



September 2011

Graphs For Dummies: The Troubled Geometry of Tim Hudak's *changebook*

By Jim Stanford

This commentary reviews in detail the 13 statistical graphs which are presented in the Ontario Conservative party's *changebook* platform. The review finds a consistent pattern of misleading visual presentation in those graphs, including a lack of quantitative proportion in graph objects, mis-labeling and/or arbitrary and/or inconsistent scaling in graph axes, inadequate or incorrect sourcing, and other fundamental flaws. In fact, not one of the 13 graphs conforms to the standards of presentation that are normally required of statistical presentations in academic and professional practice. In at least three cases, the data presented in the graphs is actually false. Whatever one thinks of the *changebook's* policy proposals themselves (and those proposals, *per se*, are not the subject of this commentary), the consistently misleading and inaccurate statistical representations contained in the *changebook* are lamentable.

Introduction

The Ontario election is in full swing, and the Conservative party's campaign is guided by a platform booklet called the "*changebook*." It's an audacious manifesto for significant change in the policy and the philosophy of government in the province, mapping out a long agenda of measures to cut taxes, balance the budget, privatize government assets and agencies, get tough on criminals, change labour laws and arbitration systems to reduce wage increases, end government support for business investments, and

many others. The *changebook* has drawn criticism from commentators on all points of the political spectrum, most pointedly for its implausible claims to cut taxes, balance the budget faster, yet still increase spending for health and other "priority" services—all funded from very small cuts to non-priority services.¹

While I disagree with its overall political thrust, of course, when I read the *changebook* my attention was diverted in a slightly different direction. I am a self-confessed numbers nerd. I am never happier than when ensconced in front of a big computer spreadsheet, crunching the numbers, generating correlations, punching out tables and graphs. And as I examined the numerous charts and graphs that illustrate Mr. Hudak's platform, niggling concerns began to gnaw away in the statistically-inclined regions of my brain. The lines were too smooth. The contrasts too dramatic. The proportions too extreme.

I got out a ruler to actually measure the bars and circles in the various graphs. I double-checked the data and the cited sources. I examined the proportions illustrated in the graphs, comparing them to the numbers contained in the *changebook's* text.

There are 13 statistical graphs contained in the *changebook*.² Shockingly, it turned out that every one of them revealed significant errors in labelling, citation, scaling, and proportion. In a few cases the illustrated data is simply wrong. In almost all of the 13 graphs,

axes and scaling have been skewed and manipulated, without proper labelling, in order to exaggerate political points. In numerous cases, the proportion of bars or other features is internally inconsistent. In some cases, it appears that the graphs were simply hand-drawn by a graphical designer (rather than being plotted quantitatively, whether by hand or computer), quite likely on the basis of numbers that were simply made up.

In fact, *not one of the 13 graphs* is completely labelled and sourced, consistently scaled, and accurately graphed. This consistent failure to accurately and completely present the empirical data cannot be ascribed to sloppiness or typographical errors. The statistical graphs in the *changebook* have been presented in ways that are clearly unacceptable in normal academic or professional practice. They consistently mislead the reader about the relative proportions of the variables being discussed. The *changebook's* graphs reflect a consistent willingness to bend the statistical truth, and a disrespect for normal standards of honesty and transparency in written work. From a group that aims to govern the province, this pattern is deeply concerning.

This commentary will review the layout, scaling, labelling, and proportions of every one of the 13 graphs in the *changebook*. The focus of the commentary is thus not on the ideas presented in the *changebook*, but rather merely on the manner in which those ideas have been empirically presented.

The graphs in the *changebook* are not numbered. In the following list, I have numbered them for clarity, as well as providing their original title and page number.

Figure 1: Overall Tax Burden (Page 2)

This graph shows a number of bubbles intended to illustrate the plethora of tax increases purportedly imposed on Ontarians by the McGuinty government. 10 bubbles are pictured in total, ranging from 2 very large ones (representing the purported impacts of the HST and the health tax, at \$3.1 billion each), to several smaller ones (associated with tire taxes, eco fees, and an unspecified “hidden hydro tax”). The intention is to show Ontarians being “riddled” with taxes—almost like a victim of gangland violence riddled with bullet holes.

How to Draw a Graph

There are a few simple rules for the proper presentation of statistical information in graphical form. Most Ontarians learn these rules in high-school math. They are reinforced in early college or university education programs. They include:

- *Properly label the axes of the graph so the reader knows what is being measured.*
- *Indicate the scale (units) being measured on each axis.*
- *Be consistent in the scaling of axes, to respect proportionality in the graph. The scaling need not be linear (for example, logarithmic scaling is used in many scientific and economic applications), but it must be consistent and clearly labelled. If there are breaks in the scaling (to incorporate an outlier observation, for example), they must be clearly indicated. The axes need not start at zero, but the starting point of each axis must be identified—again so that the reader can judge proportionality.*
- *Draw the objects on the graph (lines, bars, points) correctly, according to their true quantitative proportions. Most graphs today are generated with computer software to ensure that this occurs, but graphs can be plotted (carefully) by hand as well.*
- *Graph objects cannot be altered (smoothed, exaggerated, etc.) from their actual values, without ample and clear warning to the reader.*
- *Provide a complete and accurate citation for the source of data, including author, title, and publication details. This is essential so the reader can judge the reliability of the data, and to double-check findings if desired. If the author of the graph has altered or manipulated original data cited in the source note, this must be acknowledged.*

A student who follows these simple rules will receive high marks for their statistical assignments. Students who consistently break these rules, on the other hand, will have their work returned—and should certainly never be put in charge of a \$100 billion annual budget!

The graph is sourced “Ministries of Finance, Energy, and Environment.” This source note is obviously inappropriate: there is no such graph (or corresponding collection of data) produced by those ministries, nor would any of the data in the graph have been reported by any of those ministries as a “tax increase.” Indeed, those Ministries claim that income taxes, business taxes, and some other taxes have in fact been cut, not increased—so citing the Ministries for this graph is bizarre and dishonest. At best, the author of the graph must cite his or her own calculations and estimates, *based on data from those Ministries*—and then the author should be far more specific about where each number came from (and how it is held to constitute a tax “increase”). As it stands, this source note implies that the government itself accepts that these numbers are accurate and do indeed constitute tax increases; this is false.

However, the bigger issue with Figure 1 is that the relative sizes of the bubbles provide a very misleading perspective on the relative size of the various reported amounts—even if we accept the claim that these amounts do constitute tax “increases.” In a bubble graph, the area of each bubble represents the amount being portrayed. There is no axis or scale provided to the graph. But we can choose one of the bubbles to establish a benchmark for scale; let’s start with the largest ones (for the HST and the health tax). They are 3.3 cm in diameter, and hence their area covers 8.55 cm² each (remembering that the area of a circle equals πr^2). The implied scale of the graph, therefore (using the two largest bubbles as the benchmark), is 2.76 cm² of bubble area for each \$1 billion of tax “increase.”

