AN ANALYSIS OF TRENDS IN FIREARM CASUALTIES IN NEW ZEALAND

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ABSTRACT

This paper examines trends in firearm accident (unintentional) casualty data provided by NZ Police and NZ Mountain Safety Council (Inc) from 1935 to 2004. Firearm accidents have steadily declined, with notable reductions in the early 1950s, the early 1970s and the late 1990s. Whilst Scott and Scott (2005) estimate that this fall in total number of firearms accidents reduced annual societal cost by 253%, they recommend that significant spending is justified to further reduce firearm accidents.

The analysis falls into two distinct parts. The first discusses the multitude of factors that may have lead to changes in the casualty rate from firearm accidents such as, *inter alia*: volume of firearms, proportion of the firearm-owning population, proportion of 'high risk' population, greater awareness of the need for firearm safety, wider knowledge of first aid, and improved firearms owner licensing provisions. It also provides a descriptive analysis of changes in the composition of the firearms stock, time of day and location of accidents, age of victims and 'perpetrators', and examines the main safety rules which were violated in reported accidents.

The second part will conduct formal multi-variate time series analysis to examine the linkages between the economic, educational and institutional factors listed above. This will greatly extend the conjectures put forth in Scott and Scott (2005) and the noted correlations between access to guns and risk of death in the US by Rushforth et al (1974) and Canada by Chapdelaine and Maurice (1996).

[1] Acknowledgements and thanks are offered to the NZ Mountain Safety Council (Inc), the staff of the NZ Police National Headquarters and to the University of Otago (Injury Prevention Research Unit and Economics Departments) along with individuals too numerous to mention.

Part I: DESCRIPTIVE ANALYSIS OF NZ FIREARMS STATISTICS

INTRODUCTION AND BACKGROUND

This study is part of an exercise to gauge the value of the firearm safety programmes of the NZ Mountain Safety Council (NZMSC). The question of effectiveness has occupied its Research Committee for over five years: identifying whether the implementation of a safety programme has lead to reduced back country casualties is problematic when basic factors such as the number of participants is not known.

The NZ Mountain Safety Council (Inc) was formed in 1965 to promote the safe enjoyment of NZ back country. To help fulfil these objectives it publishes manuals on abseiling, bushcraft, firearms, HUNTS (Hunter Understanding National Training Scheme), outdoor first aid, risk management and mountaincraft. It has technical committees including Bushcraft, Firearms and Risk Management which provide advice for these publications and towards the goals of NZMSC generally.

There are over a million firearms in NZ, and a population of 4.1 million people. It might be argued that casualties arising from firearm misuse would be high compared to other countries, or to other casualty-producing causes. The reality is that the nine-year mean annual number of deaths by firearm is 79, of which 62 (79%) were by suicide, 9 (12%) the result of criminal endeavour, 0.7 (1%) by legal intervention and 4.2 (5%) by accidental (unintentional) means. (A further 3 (3%) were unable to be identified between intentional and unintentional shootings).

The segregation of firearm casualties into those arising from non-intentional misuse, as distinct from intentional misuse (as happens in suicides and in crime, for example) may seem artificial but is important when devising programmes to reduce casualties from one factor of misuse such as accidents. It is the prime function of NZMSC to reduce casualties from unintentional incidents in all facets of outdoor recreation.

While the older data are more likely to be affected by the inclusion of intentional shootings such as suicide attempts, this is less likely as we proceed along the historical timeline to the present. The proportion of fatalities to overall casualties has changed since the 1960s when fatalities were first segregated from non-fatalities. The ratio of fatalities to overall casualties was, for the ten-year period 1960 – 1969, 22.5%. For the latest available decade (1995 – 2004) this percentage was 23.2%. The distribution of the ages of the victims has changed slightly since the start of the period.

Two trends are discernible when the historical series of casualties is plotted against calendar years: there is a plateau generally from 1935 to approximately 1972. The advent of NZMSC firearm safety programmes could be argued to have begun to take effect from the late 1970s, when compulsory testing took effect after its introduction three years earlier.[2] A decline in casualties, coinciding with the aftermath of the introduction of shooter licensing in 1984 lead to a lower plateau post-1988, indicative of a lower casualty rate. This appears to be ongoing to the present.

During the study period (1935 – 2004), NZ population has increased from 1.5 million to 4.1 million. The number of firearms imported has risen from almost 365,000 to nearly 1.3 million (Thorp, 1997). The ratio of firearms per capita has increased from 0.236 to 0.311.

In earlier research (Forsyth 1985), 184 arms accidents were noted over the three year period 1981 - 1983, an average of 61.3 arms accidents per year. For the 13 year period 1988 - 2000, 154 accidents took place, with 158 casualties, an average of 12.1 per annum. For the most recent triennium for which accident data are available, (2001-2004), 30 casualties arose from accidents, an annual average of less than 10 per year, NZMSC (2005).

The remainder of Part I will document the changes in the monthly distribution of arms accidents, the age of the victims and of the 'perpetrators', and will provide an analysis of the main safety rules violated in reported arms accidents.

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[2] This is debatable because figures for the number of candidates facing their firearms safety knowledge

FEATURES OF FIREARM ACCIDENT CASUALTIES:

OVERVIEW

While information about the firearm 'pool' of yesteryear is lacking, recent information shows some 1.1 million firearms in NZ, of which 43% are rifles, 29% are shotguns, 25% are airguns and 3% are handguns. The proportion of firearms per capita has steadily increased from 0.236 to 0.311, because of firearm imports exceeding the population growth rate[3]. The age distribution of arms accident casualties has changed slightly, with the age for accumulated 50 percentile casualties increasing from 25 years (1930 to 1966 and early 1980s data) to 30 years (1987 to 2004).

