PPPs and Price Parities in Benchmark Studies and the Penn World Table: Uses

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ABSTRACT

This conference presentation describes both the benchmark studies of the International Comparison Programme and the Penn World Table, a Space-Time System of National Accounts developed at the University of Pennsylvania. Examples of uses to which these international data have been put are included.

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Some Uses of PPPs in the Penn World Table

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I Introduction

Purchasing Power Parity and real product estimates have been produced for groups of countries since 1980 by the European Union and the OECD for their member countries and associates, and by the regional Economic and Social Commissions of the United Nations. These have often been with the support of the World Bank and the regional development banks, and individual countries, like Japan in ESCAP.[1] We refer to these various estimating projects as benchmark studies involving benchmark countries and carried out for benchmark years. This paper reports on the uses we have made of the benchmark studies, principally as wholesalers but also as retailers. We wholesale in the sense that the Penn World Table we maintain is a substantially reworked synthesis of the benchmark studies, and the Table is used extensively by others. Some of these uses are described below. But we also are direct users of the benchmarks ourselves; some of our work on the service-commodity and tradables-nontradables distinctions and on demand analysis are also reported.

Whenever judgments based on national accounts-type information must be made about countries or regions, it is necessary to take account of the relative values of the currency units of the different countries. This is so for policymakers concerned with, to take one kind of example, assistance and assessment questions. It is also so for researchers, both economists and other social scientists, searching for structural relationships that illuminate societies. The conversion of countries' national currency values of their national incomes or into a common numeraire currency is necessary for valid international comparisons of incomes and this requires the estimation of appropriate PPPs. The cliche that no single number tells more about households than their incomes holds true for whole economies. In economic models, income may enter as a variable in its own right, as in a consumption function, or as a proxy for some other variable(s)---say stage of development or index of relative factor prices---but nearly always income is introduced. Repeating, but in a slightly different way, whether national or regional income is important by itself or is included in the analysis primarily as a noise-screening device, it is nearly always needed. Certainly, one of the most common uses of PPPs is to provide Gross Domestic Product numbers that are directly comparable across countries and over time. This will be discussed in Section II below.

But to foreshadow other things to come, it should be remarked that the effective uses of the benchmark data are by no means restricted to quantity comparisons, at aggregate or disaggreggate

levels. An important concept is the national price level of a country. This is defined as the ratio of the country's PPP to its exchange rate, expressed as a percentage. National price levels across the OECD countries frequently range from 60% to 170% of the OECD average when exchange rates and PPPs are expressed relative to the United States dollar. The wide variation in price levels across countries and between the regions of countries have a number of implications for national, regional, and firm policies with respect to compensation, as well as for policies of central banks and exchange rate authorities. Barry Rodin of Employment Conditions Abroad will provide the Conference with much more detail on national price levels and compensation policies, especially for employees posted in countries other than that of their home offices. The use of national price levels for consumption or GDP are discussed in Section III below.

A final introductory remark: National or regional price levels are perhaps even more interesting at disaggregate levels. Many of the uses here---for example, cross-section energy demand studies---require detailed benchmark data. We report in Section IV below on some of our uses of the detailed data, both from the Penn World Table (henceforth, PWT) and the benchmark studies. Unfortunately, it appears to us that the detailed benchmark data have been underutilized relative to the extensive use of secondary sources like PWT. In an Appendix we summarize a partial study of citations of data sources used in articles published in social science journals. Complimentary as it might be to us, we fully recognize an imbalance between the number of uses PWT has been put to compared with the benchmark data.

II The Penn World Table and the Uses to Which It Has Been Put

A. What is PWT?

PWT is a first cut at the construction of a Space-Time System of National Accounts. The national income accounting framework, the conventional SNA, is the standard statistical device for describing countries' economic affairs. Entries in the usual System of National Accounts (SNA) are maintained by most of the 170-plus members of the United Nations. The SNA is a very effective data system for describing the details of a country's economic condition at a point in time and over a period of time. Unfortunately, the SNA by itself does not permit effective comparisons between countries. Intertemporal comparisons, YES; but interspatial ones, NO. The SNA's intertemporal viability had no interspatial counterpart until the price survey work---the benchmark studies---of the United Nations International Comparison Project (ICP) began in 1968 at the United Nations and the University of Pennsylvania. Since 1980 the Penn researchers have moved on to generalize the benchmark work. The focus has been on integrating the different benchmark studies and developing methods that