On this basis, however, all of the other bubbles in the graph are too large, misleading the reader to conclude that that “plethora” of smaller tax “increases” is far more important economically than they actually are. Consider the smallest bubble, for example: representing \$39.4 million in eco fees revenue. Again, our focus here is not whether or not this actually constitutes a “tax increase,” but merely whether the empirical information has been accurately and fairly portrayed in the graph. The eco fees would accurately be represented by a bubble with area of 0.11 cm², and hence with a diameter of 0.37 cm. In reality, this bubble is drawn with a diameter of 1 cm, and an area of 0.79 cm². The eco-fees bubble is thus *7 times larger than it should be*, given the relative importance of

\$39.4 million compared to the \$3.1 billion portrayed for the HST and health taxes. This exaggeration of the importance of eco fees on this graph is clearly consistent with the rhetorical exaggeration of this issue in the Conservatives’ campaigning—but it is empirically false.

The same problem is true of all the other bubbles on this graph. Every other bubble on the graph is too large (some of them, like the tire taxes and the hidden hydro taxes, are several times too large) relative to their actual economic value (even accepting the Conservatives’ data and interpretation of the data), compared to the HST and health tax bubbles. The most accurate bubble is the one representing the \$900 million in alleged income tax hikes; it is only a shade too large relative to the benchmark. It would not matter if we used another bubble to establish the initial scale; it would be best of all, of course, if the author established and indicated the scale. In any case, the relative importance of those several smaller “taxes” is dramatically overstated in this graph.

Most likely, these bubbles were just drawn by a graphic artist with the political goal of creating an impression that Ontarians have been riddled with many major tax increases. It is fine to make this political point—but as soon as it is presented in the format of an empirical graph, then due attention must be paid to accuracy and proportion. This graph fails this basic test of empirical accuracy.

Figure 2: Income Sharing (Page 2)

This graph purports to show the tax savings that would accrue to families with \$70,000 in income as a result of the Conservative proposal for income-sharing on tax returns (whereby two-filer households are allowed to file returns based on their joint income, generating tax savings for tax-filers in higher tax brackets whose spouse is in a lower tax bracket).

In the first place, this graph is incorrectly labelled. The concept of income-sharing only generates savings for a particular group of households: those with two tax-filers, where one earner is in a higher tax bracket. Families with only one tax-filer, and those where two filers are in the same tax bracket, receive no benefit. This important point is not defined in the graph, which implies that *all* families with \$70,000 in income will receive benefits. At a minimum, the graph should

specify that it is illustrating the *maximum* benefit accruing to \$70,000-income households with *two* filers in *different* tax brackets.

Again, however, the bigger problem relates to the visual representation of the amounts. The graph presents before and after tax figures for both single-earner (but dual-filer) households and dual-earner households (assuming implicitly that the two earners are in different tax brackets). There is no label or scale on the y-axis, which is held to represent provincial taxes paid. For the single-earner family, taxes are estimated by the Conservatives to fall by 29 percent (from \$4721 to \$3358). The unlabeled graph, however, indicates that taxes fall by 75 percent: the first bar is 4.55 cm tall, and the second is only 1.15 cm tall. It thus overstates the relative decline in taxes (again, for that specific but unstated sub-set of families which attain maximum benefits under this scheme) by a factor of almost 3.

This assumes that the y-axis scale begins (at the intercept) at a level of zero, which is the correct assumption to make unless the axis is labelled differently. It would be possible to present the two bars accurately with a non-zero starting point for the y-axis, but only with appropriate labelling to inform the reader's perspective. In this case, on the basis of the actual size of the two bars, the y-axis should begin at \$2897 in family taxes. This would be an odd and manipulative way to draw a bar graph (chosen in order to accentuate the apparent change between the two bars); it is legitimate only if it is labelled.

Even if the y-axis had been so labelled, however, the graph would still be incorrect because of the manner in which the *second* set of bars (portraying before and after taxes for a *two*-income family) has been drawn. Using the same implicit y-axis scale that would be required to legitimate the before-and-after comparison of taxes for a single-income family, the first bar on the right side of the graph is wrong. It has been drawn too tall (relative to the implicit y-axis scale required to legitimate the first set of bars), and hence exaggerates the apparent tax saving accruing to the *dual*-income family (even according to the misleading but unspecified y-axis scaling that was implicitly used for the single-income bars). The actual (maximum) savings accruing to the dual-income household are significantly smaller than implied in this graph, even after adjusting for the misleading and unspecified scaling of the y-axis.

Clearly, the bars in this graph (like the bubbles in Figure 1) were simply drawn in by a graphic artist with the intention of maximizing the desired political point. Unfortunately, this results in a sacrifice of empirical legitimacy.

Figure 3: Standard of Living (Page 3)

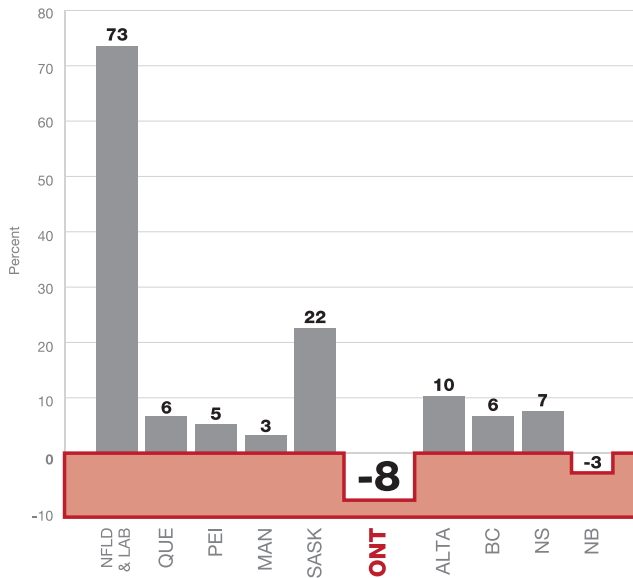
This bar graph shows the purported change in real per capita GDP by province (taken as a proxy for relative provincial living standards, which is not exactly the same thing), between 2000 and 2010. It suggests that real per capita GDP in Ontario declined by 8 percent over that decade, by far the worst performance in Canada. It provides no detail regarding the precise definition of real per capita GDP; since there are several different concepts of this measure, it is important to be specific. The only source note is to Dr. Livio Di Matteo, an economist at Lakehead University in Thunder Bay. A source note should refer to a particular publication, not just the author, so that the source can be consulted as required.

