, legalized abortion.

Concentrating on the similar crime rate patterns in the US and Canada, several authors have quickly dismissed any notion that imprisonment practices could be a legitimate explanation of the crime drop: the justice and corrections practices were dramatically different and suggest that other factors were at work (Ouimet, 2002; Zimring, 2006; Webster & Doob, 2007). Daly & Wilson (2001) emphasized the link between crime and non-criminal risky behaviour, while Fox (2005) illustrated that US arrest rates for all crimes, for violent crimes, and for property crimes, and that US victimization rates for violent crimes, declined across all age groups over the decade from 1991 to 2001. Building on these works, Mishra & Lalumiere (2009) showed that indicators of risky behaviour among the Canadian and US general and teen populations dropped considerably from 1991 to 2001 and that most of these indicators are positively correlated with homicide rates. Mishra & Lalumiere (2009: 47) concluded by hypothesizing that the drop in crime "must be due either to increased self-control in the general population, or a decrease in opportunity."

More recently, Farrell, Tilley and Tseloni (2014) expanded the analysis of the drop in crime across several developed countries in North America and Europe, and in Japan, Australia, and New Zealand. They tested 17 different cited hypotheses that could explain the recent multi-country drop in crime, while remaining consistent with the prior increase in crime, the differential patterns of different crime types, and the timing of crime changes across several developed countries. The hypotheses dismissed by Levitt (2004) for the US may also be dismissed for the sample of developed nations. Farrell, Tilley and Tseloni (2014) could also dismiss the hypotheses accepted by Levitt (2004), because they could not be applied to other countries. While there were a few hypotheses that passed the criteria that the crime drop had to be experienced across many countries and be consistent with the prior increase in crime, there was only one hypothesis that passed all of the test criteria, the strictest of which was associated with timing and trajectories of crime in various countries: improved security. Farrell, Tilley and Tseloni (2014) provide an in-depth analysis of the security hypothesis across nations to show how the timing of crime changes in various countries was influenced by the timing of security improvements and adoption, and their spillover effects into other types of crime.

In retrospect, the increasing crime rates from the 1960s to the 1990s have been viewed as the result of extended adjustments, particularly in reporting and in security and prevention measures, in developed countries over an exceptional period; "there are good reasons to believe that rising official rates of crime in some countries are artifacts of cultural changes and not of real increases in violent incidents" (Tonry, 2014b:45). There may be some role for economic changes in explaining changes in property crimes, but these should not help explain changes in violent crimes. Also, changes in imprisonment should not be helpful in explaining crime patterns given the wide differences in justice policies across developed countries Tonry (2014b).

Overall, the literature which attempts to explain the boom and drop in crime in developed countries over the last 50 years has focused on routine activity theory, security, and changes in victim and police

reporting. During the boom in crime, the increase in activities of the public outside of their homes eroded the ability of people to personally guard their possessions, so that property crime booms appeared to be driven by criminal opportunity; this led to improvements in security and situational crime prevention that caught up by the 1990s (van Dijk, Tseloni and Farrell, 2012). There are also spillover effects from property to violent crime, so that the patterns of these types tend to be similar. However, social and political awareness, attitudes, and tolerance for crimes against the person have changed dramatically over the past 50 years (Tonry, 2014b). Most likely, these changes in security and opportunity, and in social tolerance, have contributed to the decline in risky and criminal behaviour across all age groups.