satisfy the need for information about countries that have not participated in benchmark studies and for years other than benchmark years. This has been accomplished through interspatial and intertemporal extrapolations of the ICP cross-section data to nonbenchmark countries and years. The resulting very large internationally comparable PWT contains less disaggregate information (no finer than the level of Consumption, Investment, Government, and the Net Foreign Balance) but provides long time series with much more complete worldwide coverage.[2] The very latest version, PWT (Mark 5.6b), (to be available in November, 1997) will cover 170 countries and 27 variables for some or all of the years 1950-94.

PWT (Mark 5.6) has been made available to users on a 3.5" diskette accompanied by a Windows extraction program that can be used as an alternative to the DOS extraction software of earlier versions. The National Bureau of Economic Research distributes the diskette and maintains the Table on the Internet. The Table along with somewhat more powerful extraction and graphic software has also been put up on the World Wide Web at the University of Toronto. This latter action was taken without our knowledge; we learned of it from Fortune Magazine! This illustrates the public-good character of PWT and the wide interest in its availability. It also illustrates the difficulty of monitoring the Table once it is in the public domain. (A University of Bristol researcher who asked for permission to put it up on the Internet there told us that an English page on the World Wide Web would be very useful because the trans-Atlantic communication link on the Internet was frequently busy for long periods of time.)

PWT is a forerunner of a new kind of international data base we anticipate will be further developed by international organizations. And there is plenty of scope for further development! The C, I, G, and NFB breakdown should be further disaggregated, and this is planned for PWT 6. In the present version, both constant- and current-price time series are provided for GDP and each of the four major components. The prices are so-called "international" prices. (Loosely speaking, these are weighted averages of the relative prices of all the countries in the world; they are scaled so that the total GDP of a base country measured in international prices is equal to the base country's GDP expressed in its own domestic currency.) The United States serves as the base country in ICP work, but it is only a numeraire; the ICP and PWT comparisons do not depend on which country is chosen as the base. The present PWT provides GDP information in the form of three different statistical concepts (fixed-year base, chain index, and in a forms designed to allow for changes in the terms of trade; and GDP is expressed in per capita, per equivalent adult, and per worker form. In addition, population and rudimentary capital stock information appear in the Table.

B. Some Uses of the PWT Numbers

1. Levels of Real Output

Market-size studies concerned with the demand for particular commodities frequently take the form of a cross-section analysis that draws on household income, relative prices, and perhaps other country variables. PWT provides income figures (e.g., Consumption per capita) that give an indication of material well-being.[3] Studies concerned with international commodities draw heavily on estimates of real quantities and relative prices at subaggregate levels, and benchmark price parity[4] estimates are a prime source for such investigations. However, because the number of benchmark countries is limited and often no benchmark year is current, it is frequently necessary to fall back on estimating equations based on a limited sample of observed benchmark countries. These equations are then used as a basis for gauging market-size for the nonbenchmark countries or nonbenchmark years.

PPP-converted GDP per capita is a variable used in a variety of cross-section and time-series investigations of all sorts of phenomena: demand for energy, health care, services in general, etc. In addition, it has been used to illuminate a variety of socio-demographic and political indicators like longevity, literacy, "freedom," etc. In these studies GDP per capita has played both exogenous and endogenous roles. Is the PPP-converted measure an improvement over what researchers used before the ICP (and even for a while after the ICP), namely exchange-rate-converted GDP per capita?[5] We have examined this question (Summers and Heston, 1993) in a paper comparing the explanatory value of exchange-rate=converted vs. PPP-converted GDPs per capita for a variety of socio-economic-demographic variables. Not surprisingly, the PPP-converted measure performed decidedly better.

A country's level of real output can also be used as an indicator of its ability to support international activities, or of its need for special treatment from the international community in the form of, say, aid or low-interest loans. Many systems of assessment, like those of the United Nations, were established when the only convertors available were exchange rates. Some countries gain and some lose when PPPs are substituted for exchange rates, so it is hard to reach agreement on this kind of change.[6] Furthermore, the quality of the data submissions by countries may well be contaminated if country allocations are likely to be affected by the outcome of the PPP estimation. Thus, while use of real output levels to determine international contributions and transfers seems a logical use of PPP estimates, this is an area where we feel slow

adoption is justified.