I telephoned Dr. di Matteo to see where this data originally appeared. He informed me it came from a pre-budget submission he made to the provincial legislature's finance committee on January 31, 2011, and kindly provided me with his full report.³ His original graph provides some additional detail regarding the specific measure: it divides real provincial GDP (measured in constant \$1997 terms) by provincial population. The original source for his data (cited to me verbally, but not in his report) was a database on provincial economic aggregates maintained by the Canadian Institute for Health Information (CIHI). He acknowledged that the 2009 and 2010 data points in this series were forecasts (not actual data). This had to be the case since Statistics Canada (the only agency which gathers and reports this original data for all provinces) does not report provincial GDP until November of the following year. 2010 provincial GDP is *still* not available, therefore, and the 2009 data was published only slightly before Dr. di Matteo made his presentation (and could not yet have been incorporated into the CIHI database which was the secondary source he consulted). The fact that the 2009 and 2010 data points were *forecasts* should have been indicated clearly in both his original graph and in the *changebook's* reprinting of the graph—especially since the key reported number (cumulative change in real

Standard of Living, changebook Graph vs. Corrected Data

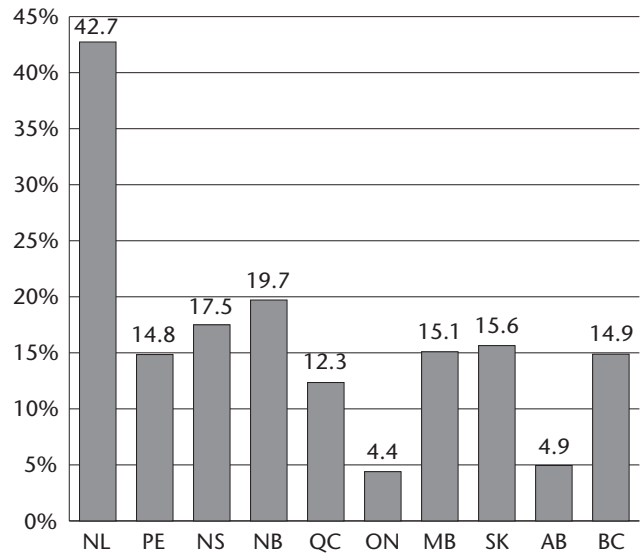
[standard of living]

Growth of Real Per Capita GDP: Canada's Provinces, 2000-2010



Source: Dr. Livio Di Matteo, Department of Economics, Lakehead University

Change in Real GDP per Capita (Chained \$2002), 1999-2009



Source Author's calculations from Statistics Canada CANSIM Tables 510001 and 3840002

GDP per capita from 2000 to 2010) depends entirely on those forecasts.

In terms of the *changebook's* re-representation of Dr. di Matteo's data, there are some small problems. Curiously, the *changebook* version has altered the normal ordering of the provinces in the graph. Statistics Canada reports its provincial GDP data by province moving from east to west, and Dr. di Matteo's graph stuck to that tradition. The *changebook* version, however, opted for a random ordering (neither by geography, nor by value)—perhaps because the designer felt that arrangement better highlighted Ontario's poor relative showing. This graph does provide a consistent labelled scale for its y-axis (unlike Figure 2). However, the size of the provincial bars is not entirely true to that scale. For example, the bar associated with Quebec (reporting a 6% 10-year gain in real per capita GDP) is too big relative to the specified scale, and is indeed notably taller than the bar for B.C. (which also reports a 6% gain). This suggests again a process of "eyeballing" the data by a graphical designer, rather than actually plotting it.

This graph also is the first in the *changebook* to invoke a very odd and illegitimate technique, of *fattening* the specific bar that the author wishes to emphasize. In this case, the Ontario bar (at minus 8%) is *twice* as wide as the bars for all other provinces. A graph designer can choose other means (bright colour, a label, a flashing arrow, etc.) to highlight a desired point. But widening a particular bar is not acceptable, because it implies a larger *area* for that observation, and hence a greater importance for the variable in question. Indeed, there are some specialized bar graphs in economics in which different bars are deliberately given varying width as well as height, in order to capture two dimensions of variation within a single graph. (Bar graphs which illustrate the relative contribution of different components of GDP to overall growth are a common example of this technique.) Fattening the negative Ontario figure is an artificial and illegitimate way to exaggerate the author's political point.

By far the most important problem with this graph, however, is that the underlying data is wrong. As noted, the original work by Dr. di Matteo relied on a secondary source which forecast the 2009 and 2010 data. Also, that secondary source used a deflation

methodology (converting to \$1997 constant dollars) which is outdated and is no longer utilized by Statistics Canada. Economists understand that calculating real GDP numbers is a delicate exercise, highly sensitive to the choice of deflator, and deflators themselves evolve rapidly over time due to the changing composition of economic production. Statistics Canada's favoured deflator now (in use for the past several years) is a chained (or linked) deflator, in which the composition of the deflating basket of goods is adjusted each year, measured in 2002 dollar terms.

I have recalculated the series from this graph using actual 10-year trends (up to and including 2009, the last year for which actual province-wide data is available), deflated using Statistics Canada's preferred 2002 chained deflator (and divided by mid-year population data, also reported by Statistics Canada). The results are striking, as illustrated in the side-by-side comparison of the original *changebook* graph (using forecasts for 2009 and 2010, a \$1997 deflator, and secondary data from CIHI) with the corrected one (using actual 10-year original data to 2009, and a \$2002 chained deflator, attained directly from Statistics Canada) as shown on page 5. Ontario's real per capita GDP grew by 4.4% over the most recent 10-year period of actual data. That's still the worst in Canada (slightly behind Alberta), reflecting the province's heavy reliance on manufacturing which had a dismal decade. Low per capita real GDP growth also reflects Ontario's rapid population growth: second-highest in Canada over that time (next to Alberta), driven by a disproportionate share of new immigrants settling in this province. (Higher population growth reduces GDP per capita growth even if the overall economy is growing strongly; this is an important factor to keep in mind when making per capita GDP comparisons, which the *changebook* ignores.) But the actual data indicates that Ontario's performance is not nearly so far removed from that of other provinces as is implied in the *changebook* version of the graph. And the *changebook's* key qualitative claim that living standards (proxied by real GDP per capita) have declined in Ontario over the past decade is false.⁴

The *changebook's* authors might respond that they were simply reprinting data that appeared in another source, so these errors are not "their fault." This is an inadequate response. First, that other source was not properly cited in the *changebook*, nor were key details (such as choice of deflator, nor the crucial fact that

the last 2 years of data were forecasts). More crucially, policy-makers who aim to run a large government must be far more rigorous in their analysis than simply cutting and pasting graphs submitted from particular participants in a public consultation. They must show a modicum of empirical due diligence in reviewing, verifying, presenting, and interpreting this data. On this score, the *changebook's* inclusion of a false portrayal of Ontario's relative economic performance is damning indeed.