Steady improvements in firearm safety, arising from training programmes particularly those instigated since the inception of the NZMSC (Inc) in 1965, and arms owner licensing requirements dwelling upon user suitability (since 1984) culminating in the improvements effected by the Arms Amendment Act (1992) have lead directly to reductions in arms accidents among law abiding users of legal firearms.

Almost half (46.7%) of the most recent data about arms accidents involve rifles, more than a fifth (21.0%) involve shotguns and a lesser percentage (almost 8%) involves handguns. Airguns feature in almost 6% of all arms accidents.

The steady decline in the proportion of cartridge-firing rifles in accidents is one feature which perhaps merits comment. It is possible that users of such firearms are more likely to have taken the trouble to acquaint themselves with the details of safe firearm handling than users of firearms which have not shown such a decline in accident involvement.

The involvement of "other" items, technically munitions but not firearms in common sporting use, have sadly have featured in accidents to a greater extent than before. This group includes an anti-tank missile, a rifle grenade explosion and small arms

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tests were not recorded until 1979.
[3]Firearm attrition rates are not known but we make some assumptions during the empirical analysis in Part II.

ammunition being unlawfully dismantled in separate incidents. These are highly likely to lead to casualties because when professionals have difficulties with deactivating munitions, amateurs face little chance of emerging unscathed from such endeavours (and it is mainly amateurs who make these attempts).

The emergence of the 'not stated' firearm type reflects deficiencies in the data collection.

WHERE DID THEY HAPPEN?

TABLE A: LOCATION OF ARMS ACCIDENTS

Study Period	1970-1972		1981-1983		1988-2000	
Where	Total	%	Total	%	Total	%
Home (includes surroundings)	165	55.0	71	38.6	19	12.1
Field (includes arms ranges)	86	28.7	65	35.3	100	63.7
Street (includes public places)	18	6.0	9	4.9	-	-
Vehicle (includes boats)	21	7.0	-	-	8	5.1
Workplace (includes farm)	-	-	22	12.0	-	-
Other (includes not defined)	10	3.3	17	9.2	30	19.1
Total	300	100	184	100	157	100

NOTES: Sources: NZDA (1973), ACC (1981) & NZMSC (2005). The location headings differ slightly from those used in the early 1980s. The arms accidents which took place on ranges involved only handguns during the study periods 1981 - 1983 and 1988 - 2000. We are interested in comparing the composition of location of accidents in the table - comparing absolute totals over different periods of time is not relevant.

NZ Mountain Safety Council data in *Table A* shows the places where firearm accidents took place. These accident sites reflect the modes under which firearms undergo most of their actual handling and use; hunting (field), storage (home) and transport (vehicle/boat).

A major change in the venues for arms accidents is apparent: the percentage of firearm accidents taking place in or around the home is reduced to approximately a quarter of its level in the early 1970s. However, the proportion of accidents happening in the field has increased to over half of the firearm accidents, although the inclusion of arms range accidents (involving handguns on ranges approved for pistol use) has increased the reported incidence of "field" accidents.

The reduction in casualties from arms accidents around the home and involving transport such as vehicles and boats could be attributed to changes in arms laws which, since the early 1990s, have more strictly specified the need for secure storage.

It is difficult to demonstrate a causal relationship between any campaigns (whether legal, enforcement or educational). However, it is tempting to speculate that well-intended (and considered) education programs have 'done their bit' to sharpen the awareness of those most exposed to arms accidents. This would include arms owners and their immediate families. The contribution of sound laws may be a factor as well, particularly with the security requirements which law abiding arms owners must observe. We investigate this more formally in the empirical section.

That fewer become casualties from cartridge firearms is shown by the dominance of single figure annual fatality reports and by the reduction in the rate of firearm casualties from a high of 0.48 per 100,000 (in 1988) to an average for the past five years of 0.29 per 100,000.

WHEN DID THEY HAPPEN?

Table B is the result of an analysis of three years (1970 - 72) involving 300 incidents:

TABLE B: TIMING OF ARMS ACCIDENTS

Time of day (24 hour clock)	Number	Percentage
0600 - 1800	169	56.3
1800 - 2400	82	27.3
0000 - 0600	21	7
Unknown or not stated	28	9.3
Total	300	99.9

Source: NZDA (1973)

The division of a twenty-four hour day into three eight hour periods in *Table B* appears to be quite arbitrary and has not been followed by later research. Further analysis by O'Leary and McMillan (2002) shows that of a sample of 153 accidents which took place during the period 1988 - 2000, 92 of them (60.1%) took place in daylight, 13 (8.5%) happened during the hours of darkness and 48 (31.4%) were not identified as being day or night-time accidents.

From NZMSC data (1988 - 2000), 7.8% (10 incidents, 12 victims) appear to be workplace accidents. The nail gun incident, those featuring Police shootings and the three soldiers injured by a rifle grenade are believed to be workplace accidents, inferred from the available information.

Non-work (or inferred to be non-work) accidents numbered 140, 91.5% of those examined. Just 4 (2.6%) were not clearly identified or were not stated, featuring illegal firearms or people who were unlikely to be licensed arms owners. Most night-time shootings suggest spotlighting, but this is conjectural.

