Canadian Immigration Policy for the 21st Century

Edited by
Charles M. Beach, Alan G. Green and Jeffrey G. Reitz

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The Potential Impacts of Immigration on Productivity in Canada

Alice Nakamura, Masao Nakamura
and W. Erwin Diewert

Introduction

Immigration has been an important source of population and labour force growth for Canada. Beaujot (2000) finds that over the period of 1901 to 1996, the total immigration of some 12 million persons and the estimated emigration of some six million produced a net population gain of six million. This represents a fifth of Canada's population growth over that period. By historical standards, immigration levels have been especially high in more recent years. For the 1951–91 period, net migration accounted

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for about a quarter of population growth, and this proportion rose to 51% for the years 1991 to 1996.[1]

In many respects, Canadians seem to prefer immigrants who mirror their own behaviour patterns. Certainly some past immigration policies reflect this preference (see Green, 1995). However, when it comes to workforce qualifications and performance, the hopes and fears for where immigration will lead the nation stem from expectations that immigrants will do differently than the incumbent population. Earlier waves of immigrants to Canada achieved higher average earnings than the Canadian-born. It is widely believed that this is because they contributed skills and knowledge in scarce supply and were unusually hard working. Many Canadians would like the immigration program to continue to make this sort of contribution to Canadian economic development.

We show that more recent immigrants from the United States and United Kingdom have continued to enjoy relatively high earnings compared with the Canadian-born. However, more recent immigrants born outside the United States and United Kingdom seem not to have done as well on average. Moreover, the proportion of immigrants born outside the US and UK has risen over time, so their experiences have come to dominate the overall immigrant results.[2] Some Canadians fear that the lower earnings of more recent immigrants mean that they are less desirable to employers because their skills or work habits are less well-suited for Canada. There are fears that these newer immigrants will pull down the productivity of the nation, with productivity being viewed as an important long-run determinant of the standard of living. We present, and probe the implications of, empirical facts and alternative measures of labour input and productivity growth that are relevant to assessing these concerns.

Using 1991 and 1996 Canadian census data, we replicate and extend findings of others on the earnings outcomes of more recent immigrants to Canada.

[1]Information on the immigrant population and the Canadian immigration program can be found in Citizenship and Immigration Canada (1994, 2000, 2001) and in Informetrica (2000).

[2]Other studies include Baker and Benjamin (1994), Beach and Worswick (1994), Grant (1999), Li (2001), Nakamura and Nakamura (1992), and Nakamura *et al.* (1999).

We then explore how influxes of workers who do better, or worse, on average than the Canadian-born would be expected to affect the productivity growth of the nation. We show that the answer depends, in part at least, on the formula adopted for measuring productivity growth. The choice of a formula depends, in turn, on the concept of the true productivity growth that is embraced. A framework is developed for assessing the potential labour and total factor productivity growth effects of immigration.

Earnings of Immigrant vs. Canadian-Born Workers

In this section, we examine earnings and other employment outcomes for immigrant and Canadian-born workers. Our analysis is limited to those 25 to 64 years of age in the designated census year. We also restricted our immigrant data samples to those who were at least 15 at the time of immigration.[3] The immigrant data samples were divided into two place-of-birth categories: the United States or United Kingdom, and elsewhere. (We sometimes refer to these groups as "US/UK born" and "born elsewhere", respectively.) We also divided the immigrant data samples into three periods of immigration categories: (i) those who came before 1971, (ii) those who came in 1971–81, and (iii) those who came in 1981–90. We examine the average annual earnings of the Canadian-born and immigrant workers, and the averages for their hours of work in the census reference week, their weeks of work in the previous calendar year, and their estimated hourly and weekly rates of pay.[4]

[3]Kossoudji (1989) finds it is important to exclude, or separately examine, those who immigrated before age 15 in studies of the workplace assimilation of immigrants. Schaafsma and Sweetman (2001) also find that age at immigration seems to have substantial effects on the relative earnings of visible-minority immigrants.

[4]The census reference week is the week prior to when the designated census was conducted. Those immigrants included in the 1991 Census of Canada are persons who applied for and were approved for immigration, who came, and who were still alive and living in Canada as of when the 1991 census was taken. We did not include in this study those who reported that they were in Canada on a temporary basis or illegally.

Table 1 shows the country of birth composition of Canada's foreign-born population. We see that as of the 1991 Census of Canada, the proportion born in the United States or United Kingdom was 29.6% for those who came before 1971, 20.0% for those who came in 1971–80, and 9.8% for those who came in 1981–91. The Anglo-American inflow had dwindled by 1981–91 to less than the inflow from other parts of the world such as Asia.

The next eight tables document the employment outcomes for different immigrant groups and the Canadian-born.

The figures in Table 2 are for workers in all industries. These figures show that, in general, the US/UK born immigrants who came before 1981 as well as those who came in 1981–90 had higher average earnings than the Canadian-born.[5] We also see that the average earnings of the immigrants born elsewhere who came in 1981–90 (column 5) were considerably lower than for the Canadian-born.[6]

Is it a problem that more recent immigrants born in countries other than the US and UK have lower average earnings than the Canadian-born? There are many aspects of that question that go beyond the scope of this paper. Here we confine our attention to the question of whether the lower average wages for some groups of immigrants might be an indication that they are dragging down the productivity of the nation. From this perspective, a key issue is whether the lower average wages reflect the reality that, in comparison with their Canadian-born counterparts, the work effort or qualifications of these immigrants provide lower average productive value to employers.

There is no direct evidence in the Census of Canada for 1991 or 1996 on work effort. However, there is information on the worker occupation, years of schooling, and certain personal attributes, including sex and visible-minority status that may be useful for assessing the potential

[5]The exception is that women born in the United States/United Kingdom who came in 1981–90 had lower earnings for the year than the Canadian-born women, although their average hourly wage rate was higher. These US/UK born women earned less for the year because they worked fewer weeks in 1990 and fewer hours per week.

