Queen's Economics Department Working Paper No. 948

Standardized Mortality Ratios in Capitation Funding Models: Emipirical Issues from Canadian Data

Kelly Bedard John Dorland Allan Gregory Mark Rosenberg

Department of Economics
Queen's University
94 University Avenue
Kingston, Ontario, Canada
K7L 3N6

5-1997

Standardized Mortality Ratios in Capitation Funding Models: Emipirical Issues from Canadian Data

Discussion Paper #948

May, 1997

Kelly Bedard, John Dorland, Allan W. Gregory and Mark Rosenberg

ABSTRACT

Needs based capitation models have been suggested as an alternative to funding methods based on historical utilization patterns. The standardized mortality ratio (SMR) applied in conjuction with an age/gender adjustment is the most widely adopted measure of relative need. This paper addresses a number of important index construction issues using Canadian data. These include the influence exerted by the reference population (national versus provincial), the age structure (excluding people over 64 versus 74), the optimal period over which to average the SMR in order to smooth meaningless fluctuations, and the correspondence between SMRs, standard socio–economic indicators (i.e. unemployment, education, and income), health care 'need', and expenditures.

The authors thank the National Health Research and Development Program (NHRDP) for financial support. Bedard also thanks the Canadian International Labour Network (CILN) at McMaster University for financial support. We thank David Feeny, Paul Grootendorst, and the Queen's Health Policy Seminar participants for helpful comments, as well as Jeff Moon for data collection assistance.

Keywords: Capitation Funding, Standardized Mortality Ratios, Region, Age, and Gender

JEL Classification: I0, H51

Kelly Bedard, Department of Economics, McMaster University, Hamilton, Ontario, bedardk@mcmail.cis.mcmaster.ca.

John Dorland, Department of Community Health and Epidemiology Queen's University, Kingston, Ontario, dorland@post.queensu.ca.

Allan W. Gregory, Department of Economics, Queen's University, Kingston, Ontario, awg@qed.econ.queensu.ca.

Mark Rosenberg, Department of Geography, Queen's University. Kingston, Ontario.

1. Introduction

Regional health status disparities and inequitable health care access have led many to argue for funding mechanisms that lead to a more equitable distribution of resources. Capitation models have been suggested (and in some jurisdictions adopted) as an alternative to funding methods based on historical utilization. This funding method is fundamentally a population–based system of resource allocation. Resources are distributed to regions, or rosters, in direct proportion to population size. It is generally accepted, however, that relative resource needs depend on more than population size. Demographic characteristics, such as age and gender also influence regional health care requirements.

In practice, capitation models include adjustments beyond age and gender since there is wide spread agreement that age and gender alone do not adequately account for relative health needs. In an ideal world these 'need' adjustments would be made using prospective measures. Since no such measures exist capitation funding models must rely on retrospective indicators. The Standardized Mortality Ratio (SMR) is the most widely used retrospective measure. For example, it has been used in the United Kingdom, Finland, Canada, and Australia. The SMR is a single index number which compares the mortality experience of a given region's population to that of a reference (or base) population. Since a capitation model operates under a balanced (fixed) budget, the allocation formula is constructed to address relative, rather than absolute need. Everything else being equal, regions with greater relative health care requirements (higher SMRs) are therefore allocated relatively more resources.

Although reliance on the SMR to adjust for regional needs has been criticized, it is nevertheless widely used. The SMR is attractive because it is easily calculated, uses readily available data, and is difficult for interested parties to manipulate. However, it has been argued that the SMR is sometimes a poor proxy for morbidity, is biased towards deaths in older age groups, and that the implied one–to–one relationship between relative mortality rates and relative health care needs may be inaccurate.

Given the policy direction towards capitation funding models that incorporate an SMR adjustment, a complete understanding of the implications inherent in various SMR constructions is of considerable practical importance. For instance, excluding certain groups or using a different reference population can have a large impact on SMR measures.

While SMR construction is relevant for all countries, in this study we focus on the issues and difficulties associated with incorporating SMRs in capitation funding models using Canadian data. The Canadian case is particularly insightful since health care is, for the most part, entirely funded by the state and under the control of the provincial governments. Each province, subject to national standards and portability requirements, is free to develop their own health care system. The Canadian case, with its ten socio–economically diverse provinces therefore provides a good testing ground for investigating the use of SMRs in funding formulae.

The purpose of this study is to illustrate the time series properties of various SMR indices using Canadian data and to discuss their more general implications for capitation funding models. While we focus on the SMR, there are of course many other issues (not dealt with in this paper) that arise in moving from historical utilization to population–based funding. These include patient flows across boundaries in the case of geographic regions and cream–skimming in the case of rosters, the funding of existing infra–structure, program exclusion, and so on.

The remainder of the paper is as follows. Section 2 defines the SMR index and sketches its present use in selected countries. Section 3 uses maps to illustrate the differences between SMRs constructed using different base populations, age cut–offs and averaging periods across the Canadian Census Divisions (CDs) between 1986 and 1993. Section 4 examines the relationship between SMRs and standard socio–economic indicators such as regional unemployment rates, education levels, and income. Section 5 looks at the relationship between SMRs, health status, and current funding. Section 6 concludes.

2. Background: SMRs in Capitation Funding Models

An SMR compares the age/gender specific mortality rates for a given region to those of the base population. More precisely, a SMR compares the number of actual deaths that occur in region r ($r = 1, ..., R$) to the number of deaths that would be expected if region r experienced the same age/gender specific death rates as the base (reference) population.

$$SMR_r = \frac{RRMR_r}{(1/R)\sum_{r=1}^{R} RRMR_r} \qquad RRMR_r = \frac{\sum_{g=1}^{2}\sum_{i=1}^{n} d_{rgi}p_{gi}}{\sum_{g=1}^{2}\sum_{i=1}^{n} d_{gi}p_{gi}}$$

where, $RRMR$ = relative regional mortality rate, d = death rate, p = population, and i = age groups ($i = 1, ..., n$). The death rate is defined as the number of deaths in a specific region/gender/age group divided by the population of the specified group. In other words, p_{gi} refers to all individuals of gender g in age group i in the specified reference population (a province or the country as a whole). The SMR divides the $RRMR_r$ by the mean $RRMR_r$ in order to standardize the index. The average SMR is 1 and regions with below average mortality rates have SMRs below 1 and high mortality regions have SMRs above 1.

Capitation funding models can be constructed to adjust for specific factors, exclude programs, weight the re–distribution associated with certain factors and so on. In its most simple form a capitation funding model might simply distribute a fixed provincial or national budget (B), across regions according to the age/gender composition and need:

$$B = \sum_{r}^{R} \theta_r B \qquad \theta_r = \frac{SMR_r B_r^{a/g}}{\sum_r^R SMR_r B^{a/g}}$$

where, θ_r = the share of the budget allocated to region r. The share allocated to region r depends on population, age/gender composition, and relative need (SMR). It is important to keep in mind that this formulation is only one of many possible functional relationships between the SMR and the associated monetary transfer to a region.

The specific functional form in which the SMR enters a capitation funding model is important, and as of yet little work has been done to guide this decision. While the exact functional relation may differ from place to place (in the U.K. the square root enters the formula) all share the feature that a higher SMR for region r leads to more resources for that region. Of course the exact monetary transfer depends on the functional form. Rather than focus on the implied financial aspects, we step back slightly and examine the more basic problem of constructing the SMR index. SMR constructions that lead to substantially different indices (different age cut–offs for example) almost certainly lead to very different resource allocations under most functional forms.

It is worth noting that 'region' r can refer either to a geographic region or to a roster of individuals. However, most of policy discussions focus on geographic–based regional definitions and we follow this convention. One draw–back of geographic regions is that funding tensions arise when people cross boundaries to obtain health services. While roster schemes avoid cross–boundary accountability problems, they have other inherent shortcomings such as the incentive to select desirable, low cost individuals (cream–skimming).

There has been a significant movement towards capitation funding in many countries. The U.K., Australia, New Zealand, and Canada have, or are in the process of adopting needs–based funding to various degrees. The United Kingdom's Regional Allocation Working Party (RAWP) funding formula distributes resources to fourteen Regional Health Authorities (RHAs) which in turn allocate funds to District Health Authorities (DHAs). This model incorporates an age/gender adjustment as well as several socio–economic and morbidity adjustments. SMRs are included to reflect aspects of relative need not completely accounted for by age and gender. It is assumed that the SMR serves as a proxy for morbidity, which in turn, serves as a proxy for need. RAWP also includes an adjustment for inter–regional patient flows. In the absence of a flow adjustment, regions with outflows benefit to the detriment of regions with inflows. Refer to Raftery (1993), Carr–Hill and Sheldon (1992), Sheldon and Carr-Hill (1992) or Snaith (1978) for more detail.

In Australia, the health care resource allocation disparities between Sydney and the North and Central Coast areas prior to the 1990s were largely the result of a historical utilization based funding method which failed to account for recent demographic trends.