The first period in *Table C* is of four years duration, the second is of some 17.5 years duration (the accident record began mid-year). Changes in the monthly distribution of accidents (which were derived by noting the calendar month of occurrence) shows that March is no longer a ‘peak’ month for arms accidents during the more recent study period. Additionally, while May remains a ‘peak’ month, April has also become one as well. Game bird and waterfowl seasons in NZ begin in May and run through until the end of June for avian species recognised as "game" under NZ wildlife legislation. Animals such as deer and pigs, being introduced are generally hunted throughout the entire year.

The monthly 'peaking' in observed arms accidents coincides with the onset of the 'roar', the deer mating period (when males generally lose some of their caution in their quest for females). In NZ this is usually in April, but may begin late in March. The game bird and waterfowl season begins the first weekend of May; both of these coincide with, for the early 1970s, over a third of all arms accidents and for the 1987 - 2004 period, almost 40% of all that were reported.

Otherwise, little evidence of seasonal 'peaking' is evident, although before the onset of market reforms in the late 1980s, such peaking tended to coincide with the Christmas New Year holiday periods and is reflected in the older data in *Table C*.

TABLE C: MONTHLY DISTRIBUTION OF ARMS ACCIDENTS

Study Period	1969-1972		1987-2004	
Month	Average Number	%*	Average Number	%
January	27	7.7	16	8.0
February	23	6.6	13	6.5
March	38	10.8	12	6.0
April	26	7.4	31	15.4
May	35	10.0	33	16.4
June	30	8.6	15	7.5
July	23	6.6	16	8.0
August	27	7.7	9	4.5
September	28	8.0	14	7.0
October	29	8.3	16	8.0
November	29	8.3	13	6.5
December	36	10.3	13	6.5
Total	351	100.3	201	100.0

NOTES: Sources: NZDA (1973), NZMSC (2005). * Rounding to one decimal place has introduced some small errors which show in the total percentage. We are interested in changes in the monthly distribution of accidents in the table - comparing absolute totals over different periods of time is not relevant

Possible reasons for these shifts include changes in seasonal weather patterns (which affect the timing of holidays), an increase in paid holidays (from two to three weeks annually) and a wider variety of holiday options in terms of accommodation and recreational opportunities.

WHAT FIREARMS WERE INVOLVED?

A knowledge of the firearms involved would seem to be useful for identifying factors contributing to accidents. Unfortunately, without being able to gain insight into the makeup of the pool of firearms (past and present) in New Zealand, it is difficult to offer quantifiable data, despite the efforts made by Thorp (1997) made to gauge the number and type of firearms in NZ.

Table D provides a breakdown of the composition of reported accidents by firearm type. We see a decline in the proportion of rifle-related accidents over time but note that this coincides with an increase in the proportion of accidents involving unspecified firearms.

TABLE D: FIREARM TYPES IDENTIFIED IN ARMS ACCIDENTS

Survey Period	1969-1972		1973-1974		1981-1983		1987-2004	
Firearm Type	Number	%	Number	%	Number	%	Number	%
.22 rimfire	174	49.6	41	43.6	-	-	29	14.9
Centrefire	87	24.8	22	23.4	-	-	31	15.9
Rifle Total*	**261**	**74.4**	**63**	**67.0**	**100**	**54.4**	**60**	**46.7**
Shotgun	72	20.5	22	23.4	76	41.3	41	21
Unspecified firearm	-	-	-	-	-	-	29	14.9
Handgun*	5	1.4	-	-	8	4.3	15	7.7
Airgun*	12	3.4	8	8.5	-	-	11	5.6
Other*	1	0.3	1	1.1	-	-	8	4.1
Total	351	100	94	100	184	100	195	100

NOTES: Sources: NZDA (1973), Walsh et al (1975), ACC (1981), NZMSC (2005). Figures in bold are subtotals. * Includes all cartridge-firing handguns, may include air- and gas-pistols. We are interested in changes in the composition of accidents by type of firearm type in the table - comparing absolute totals of accidents over different periods of time is not relevant

Shoulder Arms ('Longarms')

The unregistered longarms, the rifles, shotguns and airguns in common sporting use are involved in more than 80% of the accidents yet are more than 97% of the NZ firearm 'pool'. They are under-represented when their preponderance in the firearm 'pool' is considered.

Accidents with Rifles

The appearance of rifles can hardly be a surprise when, comprising some 43% of the overall firearm pool, they feature in almost 47% of the accidents. New firearm users generally begin with a rimfire rifle before gaining more experience and venturing into the back country in pursuit of larger wild animals like deer. Rimfire rifles are widely used for pest control including recreational rabbit hunting.

Users of centrefire rifles tend to be more experienced. Nugent's (1989) report does not support this because he found that big game hunters (who use centrefire rifles) "retire" slightly earlier than small game hunters perhaps because of the more strenuous nature of their recreation. He also noted that the percentage of big game hunters less than 25 years old appeared to have decreased slightly. Nonetheless, earlier studies suggest that rimfire rifles feature in more arms accidents than other firearms, and the young (up to the age of 20 years) are represented to a greater extent than other age-groups.

Shotgun Accidents

Shotguns, some 29% of the overall firearm pool, feature in 21% of the accidents. These are in proportion with the firearm types found in NZ use but unlike rifles, there is a more pronounced seasonal aspect to their use in the game field.

Airgun accidents

Langley et al (1996) investigated airgun accidents for the years 1979 - 1992. In this fourteen year period they found that the airgun injury rate is less than 1.6 per 100,000. These data are for 718 inpatient hospital discharges, of which 96% (689) were unintentional, 2.2% (16) were intentional and 1.8% (13) were ‘undetermined’. Their data shows an annual average of 51.3 airgun accidents.