Figure 4: Hydro Rates (Page 5)

This graph purports to show that electricity prices in Ontario have increased by 150% from 2003 through 2011, as a result of peak-pricing systems and what the *changebook* calls "smart meter tax machines." It shows one bar indicating a 4.3 cent per kilowatt hour price in 2003 (when prices had been cut and then frozen by the previous Conservative government in an effort to dampen controversy associated with its failed electricity restructurings), and a second one indicating a 10.7 cents per kilowatt hour price in 2011 — accented with a fat, cross-eyed piggy bank. The source for the graph is listed as "Ontario Energy Board."

There are many problems with this graph:

There was no differentiation in electricity prices according to peak times in 2003, so the regulated 4.3 cent price applied to all purchases. The 10.7 cent price cited for 2011 is only the *maximum* price paid at *peak-load* hours (between 11 am and 5 pm in summer, and between 7 and 11 am and 5 and 7 pm in winter). At other times, consumers pay less—as little as 5.9 cents in the lowest peak periods. Nowhere does the graph indicate that it is picturing the peak load price only; this is terribly misleading. The actual price paid by consumers will depend on their respective blending of peak and off-peak prices. True average electricity prices in Ontario have grown by much less than implied by the *changebook*.⁵

The increase in price from 4.3 to 10.7 cents per kilowatt hour (even accepting the previous definitional issue) is 148.8%, not 150%.

Again, there is no y-axis label or scale provided. Assuming that the y-axis starts at zero (as we must without labelling to the contrary), the larger graph is drawn too high, exaggerating the apparent height of

the increase. The actual scale of the graph implies a 160% increase in electricity prices, not 148.8%.

Again, the graph designer has chosen to arbitrarily fatten the size of the higher-priced bar: it is 2.35 cm wide, where the initial bar is only 1 cm wide. As noted above, this is not legitimate in an empirical presentation, as the area of the bars is often (in many applications) associated with a measurement. The area of the second bar is thus over 6 times as large as the area of the first bar—implying an increase in consumer burden of over 500% (rather than the claimed 150%). This dramatically over-exaggerates the presentation of the *changebook's* own flawed claim.

Citing this graph to the Ontario Energy Board is entirely misleading. While OEB documents (on its web page and elsewhere) do indeed report that the regulated price of electricity in 2003 was 4.3 cents per kilowatt hour, and that the peak hour price in 2011 is 10.7 cents, the Board would rightly be aghast that its name has been invoked as the source of a claim that electricity prices in Ontario have increased by 150%. At minimum, the graph should be sourced as: “Author’s calculations and estimates based on price data reported by the Ontario Energy Board.”

The multiple errors in this graph reinforce the emerging pattern that these graphs are not actually empirically presentations. They are more like “cartoons,” drawn by hand to emphasize particular political points, which may or may not hold any quantitative credibility.

Figure 5: Growth in OPA (Page 5)

As part of the Conservatives’ populist emphasis on government-inspired waste in the electricity sector, this graph illustrates the cost and employment levels associated with the operation of the Ontario Power Authority. It compares expenses and staffing in 2005 (when the agency was first being established) to 2011, with graphs composed of dollar-signs and human body icons. No y-axis title or scale is provided.

The appropriateness and relevance of this comparison is surely open to question. The budgets and staffing of any organization (including a private business) will be small when it is starting operation, compared to when it is fully operational. And whether the OPA’s administrative scale has any bearing on electricity prices in Ontario is obviously open to considerable

discussion. But we are focusing here on the legitimacy or lack thereof of the *changebook's* empirical presentation of its stated claims, rather than on the logic of the claims themselves.

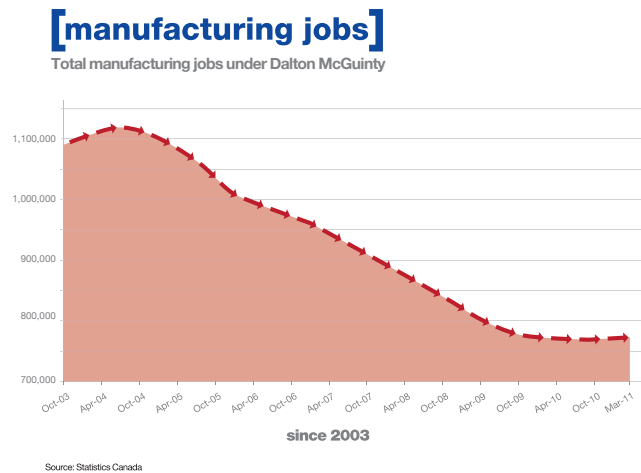
The first pair of bars shows expenses in 2005 and 2011, rising from \$14 million to \$74 million. But the second bar contains 30 dollar-signs (in 3 columns), versus only 3 (in 3 columns) in the first bar. That implies a 10-fold increase in expenses, about *twice as large* as the actual proportional increase in the stated numbers (from \$14 million to \$74 million). Each dollar sign in the first bar represents almost \$5 million in expense. Each dollar sign in the second bar represents less than \$2.5 million in expense—so it’s no wonder there are a lot more dollar signs!

The second set of bars, refreshingly, provides a more honest empirical comparison: each body icon represents 5 people. The second bar is wider than the first (5 columns instead of 3), but in this case that increased width is legitimate: the increased area provides for a proportional illustration of the fact that the OPA grew from 15 employees in its first year of operation to 253 at present. Whether that is a legitimate rate of growth or not for a newly-established agency is a separate issue; the dominant political impression that the authors wish to leave is of out-of-control bureaucracy and waste, and the scope of that impression is unduly exaggerated by the manipulation of y-axis scaling in the first set of bars.

Figure 6: Hydro Bill Increases (Page 6)

Here is another graph motivated by the Conservatives’ effort to make electricity prices a central campaign issue. The graph uses lightning bolt icons to represent the expected rise in monthly electricity costs over the 2010 through 2015 period. No y-axis scale is provided, nor is any detail provided regarding what type of monthly expense is being measured (residential, commercial, or industrial? average, median, or some other definition? real or nominal dollars?). The graph portrays an increase in monthly electricity bills from \$130 in 2010 to \$191 in 2015. The graph is sourced to “Canadian Manufacturers and Exporters,” but with no additional information regarding any specific publication or document, date of publication, nor to the source of original data used by that group to develop its projections. These details are essential in any legitimate citation of secondary sources. I have

Manufacturing Jobs, changebook Graph vs. Corrected Data



searched the public areas of the CME’s website and cannot find any obvious link to a report that would project electricity prices in Ontario, and provide more details regarding the methodology and data used in that projection; such a document may be there, but it is incumbent on the author citing it to provide full citation details to allow for cross-reference and double-checking.