In the early 1990s New South Wales switched to a population–based Resource Allocation Formula (RAF) in an attempt to distribute health care services more equitably (Services Development and Planning 1993; and Gilbert et. al. 1992). However, like the RAWP model, the RAF was criticized for incorporating SMRs as a proxy for morbidity. The SMR was generally regarded as an poor proxy for health needs in New South Wales. RAF was revised in 1993 to include a composite SMR/socio–economic/rural–urban indicator.

The New Zealand Population Based Funding Formula (PBFF) was designed to allocate funds across four Regional Health Authorities (RHAs). As with all operational capitation formulas, the New Zealand model includes a needs adjustment. Unlike most models, New Zealand chose the Health Equity Quotient (HEQ) rather than the SMR. The HEQ is a rather complex statistical index (based upon principal component analysis) composed of socio–economic variables which were found to be related to need in New Zealand. However, few resources are actually re–distributed as a result of needs adjustments once age and gender are accounted for (Health Reforms Directorate 1992).

Although only a limited number of provinces have done so, there is pressure in Canada to move away from historical utilization–based funding and towards capitation–based funding. Saskatchewan recently instituted a capitation funding model (Driver 1994; and Strategic Planning Branch 1994). The model includes: age, gender, a supportive care indicator, and an acute care indicator (a variation on the SMR). Nova Scotia, New Brunswick, and British Columbia are also moving towards capitation–based funding.

3. SMRs in Canada

All analysis in this paper is conducted at the Census Division (CD) level because most of the policy discussions in Canada focus on geographic–based regional definitions. We use the 1991 CD definitions to identify regions. CDs were selected as the unit of measure because a reasonably long time series of both mortality and population are available for all provinces. We have mortality data from 1986–93 and population counts for 1986 and 1991

(Table 1 reports all data sources). All data are standardized to the 1991 CD definitions; two–hundred and ninety CDs which are further broken into five year age groups by gender (there are twenty–eight age/gender groups within each CD). All indices prior to 1990 use the 1986 population and all post–1990 indices use the 1991 population. It would clearly be preferable to use annual population figures, standardized to the 1991 CD definitions, but these were unavailable. However, one would expect that relative population growth is small compared to relative mortality changes.

3.1 Base Case: Provincial Base Excluding People over 74

Our analysis begins with the most commonly used SMR definition: the SMR restricted to individuals under 75 years of age calculated using provinces as the base population. Previous studies have employed the 75 year age cut-off because it has been found that the SMR for a population, excluding the elderly, is correlated with those types of morbidity that are associated with considerable medical costs (Eames, Ben–Shlomo and Marmot 1993; Mays, Chinn and Ho 1991; and Carstairs and Morris 1989c are examples). The provincial base is a natural starting point because health care is under provincial jurisdiction.

Unless otherwise indicated, all figures and discussions in this section pertain to 1993. We have selected 1993 because the data for this year appear to be more reliable than for previous years.[1] Figure 1 highlights several regularities. First, CDs with high Aboriginal populations (the northern CDs in each province from Quebec to British Columbia and the Territories) have high SMRs. This is not surprising given the strong positive correlation between SMRs and the percentage of the population reporting Aboriginal heritage. Second, three of the Northwest Territories CDs report low SMRs. This is an artifact of the provincial reference population; they are low because they are measured against two very

[1] Prior to 1993 several Quebec CDs (and one British Columbia CD) report no deaths. This is clearly wrong and affects the SMRs in the CDs reporting no deaths as well as those reporting higher death rates as a result. However, the 1993 patterns are consistent with those from 1986–92 in all unaffected areas.

high CDs, not because they have low mortality rates.[2] Under a national base all Territory CDs have high SMRs. Third, the western SMRs appear to be more similar across CDs than those in Ontario, and Quebec.

To further investigate the variance in SMRs within provinces Table 2 presents the sample sizes, the minimum SMR, the maximum SMR, and the standard deviation for all observations and the standard deviation excluding the minimum and maximum.[3] With the exception of Alberta, the western provinces display the most variation. Notice that the variance in the Saskatchewan and British Columbia SMRs are heavily effected by the presence of outliers. Excluding the minimum and maximum SMRs lowers the standard deviation from 0.25 to 0.50 in Saskatchewan and from 0.22 to 0.11 in British Columbia. On the other hand, the Manitoba SMRs continue to exhibit the highest variance.

While it is true, broadly speaking, that northern areas tend to have high SMRs and more populous areas tend to fair somewhat better, the pattern of SMRs across northern and 'more' urban CDs are distinct across provinces. For example, the SMRs across southern Saskatchewan tend to be relatively homogeneous while there is significant degree of variation across southern Ontario. These differences are reflected in the distinct range and variance patterns across provinces, and (as demonstrated in the next section) SMRs calculated using Canada as the reference population.

3.2 A National Base

The Canada Health Act states that while health care is under provincial jurisdiction, there are nevertheless certain national, and equal access standards that must be maintained. In light of the rather large federal role in health care, both legally and in terms of health care transfers, it seems natural to consider SMRs calculated against a national base. This leads to comparing relative regional needs across provincial boundaries.

---

2 The Yukon has only one CD and hence an SMR of 1 by definition.

3 Prince Edward Island, the Yukon, and the Northwest Territories are excluded because they have very few CDs.

CD level SMRs change substantially when a national base is used in place of the provincial bases. This is not surprising given the sizable range in mean province level SMRs (national base); they range from 1.90 for the Northwest Territories to 0.85 for Saskatchewan (Table 3). Figure 2 illustrates the SMRs under a national base for 1993. Since the difference in SMRs under provincial and national bases is sometimes difficult to identify from Figures 1 and 2, Figure 3 shows the percent difference between the two bases. Some summary statistics for moving to the national base are also reported in Table 4.

SMR changes are remarkably consistent within provinces. The Yukon, Northwest Territories, British Columbia, northern Manitoba, and Newfoundland (excluding Labrador) CDs have higher SMRs under a national base. Not surprisingly, the Yukon and the Northwest Territories rise most significantly; they increase by an average of 29% and 89% respectively. The SMRs in the remaining maritime provinces drop by average of 5 percent (comparable in magnitude to the increase in British Columbia). The SMRs in the two largest provinces (Ontario and Quebec) change very little, they drop by an average of 1%, because they dominate the national average. It is the shear magnitude of the northern SMRs, and the above average SMRs in the third largest province (British Columbia) that leads to a small drop for Ontario and Quebec. But it is the 15% drop in the average Saskatchewan SMR that is most spectacular. The average Saskatchewan SMR, under this national base, lies far below that of any other province.

3.3 Excluding People over 64

Carstairs and Morris (1989a-c) find that SMRs for the non–elderly are a good indicator of health care requirements in the United Kingdom. They find that hospital bed use and SMRs are highly correlated under both a 65 and 75 year age cut–off, although somewhat less so under the later definition. We explore the possibility that SMR cut–off age changes effect each province in a distinct manner.

In Table 3 we present the province level SMRs (national base) under both a 65

(SMR_{65}) and 75 (SMR_{75}) year age cut–off. The simple summary statistics presented in this table suggest that an age cut–off change will impact each province in a unique way. However, under provincial, rather than a national base, there will not be consistent changes across entire provinces because we are comparing provincially based indices. Table 4 clearly shows that changing to a 65 year age cut–off has a much less uniform impact on SMRs across provinces than does changing to a national base. We do not see trends across regions; contiguous CDs experience drastically different changes when SMRs are restricted to individuals under the age of 65. The mean change is approximately zero in all provinces, but this masks the large CD specific changes. Such large differences between SMR_{65} and SMR_{75} would imply quite different resource allocations under the competing indices. Regions will not be indifferent about age group inclusion, and policy–makers will have to think carefully about choosing the appropriate SMR measure.

3.4 The SMR Across Time

Short-run, or one time fluctuations in regional SMRs are unlikely to reflect changes in health care needs. Small populations are particularly vulnerable to this problem. A wide range of abnormal occurrences can have a major impact on annual SMRs. For example, a major accident or natural disaster in a small region might cause spurious swings in the SMR. Such high frequency fluctuations suggests that we should smooth the index by calculating a rolling average over some suitable time period. For instance, Birch, Eyles, and Newbold (1995) and Eames, Ben–Shlomo and Marmot (1993) use SMRs averaged over 5 years. While it is clear that we do not want to use an annual SMR, it is equally obvious that averaging over a very long period will render the SMR virtually time invariant. That is, the index would not change from year to year and would be insensitive to secular trends.