“Airgun injuries, while not as serious as powder firearm injuries, account for a significant personal and societal burden. The results suggest strategies aimed at controlling these injuries, especially those pertaining to children, are in need of review”, Langley et al (1996, p.117).

Airgun incidents continue to decline, from a three-year average of 1.65 per 100,000 (1979 - 1981) to 1.27 (1990 - 1992), Langley et al, 1996. Once again, the existence of established training programmes in the basics of safe firearms handling is suggested as the main reason for the decline.

Airgun accidents are more likely to involve people who have not benefited from NZ Mountain Safety Council firearm safety instruction programmes. This is because for those aged 18 years or over, a firearm licence is not required. Although some encouragement is given to prospective, non-firearm licensed purchasers to undergo such training, many choose not to undergo these brief but valuable courses. The completion of this course is mandatory for any intending firearm licence applicant.

Handguns

It is the handguns which provide a surprise. Although only 2.6% of the overall firearm pool, they feature in 15.5% of the accidents. Despite very close controls, including individual handgun registration, firing permitted only on police approved ranges and the owners requiring endorsed arms licences to possess them, handguns are over represented in table of arms accidents.

An analysis was performed on the seventeen accidents which involved handguns for the seventeen year period 1987 - 2004. The only two fatalities took place in 1988 and 1991 where considerable foolishness can be inferred from the brief descriptions of the circumstances. Of the remaining 15 casualties, eleven occurred from 1995 onwards. There have been no reported accidents with handguns since 2000.

NZMSC data shows handguns feature in 3.6% fatalities for the period 1988 to 2000, and in 9.6% of the total firearm casualties for that thirteen year period.

The increase in handgun accidents may be attributed to the acceptance of handling techniques (involving the use of holsters, for example). Changes to police equipment which took place from 1995 onwards lead to some accidents as officers became acquainted with a new handgun. That these officers feature in accidents is perhaps less surprising when all 7,000 of them must undergo at least two range shoots annually, yet only a few of them (perhaps 10%) could be regarded as experienced arms users in the sense they belong to recreational shooting clubs (their shiftwork often precludes much active involvement in such organisations anyhow).

HOW - The Main Factors

An analysis of the incidents on the basis of the seven basic rules of firearm safety reflects some key issues of the events leading up to an accidental shooting. Heedless action is a key factor here.

The NZMSC information (NZMSC 2005) for arms accidents for the thirteen year period 1988 - 2000 was analysed in terms of departures from the Seven Basic Rules of firearm safety (O'Leary and McMillan 2002). These data derive from 154 incidents and 158 victims. Each incident was considered and up to three firearm handling errors (in terms of the Seven Basic Rules) were identified. This resulted in 208 factors being sorted. The firearm handling errors were ranked in terms of their perceived contribution to the accidental shooting incident. The contravention of these rules is not mutually exclusive and as such attribution of the primary rule 'broken' contains an element of subjectivity.

Most of the factors (38.9%, 81 incidents in number) featured failing to always point the firearm in a safe direction, a violation of rule No 2. Failing to treat every firearm as loaded was identified 21.in 21.2% (44 incidents) and failure to properly identify the target was found in 15.4% (32 incidents).

TABLE E: Factors In Firearm Accidents 1988 - 2000; "Failures to observe"

Basic Rule Number	1970 - 1972 Number (%)	1988 - 2000 Number (%)
1	83 (20.0)	44 (21.2)
2	34 (8.2)	81 (38.9)
3	113 (27.2)	19 (9.1)
4	17 (4.1)	32 (15.4)
5	25 (6.0)	17 (8.2)
6	88 (21.2)	2 (1.0)
7	7 (1.7)	4 (1.9)
'Other'	48 (11.6)	9 (4.3)
Total	415 (100)	208 (100)

Sources: NZDA (1973), NZMSC (2005).

Table E shows the complete breakdown of this analysis. 'Other' refers to incidents such as the dismantling of ammunition which while not strictly a failure to observe any of the Seven Basic Rules is a departure from common-sense when expertise is deficient. A possible suicide is also included within this category.

THE VICTIMS

Gender Pattern

For the period 1988 - 2004 (NZMSC, 2005), twelve (6.0%) of the 201 casualties are female. With something like half of all people around the home female, it is perhaps no surprise to find that of the 'home and environs' accidents, six of the 19 had female victims. The rarity of females involved in hunting and the relative safety of range shooting where female participation is far greater, (but still only approximately 25%) ensures they almost never become victims of accidental shooting.

Age of Those Involved

Information on the ages of those involved in arms accidents is generally limited to that of the victims. Only rarely is any light shed upon the age of the, for want of a better term, the 'perpetrator'. Information was gathered for one year only, the calendar year 1972; that for victims is for the years 1969 to 1972. These data are presented in *Table F*.

TABLE F: AGES OF SHOOTERS AND OF THEIR VICTIMS

Age Group of Shooter	No.	%	Age Group of Victim	No.	%
0 - 10	6	5.5%	0 - 10	21	6.2%
11 - 15	9	8.3%	11 - 15	49	14.4%
16 - 20	28	25.6%	16 - 20	80	23.5%
21 - 30	25	22.9%	21 - 30	82	24.1%
31 - 45	10	9.2%	31 - 45	43	12.6%
Over 45	31	28.4%	Over 45	65	19.1%
Total	109	100.0%	Total	340	100.0%

From the data in *Table G* it appears that males between the ages of 10 and 25 are at greatest risk from arms accidents.