The obvious empirical flaw in this graph is its effort to vastly exaggerate the scale of the coming increase in electricity prices. Each bar arranges the lightning bolts in 4 columns. From 2010 to 2011 the number of bolts doubles—even though the numerical estimate of (unspecified) monthly cost increases by 8 percent. This pattern continues, with each year’s lightning bolt tally exaggerating the increase in that year’s monthly price. By the end of the graph in 2015, prices are portrayed as having increased by 4.5 times (from 8 lightning bolts to 36), when the corresponding data indicates an increase in the monthly bill of 47 percent. The graph thus visually exaggerates the rise in electricity prices by a factor of over 7. This is a laughable presentation of empirical data; a graph like this would be immediately rejected by any first-year statistics or economics professor for its inadequate labelling, its inadequate sourcing, and its grossly misleading visual presentation.

Again, this analysis of the errors in Figure 6 implies nothing about the validity of the underlying claim pictured in that figure (namely, that electricity prices are out of control, and it is the current government’s fault). It is worth noting, however, that independent (and well-sourced!) economic studies⁶ have suggested that future increases in electricity prices will occur regardless of proposed changes to the Green Energy Act and other features of provincial policy.

Figure 7: Manufacturing Jobs (Page 7)

It comes as no surprise to anyone that manufacturing employment in Ontario has been hard-hit in the past decade. That bitter experience has been shared by all manufacturing jurisdictions in North America (even low-cost, low-tax Mexico), and reflects the impact of broad factors including technological change and productivity growth, the migration of manufacturing to offshore locations (including China), the impact on Canada of the sharp appreciation and over-valuation of the Canadian currency (a rise which began in 2002), and of course the effects of the 2008–09 financial crisis and subsequent recession.

So I was not surprised at the general portrait painted by this figure, which illustrates the decline in manufacturing employment in Ontario. The

changebook graph shows manufacturing employment first rising, then peaking at over 1.1 million jobs in 2004, then plunging to well under 800,000 jobs by mid-2009, and then flattening (with no recovery) since then. The graph is sourced to “Statistics Canada,” with no further detail regarding which specific survey or publication it comes from. As there are many different employment series published by Statistics Canada (based on household or employer surveys, seasonally adjusted or not, employees only or self-employed included, etc.), the reference needs to be more specific. But the overall picture rang true.

However, on second glance, I became suspicious. As a labour economist, I follow monthly labour force numbers closely. There is a lot of “noise” in labour force data, reflecting sampling errors, transitory effects, and other short-term factors; no labour force trend is ever as perfectly “smooth” as the series portrayed in this figure.

So I gathered the actual Statistics Canada data for a comparison. Despite the lack of a detailed citation, I could ascertain that the *changebook* figure presents seasonally adjusted data for all employees (including self-employed) in Ontario manufacturing as reported by the monthly Labour Force Survey. It is published in Statistics Canada’s CANSIM Table 2820088. The actual data for this series is presented on page 8, right beside the corresponding figure appearing in the *changebook*.

The overall trend portrayed by both graphs is similar; again, no surprise about the brutal shake-out experienced in manufacturing. But some subtle yet important differences indicate an attempt by the *changebook* authors to doctor the data to reinforce their effort to pin blame for the whole problem on the McGuinty government.

The y-axis, for a change, is scaled and labelled accurately. While the y-axis has been designed to exaggerate the scale of the vertical fall in the series (beginning the axis at 700,000 rather than zero), this is legitimate so long as it is clearly labelled, as it is. However, the graph has clearly been artificially “smoothed” — probably hand-drawn by an artist who broadly and roughly followed the actual data. This is not legitimate in economic presentations unless the method of smoothing (eg. a multi-period moving average) is systematic and clearly specified.

The choice of starting period for the graph is also interesting. It begins in October 2003 (when the McGuinty government was elected—although it did not take power until later that year). In reality, manufacturing employment was already weakening in Ontario (and elsewhere in North America) for some time previously, reflecting global factors, the post-9-11 recession in the U.S., and the escalation of the Canadian dollar. The *changebook* eliminates that historical context, which might lead the reader to conclude that the data reflects a bigger set of problems than just who is holding provincial office in Ontario. Intriguingly, the *changebook* graph begins precisely at a mini-trough in manufacturing employment (the lowest point during the previous 18 months). This may reflect a deliberate effort to create the (false) impression that the McGuinty government inherited a healthy industry, with growing employment, and then messed it up. In fact, Ontario manufacturing was already in trouble before the McGuinty government came to power.

However, the most concerning manipulation of the data in this graph is the obviously deliberate effort to avoid any impression that manufacturing employment in Ontario is rebounding. Since the trough of the recession, Ontario manufacturing employment has come back by about 7 percent (using that same seasonally adjusted LFS data source), and now exceeds 800,000. Only a small share of lost manufacturing jobs has been replaced, but the direction of change is important. The hand-drawn *changebook* version of the data, however, eliminates any sign of a rebound in employment since 2009, and falsely portrays Ontario manufacturing employment as remaining substantially below the 800,000 job threshold even as late as March 2011 (the last data point indicated on its x-axis). In this regard, this graph is not just manipulative in its presentation; it is explicitly false.

The subtly manipulated nature of this graph suggests again that the *changebook* authors directed their graphical artists to portray a certain conclusion with their figures, rather than letting the numbers speak for themselves. This is dangerous coming from a political party which hopes to hold office.

Figure 8: Debt Doubling (Page 12)

This may be the most bizarre of the graphs contained in the *changebook*. It purports to show that total nominal provincial debt, after many decades of very

slow growth (under Ontario's first 23 premiers), took off like a rocket ship once the McGuinty government came to power. Again, it is no surprise that Ontario (like other provinces, the federal government, and most jurisdictions in the world) has been burdened by large deficits since the financial crisis and recession of 2008–09. But this graph utilizes several very questionable techniques to manipulate and exaggerate that basic, universally acknowledged truth:

The y-axis scaling of the graph is entirely unusual. It features 4 evenly spaced "ticks," each positioned 1.3 cm apart rising up the y-axis. The first tick is labelled \$150 billion. The y-axis is clearly meant to start at 0, because that is where the long slow increase in nominal debt (dating back to 1867) is pictured to begin. But then, suddenly, the axis scaling shifts, so that each subsequent vertical tick now represents only \$50 billion (not \$150 billion). The effect is to triple the apparent scale of the vertical rise in debt. While the title of the graph indicates that nominal debt has doubled since 2003, the graph implies that it has quadrupled.