In an attempt to document the speed at which SMRs approach time invariance we calculate the percentage spread between the minimum and maximum of each possible moving average between 1986 and 1993 for each CD. This gives us a sense of the variation across time in individual CDs. Figures 4 and 5 present the spread between the minimum and maximum SMRs for single year SMRs (eight observations) and SMRs averaged over four years (five observations).[4] Several regularities are immediately apparent. First, there is substantial movement in annual SMRs across all provinces, although it is somewhat less dramatic in Ontario. Second, SMRs smooth out relatively quickly. By the time SMRs are averaged over four years (Figure 5), the vast majority of CDs exhibit less than a 10% difference between the highest and lowest SMR. British Columbia and Manitoba are exceptions; more than 20% of CDs in these provinces (some with substantial population) exhibit at least a 10% min/max spread when averaged over four years. However, by six years even the CDs in these provinces have less than a 10% min/max spread (except for two British Columbia CDs and one Manitoba CD). Third, SMRs are generally smoother in more populous areas. Despite the apparent link between population and the averaging length required for virtual time invariance, it is not possible to define the averaging length required for stationarity as a simple function of population. For example, non–metropolitan CDs in Saskatchewan are generally smaller than those in British Columbia but time averaged SMRs are smoother in Saskatchewan than in British Columbia.

4. SMRs and Standard Socio–Economic Variables

Many studies have shown that there exists a positive relationship between socio–economic status and health status (Hay 1988, D'Arcy and Siddique 1985, and Kessler 1982). Still other studies have shown that community level unemployment, income, and education levels are correlated with mortality rates (Eames, Ben–Shlomo and Marmot 1993; Carstairs and Morris 1989a, 1989b, and 1989c; D'Arcy 1985, and Saveland and Gillieson 1971). It has also be shown that the low life expectancy of Aboriginal Canadians

[4] Quebec is excluded because some CDs fail to report deaths prior to 1993. The single British Columbia CD that reports no deaths prior to 1993 is excluded, but the rest of British Columbia is included. While this error does distort the remaining British Columbia numbers somewhat, the small size of the excluded CD (the population was about 5000 in 1991) ensures that resulting mis–reporting in other CDs is also minimal.

is related to the aforementioned socio–economic factors (D'Arcy 1989). Interest in the relationship between mortality and socio–economic factors has generally arisen because there is a desire to use both types of information to direct health care funds towards high need areas. We are interested in this link because we wish to evaluate the ability of the SMR to proxy these measures of relative need across jurisdictions.

All data used in this section are for 1991. The socio–economic data are 1991 Canadian Census data aggregated to the 1991 CD definitions. Hence, all SMRs reported in this section are for 1991, or are averages that end in 1991 and use a provincial base.

In Table 5 we regress the 3 year average SMR (provincial base) under both the 65 and 75 year age cut–off on a variety of socio–economic variables for each province. While we have calculated heteroscedastic robust variance–covariance matrices for inference, the estimated specifications are unlikely to 'pass' a serious model evaluation exercise. Instead these regressions are intended to identify important correlations in the data and are not to be viewed as a model determining SMRs.

The first panel (of Table 5) presents the regression results under a 75 year age cut–off and the second panel presents the results under a 65 year age cut–off. The dependent variable is the 3 year average SMR for 1991 and the socio–economic variables include high school graduation rates, unemployment rates (for men[5]), the proportion of families classified as low income (annual income $\leq \$20,000$), the proportion of the labour force employed in the manufacturing sector, and percentage of people who are of Aboriginal origin.[6] While the magnitude of the coefficients for the socio–economic variables differ substantially across provinces, they are generally of the same sign when the variables are statistically significant (at conventional levels). A higher unemployment rate, a larger

[5] Overall and female unemployment rates are in general not very highly correlated with SMRs. It should also be noted that the male unemployment rates presented throughout the paper are for the male population aged twenty–five and over. The results are not particularly sensitive to this definition, similar results are found using the male unemployment rate for men aged fifteen and over.

[6] Quebec is excluded due to non–reporting CDs prior to 1993. The Yukon, the Northwest Territories and Prince Edward Island are excluded because they contain a small number of CDs.

Aboriginal population, and a smaller manufacturing sector are all associated with higher mortality. The only anomalous result is the negative relationship between the proportion of families earning less than $20,000 and the SMR in British Columbia. It is generally found that income and health status (as well as life expectancy) are positively related.

With the SMR_{65} as the dependent variable, the socio–economic variables explain a greater percentage of the intra–provincial SMR variation. Interestingly, the relationship between specific socio–economic variables and the SMR change substantially. Under the 65 year age cut–off, the unemployment rate becomes statistically insignificant in Ontario and significant in Nova Scotia while the proportion of low income families becomes insignificant in British Columbia and significant in Ontario and Alberta.

The results presented in Table 5, as well as the correlation of socio–economic variables (by province) presented in Table 6, suggest that precise estimates of individual coefficients will be difficult because of collinearity. This appears to be particularly relevant for Manitoba and Saskatchewan. To illustrate the problem, Table 7 repeats the Table 5 regression for the Saskatchewan but with each variable entering individually and then in combination with all other variables. Individually, the unemployment rate and the proportion of the population that is of Aboriginal origin are strongly correlated with the SMR. When all variables enter jointly, however, the coefficients on the two individually significant variables are smaller and less precisely measured, presumably as a result of collinearity among the socio–economic variables.

One might ask whether the apparent patterns hold under a different degree of time averaging.[7] Table 8 repeats the Table 5 regressions for Ontario[8] using SMRs averaged over one through six years. Using a different averaging length has little impact, and more importantly the changes are not consistent across socio–economic variables. While the exact patterns differ across provinces the flavour is the same.

---

[7] We do not present results for the national base because this change has very little impact on the correlation of socio–economic variables and the SMR.

[8] The results for a single province are presented for descriptive purposes.

5. Ontario SMRs, Health Status and Current Funding

Since one aim in collecting SMR data is the re–allocation of health care resources to high need regions, it is also useful to consider the connection between SMRs (or various SMRs) and reported health status measures and current levels of funding. Current health status measures such as self–assessed health status are most often cited as the appropriate relative need measure (for example see Birch, Eyles, and Newbold, 1995). These variables could not themselves be used in an on going index due to data availability and potential manipulation from interested parties. Nevertheless, a good measure of need is expected to be highly correlated with these types of health status measures. On the other side, it is interesting to see how current (historical) expenditures relate to SMRs. Are regions with high SMRs receiving relatively more dollars under the current funding system?

The analysis in this section is restricted to Ontario. This exercise requires health status measures and expenditure data by region, as well as mortality and population data. We were able to obtain the required health status data from the Ontario Health Survey (OHS) and expenditure data from the *Ontario Health Expenditures* (Ontario Ministry of Health, 1989/90). All data are aggregated to the health district level (which differ somewhat from CDs). The OHS was conducted in 1990, expenditure data is for 1990–93 (deflated to 1990 $'s), the mortality data is for 1987–90 and the population data is for 1986.

5.1 Ontario SMRs and Health Status Variables

Following the literature, we take self–assessed health status (SAHS) as our measure of relative need. As with the SMR, a health district level standardized health ratio (SHR)[9] compares the age/gender specific health status rates for a given health district to those of the province. The construction of this index is identical to that of the SMR (with slightly different age group definitions). Health districts with below average health status have an SHR above 1 and high health status health districts have a SHR below 1.

---

[9] We adopt the index name coined by Birch, Eyles, and Newbold (1995).

The OHS asks people to rate their health compared to people their age on a scale from 1 (excellent) to 5 (poor). The frequency of empty cells necessitates aggregation. We aggregate to two categories: 1–2 (excellent–very good) and 3–5 (good–poor). The results are not sensitive to this definition, we also ran all regressions defining the groups as 1–3 and 4–5 and the differences are always negligible. Unlike the SMR calculations, we use 10 year age categories instead of 5 year age categories, again because some cells have very few observations. As before, our results are not sensitive to this definition, all regression results are largely unchanged when 5 or 15 year age categories are used. Finally, there is no SAHS variable for people under 15 years of age, so children are excluded from the SHR.

Since the OHS is for 1990, and our earliest mortality data is for 1987, the longest SMR averaging period is 4 years. Table 9 presents our regression results under all four averaging lengths and both age cut–offs. The coefficients, under all averaging lengths, are significant at the 5% level and the regression fit rises with the averaging length. However, there is very little difference in the coefficients or the regression fit between base definitions. A 1% increase in the SMR is associated with a 0.5% and 0.4% increase in the SHR under a four year average and a single year respectively for both the 75 and 65 year age cut–offs. These results are consistent with those of Birch, Eyles, and Newbold (1995) for Quebec.

The similarity in the correlation between 65 and 75 year age cut–off SMRs and SHRs does little to guide us in choosing a SMR base definition appropriate for a funding model. This does not mean, however, that the base definition does not matter. While the correlation between SMRs and SHRs under different age cut–offs might be similar, recall the large differences between SMR_{75} and SMR_{65}, and hence the potentially large resource allocations differences.