[6]In our forthcoming monograph (listed in the references as Nakamura *et al.*, 2003) we demonstrate that the findings based on the group mean value patterns presented in this paper are unchanged when multivariate methods are used.

Table 1: Percentage Distributions of Foreign-Born by Country of Birth for Three Periods of Immigration

	Period of Immigration		
Country of Birth	*Before 1971*	*1971–80*	*1981–91*
United States (US)	5.4	6.7	4.3
Europe			
United Kingdom (UK)	24.2	13.3	5.5
Federal Republic of Germany	7.2	1.6	1.3
Italy	15.3	2.8	0.7
Portugal	3.0	6.2	2.7
Poland	4.6	1.1	6.3
USSR	3.9	0.8	0.9
Other Europe	23.8	9.9	7.1
Asia			
Middle East and Western Asia	0.9	3.0	8.1
Southern Asia	1.6	8.4	9.1
Hong Kong	0.6	4.0	7.8
Peoples' Republic of China	1.9	4.0	5.8
Philippines	0.5	4.6	5.4
Viet Nam	0.0	4.5	5.5
Other East/South East Asia	0.8	4.9	6.3
Africa	1.6	5.9	6.1
Central and South America, Caribbean and Bermuda	4.0	16.8	16.2
Other	0.6	1.4	1.0
Total	100.0	100.0	100.0

Source: Based on the 1991 Census Public Use Sample data for individuals, available from Statistics Canada.

Table 2: Mean Values for All Industries

	US/UK Born			Born Elsewhere	
	Native-Born	*Came before 1981*	*Came in 1981–90*	*Came before 1981*	*Came in 1981–90*
Men 25–64 who worked in 1990					
Annual earnings ($)	35,275	47,456	42,727	35,935	24,524
Weekly earnings ($)	791	1,010	995	814	605
Hourly earnings ($)	17.64	22.53	22.98	18.11	13.27
Weeks of work in 1990	46	48	47	46	42
Hours of work per week	38	38	40	36	34
Sample size	133,864	4,153	639	16,102	6,739
Women 25–64 who worked in 1990					
Annual earnings ($)	21,010	23,818	20,116	21,440	15,813
Weekly earnings ($)	503	534	508	511	422
Hourly earnings ($)	14.33	15.37	16.11	14.26	10.78
Weeks of work in 1990	44	45	41	44	40
Hours of work per week	29	28	27	30	27
Sample size	111,764	3,832	732	12,000	5,672

Source: Based on the 1991 Census Public Use Sample data for individuals, available from Statistics Canada.

productivity relevance of the lower wage rates of more recent immigrants born outside the United States and United Kingdom.

The main patterns of interest in Table 2 for workers in all industries show up as well for each of the 11 major industry groups. This can be seen, for example, for the finance, real estate and business services industries in Table 3; for the manufacturing industries in Table 4; and for the retail trade industries in Table 5.

The 1991 census data reveal that, in high-earning and low-earning industries alike, the immigrants born in the US or UK had higher average annual earnings and hourly wage rates than the Canadian-born, with the

Table 3: Finance, Real Estate and Business Services Industries Mean Values

	US/UK Born			Born Elsewhere	
	Native-Born	*Came before 1981*	*Came in 1981–90*	*Came before 1981*	*Came in 1981–90*
Men 25–64 who worked in 1990					
Annual earnings ($)	44,209	53,243	52,189	43,113	29,486
Weekly earnings ($)	943	1,117	1,133	979	656
Hourly earnings ($)	21.96	27.91	24.35	21.49	16.12
Weeks of work in 1990	47	48	47	48	44
Hours of work per week	39	39	40	37	36
Sample size	13,867	650	115	1,547	861
Women 25–64 who worked in 1990					
Annual earnings ($)	23,245	27,212	23,125	25,739	20,271
Weekly earnings ($)	532	589	647	569	499
Hourly earnings ($)	14.92	17.15	14.01	17.18	13.17
Weeks of work in 1990	45	46	41	46	42
Hours of work per week	30	30	27	32	29
Sample size	15,903	610	127	1,403	909

Source: Based on the 1991 Census Public Use Sample data for individuals, available from Statistics Canada.

Table 4: Manufacturing Industries Mean Values

	US/UK Born			Born Elsewhere	
	Native-Born	*Came before 1981*	*Came in 1981–90*	*Came before 1981*	*Came in 1981–90*
Men 25–64 who worked in 1990					
Annual earnings ($)	35,757	47,746	44,402	35,811	24,199
Weekly earnings ($)	782	985	977	803	587
Hourly earnings ($)	16.83	21.73	20.49	17.38	12.18
Weeks of work in 1990	47	49	48	47	43
Hours of work per week	36	37	39	35	32
Sample size	25,320	872	134	4,237	1,722
Women 25–64 who worked in 1990					
Annual earnings ($)	21,280	26,240	23,362	18,975	14,924
Weekly earnings ($)	516	563	498	461	406
Hourly earnings ($)	11.85	13.32	11.66	10.41	8.68
Weeks of work in 1990	44	46	45	44	40
Hours of work per week	30	32	30	29	28
Sample size	9,827	286	59	2,342	1,137

Source: Based on the 1991 Census Public Use Sample data for individuals, available from Statistics Canada.