TABLE G: AGES OF VICTIMS OF ACCIDENTAL SHOOTINGS 1988 - 2000

Age (Years)	No.	%	Cumulative %
0 - 10	8	5.5	5.5
11 - 15	28	19.3	24.8
16 - 20	17	11.7	36.5
21 - 25	19	13.1	49.6
26 - 30	7	4.8	54.4
31 - 35	10	6.9	61.3
36 - 40	8	5.5	66.8
41 - 45	9	6.2	73.0
46 - 50	3	2.1	75.1
51 - 55	3	2.1	77.2
56 - 60	1	0.7	77.9
61 - 65	2	1.4	79.3
66 - 70	1	0.7	80.0
71 - 75	1	0.7	80.7
76 - 80	1	0.7	81.4
81 & over	1	0.7	82.1
Not stated	26	17.9	100.0
Total	145	100	

The Hazard

The trend in arms accident casualty rates, irrespective of data sources, is downward, and has been so since the early 1950s. The wounding potential of firearms is a function of the power and the capacity for doing ‘work’. It is relatively constant over time and the composition of the firearm ‘pool’ may have changed slightly but the extent of his change remains unknown. (The proportion of the total firearm pool made up by the five broad types of firearm, namely airgun, rimfire rifle, handgun, shotgun and centrefire rifle, in approximate order of increasing ‘power’.

It is also likely that the advent of formalised firearm safety training programmes have reduced the errors in firearm handling which are the main contributors to accidental shootings. It does not reflect a decline in the wounding potential of firearms.

The wounding potential of firearms will be explored later along with some comment about “lethality”. This is the ‘risk of death’ but is sometimes obscured by emotive issues arising from the treatment afforded this topic by the entertainment industry.

The real hazard may be quite simply put: “How does the number of casualties from accidents with firearms compare with those arising from other causes in our society?”

The Risk of Death

Deaths from all causes in NZ annually approximate 28,000 (741.1 per 100,000 population). Of these, some 1,200 (33.3 per 100,000) fall victim to death by accidents, poisoning or violence for the three most recent years available (1995 - 1997). This is approximately 4.4% of all annual fatalities. The fatality rate from arms accidents was, for the five years 1935 - 1939, 3.9 per 100,000.

As the overall casualty rates have declined for arms accidents, so has the fatality rate. After the figures were first segregated in 1960, the annual fatality rate was 0.44 per 100,000 for the decade beginning 1960. For the decade ended 2004, the annual fatality rate was 0.07 per 100,000 population. This is a significant decline which is noticeable from about 1980 onwards.

The difference between an injured casualty becoming a fatal one is dependent upon such mundane factors as the rapidity with which it can be admitted to hospital, and not necessarily the severity of the injuries (although of course these remain a factor in the survival of any casualty).

Reducing the casualties

The market reforms of the late 1980s have lead generally to a six day working week for many New Zealanders, and to some extent, the casualisation of the workforce. This has reduced leisure time and so the time available for recreational pursuits of all kinds. If there is less time available for recreational pursuits involving firearms, such as collecting, researching, restoring and using them on the game fields and on arms ranges, then arguably there is less opportunity for their misuse in accidents.

Reduced leisure time, the reduction of opportunity for leisure in general might well be considered to have contributed to the decline in arms casualty rates particularly since the late 1980s. Legislative changes, particularly those arising from the Arms Act (1983) and the Arms Amendment Act (1992) are considered to have made major contributions towards arms accident casualty reduction, by both ensuring the suitability of arms owners and by enforcing storage requirements for firearms and ammunition.

Trend in Casualties

The trend in arms accident casualty rates, irrespective of data sources, is downward, this trend beginning in the 1950s and being more obvious since the 1970s.

The reasons for this long-term decline are many. These include the reduction of travel times arising from highway improvements and the availability of aerial rescue facilities, improvements in ambulance services and in more widespread knowledge of the basics of first aid. Emergency medical services continue to offer more improved treatments and are more readily available.

It is also likely that the advent of formalised firearm safety training programmes have reduced the errors in firearm handling which are the main contributors to accidental shootings.

Trends in victim age

Changes from observations derived from ACC data in the early 1980s (Forsyth, 1985) shows that the percentage of the very young (less than 16 years, the minimum lawful age for firearm possession) has increased from just over 16% to become almost 25% of the casualties.

Almost half of the casualties were aged 25 years or less, another change in the age distribution from that observed almost two decades earlier. Then, for a similar percentage of victims, the age was 20 years or less. This suggests an ageing population of shooters.

CONCLUSIONS

Irrespective of these data sources, the annual trend is downward, a reflection of (among other things) improvements in the quality of emergency medical services. It does not reflect a decline in the wounding potential of firearms because this is comparatively constant over time.

We noted the changes in the monthly distribution of arms accidents, of the age of the victims and of the 'perpetrators', and an analysis of the main safety rules violated in reported arms accidents.

The annual casualty data for accidental shootings is widely variable (NZ Deerstalkers' Association, (1974)), NZ Mountain Safety Council, (2005) and the data is a little inexact (Forsyth, 1985), particularly before 1980 (Scott, 2005 unpublished), more so before 1960.

When the historical series of casualties is plotted against calendar years there is a plateau generally from 1935 to approximately 1972. The advent of NZMSC firearm safety programmes could be argued to have begun to take effect from the late 1970s, when compulsory testing of elementary firearm safety knowledge took effect after its introduction three years earlier.[4] A decline in casualties, coinciding with the aftermath of the introduction of shooter licensing in 1984 lead to a lower plateau post-1988, indicative of a lower incident rate. This appears to be ongoing to the present.