5.2 Ontario SMRs and Health Care Expenditures

Since SMRs are ultimately to be used for re–allocating funds to high need (high SMR) areas, it seems wise to look at the relationship between current health district level per capita expenditures and the SMR. Figure 6 and Table 10 summarize our results. This figure illustrates the correlation between real (in 1990 \$'s) per capita expenditures and the 3 year averaged SMR from 1990–93 for Ontario. Health districts with teaching hospitals are denoted by t and are not included in the regression lines in Figure 6. It is clear that we must control for teaching centers when estimating the relationship between expenditures and the SMR. This is not surprising since the SMR can not account for the expenditures required to maintain teaching hospitals. The relationship between expenditures and SMRs is both statistically significant and numerically large. A 1% increase in the SMR is associated with increase in per capita expenditures for non–teaching centers of approximately 1% and approximately 0.6% for teaching centers. As expected, decreasing the cut–off age to 65 reduces the SMR coefficients and increases the constant.

It is clear that moving away from historical utilization–based funding and towards capitation–based funding will mean a substantial re–allocation of health care funds. Further, we have shown that the regional resource allocations resulting from the use various SMRs in a balanced budget funding model may differ dramatically. However, if a significant proportion of funding is already flowing to high SMR areas then the re–allocation resulting from incorporating an SMR measure in the funding model might not be as severe. There is some indication (Table 10) that regions with high SMRs are already receiving higher levels of per capita funding. Of course, such raw correlations do not control for utilization factors such as hospitals, physician densities, and so on.

6. Conclusion

This paper has presented an extensive analysis of several standardized mortality ratio (SMR) indices for Canada. We have explored the impact of different reference populations (provincial versus national), different age cut–offs (75 versus 65), and various averaging periods. Further, we have analyzed the relationship between these various SMR measures and socio–economic factors, health status, and current expenditures.

We believe that the analysis presented in this paper clearly shows that for Canada the precise SMR definition used in a funding formula is important, and has potentially large re–distributive implications. The geographic base, age cut-offs, and averaging periods significantly effect the SMR index. Although the correlation between socio–economic variables and the SMR provide some evidence in support of using a 65 year age cut–off, the correlation between the health status (SHRs) and SMRs gives us little guidance. While it is also clear that some degree of time averaging is required to remove meaningless fluctuations, the available data does not suggest an optimal averaging period or rule. Given these results, there is little to guide Canadian policymakers in choosing a specific SMR construction. Unfortunately, the alternative choices imply potentially large differences in monetary transfers.

References

Birch, Stephen, Shelley Chambers, John Eyles, Jeremiah Hurley, and Brian Hutchison (1990), "Development and Application of a Needs-Based Methodology for Allocating, Health Care Resources Among Populations at the County Level." CHEPA, 90–13.

Birch, Stephen, John Eyles, and K. Bruce Newbold (1995), "The Inevitability of Mortality? Evaluating Alternatives to the SMR," CHEPA working paper 95-10.

Carr-Hill, Roy and Trevor Sheldon (1992), "Rationality and the Use of Formulae in the Allocation of Resources to Health Care," *Journal of Public Health Medicine*, 14(2), 117-126.

Carstairs, V. and R. Morris (1989a), "Deprivation: Explaining Differences in Mortality Between Scotland and England and Wales," *British Medical Journal*, 299:886-889.

Carstairs, V. and R. Morris (1989b), "Deprivation and Mortality: an Alternative to Social Class?," *Community Medicine*, 11(3):210-219.

Carstairs, V. and R. Morris (1989c), "Deprivation, Mortality, and Resource Allocation," *Community Medicine*, 11(4), 364-372.

D'Arcy, Carl and C.M. Siddique (1985), "Unemployment and Health: An Analysis of Canada Health Survey Data," *International Journal of Health Services*, 15(4), 609-635.

Driver, Deana (1994), "Saskatchewan First to Implement New Funding Formula," *Medical Post*, May.

Eyles, John and Stephen Birch (1993), "A Population Needs-Based Approach to Health Care Resource Allocation and Planning in Ontario: A Link between Policy Goals and Practice?" *Canadian Journal of Public Health*, 84(2), 112-117.

Gilbert, Richard et al. (1992), "The New South Wales Resource Allocation Formula: A Method for Equitable Health Funding," *Australian Health Review*, 15(1), 6-21.

Hay, David Ian (1988), "Socioeconomic Status and Health Status: a Study of Males in the Canada Health Survey," *Social Science and Medicine*, 27(12), 1317-1325.

Health Reforms Directorate (1992), "Population-Based Funding of Regional Health Authorities for the Purchase of Core Personal Health Services," New Zealand Ministry of Health, November.

Jamsen, Raimo (1994), "Planning and Financing System for Social and Health Services," Ministry of Social Affairs and Health, Helsinki, Finland, March.

Mays, Nicholas and Susan Chinn (1989), "Relation between All Cause Standardized Mortality Ratios and Two Indices of Deprivation at Regional and District Levels in England," *Journal of Epidemiology and Community Health*, 43, 191-199.

Morris, R. and V. Carstairs (1991), "Which Deprivation? A Comparison of Selected Deprivation Indices," *Community Medicine*, 13(4), 318-326.

Ontario Ministry of Health, Ministry of Community and Social Services, and Ministry of Citizenship (1993a), "Building Partnerships in Long-Term Care: A New Way to Plan, Manage, and Deliver Services and Community Support - A Local Planning Framework," May.

Ontario Ministry of Health, Ministry of Community and Social Services, and Ministry of Citizenship (1993b), "Building Partnerships in Long-Term Care: A New Way to Plan, Manage, and Deliver Services and Community Support - A Policy Framework," April.

Raftery, James (1993), "Capitation Funding: Population, Age and Mortality Adjustments for Regional and District Health Authorities in England," *British Medical Journal*, 307, 1121-1124.

Services Development and Planning Branch, Operations Division (1993), "A Resource Allocation Formula for the New South Wales Health System - 1993 Revision," New South Wales (NSW) Department of Health, July.

Sheldon, Trevor and Roy Carr-Hill (1992), "Resource Allocation by Regression in the National Health Service: A Critique of the Resource Allocation Working Party's Review," *Journal of the Royal Statistical Society*, 155(3), 403-420.

Snaith, A.H. (1978), "Subregional Resource Allocations in the National Health Service," *Journal of Epidemiology and Community Health*, 32, 16-21.

Strategic Programs Branch (1994), "Introduction of Needs Based Allocation of Resources to Saskatchewan District Health Boards for 1994-95," Strategic Programs Branch, Saskatchewan Health, March.

Table 1. Data Sources

Variable	Data	Sources	Years
SMRs (all CDs)	Mortality	Statistics Canada	1986--93
	Population	Canadian Census	1986 \ 1991
Socio--Economic Variables		Canadian Census	1991
SMRs (Ontario)	Mortality	Ministry of Health	1987--93
	Population	Ministry of Health	1986 \ 1991
SHR (Ontario)	SAHS	Ontario Health Survey	1990
Ontario Health Expenditures		*Ontario Health Expenditures*	1990--93

Table 2. 1993 SMRs (Provincial Base) Excluding People over 75 Years of Age

Province	# of CDs	Std Dev (rank)	Min SMR	Max SMR	Std Dev* (rank)
Newfoundland	10	0.18 (6)	0.76	1.33	0.13 (7)
Nova Scotia	18	0.12 (1)	0.77	1.21	0.09 (2)
New Brunswick	15	0.16 (4)	0.66	1.27	0.12 (5)
Quebec	99	0.17 (5)	0.63	1.65	0.15 (8)
Ontario	49	0.13 (2)	0.77	1.33	0.12 (6)
Manitoba	23	0.37 (9)	0.56	1.97	0.30 (9)
Saskatchewan	18	0.25 (8)	0.82	1.98	0.05 (1)
Alberta	19	0.13 (3)	0.82	1.27	0.11 (3)
British Columbia	30	0.22 (7)	0.73	1.97	0.11 (4)

* Excluding the minimum and maximum SMRs

Table 3. 1993 Province Level SMRs (National Base)

Province	<75 SMR	(Rank)	<65 SMR	(Rank)
Newfoundland	1.02	(9)	0.95	(3)
Prince Edward Island	0.94	(2)	0.96	(5)
Nova Scotia	0.95	(3)	0.92	(1)
New Brunswick	0.95	(4)	0.95	(4)
Quebec	0.99	(8)	0.97	(6)
Ontario	0.99	(6)	0.98	(7)
Manitoba	0.99	(7)	1.05	(9)
Saskatchewan	0.85	(1)	0.93	(2)
Alberta	0.97	(5)	1.01	(8)
British Columbia	1.05	(10)	1.07	(10)
Yukon	1.29	(11)	1.21	(11)
Northwest Territories	1.90	(12)	1.95	(12)