Table 5: Retail Trade Industries Mean Values

	US/UK Born			Born Elsewhere	
	Native-Born	*Came before 1981*	*Came in 1981–90*	*Came before 1981*	*Came in 1981–90*
Men 25–64 who worked in 1990					
Annual earnings ($)	28,979	35,319	34,898	30,347	20,874
Weekly earnings ($)	631	724	755	649	550
Hourly earnings ($)	14.04	16.17	16.75	14.20	11.67
Weeks of work in 1990	47	49	46	48	41
Hours of work per week	39	39	36	40	36
Sample size	11,810	242	46	1,392	688
Women 25–64 who worked in 1990					
Annual earnings ($)	15,077	15,632	15,646	17,812	13,354
Weekly earnings ($)	375	376	437	439	351
Hourly earnings ($)	10.59	11.79	11.37	13.29	8.51
Weeks of work in 1990	43	45	39	45	39
Hours of work per week	27	25	25	30	29
Sample size	13,073	444	77	1,325	597

Source: Based on the 1991 Census Public Use Sample data for individuals, available from Statistics Canada.

exception sometimes of the women who came in 1981–90. On the other hand, the men and women who were born elsewhere and came in 1981–90 consistently had average earnings below their Canadian-born counterparts. Thus, the higher earnings of the US or UK born immigrants and the lower earnings of the more recent immigrants born outside the United States and United Kingdom seem to be an economy-wide phenomena.

Differences in earnings are often thought to reflect differences in schooling. Certainly, more schooling can often raise the productive value of a worker to employers.

The mean values for years of schooling for the different groups of workers are shown in Table 6 for all industries as well as for the three industry groups for which earnings results were shown in Tables 3 through 5. We see that male workers had more schooling than the corresponding groups of female workers, and their earnings averages are consistently higher. Both male and female workers in the high-earnings finance, real estate and business services industry group generally had more schooling than those in manufacturing or retail trade. Schooling differences appear to be part of the explanation as well for the higher earnings of the US/UK born immigrants.

However, the immigrants born outside the US and UK who came in 1981–90 typically have more years of schooling than the Canadian-born workers. Yet these immigrants were found to have the *lowest* earnings averages.

Some observers have suggested that the reason immigrants born in countries other than the United States or United Kingdom have done less well in the Canadian labour market is that many belong to visible minorities. The suggestion is that they suffer from discrimination (see Li, 2001; Reitz, 2001; Beck, Reitz and Weiner, 2002). Table 7 shows that by 1981–90, visible minorities comprised 70 to 80% of the immigrants born outside the US and UK who worked. If we rank the immigrant columns in this table by how high the percent is of those belonging to visible minorities, going from the lowest to the highest, column 2 for the US/UK born who came before 1981 gets a rank of 1, column 3 for the US/UK born who came in 1981–91 gets a rank of 2, column 4 for those born elsewhere who came before 1981 gets a rank of 3, and a rank of 4 goes to those born elsewhere who came in 1981–90. For the men, this is the same ordering that results from ranking by the average annual earnings, going from highest to lowest. This pattern is less clear for women, but the column 5 average earnings figures for those born outside the United States and United Kingdom who came in 1981–90 are always the lowest. The pattern for men, at least, could be a symptom of labour market discrimination against visible minorities.

Table 6: Average Years of Schooling

		US/UK Born		*Born Elsewhere*	
	Native-Born	*Came before 1981*	*Came in 1981–90*	*Came before 1981*	*Came in 1981–90*
Men 25–64 who worked in 1990					
All	12.7	14.6	15.2	12.1	13.6
Finance, real estate and business services	15.5	14.9	15.6	14.8	15.5
Manufacturing	12.2	14.0	14.8	11.4	12.7
Retail trade	12.3	13.7	14.1	12.0	13.5
Women 25–64 who worked in 1990					
All	13.0	13.9	14.5	11.9	13.3
Finance, real estate and business services	13.3	13.9	14.3	13.9	14.6
Manufacturing	12.0	13.1	14.1	9.5	11.7
Retail trade	12.0	12.7	13.6	11.6	13.4

Source: Based on the 1991 Census Public Use Sample data for individuals, available from Statistics Canada.

Table 7: Percentage Belonging to a Visible Minority: Men and Women 25–64 Who Worked in 1990

		US/UK Born		*Born Elsewhere*	
	Native-Born	*Came before 1981*	*Came in 1981–90*	*Came before 1981*	*Came in 1981–90*
All men	1.2	1.9	6.9	39.8	71.3
Men in finance, real estate and business services	1.9	2.2	11.3	53.0	78.3
Men in manufacturing	0.8	1.9	4.5	39.1	72.0
Men in retail trade	1.2	2.1	10.9	47.0	79.7
All women	1.3	2.0	4.6	48.3	73.3
Women in finance, real estate and business services	1.5	2.1	4.7	59.2	79.5
Women in manufacturing	1.2	2.8	10.2	41.8	73.0
Women in retail trade	1.2	1.6	2.6	41.9	74.9

Source: Based on the 1991 Census Public Use Sample data for individuals, available from Statistics Canada.

It is true, as can be seen from Table 7, that high proportions of the immigrants born elsewhere and who came in 1981–91 belong to visible minorities.[7]

However, Table 8 reveals that when we divide the immigrants into those belonging to a visible minority and those who do not, the earnings averages for the non-minority immigrants are still lower by a considerable amount for those born outside the US and UK who came in 1981–91.[8] Moreover, the average years of schooling of the non-minority immigrants born elsewhere who came in 1981–91 are higher than for the native-born.[9]

These results for the more recent non-minority immigrants born outside the United States and United Kingdom suggest that something other than, or in addition to, discrimination is responsible for the relatively low earnings of the more recent immigrants born elsewhere. Lacking convincing evidence of what that something else might be, in the following section where we introduce alternative measures of productivity growth we simply note that understanding the causes of the observed immigrant earnings

[7]In the 1991 census, persons were classified as to whether they belonged to a *visible minority* in Canada primarily by their responses on the ethnic origin question. However, the classification process also made use of responses on place of birth, mother tongue, and religion. The definition of visible minorities used in deciding on this classification process was developed by the Interdepartmental Working Groups on Employment Equity Data. Ten visible-minority subclassifications were also established (Black, South Asian, Chinese, Korean, Japanese, South East Asian, Filipino, Other Pacific Islanders, West Asian and Arab, and Latin American). However, we made no use of these subclassifications in the reported empirical work.

[8]We first presented this part of our results in Nakamura *et al.* (1999).