Two specific research-type uses of the GDP estimates in PWT by international organizations may be mentioned. The International Monetary Fund began in 1993 to use PWT in preparing estimates of regional and world growth rates for its World Economic Outlook. The growth rate for a region is calculated as a weighted average of the growth rates of the individual countries of the region, where the weights are the country shares of the total regional output. Before 1993 the IMF's shares were based on exchange-rate converted GDPs from the World Bank instead of ICP ones based on PPPs. The IMF was getting what it considered unrealistically low world growth rates because, except for Hong Kong and Japan, the fastest-growing countries in Asia were receiving low weights and the slower-growing countries of Europe were receiving high weights. (The systematic difference between exchange rates and PPPs for rich and poor countries is responsible for this perverse effect on world growth rates. Fast-growing Hong Kong and Japan were heavily weighted, but not enough to begin to compensate for the very low weight given to the high growth rates of the remainder of East Asia.)

The other international-organization use of PPP-converted GDP figures is in the computation of the Human Development Index developed by the United Nations Development Programme. Descriptions of the HDI and its underpinnings appear in the UNDP's various Human Development Reports.

2. Growth of real output

The explanation of economic growth has been the subject of a cottage industry of researchers in recent years. (Convergence considerations---e.g., "Do the rich get richer and the poor get poorer?" or "Do the rich get richer faster than the poor get richer?" etc.---all require proper real GDP computations.) For better, or some would say worse[7], the ease of using PWT has made it the most frequent data source for these studies. Real GDP per capita is a critical explanatory variable because most of these growth models, following Barro and others, use the coefficient on early-period real income as a measure of the speed of convergence or divergence. In this work PWT's real GDP numbers provide an aggregate measure of productivity. However, for sectoral productivity studies, the work of ICOP at Groningen described by Bart van Ark today is the appropriate data set with which to work.

3. Price Parities and Shares of Real Output

Sharply focused comparisons of various social policies across countries---social security or taxation, for example---often involve real quantities rather than expenditures denominated in national currencies. Even if all economic variables enter into the analysis in share form, (e.g., government transfers as a proportion

of consumption), real shares are normally needed. To illustrate the importance of using real share data, consider an analysis of the role of capital formation in the growth process. Any effort to develop comparable capital stock estimates across countries by cumulating investment over time must be carried out in terms of real investment figures. This requires that differences in capital goods prices relative to all other prices across countries must be allowed for. This is especially important for developing countries because their real investment share of GDP is usually one-half to two-thirds of their nominal, domestic-price share; on the other hand, the real share of industrial countries may well be larger than the nominal shares.

For example, in 1990 the Philippines and Japan had nominal investment shares of 32% and 34%, respectively. However when all peso and yen investment expenditures are converted by the appropriate price parities, PPPs for GDP and the investment price parity for investment, the respective shares are 18% and 36%! This is a consequence of the very high relative prices of investment goods in the Philippines. These latter shares reflect the real quantities of construction and machinery investment being put in place in the two countries. They also explain the puzzle of why many poor countries with seemingly high investment shares---high nominal shares, that is---in fact have low growth rates.

The difference between real shares and nominal (those based on domestic prices) turns on systematic differences in price structures across countries and these differences exist even among countries at similar levels of development. Consider a striking example of this in the area of consumption for the relatively affluent countries of the OECD. The United States' proportion of total spending devoted to health goods and services is typically greater than that of any other member of the OECD. However, when account is taken of the higher relative price of health items in the United States, one finds that the American real share of health expenditures ranks only 13th out of the 24 OECD countries. (These rankings are derived from the 1993 benchmark study.)

4. Exceptions to the usual superiority of PPPs over exchange rates in international comparisons

It was remarked above that exchange rates play an important role along with PPPs in setting assessments. Here are two examples of international comparison situations where PPPs and price parities are not to the point. First, in comparing household savings rates across countries, one should recognize that relative prices influence behavior: what counts are the proportions of total income spent and saved and not the quantities of goods actually purchased or foregone. Secondly, for most external debt comparisons it is relevant to know what exactly will have to be given up at the time of repayment and that of course depends upon the exchange rate.