Table 4. 1993 SMR Base Changes

	% Change Moving to National Base				% Change Moving to 65 Age Cut-Off			
	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Newfoundland	1.65	1.31	-1.78	3.20	0.16	6.31	-9.04	11.94
Prince Edward Island	-5.87	0.11	-5.99	-5.79	0.01	0.43	-0.46	0.40
Novia Scotia	-4.95	0.38	-5.99	-4.41	0.09	7.27	-10.00	14.21
New Brunswick	-4.85	0.34	-5.52	-4.02	0.37	10.98	-29.72	16.99
Quebec	-0.80	0.49	-2.54	0.01	-0.18	11.07	-29.26	41.96
Ontario	-1.12	0.36	-2.21	-0.40	-0.42	7.91	-12.95	22.68
Manitoba	-1.24	1.55	-2.88	2.63	-0.89	15.67	-26.28	34.86
Saskatchewan	-15.23	1.81	-16.78	-8.80	-0.40	8.57	-12.54	15.41
Alberta	-2.57	0.37	-3.11	-1.78	-0.26	11.06	-20.20	28.12
British Columbia	4.88	2.88	0.66	12.32	0.04	7.98	-20.72	12.69
Northwest Territories	88.80	6.20	83.00	95.05	-0.79	9.62	-13.48	13.58

Table 5. 1991 SMRs and Selected Socio-Economic Variables (Provincial Base)

	Nfld	N.S.	N.B.	Ont.	Man.	Sask.	Alb.	B.C.
Dependent Variable: 3 Year Average <75 SMR								
H.S. Grad	-0.205	-0.146	-0.034	-0.064	-0.030	0.018	0.230	-1.226
	(0.361)	(0.495)	(0.178)	(0.324)	(0.187)	(0.075)	(1.204)	(1.686)
UER	-1.570	2.959	-0.880	3.249	4.357	4.168	-0.165	5.035
	(0.816)	(2.564)	(1.407)	(2.773)	(3.615)	(1.863)	(0.063)	(1.731)
Low Inc.	1.507	-0.996	1.543	0.145	-0.377	-0.873	0.748	-4.986
	(1.395)	(1.035)	(3.602)	(0.182)	(1.066)	(1.367)	(0.657)	(2.344)
Man. Emp.	-0.243	-0.150	0.082	-0.603	-0.015	-1.650	1.117	-2.281
	(0.310)	(0.241)	(0.394)	(2.395)	(0.026)	(1.682)	(1.050)	(1.883)
Abor. Pop.	3.064	-0.989	-1.830	1.088	1.153	1.151	1.215	0.130
	(3.669)	(0.325)	(1.039)	(2.252)	(3.976)	(3.009)	(2.751)	(0.228)
Constant	1.123	1.119	0.795	0.934	0.755	0.969	0.535	2.878
	(1.275)	(1.995)	(3.031)	(3.278)	(3.984)	(3.882)	(1.794)	(2.761)
N	10	18	15	49	23	18	19	29
F(5,N)	17.38	4.93	19.80	7.75	105.07	302.27	78.67	48.47
R-Squared	0.61	0.60	0.60	0.59	0.96	0.95	0.53	0.46
Dependent Variable: 3 Year Average <65 SMR								
H.S. Grad	-0.365	-0.442	-0.084	-0.241	-0.516	-0.073	0.359	-0.753
	(0.457)	(1.497)	(0.331)	(1.620)	(1.947)	(0.265)	(2.006)	(1.193)
UER	-1.506	2.747	-0.063	0.588	7.089	5.221	-1.354	4.559
	(0.574)	(2.703)	(0.092)	(0.563)	(3.798)	(1.648)	(0.473)	(1.693)
Low Inc.	2.007	-1.250	1.252	1.259	-0.556	-0.339	2.595	-2.732
	(1.400)	(1.660)	(2.055)	(2.262)	(1.068)	(0.347)	(2.457)	(1.434)
Man. Emp.	-0.682	-0.067	0.287	-0.590	-0.398	-0.668	1.809	-2.429
	(0.656)	(0.119)	(0.722)	(2.783)	(0.503)	(0.492)	(1.741)	(2.090)
Abor. Pop.	3.198	1.014	-0.757	1.836	0.933	1.319	2.179	0.956
	(2.736)	(0.373)	(0.383)	(8.334)	(1.995)	(2.294)	(4.099)	(1.780)
Constant	1.194	1.420	0.780	1.087	1.089	0.842	0.080	2.055
	(0.972)	(2.585)	(2.156)	(5.107)	(3.702)	(2.423)	(0.338)	(2.229)
N	10	18	15	49	23	18	19	29
F(5,N)	9.12	8.64	7.14	45.69	56.15	833.65	102.79	50.58
R-Squared	0.48	0.61	0.59	0.77	0.93	0.96	0.70	0.59

Absolute value of heteroscedastic consistent t-statistics in parentheses

Table 6. 1991 Correlation of Selected Socio-Economic Variables by Province

Newfoundland

	1.	2.	3.	4.	5.
1. H.S. Grad	1.00				
2. UER	-0.84	1.00			
3. Low Inc.	-0.69	0.84	1.00		
4. Man. Emp.	-0.74	0.40	0.46	1.00	
5. Abor. Pop.	0.42	-0.48	-0.67	-0.42	1.00

Manitoba

	1.	2.	3.	4.	5.
1. H.S. Grad	1.00				
2. UER	-0.12	1.00			
3. Low Inc.	-0.79	0.24	1.00		
4. Man. Emp.	0.49	-0.23	-0.73	1.00	
5. Abor. Pop.	-0.31	0.90	0.48	-0.48	1.00

Nova Scotia

	1.	2.	3.	4.	5.
1. H.S. Grad	1.00				
2. UER	-0.38	1.00			
3. Low Inc.	-0.69	0.16	1.00		
4. Man. Emp.	-0.67	-0.12	0.46	1.00	
5. Abor. Pop.	-0.15	0.63	-0.09	-0.39	1.00

Saskatchewan

	1.	2.	3.	4.	5.
1. H.S. Grad	1.00				
2. UER	0.18	1.00			
3. Low Inc.	-0.55	0.62	1.00		
4. Man. Emp.	0.48	0.19	-0.12	1.00	
5. Abor. Pop.	-0.05	0.94	0.71	-0.11	1.00

New Brunswick

	1.	2.	3.	4.	5.
1. H.S. Grad	1.00				
2. UER	-0.81	1.00			
3. Low Inc.	-0.87	0.69	1.00		
4. Man. Emp.	-0.49	0.40	0.59	1.00	
5. Abor. Pop.	-0.45	0.59	0.22	0.13	1.00

Alberta

	1.	2.	3.	4.	5.
1. H.S. Grad	1.00				
2. UER	0.15	1.00			
3. Low Inc.	-0.79	0.15	1.00		
4. Man. Emp.	0.21	0.44	-0.14	1.00	
5. Abor. Pop.	-0.05	0.64	0.25	-0.16	1.00

Ontario

	1.	2.	3.	4.	5.
1. H.S. Grad	1.00				
2. UER	-0.38	1.00			
3. Low Inc.	-0.75	0.57	1.00		
4. Man. Emp.	0.14	-0.05	-0.45	1.00	
5. Abor. Pop.	-0.23	0.13	0.34	-0.35	1.00

B.C.

	1.	2.	3.	4.	5.
1. H.S. Grad	1.00				
2. UER	-0.40	1.00			
3. Low Inc.	-0.57	0.13	1.00		
4. Man. Emp.	-0.44	0.39	-0.01	1.00	
5. Abor. Pop.	-0.23	0.81	0.01	0.23	1.00

Table 7. 1991 Saskatchewan <75 SMRs and Socio-Economic Variables
Dependent Variable: 3 Year Average <75 SMR (Provincial Base)

	1.	2.	3.	4.	5.	6.
H.S. Grad	0.189					0.018
	(1.659)					(.075)
UER		8.284				4.168
		(7.743)				(1.863)
Low Inc.			3.447			-0.873
			(1.608)			(1.367)
Man. Emp.				-0.985		-1.650
				(.325)		(1.682)
Abor. Pop.					1.796	1.151
					(19.529)	(3.009)
Constant	0.845	0.676	0.291	1.037	0.851	0.969
	(7.231)	(15.337)	(.723)	(5.876)	(44.184)	(3.882)
N	18	18	18	18	18	18
R-Squared	0.01	0.87	0.35	0.00	0.92	0.95

Absolute value of heteroscedastic-consistent t-statistics in parentheses

Table 8. 1991 Ontario SMRs and Selected Socio-Economic Variables (Provincial Base)