[9]In contrast, the corresponding visible-minority immigrants have somewhat less schooling on average than their native-born counterparts. This may explain why Baker and Benjamin find that "the immigrant advantage in this dimension has been declining over time — most dramatically, between 1981 and 1986" (1994, p. 376). The mean values for years of schooling that Baker and Benjamin report for native-born Canadians are 11.01 years for the 1971 census, 12.82 years for the 1981 census, and 13.76 years for the 1986 census. The corresponding values that they report for Canadian immigrants who arrived in the five years prior to each of the censuses are 12.51, 14.21 and 14.50, with visible minorities making up large portions of these more recent groups.

Table 8: All Industries Mean Values, Men and Women 25–64 Who Worked in 1990

		US/UK Born		*Born Elsewhere*	
	Native-Born	*Came before 1981*	*Came in 1981–90*	*Came before 1981*	*Came in 1981–90*
Annual earnings (1990$), men					
Non-minority	35,287	47,566	43,624	36,056	28,041
Minority	34,266	41,741	30,597	35,752	23,105
Years of schooling, men					
Non-minority	12.7	14.6	15.2	11.0	13.6
Minority	14.1	14.7	14.8	13.8	13.6
Sample size, men					
Non-minority	133,321	4,074	595	9,700	1,937
Minority	1,543	79	44	6,402	4,802
Annual earnings (1990$), women					
Non-minority	20,978	23,786	20,100	20,265	16,223
Minority	23,566	25,361	20,459	22,696	15,663
Years of schooling, women					
Non-minority	13.0	13.9	14.5	10.7	13.7
Minority	13.8	14.7	14.1	13.1	13.2
Sample size, women					
Non-minority	110,351	3,755	698	6,201	1,516
Minority	1,413	77	34	5,799	4,156

Source: Based on the 1991 Census Public Use Sample data for individuals, available from Statistics Canada.

patterns is relevant for assessing the impact of immigration on national productivity.

Tables 1 through 8 are based on Public Use Sample data from the 1991 Census of Canada. This data source can be obtained and used by anyone: a potentially important advantage in an emotionally charged area of policy choice. Moreover, the qualitative results we have presented hold when

multivariate methods are used with the Public Use Sample data and other aspects of human capital are accounted for as well, including knowledge of English or French (see Nakamura *et al.*, 2003). However, one problem with these results could be that to protect the privacy of individuals, the Public Use Sample only contains records for a sample of the individuals covered in the master census files. Hence, the number of observations in some immigrant groups is small. Also, only partial information is provided for some variables. Of special relevance for this study, earnings are top-coded in the Public Use Sample data, meaning that all those in a region with incomes above a specified top-code value have their incomes reported as equal to that value.[10]

In Table 9 we compare key aspects of our 1991 Public Use Sample results with the results from special tabulations prepared by Statistics Canada for us and based on the master 1991 and 1996 census data files. The 1996 census results shown in Table 9 also allow us to check what happened in 1991–95 to those immigrants who arrived in 1981–90 and before, and to observe the situation of the immigrants who came in 1991–95.

Table 9 consists of three panels for men and three for women: one for annual earnings, one for years of schooling, and one giving the sample sizes. To facilitate comparisons, in the top two rows of each panel we again show the relevant annual earnings averages from Table 8. The next two rows are based on the special Statistics Canada tabulations from the master 1991 census data. The first of these rows is for non-minority workers while the second is for the visible-minority workers. The last two rows in each panel are based on the special Statistics Canada tabulations from the master 1996 census data file. Again, the first of these is for non-minority workers while the second is for those who belong to a visible minority.

The Table 9 results from the master file computations fully confirm the Table 8 Public Use Sample results. Moreover, the 1996 census figures reveal a further earnings drop relative to the native-born for those born elsewhere who came in 1991–95. This is despite the fact that, for those who do not belong to a visible minority, there is a rise in their average years

[10]The top-code amount differs from region to region depending on the population size of the demographic group and its employment rate and earnings distribution. Lower values are used in smaller places like the Atlantic provinces and for groups, like married women, that have lower percentages of higher earning workers.

Table 9: All Industries Mean Values: 1991 Public Use Sample Data versus 1991 and 1996 Full Census Data

		US/UK Born			*Born Elsewhere*		
	Canadian-Born	*Came Before 1981*	*Came in 1981–90*	*Came in 1992–95*	*Came before 1981*	*Came in 1981–90*	*Came in 1992–95*
Annual earnings, men 25–64							
1991 Public Use Sample[a]							
Non-minority	35,287	47,566	43,624		36,056	28,041	
Minority	34,266	41,741	30,597		35,752	23,105	
1991 Census Data[b]							
Non-minority	36,842	50,350	44,669		40,151	30,373	
Minority	36,462	42,447	31,906		38,566	24,639	
1996 Census Data[b]							
Non-minority	40,704	54,837	50,274	48,378	42,937	35,421	28,132
Minority	37,109	38,822	36,403	30,305	41,808	28,169	20,843
Years of schooling, men 25–64							
1991 Public Use Sample[a]							
Non-minority	12.7	14.6	15.2		11.0	13.6	
Minority	14.1	14.7	14.8		13.8	13.6	
1991 Census Data[b]							
Non-minority	12.7	14.2	14.7		11.3	13.3	
Minority	13.7	14.4	14.3		13.5	13.2	
1996 Census Data[b]							
Non-minority	13.2	14.5	14.7	15.1	11.8	13.4	14.4
Minority	14.1	14.5	14.5	14.5	13.7	13.3	13.6