The reduction of firearm accidents from one a week, to the present-day frequency of one a month, is significant. The involvement of NZ Mountain Safety Council programmes in firearm safety has had some discernable impact upon the frequency of such incidents over the long term. This suggests that the NZMSC safety programmes in the longer term been very successful.

[4] However, figures for the number of candidates facing their firearms safety knowledge tests were not recorded until 1979.

Part II: Empirical Analysis: Modelling Accidental Firearms Casualties in New Zealand: A Cointegration Approach

This section reports preliminary results based on a formal multivariate time series analysis of the relationships between aggregate (macroeconomic) proxies and accidental casualties.[5] More technical details are in a preliminary manuscript which is available from the authors, the abstract of which, follows:

> *In this study we construct and estimate a parsimonious model of accidental firearms casualties in New Zealand over the period 1960-2004 using a cointegration approach. We find that casualty rates per head of population are positively related to economy-wide income and the total percentage of the population that is male and aged between 10 and 25, and in another specification of the model, beer consumption per head. Further there is strong evidence that casualty rates have significantly fallen following the Arms Act 1983, and its amendment in 1992 which also coincided with compulsory breath testing for motorists, by approximately 40% and 30% respectively. From these results we conclude that whilst the legislative changes have led to a prolonged and sizeable reduction in casualty rates, we may need to include more specific information on variables reflecting resources devoted to firearms safety over the sample period in the model to fully account for the negative correlation between the stock of firearms and casualty rates.*

Figure One disaggregates total firearms casualties rates per 100,000 head of population into deaths and injuries over the period 1935-2004. We see a steady downward trend and reduction in volatility across all three series over time.

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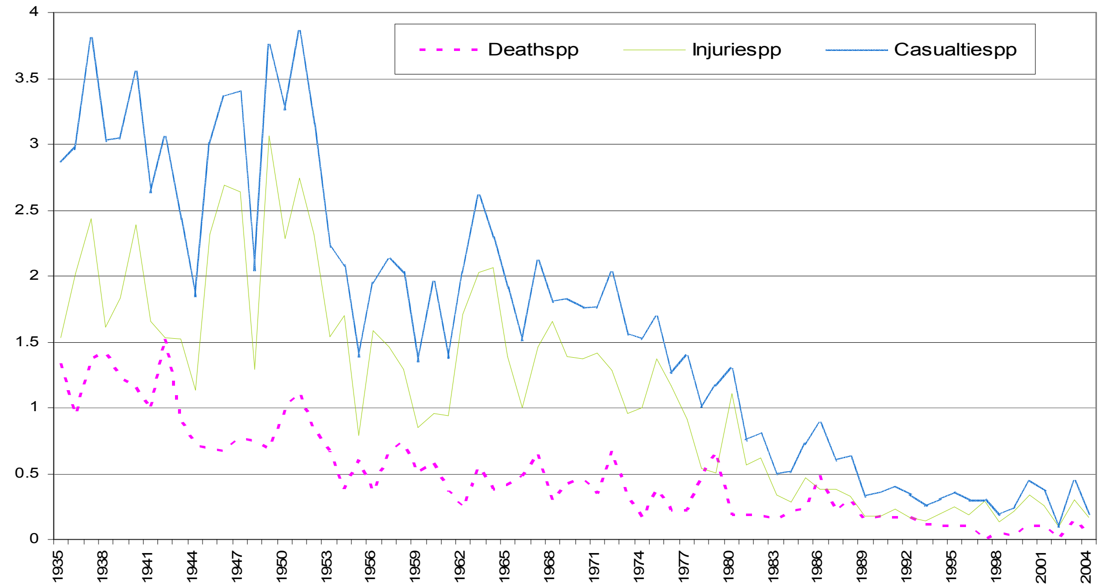
[5] This greatly extends on the univariate and pair wise approaches taken in many studies.

Figure One: Accidental Fatal and Non-fatal Casualty Rates: 1935-2004



Source: NZ Police, NZDA and NZ Mountain Safety Council (Inc)

To attempt to explain the behaviour of the total casualties' series two complementary specifications are estimated:

$$\ell ncas_t = \phi_1 + \phi_2\, \ell nGDP_t + \phi_3\, \ell nMPOP1025_t + \phi_4\, \ell nStock_t + \phi_5\, DARMS_t + \phi_6\, D1993_t + v_t \qquad (1)$$

$$\ell ncas_t = \beta_1 + \beta_2\, \ell nGDP_t + \beta_3\, \ell nMPOP1025_t + \beta_4\, \ell nStock_t + \beta_5\, DARMS_t + \beta_6\, \ell nBEER_t + \varepsilon_t \qquad (2)$$

where $\ell ncas$ is the natural logarithm of total annual firearm accident (unintentional) casualties per head of mean population of New Zealand in each year. The data was provided by NZ Police, NZDA and NZ Mountain Safety Council (Inc) and covers the period 1935 to 2004. The data excludes suicides. Our initial analysis is conducted over the period 1960-2004 because of the different structure of the series over the WWII period. Further, we model total casualties (the sum of deaths and injuries) instead of the death rate only for two reasons. Firstly, we are primarily interested in firearm *safety* issues and secondly exogenous medical advances may imply a lower death rate. As such we are not investigating the link between firearms and violent crime.