	6 Years	5 Years	4 Years	3 Years	2 Years	1 Year
Dependent Variables: <75 SMR Averaged Over Years Listed in Heading						
H.S. Grad	-0.031	-0.081	-0.032	-0.064	-0.191	-0.197
	(0.182)	(0.436)	(0.171)	(0.324)	(0.896)	(0.684)
UER	2.018	2.529	2.399	3.249	3.630	4.100
	(1.895)	(2.326)	(2.140)	(2.773)	(2.795)	(2.097)
Low Inc.	0.709	0.282	0.442	0.182	-0.191	0.512
	(0.989)	(0.373)	(0.570)	(0.182)	(0.210)	(0.420)
Man. Emp.	-0.486	-0.564	-0.526	-0.603	-0.690	-0.552
	(2.057)	(2.323)	(2.202)	(2.395)	(2.369)	(1.277)
Abor. Pop.	1.237	1.134	1.123	1.088	1.012	0.826
	(3.196)	(2.558)	(2.489)	(2.252)	(1.810)	(1.196)
Constant	0.875	0.966	0.899	0.934	1.095	0.960
	(3.444)	(3.539)	(3.224)	(3.278)	(3.523)	(2.290)
N	49	49	49	49	49	49
F(5,N)	10.87	8.30	7.99	7.75	6.87	4.64
R-Squared	0.67	0.62	0.59	0.59	0.57	0.49
Dependent Variables: <65 SMR Averaged Over Years Listed in Heading						
H.S. Grad	-0.224	-0.246	-0.201	-0.241	-0.305	-0.303
	(1.629)	(1.697)	(1.343)	(1.620)	(1.792)	(1.038)
UER	-0.148	0.071	-0.451	0.588	0.525	2.512
	(0.145)	(0.069)	(0.419)	(0.563)	(0.453)	(1.236)
Low Inc.	1.475	1.309	1.606	1.259	1.302	1.558
	(2.575)	(2.306)	(2.704)	(2.262)	(1.862)	(1.255)
Man. Emp.	-0.456	-0.465	-0.424	-0.590	-0.572	-0.426
	(2.278)	(2.288)	(2.143)	(2.783)	(2.130)	(0.932)
Abor. Pop.	1.951	1.883	1.832	1.836	1.907	1.771
	(7.565)	(7.153)	(6.558)	(8.334)	(5.134)	(2.874)
Constant	1.060	1.094	1.034	1.087	1.142	0.973
	(5.221)	(5.164)	(4.741)	(5.107)	(4.509)	(2.200)
N	49	49	49	49	49	49
F(5,N)	39.07	34.35	35.40	45.69	22.35	9.62
R-Squared	0.82	0.79	0.78	0.77	0.75	0.61

Absolute value of heteroscedastic-consistent t-statistics in parentheses

Table 9. 1990 Ontario SMRs and Self--Assessed Health Status

	SMR Averaged Over			
	4 Years	3 Years	2 Years	1 Year
Dependent Variable: <75 SHR				
<75 SMR	0.468	0.489	0.454	0.391
	(3.251)	(3.107)	(2.900)	(2.593)
Constant	0.532	0.511	0.546	0.609
	(3.934)	(3.448)	(3.718)	(4.298)
N	37	37	37	37
R-Squared	0.20	0.20	0.17	0.13
Dependent Variable: <65 SHR				
<65 SMR	0.482	0.467	0.407	0.359
	(3.696)	(3.216)	(2.842)	(2.680)
Constant	0.518	0.533	0.593	0.641
	(4.228)	(3.896)	(4.407)	(5.085)
N	37	37	37	37
R-Squared	0.23	0.20	0.15	0.14

Absolute value of heteroscedastic-consistent t-statistics in parentheses

Table 10. Ontario SMRs and Per Capita Health Care Expenditures

	1990	1991	1992	1993
Dependent Variable: Real Per Capita Expenditures (1990 $'s)				
<75 SMR	1229.908	1435.187	1354.071	1298.985
	(5.803)	(5.281)	(5.286)	(5.580)
Teaching Center	851.734	846.514	905.917	936.359
	(7.965)	(8.751)	(9.967)	(9.966)
Constant	-99.149	-274.843	-56.904	-25.145
	(0.474)	(1.052)	(0.228)	(0.110)
N	37	37	37	37
F(2,N)	52.29	58.78	69.53	68.11
R-Squared	0.75	0.76	0.77	0.76
Dependent Variable: Real Per Capita Expenditures (1990 $'s)				
<65 SMR	1004.339	1123.656	1057.071	1008.153
	(4.377)	(4.362)	(4.078)	(4.317)
Teaching Center	847.565	844.490	906.136	939.042
	(8.687)	(8.906)	(9.885)	(9.757)
Constant	126.982	36.963	240.067	265.325
	(0.545)	(0.151)	(0.963)	(1.184)
N	37	37	37	37
F(2,N)	52.57	57.07	62.94	59.58
R-Squared	0.73	0.73	0.75	0.75

Per capita expenditures are deflated using the Ontario CPI
Absolute value of heteroscedastic-consistent t-statistics in parentheses

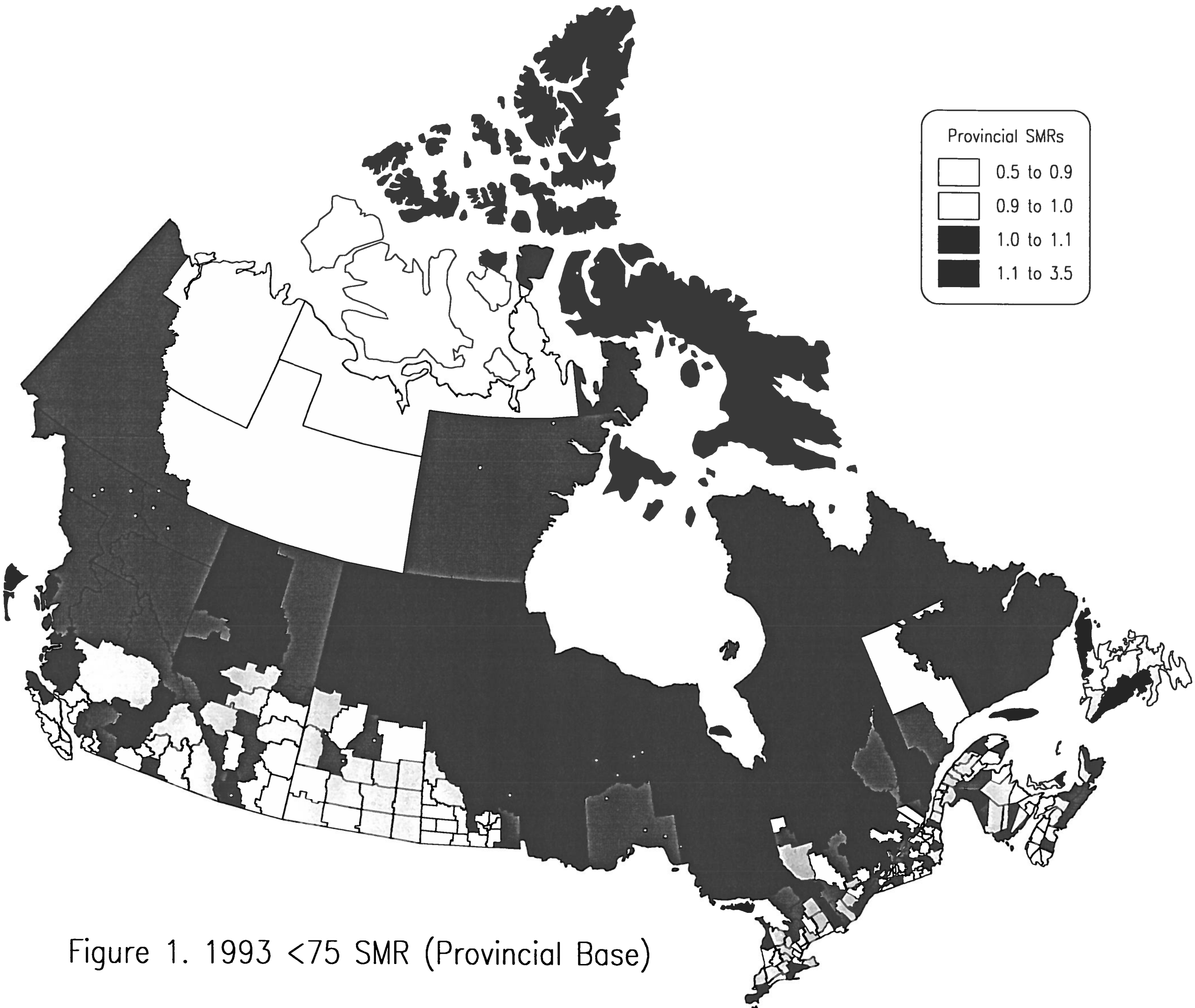

Figure 1. 1993 <75 SMR (Provincial Base)