Table 9 continued

Sample size, men 25–64							
1991 Public Use Sample[a]							
Non-minority	133,321	4,074	595		9,700	1,937	
Minority	1,543	79	44		6,402	4,802	
1991 Census Data[b]							
Non-minority	1,037,571	30,299	5,256		66,944	14,795	
Minority	11,439	601	313		43,707	36,352	
1996 Census Data[b]							
Non-minority	1,003,028	23,421	5,493	1,640	49,118	18,834	7,581
Minority	11,458	363	297	101	36,505	42,043	22,272
Annual earnings, women 25–64							
1991 Public Use Sample[a]							
Non-minority	20,978	23,786	20,100		20,265	16,223	
Minority	23,455	25,361	20,459		22,696	15,663	
1991 Census Data[b]							
Non-minority	22,220	25,737	21,559		22,421	17,956	
Minority	25,214	25,254	20,383		24,645	17,061	
1996 Census Data[b]							
Non-minority	25,901	30,083	26,956	24,030	25,646	22,325	16,478
Minority	27,884	31,998	24,121	19,636	28,589	20,943	14,950

Table 9 continued

Years of schooling, women 25–64							
1991 Public Use Sample[a]							
Non-minority	13.0	13.9	14.5		10.7	13.7	
Minority	13.8	14.7	14.1		13.1	13.2	
1991 Census Data[b]							
Non-minority	13.1	13.8	14.3		10.9	13.2	
Minority	13.8	14.0	14.2		12.9	12.6	
1996 Census Data[b]							
Non-minority	13.5	14.0	14.4	14.8	11.5	13.4	14.3
Minority	14.3	14.4	14.3	14.8	13.2	13.0	13.2
Sample size, women 25–64							
1991 Public Use Sample[a]							
Non-minority	110,351	3,755	698		6,201	1,516	
Minority	1,413	77	34		5,799	4,156	
1991 Census Data[b]							
Non-minority	855,034	27,925	5,507		43,509	11,278	
Minority	9,905	536	278		38,542	31,178	
1996 Census Data[b]							
Non-minority	862,023	22,437	5,938	1,543	34,022	14,637	6,142
Minority	10,132	331	337	101	33,078	36,153	19,335

Notes: [a]Masao Nakamura carried out the computations for these portions as well as for Tables 1–8 using the 1991 Public Use Sample data.
[b]Logan McLeod of Statistics Canada carried out the computations for these portions using the master 1991 and 1996 census data files.

of schooling in moving from the pre-1981 arrival group to the 1981–90 one and then to the 1991–95 one.

Immigration and Labour Productivity

> Productivity is commonly defined as a ratio of a volume measure of output to a volume measure of input use.
> (Paul Schreyer, 2001)

In the previous section we found that, on average, immigrants born in the United States or United Kingdom have higher annual and hourly earnings than Canadian-born workers. We found too that more recent immigrants born in countries other than the US or UK have tended to have lower average annual earnings and hourly wages than Canadian-born workers. How might immigrant influxes of these sorts affect Canadian productivity? We examine the definitions for alternative measures of labour and multi-factor productivity growth, and then consider how the values of these would be affected by immigrant inflows of specific sorts.

Productivity Growth: The 1–1 Case

A ratio of output quantity to input quantity is how productivity is usually defined.

For a production process with a single output and a single input (the 1–1 case), there is no need to decide how to add up the quantities of different output goods or of different input factors to construct aggregates for total output quantity and total input quantity. Thus, it is easy to define a measure of productivity in the 1–1 case. We denote the quantity for the single output good by y^t the quantity for the single input factor by x^t.[11]

[11]We use the term production scenario to refer to a production unit in a given time period. The production unit could be a plant or firm or a conglomerate of producers such as an industry or nation. When productivity comparisons are made for the same production unit over time, then the superscript t is used to denote time. When comparisons are made over multiple production units for the same time period, the superscript denotes the production unit. With panel data, separate superscripts for time and the production unit are often used.

Total factor productivity (TFP) for a 1–1 process can be defined and measured by the ratio of the observed period t output and input quantities:

$$(1)\quad a^t = y^t / x^t \; TFP^t , \qquad for\ t = 1,\ldots,T.$$

The coefficient a^t in (1) is referred to in the engineering and production management literatures as an output-input coefficient.[12]

For the 1–1 case, total factor productivity growth (TFPG) from period s to t can be represented equivalently as the ratio of the output-input coefficients for the two time periods, or as the ratio of the period t and period s rates of transformation of input into output, or as the growth rate of output divided by the growth rate of input, with the growth rate of a variable represented as the ratio of the period t and period s values of the variable. Thus we have:

$$(2)\quad a^t / a^s = (y^t / x^t) / (y^s / x^s) = (y^t / y^s) / (x^t / x^s) = TFPG^{s,t} .$$

For the 1–1 process, we say that productivity growth is positive when (a^t / a^s) is greater than 1.[13] The Statistics Canada productivity measurement

[12]By itself, an output-input coefficient is no more abstract than, say, speed measured as distance travelled per some unit measure of time. This is true as well of the ratio of the quantity for a single output to the quantity of any one input for a multiple input production process. In contrast, in the economics literature when a^t is specified to be an exogenous shift term in a production function obeying certain assumptions, this is an abstract concept. See Diewert and Nakamura (2003).

[13]TFP^t and $TFPG^{s,t}$ are summary statistics for a production process. These summary measures can be shown, under certain conditions, to equal parameters in producer behavioural relationships, as specified in economic theory. However, the measures can still be computed whether or not the assumptions enabling a structural, economic theory interpretation are true. See Diewert and Nakamura (2003).

program focuses on productivity growth rather than productivity levels, and so do we.[14]

Notice that we can represent the growth in output as the product of productivity growth and input growth terms. We have:

$$(3)\quad \frac{y^t}{y^s} = \left(\frac{a^t}{a^s}\right)\left(\frac{x^t}{x^s}\right) = TFPG^{s,t}\left(\frac{x^t}{x^s}\right).$$

The appeal of getting more output growth for any given rate of input growth is the reason for public and government interest in productivity growth.

Productivity growth can happen because of the adoption of a new production technology; that is, it can happen because of technical progress. Or it can happen because the period s technology is operated in period t at a more efficient level, allowing the production unit to reap the benefits of increasing returns to scale. Immigration can have both technical progress and returns-to-scale effects. From only the observed input and output data, we cannot usually determine the relative contributions of technical progress and returns to scale. However, the aspects of immigration and other policy measures that might result in productivity gains from returns to scale versus technical progress are different. Hence, it is useful to recognize that $TFPG^{s,t}$ is affected by both.