III Some Special Uses of Consumption Price Parities[8]

A. Post-allowance calculations

It is not necessary to detail in this presentation the uses to which consumption price parities have been put to help both private and public sectors employers compensate appropriately employees assigned to foreign posts. That was done by the previous speaker.

B. Poverty Measures

At the international level, the World Bank and others who have done poverty counts typically obtain national currency poverty lines by converting an international poverty line (usually based on India) by PWT-like consumption price parities for each country. These are then used in conjunction with country-specific surveys of family income or expenditures to arrive at a poverty count. Michael Ward and his colleagues at the World Bank have been actively exploring the use of price parities related to poverty populations to get a better handle on comparable measures across countries.

It's also true that price parity applications to poverty counts are quite important within countries. The poverty line in the United States is the same whether the count is being taken in New York City, Jackson, Mississippi, or Klamath Falls, Oregon, but can this be right? In a recent paper, Aten [1995] estimated what the poverty line budget threshold for the United States as a whole, $5,778 per person in 1987, implied for a high-cost area---New York City---and the lowest-cost area---the North Central region. It turns out that the counterpart of the overall United States poverty line ($5,778) was $7,507 for New York City and $4,651 for the North Central region. There is a difference of 61 per cent between the two figures!

C. Immigration Studies

In a study of income convergence within countries, Barro and Sala-i-Martin (1992) found that a major part of the explanation revolves around migration. It seems likely that holding unemployment constant, a measure of differences in wages between regions adjusted for differences in prices across regions will be much better as a predictor of internal migration than nominal wages.

An interesting international immigration application drawing on consumption price parities has recently been carried out by Jasso, Massey, Rosenzweig, and Smith (1997). They report the results of an immigration survey in the United States in which informants reported their wages both prior to immigration and in their current United States employment. In order to compare

immigrants' wages in their country of emigration with their subsequent United States wages, the authors converted the former figures at the consumption price parities from PWT.

D. International Demand Analysis

Are tastes the same the world round? That is the question that introduced the last chapter of Kravis, Heston, and Summers (1982), a volume reporting on the 1975 benchmark study. To gain some insight into the answer, the income and detailed price and quantity data of the study's 34 benchmark countries were examined in a variety of ways. Beginning with a highly pragmatic, non-theoretic formulation---simply, (i) if a country's price for a good is high, does it consume less than if its price is low, holding income constant? and (ii) if two countries' price structures and incomes are similar, are their output compositions also similar, and vice-versa?---we went on to search for revealed preference violations, and then examined the data through the filter of a theoretical, utility-based model (the linear expenditure system). Our conclusion: Nothing we saw contradicted the "common tastes" hypothesis. Needless to say, this isn't quite the same as saying YES, TASTES ARE THE SAME THE WORLD ROUND!

IV Analytical Uses of Benchmark Data

A. Service-Commodity and Tradable-Nontradable Breakdowns

We have made use of two less conventional aggregations of the detailed expenditure data of benchmark studies. We divided aggregate output first into its service and commodity components, and then into its tradables and nontradables components.[9]

Services vs. Commodities The basic conclusion arrived at was that the real share of services in GDP is flat with respect to income. This striking finding contradicts the basic proposition of Colin Clark that the service share becomes larger as countries become more affluent and is greater in more affluent countries. However, Clark had in mind the production side and we were dealing with expenditures. The straightforward interpretation of what is going on is this: the real quantity of services being consumed as a share of output does not rise with country income but the relative price of services does. This leads to the share calculated from domestic-prices rising with income, which was the basis of the Clark proposition.

Tradables vs. Nontradables When the relationship between tradables and nontradables was examined in relation to income and other variables, it was found that the relative prices of both rose with income, but that the nontradable prices rose more rapidly. This is consistent with the Balassa-Samuelson explanations of why national price levels rise with income. (See Heston, Summers, and

Nuxoll (1994).)

The conclusions about both the price parities and real quantities for the commodity-service and tradable-nontradable breakdowns seem fairly robust across benchmark studies.