This time, however, the graph also incorporates a curious break in the scale of its x-axis. The 136 years of time covered by Ontario's first 23 premiers is portrayed with 12 data points stretching across the first 6 horizontal centimetres of the graph. The next 8 years, then, are portrayed with 14 data points, stretched across the remaining 5 cm of horizontal range of the graph. How the discrete data points correspond to particular years of data (since debt data is normally presented on an annual basis) in either horizontal section of the graph is not clear. Ironically, the impact of this bizarre x-axis scaling is to *reduce* the apparent acceleration of data under the McGuinty government. With normal x-axis scaling, the entire McGuinty period would be captured within the farthest-right 61 millimetres of the graph. However, that might have made the graph less legible with respect to the authors' desired point, and so the x-axis scaling was adjusted to give more attention to the McGuinty years.

The graph portrays the evolution of Ontario's debt (without specifying whether it is gross or net debt, financial or non-financial, or other key details) since Confederation. The end-point for the graph is not labelled but is presumably 2011 —since a Conservative election brochure is obviously not premised on the assumption that the McGuinty government will last any longer than that! The graph indicates a 2011 debt

of something over \$300 billion, representing (they say) a doubling of debt from around \$150 billion when McGuinty took office. Most analysts use net debt as the best measure of government obligations, since governments (like any other economic actor) possess both financial assets and financial liabilities at any point in time. Indebtedness is usually defined as the difference between the two. Ontario's net debt at the end of fiscal 2010–11 was \$214.5 billion, about one-third lower than the (unspecified) figure reported in the graph. Ontario's gross debt (that is, the sum of all financial liabilities, not deducting cash and other financial assets held by the government) was only \$282.9 billion.⁷ The *changebook* graph therefore corresponds to neither of these figures—not even within a margin of error. It is not clear at all what measure of debt, nor what source of data for the debt, is incorporated within this graph. Ontario's net debt grew by 54.5% in nominal terms between 2003–04 and 2010–11. That's about half of the purported "doubling" claimed by the graph. Measured more appropriately (as most analysts do) as a share of provincial GDP, Ontario's net debt grew by one-quarter between 2003–04 and 2010–11 (from 28% of GDP to 35% of debt today). It goes without saying that Ontario, like most jurisdictions, faces serious fiscal challenges. But the *changebook* graph's portrayal of those challenges is misleading in the extreme.

In fact, deeper questions must be asked about the data lying behind this graph. I am not aware of any published consistent data series on provincial debt going back to 1867. The graph cites "Ministry of Finance," which reports current and recent historical data, but has no published series going back to 1867. Statistics Canada has a publication titled *Historical Statistics of Canada*, which reports Ontario's net debt for certain years going as far back as 1933. That series, interestingly, does not increase monotonically as portrayed in the *changebook* graph; there are several years when Ontario's net debt fell. It would have required a difficult and detailed archival effort to try to assemble a true series on Ontario's debt going back to 1867. I doubt that this occurred, and at any rate would require detailed citations indicating original sources, methodology used for splicing disparate data series, and other crucial empirical issues. Finally, Ontario's debt at Confederation was not zero, as implied in the graph. The new provincial government would have inherited obligations incurred by the former administrative structure of Upper Canada. For all of

these reasons, I suspect that the original data in this graph (up to about 2000 or so) was simply drawn by hand, in a more-or-less straight line running from the false estimate of 0 in 1867 to the assumed \$150 billion (in gross debt?) purportedly passed on to the new McGuinty government shortly thereafter. This is obviously not a legitimate way to portray important economic and fiscal information.

A fundamental problem with any long historical series of nominal data like this one (governing any dollar variable, including aggregate GDP, incomes, taxes, etc.) is that they all look the same: a long flat line, followed by a “take-off” at the far right side. Going back many decades (over a century in this case) reduces the nominal value of any such series to almost zero (relative to the large nominal values of current years). Then, as the graph moves to the right, the series “takes off” —since even a constant rate of growth of a nominal series will convert into an accelerating rise in any linear-scaled graph. This is as true of “good” things (like GDP or consumer spending) as it is of “bad” things (like debt). That’s why economists, in presenting these very long nominal series, normally either normalize the data (presenting it as a share of GDP, for example), or else utilize a logarithmic y-axis scale to indicate how the rate of growth of the series (rather than its nominal value) is changing over time. A more appropriate presentation of provincial debt data would indicate that Ontario’s fiscal situation is serious, to be sure, but without implying a sudden “collapse” of fiscal wellbeing as is implied in this manipulative graph.

Figure 9: Increase in Government Spending (Page 13)

This graph reinforces the Conservative theme that provincial financial discipline has collapsed entirely since the McGuinty government came to power. It shows total provincial program spending increasing from \$64.3 billion in 2003 to \$113.8 billion in 2011, an increase of 77%. The text accompanying the graph interprets this rise as a 77 percent increase in the *size* of government, which is ridiculous: the true “size of government” should be measured as a share of GDP, or in real per capita terms, or by the total number of employees, or any other real operational measure—not by the nominal value of total program spending.

The graph, like Figure 8, is sourced to the Ministry of Finance. It suffers once again from tremendous

imprecision in reporting and citations. Provincial budgets are set for fiscal years running from April through March, therefore fiscal years are usually referred to as 2003–04, 2010–11, etc. It is thus unclear which fiscal year is referred to in 2003, for example: 2002–03 or 2003–04. Since the graph subtitle refers to growing spending under McGuinty, it would only be appropriate to use the 2003–04 fiscal year as the starting point since that was the last budget implemented by the previous Conservative government. That year total program spending was \$70.1 billion.⁸ By 2010–11 that increased to \$111.2 billion, an increase of 58.6% (not 77%). So it is not clear, for starters, where the *changebook’s* initial data comes from, and to what it precisely refers; a sorely inadequate source reference prevents us from clarifying the source or meaning of the presented data.

Again, however, these weaknesses are magnified by a manipulative visual presentation of the claimed data. The graph has no y-axis label or scale. The first bar includes 5 human body icons, in 5 columns. The second contains 25, in 5 columns, implying a five-fold increase in government program spending. The graph therefore implies that government spending has grown *more than 5 times as much* as the stated numbers claim (77%)—even before considering the weakness of those stated numbers.

It would be possible to draw a legitimate graph like the one on p.13 of the *changebook*, if the y-axis was scaled to begin at \$51.925 billion in spending, increasing in equal increments of \$12.375 billion. That is the only approach which would be consistent with the relative proportions of the two bars. This strange scaling would have to be clearly labelled, in order to allow the reader to have perspective on the relative values being portrayed. Of course, that is clearly not how this graph was actually prepared. Once again, a graphic artist was instructed to simply draw an eye-catching graph that makes it look like government spending has grown dramatically. And once again, this is entirely illegitimate in any application which purports to show real economic data (rather than cartoons).