$\ell nGDP$ is the natural logarithm of gross national product of New Zealand and is intended to proxy a range of influences such as: the ability to purchase firearms, summarise the potential changes in behaviour of individuals as standards of living improve such as an increase in availability of television and other rival leisure activities. We acknowledge with such a complex variable the linkages are far from clear.[6]

To get a sharper measure of the segment of the population that is at 'greater risk' we include the proportion of the population that is (i) male and (ii) male and aged between 10 and 25 (to get sufficient variation). Because there is a relative lack of variation in the former over the sample period we go with the latter: $\ell nMPOP1025$. The age distribution of the population broken down by gender is taken from New Zealand Official Year Books from 1935 to 2005.[7] We choose this age band because this is the highest percentage involved in firearms accidents, whether victim or 'perpetrator', see Forsyth (1985, Graph 1D, p.11 or *Table G* in Part I). Further Cherry et al (2001) in reviewing 390 unintentional shooting deaths in North Carolina (USA) over the periods 1985-94 and 1979–82 find that 15-24 year olds were the most likely age-group to feature.[8]

$\ell nStock$ is the natural logarithm of the cumulated value of total number of firearms imported. Total firearms in circulation would tend to incorporate the price of firearms ie: would adjust if the price was a sufficient deterrent to demand. We make three assumptions in calculating the value of this variable:

1. The decay rate of stock in 1880 is at 5% exponential rate per year
2. The decay rate of imports from 1935 to 1948 is at 2% exponential rate per year
3. Depreciation rates are zero from 1948 onward due to non-corrosive ammunition.[9]

[6] In work in progress we are collecting data on variables capturing number of hours worked per week which incorporates reduced leisure time, hourly wage, television coverage across NZ etc.

[7] $\ell nMPOP1025$ is not a truly continuous variable, taking constant values in years where data was unavailable, but we take the natural logarithm anyway so coefficient can be interpreted as an elasticity.

[8] Similar results were obtained using age band 15-30 years.

[9] These rates were implied after a personal communication with Grant Sheriff.

There is strong evidence on the presence of significantly positive relationship between access to guns (as proxied by the stock in circulation) and various measures of firearms casualties. LaFollette (2001) claims that widespread firearm availability is demonstrably linked to increases in firearm homicides, suicides and accidental deaths whilst Rushforth et al (1974) and Chapdelaine and Maurice (1996) find significant correlations between access to guns and risk of death in the US and Canada respectively.

We collected data on three alcohol variables: $\ell nBEER$ $\ell nWINE$ and $\ell nSPIRITS$, defined as the total amount (in litres) of beer, wine and spirits available for local consumption and is calculated as production plus imports less exports. These data are taken from New Zealand Official year books from 1935 to 2005, Forsyth (1985) and Statistics New Zealand.[10],[11] In international studies the effects of alcohol is mixed; Ornehult and Eriksson (1987) found that alcohol was not a key factor in Sweden, whilst Rushforth et al (1974) found evidence to the contrary in their study of firearm accidents in Cleveland, Ohio. Due to the strong collinearities within the alcohol variables we only include $\ell nBEER$ in the model.

We also include two dummy or indicator variables to see how legislative changes have affected casualty rates. The first variable, $D1983$, takes a value zero for years from the start of the sample up to 1983 and assumes a value of unity thereafter. This is intended to account for the effect of the Arms Acts 1983, which abolished registration of shoulder arm firearms and introduced lifetime shooter licensing. We anticipate a drop off in casualty rates post-1983 Act hence a negative coefficient on $D1983$.

The second variable, $D1993$, is similarly defined taking a value zero for years from the start of the sample up to 1993 and assumes a value of unity thereafter. This is intended to account for the 1992 Arms Amendment Act which, *inter alia*, (a) abolished the lifetime arms licence, (b) instituted the ten-year licence, (c) increased

[10] http://www2.stats.govt.nz/domino/external/pasfull/pasfull.nsf/0/4c2567ef00247c6acc256fac00084f9b/$FILE/Alltabls.xls

[11] Details about changes in the strength of percentages content of alcohol. Values over the period 1982-1988 were imputed from consumption of absolute alcohol reported in various Year Books.

fees per licence (arguably placing more impediments in the path of prospective licensed arms owners by making it more expensive), (d) set specific secure storage requirements for all licensed arms holders before the granting of a licence, (e) created a new class of firearm which required another class of arms licence (for lawful possession) allied with stricter storage requirements, more references and set other conditions on lawful possession and use; and (f) restricted mail-order sales etc. This year also coincided with compulsory breath testing and the launch of Fish and Game Magazine.

Empirical Methodology

The accompanying slides summarise the key points of the empirical methodology.

As we are dealing with time-series data, before we can estimate (1) and (2) we need to investigate the order of integration of each series as the results can affect the choice of estimation technique. In particular, we need to determine whether each variable is either integrated of order zero (I(0), i.e., the series' data generating process is stable, or 'stationary' over time), or integrated of an order greater than zero (i.e., the variable is 'non-stationary'; its mean, variance and/or autocorrelation function changes over time).

The test for stationarity most commonly applied in the empirical literature is the augmented Dickey-Fuller (ADF) test. The ADF test, however, is known to suffer from size distortions and it has low power in finite samples (Maddala and Kim, 1998, Ch. 4). Therefore, we choose to employ the generalised least squares version of the Dickey-Fuller test (DF-GLS) proposed by Elliot et al. (1996) instead. They show that, when a deterministic mean or trend is present in a series, DF-GLS is considerably more powerful than the standard ADF test. Details of the application of the DF-GLS test are available in the manuscript.