B. Similarity of Price Structures

Many economic studies find it convenient to assume that across countries there is a convergence of price structures over time. This is typical in projections of costs of current resource-use patterns for the global environment. Is it reasonable to think that price structures converge across countries? Examining such a question calls for a measure of price similarity. The one we developed, a little too complicated for close definition here, was used to examine the proposition that countries with similar incomes will have similar price structures. Indeed, it was found in each of the benchmark studies that countries display more similarity in price structure the closer they are in income. A more subtle examination of the similarity of prices of tradable and nontradable goods across countries revealed a more complicated relationship, but one that was basically consistent with the proposition that the prices of tradables should tend to be more equal across countries than nontradables. (See Heston, Aten, Summers, and Nuxoll (1995).)

A preliminary examination of a sample of benchmark countries between the years 1970 and 1985 did not suggest convergence of price structures, even for countries like Japan and the United States where there had been a convergence of relative incomes (Heston and Summers(1993)). However, this result appears to be sensitive to how similarity is measured from one benchmark to another, and thus remains a subject of further research.

C. Investment and Capital Stock

The investment price parities in the benchmark comparisons and PWT have been used extensively in economic growth and productivity comparisons. Uniquely, DeLong and Summers (1992) examined the proposition that the composition of a country's investment is important in determining its rate of growth. Using disaggregated investment data from the 1980 and 1985 benchmark studies, they found that machinery investment contributed more to economic growth than construction, and that that was true for both benchmark studies. This conclusion drew on two related pieces of information only available through benchmark studies; the price of machinery investment relative to the prices of other goods and services, and the real quantities of machinery investment in different countries. Generally speaking, investment flows are used as a proxy for the increase in the size of the capital stock when they are used to explain economic growth. But note that strictly speaking investment should be accompanied by a denominator in the form of the size

of the capital stock.

For this reason time-series of capital stock estimates for over 60 benchmark countries have been developed for PWT. In addition to capital stock estimates, the PWT 5.6 diskette contains a separate file of estimates of quantities for five fairly detailed headings of capital formation. (In this file Producers Durables Transport Equipment is distinguished from Other Equipment in an attempt to better capture the disparate service lives within Producers Durables.) It is expected that future versions of PWT will contain capital stock estimates for more countries, including nonbenchmark ones.

V Conclusion

This brief survey has reported on a major wholesale distribution of international comparisons derived from the various benchmark studies of the ICP. Besides the extended discussion of the Penn World Table, a variety of direct applications have been presented, our own retail uses and those of others. An Appendix listing Penn World Table and International Comparison Programme citations from learned journals and Internet usage has been added to this text to give some idea of the scope of usage of the international comparison materials.[10] We argue in the Appendix that the data of the benchmark studies have been underutilized compared with the Penn World Table. We think that the long time series on national price levels in PWT are also underutilized compared to the growth and GDP per capita numbers.[11]

In 1968 the economics community was 2 per cent of the way along to a Space-Time System of National account. Dare we say now thirty-ish years later, that we are 75 per cent of the way? Yesterday's bells and whistles soon will be our everyday standard.

ENDNOTES

1. Prior to 1980 the benchmark comparisons were produced for a smaller number of countries by a group at the University of Pennsylvania and the United Nations. For a discussion of the sequence of comparisons up to 1990, see Summers and Heston (1991).

2. A separate file of disaggregated investment quantities is presently available with PWT for 60 benchmark countries, but at present these data are not integrated into PWT.

3. In fact one variable in PWT particularly reflects current material well-being. The "Standard of Living" variable is private-plus-public consumption minus military expenditures.

4. The common terminology: PPP refers to the relationship between the prices of a country and a base country at the overall GDP level, and price parity refers to the same kind of relationship at a subaggregate level.

5. Justification for using the exchange rate as a proxy for the PPP flowed from the Purchasing Power Parity Doctrine of Gustave Cassel (1916, 1983.) Alas, the ICP's empirical work has shown that though the Purchasing Power Parity Doctrine made an important contribution to critical thought about price levels, empirically it doesn't hold.

6. How much difference the shift would make is not entirely clear. Of the 35 poorest countries in the world in 1990 as determined by PPP conversions, 29 are still among the bottom 35 when the exchange rate is used. Incidentally, it is important to note that in any case exchange rates enter into assessment calculations even when the conversions are based on PPPs. Inevitably, a country's assessment will be denominated in a base country's currency but paid in its own national currency.