Figure 10: Ontario Deficit (Page 15)

This bar graph presents data on forecast provincial budget deficits for the 2011–12 fiscal year, as compiled by the RBC Economics office. The graph gives an incomplete citation to the report: the full citation is

“Provincial Fiscal Tables,” RBC Economics Research, various dates, http://www.rbc.com/economics/market/pdf/prov_fiscal.pdf. Since RBC constantly updates their tables, a date should be provided so readers can know which version of their report is being referenced. The currently available on-line version of the RBC report is dated August 23, 2011, and data for about half of the provinces has changed (due to budget updates) since the version that was used for the *changebook* graph.

The graph is a horizontal bar graph, with no x-axis label or scale (though it is obvious from the added text that the graph is measuring provincial budget balances in dollars). The major conceptual difficulty with this graph is that it makes little analytical sense to compare provincial budget balances in dollars. Ontario’s forecast deficit (at that time) for 2011–12 was \$16.3 billion (RBC has since reduced its forecast in line with Ontario’s smaller-than-expected actual deficit for 2010–11). Prince Edward Island’s, meanwhile, was “only” \$42 million. Does that mean that PEI is doing better than Ontario at balancing its books? Not necessarily: it all depends on the scale of population, GDP, and revenues in each province. Some context must be provided in order to consider whether a given nominal deficit is “big” or “small.” The most common context used by economists (including the RBC report, on the very next page following the data graphed in Figure 10) is to measure deficits relative to GDP. In this case, Ontario’s deficit is still large (2.3% of GDP in 2010–11, edging out New Brunswick’s 2.2% for the largest of any province), but not by the overwhelming order of magnitude implied by the *changebook* graph.

Even given this important methodological shortcoming, the scaling of the bars in this figure is not consistent, indicating again a pattern of crudely approximated or hand-drawn graphs. For example, the bar for B.C.’s deficit (estimated at \$925 million) is significantly too small, relative to the next largest provincial deficit (for New Brunswick, at \$449 million). The graph was clearly not prepared using a conventional graphing computer program. Ontario’s bar, meanwhile, is doubly confused. First, ironically, the bar is *too short*: it should be over 4 times as large as the next-biggest deficit in Quebec, whereas it is less than 3 times as long. But to make up for that, the designers of the graph arbitrarily fattened Ontario’s bar to give it more emphasis in the illustration: it is three times as wide as the bars for other provinces. Using the area of each bar, then, as the measure of its supposed

value, Ontario’s bar is more than 7 times as large as Quebec’s—whereas its deficit is around 4 times as large. Of course, taking into account Ontario’s larger population and GDP would add further appropriate perspective to the comparison.

Again, the point here is hardly to deny that Ontario faces a large deficit (although it is shrinking rapidly). It is to highlight a consistent pattern of visual manipulation in the presentation of empirical data in the *changebook*. In this case, that manipulation hardly seemed necessary: even in a more appropriate and honest presentation, Ontario’s numbers would still look serious. Yet the *changebook*’s authors couldn’t resist fiddling with the perspective and proportions once again, to exaggerate their political point all the further.

Figure 11: Health Spending (Page 17)

Now the direction of the political motivation for the graph has changed: the *changebook* wants to positively emphasize how much new spending a Conservative government would allocate to health care. But the techniques of manipulation are consistent: the authors use the same illegitimate techniques to show their own plan in a good light, as they used in previous graphs to show the McGuinty government’s record in a bad light.

This graph compares projected health care spending of \$47.6 billion in 2011, with a promised \$53.7 billion (\$6.1 billion more) by 2015. No source is provided for the data. Again, by imprecisely referencing fiscal years, the graph makes it difficult to verify its underlying information. According to the “Public Accounts of Ontario” (Schedule 4), the province spent a total of \$44.1 billion in health and long-term care in 2010–11, slightly lower than the budgeted \$45.4 billion. And the Provincial Budget for 2011 indicates (Table 25) ministry spending of \$47.1 billion for 2011–12. The \$47.6 billion starting point of Figure 11 matches none of these estimates; the graph needs more precise documentation in order to validate its starting point.

Then, to illustrate the addition of \$6.1 billion in spending over 4 years (an annual rate of increase of just over 3 percent), the *changebook* graph then presents two bars. There is no y-axis label or scale. The first bar has 16 ambulances arrayed in 4 columns (representing 2011), while the next has 40 ambulances arrayed in 5 columns (representing 2015). Working off the height of the bars alone, the graph implies a doubling of health

spending over the 4 years. Using the area of the bars (i.e. the number of ambulances), the graph implies a 150% increase in health spending. In reality, the actual data suggests a cumulative 12.8% increase in health spending over 4 years. (That is not enough, of course, to keep up with health care inflation and population growth, thus implying a decline in real per capita health spending under the Hudak plan.) This graph thus overstates the promised increase in health care spending by *about 12 times*.

Figure 12: Gas Tax (Page 23)

This graph is a visual representation of the number of communities which are projected to receive provincial revenue-sharing under the Conservative party's pledge to share gas tax revenue with all communities (not just those that operate transit or bus systems). At present, the graph claims, only 89 communities receive a share of that revenue. Under a Conservative government, 444 would receive revenue.

The graph pictures the extension of revenue-sharing to those 355 extra communities through a stylized vertical highway. There is no y-axis scale, and no source for the underlying data. The graph is close to accurate in terms of visual proportions, but not precise: the number of communities grows by less than five-fold under the Conservative plan, but the bar graph for 444 communities is more than 5 times as large as the bar graph for 89 communities. This suggests again a process of "eyeballing" the data by a graphical designer, rather than a true plotting of the data.

Of course, the greater question is that the concept being addressed by the graph (the number of communities receiving gas tax revenue-sharing) is arbitrary and not entirely relevant. According to the 2006 census, the population of the largest 89 cities and towns in Ontario represented over 85 percent of the total population of the province.⁹ Thus the broadening of the tax from those communities providing transit, to the much larger number of all communities, will not actually affect a large proportion of Ontarians. The *changebook's* pledge to provide new funds to 355 additional communities, without reducing the amount currently received by any of the 89 larger municipalities, is also curious.

Figure 13: Court Delays (Page 32)

This final graph in the Conservative *changebook* is perhaps the closest the platform comes to providing an accurate, fair, well-documented graph. It shows the change since 2002 in the average number of days required to dispose of a criminal case one way or the other in Ontario's courts. It shows a rising trend, with a big jump in 2010—by which time it took an average of 228 days to dispose of a criminal case in Ontario (up 16% from 2003).