7.1.1 Security

As noted above, there is growing evidence that security and preventative measures against crime have been instrumental in causing the crime rate to drop in developed nations. The supporting literature is examined by Farrell, Tilley and Tseloni (2014). The timing of the introduction and proliferation of vehicle and household security systems appears to coincide with the widespread drop in crime. The diffusion of vehicle immobilizers has varied across the US, the UK, the Netherlands, and Australia, but has coincided with the timing of declines in vehicle theft in those countries (Laycock, 2004; Farrell, Tseloni, Mailley, & Tilley, 2011; Fujita & Maxfield, 2012; Brown, 2013; van Ours & Vollard, 2013). Both permanent vehicle thefts (for the resale parts market), and temporary vehicle thefts (for joyriding) were reduced following the spread of immobilizer technology. In addition, the diffusion of immobilizers has a spillover effect on other crimes as stolen vehicles are often used by criminals to commit other crimes (Clarke & Harris, 1992). Tilley, Farrell, & Clarke (2014) found that burglaries declined by 59% for those that were susceptible to facing security devices, when compared to other burglaries which declined by only 25%, from 1994 to 2003.

Winnipeg was one city dealing with exceptionally high rates of car theft at the turn of the century. The Manitoba Auto Theft Task Force implemented several measures to reduce car thefts, but it wasn't until 2008 that measures instituted as part of the Winnipeg Auto Theft Suppression Strategy showed fruit. The initiative addressed high-risk youth and joyriding, but also required vehicle immobilizers for vehicles most at risk of car theft. As indicated in Figure 6.2, car theft declined considerably between 2007 and 2013 in Manitoba. Future work may examine the introduction of new security measures and initiatives and their impact on the drop in crime in Canada.

7.2 Reporting practices

Of particular significance to this study are the changes in UCR reporting and data methodology in 1998, and the jump in many crime rates around 2003. There is a distinct change in Canadian crime data with the shift to UCR2 recording; section 2.3 provided a brief discussion of changes in reporting methodology. The jump in crime rates around 2003 requires additional exploration.

Tonry (2014b:31-40) indicated that countries have varied in the way that they count incidents. One method is to tabulate and report crime only after police screening and investigation; this is the "output" method. The other method is to tabulate and report crime using the "input" method, whereby incidents are tabulated as they are reported to police without screening. Countries that use the output method tend to have lower rates of crime. In 1998/99 England and Wales changed reporting practices by beginning to record many minor offenses (Povey & Prime, 1999). In 2002/3, the shift from an "output" system to an "input" system of recording caused an increase in the official rate of total crime by 10%, and by even more for violent crimes in England and Wales (Simmons & Dodd, 2003).

Wallace (2004) indicated that in 2003, Canada experienced the first major annual increase in the national crime rate since 1991, by 6%. This major increase was attributed primarily to increases of property crime, and of minor offenses including mischief and disturbing the peace. Property crime rates increased by 14% and 12% in Saskatchewan and Manitoba respectively, by 25% in Saskatoon, by 15% in Winnipeg, and by 13% in Edmonton. The substantial increases in property and minor crimes have been attributed primarily "to new reporting procedures introduced in 2003 which make it easier for the public to report minor crimes to the police" (Wallace, 2004, p. 4). As an example, the Winnipeg Police Service introduced a telephone system which resulted in more minor thefts being recorded and reported by police, and this was deemed partially responsible for the 21% increase in the auto theft rate in Winnipeg in 2003.

Other changes in reporting practices may also help to explain changes in police-reported crime. As an example, the uncertainty around the introduction of Bill C-10 in 2003 which proposed decriminalization of small-scale cannabis possession was thought to have contributed to the decline in drug crimes in 2003 (Wallace, 2004). As another example, new legislation introduced in 2014 led to the addition of some offenses related to prostitution in the category of crimes against the person (violent crimes), and these changes affected violent crime rates in 2015 (Allen, 2016). A more thorough assessment of changes in legislation and police practices is required to provide additional context to changes in police-reported crime rates.

Another important factor is assessing trends in police-reported crime related to trends in victimization and victim reporting to police. Perreault (2015) found, using the General Social Survey, that while victimization rates in 2014 were lower than those in 2004 for seven of the eight offenses surveyed (the exception being sexual assault, which was stable between the surveys), the rate of reporting to the police also declined, from 34% of all incidents in 2004 to 31% in 2014. Additionally, the rate of reporting to police varies widely by offense, from 50% of break-ins reported, to 5% of sexual assaults, reported to police. These low reporting rates to police result in the underestimate of crime from police records, and changes in victim reporting to police result in possible misinterpretation of trend changes in police-reported crime.