7. In his presidential address to the American Economic Association, Zvi Griliches' commented on the overuse of PWT. He suggested that it would be better to devote efforts to developing new data sets rather than "...running 20,000 regressions..." on PWT data. (But he did spell our names right!) In this spirit, readers may be as amused as we were to learn of one study not listed in our Appendix by Wall (1995), a marvelous tongue-in- cheek use of PWT that introduced different sports to explain economic growth.

8. A reminder: PPP is a term that to refer to the price parity of the currencies of two countries with reference to the countries' aggregate outputs. (That is, GDP.) Frequently, the same term is used with reference to subaggregates of total output. Here an effort is made to stick to the term "price parity" for subaggregates.

9. Our distinction between services and nontradables---that the

latter includes construction but the former does not---is much too simple-minded, of course. In any case, these measures have their limitations. First, the benchmark studies deal with final expenditures, but the substantive interest in the breakdowns is likely to relate to production activity; second, the division of expenditure headings into either commodities or services does some violence to the reality that for many commodities, like fresh fruit, the price includes a variety of distributive services; and third, services are in some cases distinctly tradable while many (heavy, bulky) commodities are not. This latter point was examined (Heston and Summers (1992)), but necessarily in a less than satisfactory manner because of input-output matrix limitations.

10. As the draft of this presentation is completed, the delivery of the newest issue of the American Economic Review shows that its lead article makes use of PWT data, as did the two articles on the world distribution of income in the last issue of the Journal of Economic Perspectives. NB: For reasons of economizing on space, this short review has not discussed the non-trivial literature on the world distribution that owes its existence to ICP-type materials.

11. For example, the often erratic year-to-year changes in national price levels of a number of countries may well reflect questionable foreign exchange rate policies. There are also a number of anomalies in national price level movements and levels, as in the Nordic countries, that deserve much more analysis than they have received thus far.

APPENDIX

This Appendix presents a list of citations from the Social Science Citation Index of the benchmark and PWT studies going back to the first (1970) benchmark study. These materials have been brought together to provide the readers with some notion of the breadth of uses of these data. The citation count is limited because it only includes the first three benchmark studies, those in which we were directly involved. We are painfully aware that the fact that these data have been used extensively is not necessarily testimony to the quality of either the data or the studies.

Benchmark versus PWT

Through October, 1995, the number of citations to benchmark studies was 421 and to various versions of PWT, 613. These were distributed as follows:

Benchmark studies		PWT	
Phase I	108	1	45
Phase II	110	2	166
Phase III	203	4	234
		5	168
Total	421		613

Since PWT first became available five years after the first study benchmark publication, it appears there has been heavier usage of PWT than the benchmark studies. (This is even more evident when internet usage is taken into account. See below.) The World Bank makes available the benchmark studies as do we, but it remains our belief that they are a significantly underutilized resource.

Range of Journals

Those journals with over ten citations were:

American Economic Review	41	Applied Economics	31
Brookings Papers	19	Economic Letters	55
Econ Dev and Cult Change	15	Economic Journal	18
European Economic Review	19	J of Comp Economies	13
J of Monetary Economics	16	J of Pol Econ	17
J of Economic History	11	J of Econ Perspec	12
J of Developing Economies	22	Kyklos	10
Oxford Economic Papers	12	Public Finance	18
Quarterly J of Economics	18	Rev of Ec and Stat	11
Rev of Inc and Wealth	19	Weltwirtshaft Achives	20

The scope of subjects covered in this set of economics journals is wide ranging. In addition, a number of articles in other social science journals using PWT explore a variety of non-economic subjects.

Usage on the Internet

In reporting the following information about usage of PWT on the Internet, we again note that usage by itself is not the ultimate test of the quality of PWT. However, it certainly demonstrates a felt need for this kind of data set. When PWT 5.6 was introduced in Spring 1995 it offered a Windows version for the first time. The NBER had been providing PWT 5 and PWT 5.5 on diskette as well as on a remote electronic site.

To get some sense of the usage on the Internet we asked both the NBER and the University of Toronto if they had figures on usage and this was what was reported: For the period September to mid-December, 1995, about 1000 different Web sites logged into the NBER to use PWT 5.6, and the average usage was about 5 per site for a total of 5,000 hits. The Toronto version has been up a shorter time, but for 6 weeks ending in mid-December 1005 they had received about 2300 hits.

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