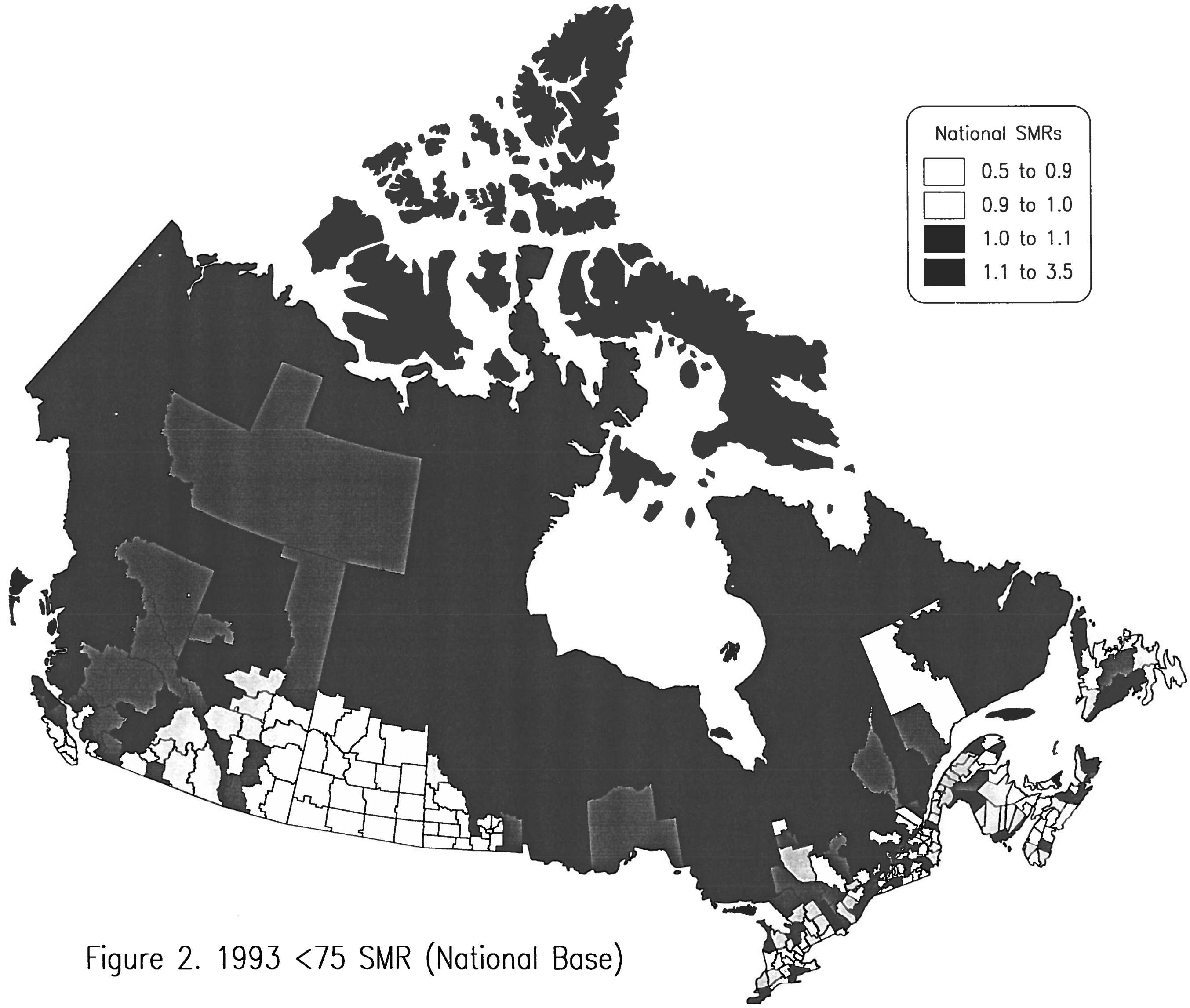

Figure 2. 1993 <75 SMR (National Base)