Productivity Growth Measurement with Multiple Inputs

Of course, many production processes yield joint outputs, and virtually all involve multiple inputs. Certainly nations have many outputs and inputs. With multiple inputs and outputs, productivity growth is measured as a ratio of an index for total output quantity growth divided by an index for the growth in the quantity of one, some, or all of the input factors used in producing the output.

[14]A good procedural reference for the Statistics Canada productivity measurement program is the Statistics Canada monograph by Baldwin *et al.* (2001) (especially the first chapter by Baldwin, Harchauoui, Hosein and Maynard and Appendix 1 by Harchauoui, Kaci and Maynard).

For general M output, N input production processes just as for 1–1 ones, there are two main ways in which increases in productivity growth can occur: technical progress and growth with increasing returns to scale. People who move to Canada from other countries bring with them knowledge that may enable technical progress. Also, if a production unit enjoys increasing returns to scale, then as the scale of operation rises, so does productivity.

Some of the suggested sources of increasing returns to scale for producers include:

- *The Laws of Physics.* The three-dimensional nature of space and the physics laws governing things such as friction can lead to economies of scale.[15]
- *The Law of Large Numbers.* These efficiencies result from the laws of probability theory and the mathematics of risk and insurance. For example, a large bank will not require as high a proportion of cash reserves to meet random demands as a small bank.[16] In a similar vein, a large property insurance company whose risks are geographically diversified faces a smaller probability of bankruptcy than a small insurance company.
- *The Existence of Fixed Costs.* Efficiencies can result from averaging or amortizing fixed costs (a kind of indivisibility) over higher output levels. For example, before a machine can yield a benefit from its operation, an operator may need to be transported from another location,[17] and the machine may also require a warming up period. These

[15]For example, Marshall (1920, p. 290) noted that: "A ship's carrying power varies as the cube of her dimensions, while the resistance offered by the water increases only a little faster than the square of her dimensions; so that a large ship requires less coal in proportion to its tonnage than a small one. It also requires less labour, especially that of navigation: while to passengers it offers greater safety and comfort, more choice of company and better professional attendance."

[16]This application of probability theory to the determination of adequate bank reserves dates back to Edgeworth (1888, p. 122). He also applied his statistical reasoning to the inventory stocking problem faced by a restaurant or club and noted that optimal inventory stocks are proportional to the square root of anticipated demand (1888, p. 124) .

[17]This example of a fixed cost is due to Adam Smith (1963, p. 7).

are examples of costs whose effects become relatively smaller the greater the scale of operation.

- *Indivisibilities and Bulk Purchasing Opportunities.* Most labour and capital inputs can only be acquired in certain amounts.[18]
- *Specialization of Factor Usage.* Adam Smith (1963, p. 14) long ago pointed out that, as the scale of an establishment grows due to the growth of markets for its outputs, the possibility of using specialized labour inputs also grows. A worker who is able to concentrate on one or a few tasks may become more proficient. Larger scale also enables more dedicated use of other factors including plant and office space.

If increasing returns to scale are a reality for enough businesses and if immigration permits Canadian businesses to grow in size, this could be a means by which immigration helps to boost productivity.

For a general M output, N input production process (an M-N process), an index for multi-factor productivity growth from period s to t can be defined as

$$(4)\quad MFPG^{s,t} = Q^{s,t} / Q^{*s,t} ,$$

where the numerator, $Q^{s,t}$, is some sort of an index for the growth of the total output quantity, and the denominator, $Q^{*s,t}$, is an index for the growth of the quantity of the specified inputs.

Different names are used for the productivity growth measure given in (4) depending on whether one, some, or all of the input factors for the production process are accounted for in the input quantity growth index in the denominator, and depending on the type or types of inputs included. When only one input factor is taken into account, this is a single factor productivity growth index: an SFPG index. When some, or all, input factors are accounted for, the productivity growth index is a multi, or a total, factor productivity growth index: an MFPG or TFPG index. When only labour inputs are included in $Q^{*s,t}$, then (4) is a labour productivity growth index: what we will denote as an LPG index.[19]

Statistics Canada produces both single and multi-factor labour productivity growth indexes as well as a variety of MFPG indexes that incorporate comprehensive sets of inputs and are intended to approximate, and will be referred to hereafter as, TFPG indexes. Both the labour productivity growth indexes and also the MFPG indexes approximating TFPG measures have as their numerator an index for the growth of total output for the nation, though there are some differences in the specification of these output indexes. The various productivity growth indexes differ primarily because of their denominators — they incorporate different input quantity indexes.

A formula must be chosen for the output quantity index, $Q^{s,t}$, in the numerator of (4) and for the input quantity index, $Q^{*s,t}$, in the denominator. These formulas specify how the amounts for the different output goods and for the designated input factors are added up.

The amounts of the output goods $m=1,...,M$ that are produced in period t ($t=1,...,T$) are denoted by $y_1^t,\ldots,y_M^t$, and the corresponding unit prices by $p_1^t,\ldots,p_M^t$. An output quantity index for the growth in volume for total output can be represented as

$$(5)\quad Q^{s,t} = \frac{\sum_{m=1}^{M} p_m y_m^t}{\sum_{m=1}^{M} p_m y_m^s} ,$$

where the p_m are weights. When period s prices are used as the weights — that is, when we set $p_m = p_m^s$ for $m=1,...,M$ — then (5) is the formula for the well-known Laspeyres output quantity index, $Q_L^{s,t}$. A Laspeyres output index evaluates the growth in output from period s to t using period s prices. Alternatively, when period t prices are used as the weights in (5) — that is, when we set $p_m = p_m^t$ for $m=1,...,M$ — then this is the formula for

[18]Bulk purchasing means that the supplying firm may be able to achieve internal economies of scale and thus can offer lower selling prices.