The DF-GLS test results for all variables contained in our data set – except the dummy variables – indicate that the regressors are a mixture of I(0), I(1) and I(2) so that cointegration (that a linear combination of the non-stationary variables are stationary) cannot be ruled out *apriori.*[12]

The implication of these unit root test results is that we should not estimate (1) and (2) using ordinary least squares (OLS), as a regression involving non-stationary variables normally results in non-stationary residual terms, violating one of the key assumptions underlying OLS. In such a case, the *t*- and *F*-statistics generated will not follow their standard distributions and, even if the variables were found to be highly correlated, the possibility that their relationship is entirely spurious cannot be discounted (see Yule, 1926; Granger and Newbold, 1974; Phillips, 1986). To deal with this problem, it is necessary to establish whether or not (1) and (2) represent valid cointegrating vectors. In other words, does a linear combination of the non-stationary variables in our model exist that is itself stationary? Given the DF-GLS results above this is possible. If such a vector exists, it implies there is a stable, long-run equilibrium relationship between the variables in equations (1) and (2) and that this relationship will correspond to a 'valid' error correction model (ECM), (Engle and Granger, 1987). If cointegration cannot be found, this implies our model is, at best, under-specified in that it omits at least one relevant non-stationary variable (a strong possibility).

In order to assess whether or not our models of casualty rates represent a valid cointegrating vector, we employ an error correction framework (ECM) proposed by Engle and Granger (1987) which is in two steps.[13] Step one involves estimation of the proposed cointegrating vector (i.e., equations (1) and (2)) using OLS. The nature of the estimated residual terms ($\hat{e}$) from this regression would, normally, then be evaluated using an ADF test with critical values that depend on the number of variables used to estimate $\hat{e}$. The usual problems with the ADF test statistic still apply here, however, and so we instead follow the approach advocated by Zivot (1994). This involves incorporating the lag of the estimated residuals in an ECM specified as follows:

$$\Delta \ell ncas_t = \mu + \lambda . \hat{e}_{t-1} + \sum_{i=0}^{m} \eta_i . \Delta X_{t-i} + \sum_{j=1}^{m} \phi_j . \Delta \ell ncas_{t-j} + \omega_t \qquad (3)$$

[12] More than one variable is integrated of order 2.
[13] Engle-Granger-Yoo propose a three-step estimation technique

where $\Delta \mathbf{X}' = [\Delta \ell nstock, \Delta \ell nGDP, \Delta \ell nMPOP1025, \Delta DARMS, \Delta D1993]$, μ is a constant, and $\lambda < 0$. The t-ratio for the estimate of the *error correction term* (λ) is then used to test for cointegration in (1) and (2). Ericsson and MacKinnon (2002) provide suitable critical values for this test.[14]

The results (reported in the manuscript and on the slides) indicate that both equations (1) and (2) represent long run equilibrium relationships; that is, there is a tendency to return to that 'state'.

Equation (1) indicates that casualty rates per head of population are (i) positively related to GDP, the percentage of males aged between 10 and 25, and beer consumption per head; (ii) negatively related to the firearms stock (*so we need more variables in the model, ie: spending, drinking age etc. to account for this*); and (iii) have significantly fallen following the Arms Act 1983

From the dynamics of the estimated ECM we can trace out the transition path of casualties to its new lower level following the Arms Acts 1983 (see accompanying slides).

The results from equation (2) are consistent with (1) and indicate that casualty rates per head of population are (i) positively related to GDP, and the percentage of males aged between 10 and 25; (ii) negatively related to the firearms stock (again we may need more variables in the model to account for this); and (iii) have significantly fallen following the Arms Act 1983, and 1993 which coincides with Arms Act 1992 amendments and compulsory breath testing.

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[14] However, even if evidence of cointegration is found, a problem still remains. Specifically, while the estimates of (1) and (2)'s coefficients found in the initial step are 'super-consistent', in finite samples they are also biased due to the omission of short-run dynamics from the regression. Moreover, the distribution of these estimates is non-normal so that the usual t-ratio critical values are no longer appropriate (Harris, 1995, p. 56). In an attempt to correct these problems, Engle and Yoo (1991) propose a third step. This involves taking the estimated residuals of (3) and regressing them against the independent variables from (1) and (2) (these having been first lagged one period and multiplied by [minus] the previously estimated value of λ). The estimated coefficients obtained from this regression represent corrections to the biased estimates found in the first step. The standard errors associated with these corrections can be used to calculate t-ratios for the corresponding corrected estimates (Harris, 1995).

Preliminary Conclusions

Given the analysis above we make two points. Firstly, we note our inability to 'mop up' the negative correlation between casualty rates and firearms stock per person. Secondly, the large income elasticity estimates for the specification reflect that GDP is a blunt proxy and is capturing a complex range of influences. We suspect the inability to 'mop up' the negative correlation and the upwardly biased coefficient on GDP results from a lack of more refined variables in our model. In further work we would like to obtain data on a range of relevant factors that have changed over the sample period such as: spending on firearms safety programmes, number of firearms publications in circulation, changes in punishment for reckless use of a firearm, changes in the drinking age, number of hours in the working week etc. Further we would like to consider various aspects of the 'Arms Acts legislation' to activate policy advice. In order to do this we need to disaggregate the features of the legislation.

A final finding of note relates to our analysis of the impact of the legislative changes in 1983 and 1993 on casualty rates. Although the main impact of this shock was felt in the immediately following years, our results indicate that its influence was not entirely transitory, with casualty rates in general down by over 40% following the Arms Act 1983 (and 30% following its Amendment) on an ongoing basis.

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