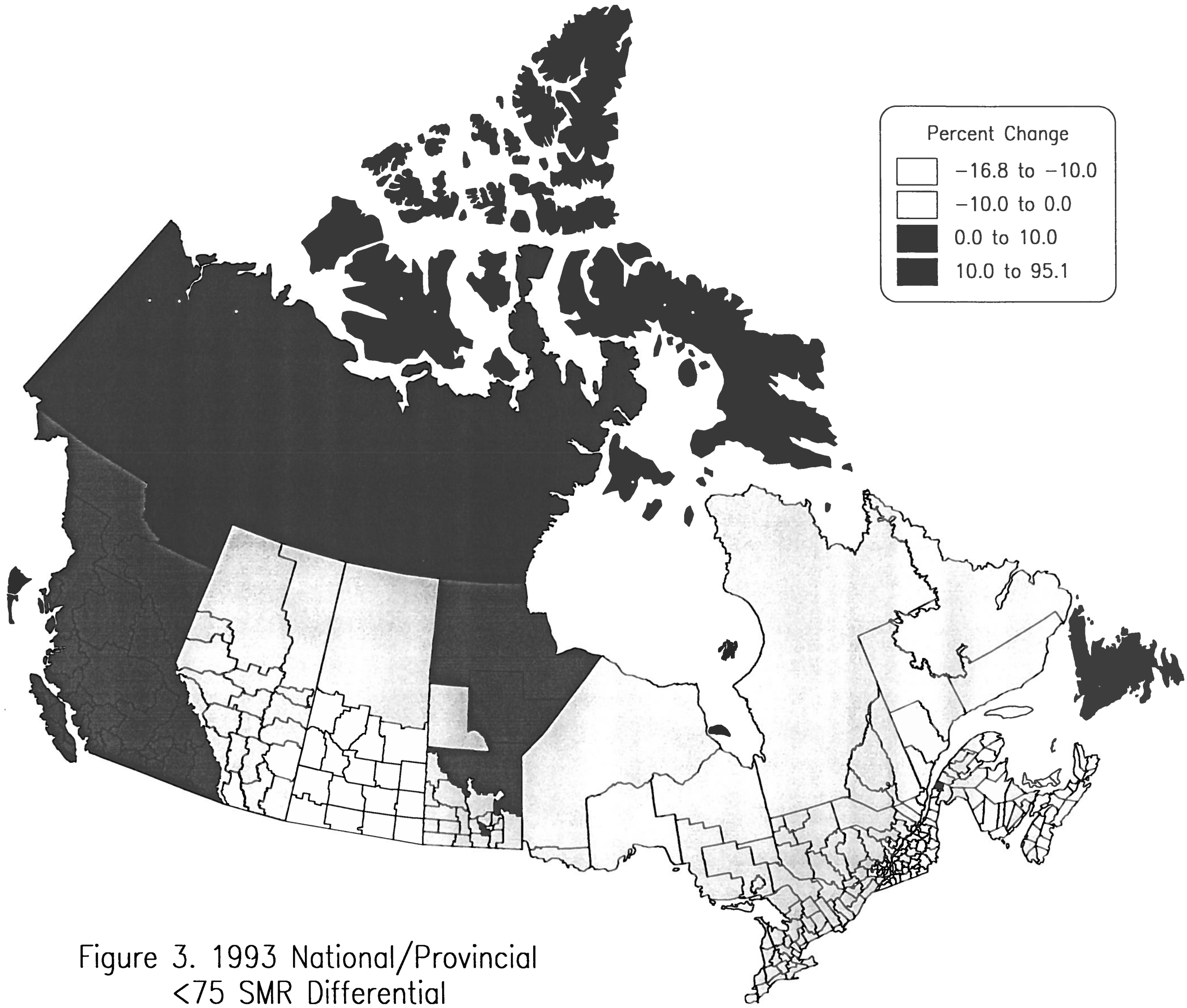

Figure 3. 1993 National/Provincial
<75 SMR Differential

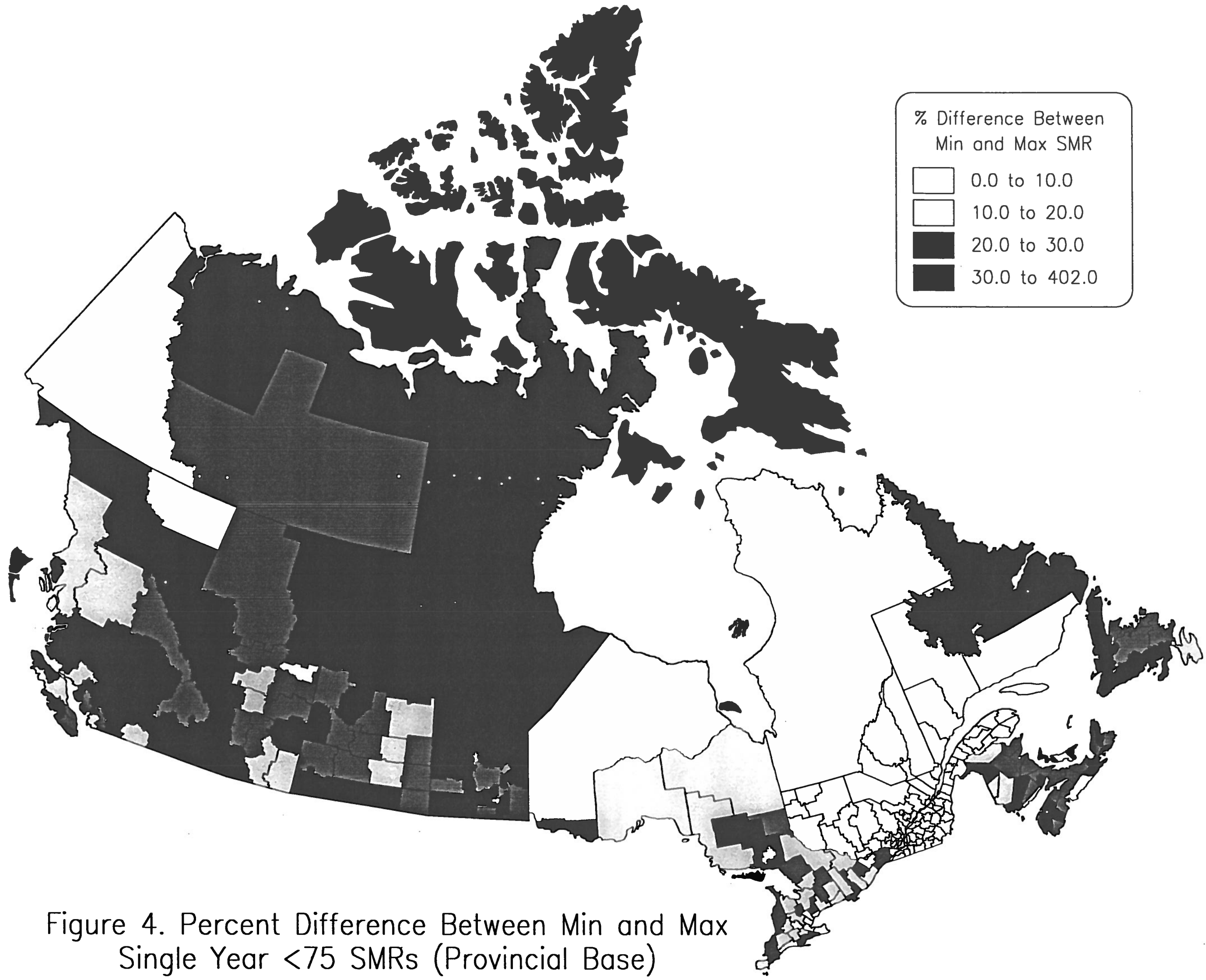

Figure 4. Percent Difference Between Min and Max Single Year <75 SMRs (Provincial Base) Between 1986–93 Excluding Quebec

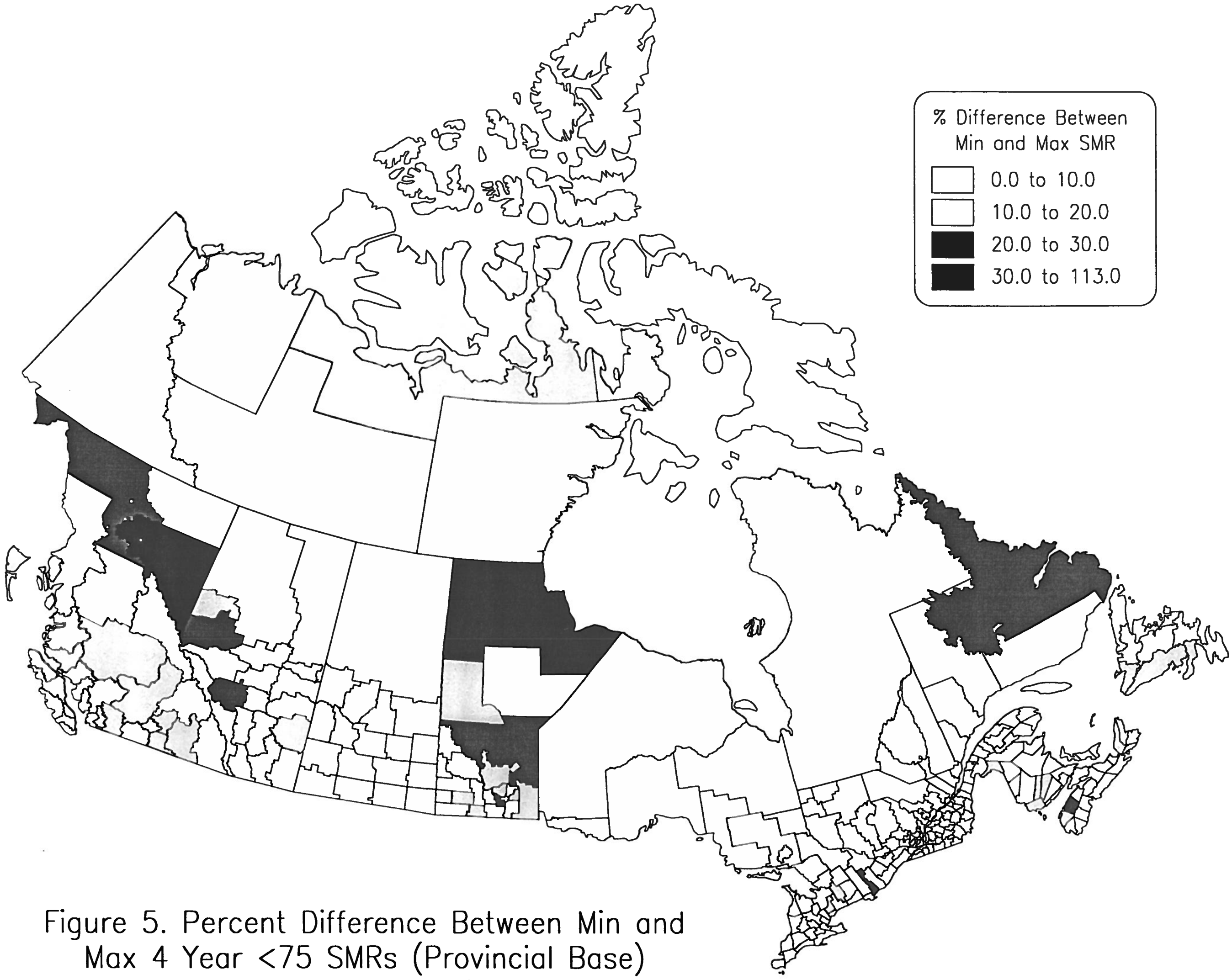

Figure 5. Percent Difference Between Min and Max 4 Year <75 SMRs (Provincial Base) Between 1986–93 Excluding Quebec

Teaching centers are denoted by t.
Regression lines exclude teaching centers.

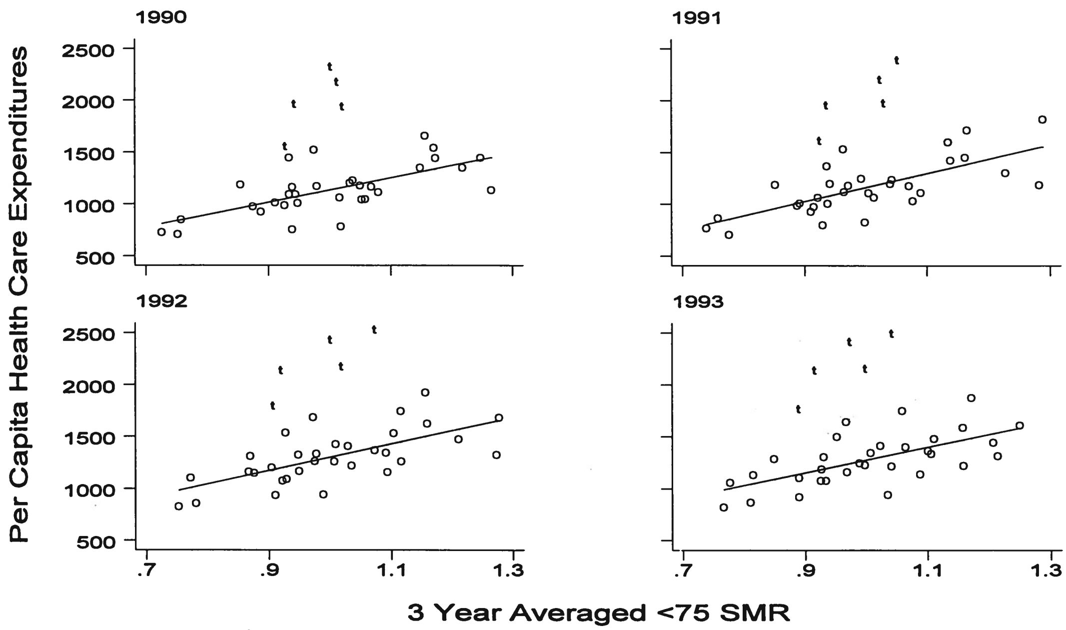

Figure 6. Ontario SMRs and Health Care Expenditures