[19]Labour productivity growth indexes are often thought of as SFPG measures because they only take account of labour and ignore the other factors of production, but actually they are MFPG measures when the quantities of different types of labour (e.g., Canadian-born versus immigrant) are included as separate factors with their appropriate weights.

the Paasche output quantity index, , $Q_P^{s,t}$. This index evaluates the output growth from period s to t using period t prices. The Fisher output quantity index is defined as the square root of the product of the Laspeyres and Paasche quantity indexes: $Q_F^{s,t} = (Q_L^{s,t} Q_P^{s,t})^{1/2}$. Statistics Canada uses Fisher type indexes to produce measures of the growth of the output of the nation.

Turning to the input side, the quantities and prices of the input factors used in producing the M outputs are denoted by $x_1^t, \ldots, x_N^t$ and $w_1^t, \ldots, w_N^t$, respectively. An input quantity index can be specified for the growth in total volume for any selected subset of the N factors of production. An input quantity index for NS of the input factors ($\leq N$) can be defined as

$$(6) \qquad Q^{*s,t} = \frac{\sum_{n=1}^{NS} w_n x_n^t}{\sum_{n=1}^{NS} w_n x_n^s}.$$

In (6), the w_n are weights. Suppose price weights are used in (6). If we set $w_n = w_n^s$ for n=1,...,NS, then (6) is a Laspeyres input quantity growth index. Alternatively, if we set $w_n = w_n^t$, then (6) is a Paasche input quantity growth index. The square root of the product of these is a Fisher input quantity index.

When Laspeyres, Paasche or Fisher indexes are used for the output and input quantity indexes, then (4) is a Laspeyres, Paasche or Fisher productivity growth index, respectively. Fisher indexes have been found to be especially desirable and are used by Statistics Canada because of that.[20] However, the points we wish to make involving price weighted indexes can be illustrated using Laspeyres, Paasche or Fisher indexes. We will use Laspeyres-type indexes for expositional convenience. (The interested reader could replicate our analysis for a Paasche-type index. The results for the preferred Fisher index could then be obtained by taking the square root of the product of the Laspeyres and Paasche indexes.)

Our primary concern here is with the choice between a wage weighted representation for the quantity of labour versus a labour aggregate formed by simply adding the hours of work for the different types of workers. This choice will systematically affect the measured impacts of influxes of immigrants of different types on labour productivity growth. (Similar conclusions hold for TFPG indexes and for MFPG indexes that incorporate a labour input.)

The traditional labour productivity growth measure incorporates an input quantity index that includes only labour inputs, with the weights all set equal to 1.[21] The Laspeyres (L) form of the traditional (TR) labour productivity growth index can be represented as

$$(7) \quad LPG_{TR,L}^{s,t} = \frac{Q_L^{s,t}}{H^t / H^s} = \frac{\left(\sum_{m=1}^{M} p_m^s y_m^t\right) / H^t}{\left(\sum_{m=1}^{M} p_m^s y_m^s\right) / H^s},$$

where $H^t = \sum_{n=1}^{NS} X_n^t$ for t=1,...,T.

A traditional labour productivity growth index can be interpreted as the growth rate of output per hour of work, measured in constant dollars.[22] From a household welfare perspective, this measure has obvious relevance (see Basu and Fernald, 1997). However, from a producer perspective, the hours of work of different types of workers usually have different costs and provide different sorts of labour services.

In a 1967 paper, Jorgenson and Griliches presented what they termed a "constant quality index" for labour, with workers differentiated by their educational attainment. Subsequently, Gollop and Jorgenson (1980)

[20]The relative merits of these different index number formulas, and of other functional forms that have been proposed, are examined in the index number literature. See Diewert (1987, 1992a, 1992b and 1998) and Diewert and Nakamura (2003). However, the choice among alternative price weighted measures is not our focus in this paper.

[21]Both Statistics Canada and the US Bureau of Labor Statistics (BLS) previously relied on measures of labour input of this basic sort in their productivity measurement programs. See Baldwin *et al.* (2001) for details.

[22]If a Laspeyres index is used for the output quantity index, as specified in (7), then the output for periods t and s is evaluated using period s prices whereas if a Paasche output quantity index is used, then the output for period s and t is evaluated using actual period t prices. If a Fisher index is used, this is equivalent to deflating the dollar values using a Fisher output price index.

produced constant quality indexes of labour input for 51 industrial sectors of the US economy. They compiled data on the hours of labour input for each industry by age, sex, educational attainment, class of employment, and occupation of the workers and then computed weighted aggregates of the hours of work data utilizing the associated hourly wages.[23]

The US Bureau of Labor Statistics (BLS) accepted the need to allow for different types of workers in measuring labour input and began producing new wage-weighted labour aggregates and using these in their labour and MFPG/TFPG productivity measurement programs. Statistics Canada now also produces wage-weighted labour aggregates.

The term "quality adjusted" as used by Griliches, Jorgenson and others in the productivity measurement literature is problematical, especially if applied in an analysis of immigrant versus native-born workers.[24] In common parlance, a poor quality worker is someone who performs their particular job poorly. Thus it is possible, for instance, for a childcare worker, who is low paid but performing a job where the parents of the children cared for have preferences for how it is carried out, to be "high quality" and for a highly paid professional, such as a surgeon who makes frequent mistakes that harm his or her patients, to be "poor quality". On the other hand, when wages are used as a metric for worker quality, then all the surgeons are classified as high quality and all the childcare workers are classified as low quality. This terminology problem is easily remedied by referring to the new labour aggregates as what they really are: wage-weighted labour aggregates.

Semantic issues aside, the deeper question that lies at the heart of inquiries into the impacts of specific sorts of immigration flows on the productivity of the nation is: What do we mean by the quantity of labour? We address this question by first posing an easier one: What do we mean by the quantity of coal? Lumps of coal are easier to size up than workers, and yet, with coal too, we face the issue of whether to use a simple sum of the quantities of different types or a price-weighted aggregate.