7.3 Cross-sectional differences in crime rates

There are wide differences in rates of crime across communities in Saskatchewan and Canada, as indicated in Wilson and Sagynbekov (2014). This study has focused on time-series and panel analysis for Saskatchewan and four other provinces over the 1967-2014 period. Annual data on the economic and demographic variables are not available at the city and community level. Some of these data are available at census dates. Levitt (2001) indicated that time series analyses should be supplemented by cross-sectional and panel analyses. Future work for Canada may use census data to identify the links between economic and demographic variables, and crime, at the community level.

8. Conclusion

This report is the third report of a larger research project focusing on the changing economy and demography of Saskatchewan and its impact on crime and policing. The first report provided an overview of economic, demographic, and policing and crime trends over the last two decades in Saskatchewan and its ten major cities. The second report presented a review of the literature on the theoretical and empirical determinants of criminal behaviour and crime.

This report showed that property crime rates consistently rose from the 1960s to 1988 in Manitoba and Saskatchewan, and to 1991 in Ontario, Alberta and British Columbia. These rates generally fell thereafter, with two exceptionally large one-period jumps, one in 1998 with the shift in reporting from UCR1 to UCR2 reporting categorization, and another in 2003, after which property crime rates re-established a trend decline to 2014. Among the economic factors examined, the estimation results provide evidence that declining property crime rates coincided with increases in real household incomes per capita, with increases in real per capita alcohol sales, and with decreases in unemployment rates. Among the demographic factors included in the analysis, the results suggest that declining property crime rates coincided with decreases in the share of youth in the population, with decreases in the immigration rate, and with decreases in the inter-provincial in-migration and out-migration rates. Estimation results using an expanded set of explanatory variables but over a smaller time period, suggested that increases in housing prices led to increases in rates of property crime. Although the empirical results do suggest important influences of the economic and demographic variables on rates of property crime in Saskatchewan, the results suggest that approximately sixty percent of the decline in the rate of property crime in Saskatchewan from 2003 to 2013 may be attributed to unidentified deterministic factors, i.e. time trends, and province-specific shocks.

This report tracked how rates of violent crime generally rose from the 1960s and into the twenty-first century, following major increases in 1998 as a result of the shift from UCR1 to UCR2 methodology in police reporting. Rates of violent crime have been consistently in decline since 2000 in Ontario and Manitoba, since 2003 in Saskatchewan, and only more recently since 2005 in BC and since 2008 in Alberta. Increases in the rate of unemployment and in real per capita alcohol sales coincided with increases in rates of violent crime. The empirical results also suggested that rising incarceration rates had deterrent and incapacitation effects, leading to decreasing rates of violent crime, and that increases in the number of police officers may have deterrent effects, but may also increase investigative activities and the rate of reported crime. However, changes in the economic and demographic variables used in the study were found to hold very little influence on rates of violent crime in the five provinces. As an illustration, undefined deterministic trends and province-specific effects accounted for all of the decline in the Saskatchewan rate of violent crime from 2003 to 2013.

Subcategories of crime were also examined in this study. The crime rates of breaking and entering, fraud, robbery, and homicide were positively linked to changes in unemployment rates, and to changes in the proportion of youth in the population. While decreases in fraud rates were also associated with decreases in the share of youth in the population, decreases in fraud rates occurred when unemployment rates rose.

Further work is required to fill in the empirical limitations of this study, and attempt to identify the unexplained trends in the rates of property and violent crime. A thorough investigation into changes in reporting and recording practices is warranted. Research on private security and crime prevention initiatives would also be fruitful. And available data at the provincial level are not sufficiently comprehensive to identify the determinants of changes in crime rates; future work may include the development and examination of richer census data at the level of the police detachment.

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