The axes on this graph are labelled and consistently scaled. The source note for the data is not perfect, but adequate: it mis-titles the original source, and neglects to report the 2002 edition of the report (even though 2002 data is included in the graph).¹⁰ One odd feature of the graph is that it pictures 8 years of annual data, yet seems to represent 21 distinct data points. Moreover, the pictured data points do not correspond to the actual points of inflection on the series (that is, the points along the line where the line "bends"). The relevance of the 21 data points is not clear: it is possible that the graph's designer simply used a series of "dots" to picture the evolution of the series, but this is misleading (since a discrete dot usually represents a discrete data point).

In measuring the average time for criminal proceedings, the original Court of Justice documents make an important distinction between days including bench warrants and days excluding bench warrants. Bench warrant days represent time expired while the accused has failed to appear in court (and hence presumably is being located by court and police officials). The *changebook* graph shows average court time including bench warrant days, but fails to specify this. If bench warrant days are excluded (which may be more appropriate if the concern, as stated in the *changebook*, is the administration and "bureaucracy" of the court process, rather than the location and apprehension of accused), then average disposition time has decreased in recent years (to 169 days in 2010), not increased. In any event, given the two commonly-used data series, the graph should have specified which series was being pictured.

As with Figure 12, the bigger question surrounding this graph is its relevance, rather than its visual presentation. No attempt is undertaken to provide

an explanation for the increase in court processing times, and the connection of this information to the corresponding policy proposal (to lengthen the hours of Ontario's busiest courts) is not made clear.

Conclusion

Many commentators have noted a common philosophical thread linking the *changebook* to the famous *Common Sense Revolution* document which ushered in the Mike Harris Conservative government in 1995. Indeed, there is a clear commonality in the two documents' major political emphases (tax cuts, promised protection for "priority" services like health care, getting tough on crime, etc.). Even some of their precise wording is eerily similar.¹¹

As I finished reviewing the questionable and in many cases dishonest statistical presentation of the *changebook*, however, I came to a different conclusion. In terms of its empirical presentation and honesty, the *Common Sense Revolution* is in a totally different class than the *changebook*. The empirical analysis contained in the *Common Sense Revolution* was overseen by a real economist: Dr. Mark Mullins, who was then the Chief Economist at Midland Walwyn, and subsequently went on to lead the Fraser Institute. Whether you agreed or disagreed with Dr. Mullins (and he and I have debated many times), his knowledge base and professional integrity were undeniable. The *Common Sense Revolution* never included hand-drawn graphs, based on invented data, with axes and scale deliberately manipulated in order to exaggerate political points. Like it or hate it, the *Common Sense Revolution* reflected a sober, empirically validated quantitative presentation.

The 13 graphs of the *changebook*, on the other hand, are more like cartoons than actual graphs. They reflect the work of graphical designers who have been given political instructions to emphasize political points, rather than present real data. While this commentary has focused on reviewing and critiquing the empirical presentation of the *changebook's* ideas (rather than the policy content of the platform, *per se*), the pattern of systematic dishonesty which is visible in that presentation should give Ontarians ample reason to question the integrity and goals of the group that designed and published it.

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Notes

1. For example, see "The Mathematically Challenged Tim Hudak," Jeffrey Simpson, *The Globe and Mail*, June 22, 2011; "Hudak Can't Have it Both Ways," Editorial, *The National Post*, May 30, 2011; "Tim Hudak and the Common Nonsense Revolution," Kenneth Gray, *The Ottawa Citizen*, July 20, 2100. The full *changebook* document can be accessed at http://www.ontariopc.com/pdf/Changebook_en.pdf.
2. This does not include a simple flowchart graphic on p.22 of the document, which simply illustrates \$30 million in scholarship support being removed from foreign students and given to Ontario students; this graphic does not aim to portray empirical proportions, and hence is not considered in this commentary.
3. A full and proper citation for this work is as follows: "An Overview of Ontario's Economic and Fiscal Situation," Livio Di Matteo, mimeo, Department of Economics, Lakehead University, January 31 2011, 16 pp.
4. The 2009 end-point for this 10-year actual comparison is conducted at the trough of the recession; subsequent economic growth has improved those numbers. Consistent interprovincial data on GDP growth for 2010 are not yet available from Statistics Canada. However, Ontario uniquely reports its own estimates of provincial GDP growth, published by the Ministry of Finance in its "Ontario Economic Accounts" (most recent edition is for the First Quarter of 2011, published in July 2011). That data indicates a 3.0% increase in real provincial GDP in 2010 (see p.53), producing an increase in real per capita GDP for that year of almost 1.9 percent.
5. For example, on my most recent bi-monthly electricity bill, I paid a weighted-average price of 7.2 cents per kilowatt hour for my purchases in June and July—and I do not do my laundry in the middle of the night! That represents a price increase since 2003 less than half the size implied by the *changebook*.
6. See, for example, "Behind the Switch: Pricing Ontario Electricity Options," by Tim Weis and P.J. Partington (Drayton Valley: Pembina Institute, July 6 2011, 65 pp.).

7. Source for both numbers is “Public Accounts of Ontario 2010–11, Annual Report and Consolidated Financial Statements,” Ministry of Finance of Ontario, August 2011, pp. 32–33.

8. The data in this section is reported in the “2011 Ontario Budget,” Table 28 (Ten Year Review of Selected Financial and Economic Statistics), and “Public Accounts of Ontario 2010–11, Annual Report and Consolidated Financial Statements,” Consolidated Statement of Operations. Program spending, of course, is total expenditures less interest payments on debt.

9. There is no obvious way of knowing whether those 89 largest communities are indeed the 89 which offer transit or bus services and hence currently share in the revenue sharing, but the overlap is likely to be very close. Source: author’s calculations from Statistics Canada, 2006 Census, 2006 Community Profiles, <http://www12.statcan.ca/census-recensement/index-eng.cfm>.

10. A complete source reference for this graph would be as follows: “Statistical Data for Criminal Proceedings,” Ontario Court of Justice, various issues, 2002 through 2010.

11. For example, the *Common Sense Revolution* pledges that “Health care, law enforcement and classroom funding won’t be touched,” while the *changebook* pledges similarly that “We will protect vital frontline positions in health, education, and public safety.” The *Common Sense Revolution* states boldly that “We will have to set priorities and stick to them,” while the *changebook* similarly promises, “We will set priorities—and stick to them.” The *Common Sense Revolution* states that to balance its budget, “We need to find...less than 1% of the total our government currently spends—not even one cent in every dollar.” The *changebook* slightly raises the ante: “We will find savings of two cents on the dollar, every year on government spending. Two percent.” See *The Common Sense Revolution*, Progressive Conservative Party of Ontario, May 1994, http://web.archive.org/web/20051124195225/http://www.ontariopc.com/feature/csr/csr_text.htm.