[23]This work was extended and updated by Jorgenson in collaboration with Fraumeni. See the papers in Jorgenson's 1995 collected works and also the 1987 book by Jorgenson, Gollop and Fraumeni.

[24]Statistics Canada has tried to use the term "composition adjusted" rather than quality adjusted, but others keep reasserting the "quality adjusted" terminology. There might be more receptivity to calling these aggregates "wage weighted" rather than just composition adjusted.

Coal is often sold by the ton and in other units of weight that can be converted to ton equivalents. We could measure the total in tons. However, there are different types of coal that produce different amounts of heat and release different amounts of pollutants. The coal types that produce more heat and less pollution are more valuable to producers and also scarcer, leading to higher prices. Since coal is sold in competitive international markets and there are established procedures for grading coal, economic theory arguments suggest that the prices of different types should reflect their relative use values to producers. If so, then if we weight the quantities for the different types by their per ton prices, the sum will be a measure of the productive use value of the coal that was used. One desirable property this aggregate will have is that a pure mix change in the quantities for the different types of coal — that is, a change in the quantities of the different types that leaves the price weighted sum unchanged — should also leave unchanged the total productive use value of the whole amount. In addition, by construction, the total amount spent on coal will be unchanged.

The decision of whether to use a simple measure of the total tons of coal of all sorts or a price-weighted one rests on whether we want to measure the change in output with respect to the change in weight for this input, without regard to the mix of the types of coal, or with respect to the change in the productive use value of the coal, or perhaps a measure of expenditure on coal. It is a choice, and one with implications for what is meant by the words "productivity growth".

Similar issues must be confronted in deciding how to aggregate the quantities of different types of labour, though there is more uncertainty involved in determining and certifying the productive use values of different types of workers, especially for workers who have acquired some of their education and work experience in other countries.

Examples with Just Two Types of Labour

To illustrate some implications of using a traditional labour productivity growth index versus a new style LPG measure incorporating a wage-weighted labour aggregate, we will suppose there are just two time periods, s and t with period s coming first, and that there are just two sorts of labour: Canadian-born (C) and immigrant (I). The hours of work and hourly wage for these two types of workers are denoted for the Canadian-born by x_C^t and w_C^t and for the immigrants by x_I^t and w_I^t. For this simplistic case,

the traditional measure of the labour input for any given time period, say t, is

$$(8)\quad H^t = x_C^t + x_I^t .$$

The new wage-weighted measure of the labour input for any given time period t is

$$(9)\quad w_C x_C^t + w_I x_I^t ,$$

where w_C and w_I are wage weights of some sort. In what follows, we will take the wage weights to be for period s, making (9) a Laspeyres-type wage-weighted labour aggregate.

To focus attention on the issues at hand, we make the further simplifying assumption that there is just one output and that we know the quantities of this output that were produced by the Canadian-born workers, y_C^t, and by the immigrant workers, y_I^t. The output of the Canadian-born and immigrant workers is sold for the same price.

For this production situation, the traditional labour productivity growth index is given by

$$(10)\quad LPG_{TR}^{s,t} = \frac{\left(y_C^t + y_I^t\right)/\left(y_C^s + y_I^s\right)}{\left(x_C^t + x_I^t\right)/\left(x_C^s + x_I^s\right)} = \frac{\left(a_C^t x_C^t + a_I^t x_I^t\right)/\left(a_C^s x_C^s + a_I^s x_I^s\right)}{\left(x_C^t + x_I^t\right)/\left(x_C^s + x_I^s\right)},$$

where, $a_C^t = y_C^t / x_C^t, a_C^s = y_C^s / x_C^s, a_I^t = y_I^t / x_I^t$ *and* $a_I^s = y_I^s / x_I^s$ are the output-input coefficients for the Canadian-born and the immigrant workers, respectively.

The new style (N) Laspeyres-type LPG index for this production situation is given by

$$(11)\quad LPG_{N,L}^{s,t} = \frac{\left(a_C^t x_C^t + a_I^t x_I^t\right)/\left(a_C^s x_C^s + a_I^s x_I^s\right)}{\left(w_C^s x_C^t + w_I^s x_I^t\right)/\left(w_C^s x_C^s + w_I^s x_I^s\right)}.$$

Notice that the numerator of (11) is the same as for the traditional LPG index in (10). In the denominator, period s wage weights are used because this is the Laspeyres form of the new style LPG index.

To consider the trade-offs involved in using the traditional LPG index given in (10) instead of a new style LPG index like the one given in (11), we must specify our concept of the "quantity of labour". In this paper, we take a producer perspective and define the true quantity of labour by its productive use value to employers. This means that we take as the true definition of labour productivity growth the growth in total output divided by the growth in the productive use value of the work time. The implications of these choices will be illustrated by example. We examine the consequences of using a traditional versus a new style LPG index to measure labour productivity growth in a variety of hypothetical cases and under two alternative scenarios concerning the extent to which the wages of Canadian-born and immigrant workers mirror the productive value of their work.

In Scenario I, we assume that the wage rates of workers of different types accurately reflect the relative productive value of their work time. Under this assumption, formulas (9) and (11) give the Laspeyres approximations of what, in scenario I, we will treat as the true value for the quantity of labour and the true LPG value. Better approximations to "the truth" could be obtained by using Fisher approximations, obtained as the square root of the product of the Laspeyres and Paasche approximations, but we ignore this from here on so as to focus attention on the consequences of using wage-weighted labour aggregates. More specifically, the question we ask for this scenario is: What happens if we use a traditional LPG measure?

Case 1. Suppose the Canadian-born and immigrant workers get paid the same wage rates and have the same rates of production, which may change over time. In this case, the traditional labour productivity growth index, $LPG_{TR}^{s,t}$ given in (10), and also the new style LPG index, given in (11), both reduce to

$$(12)\quad LPG_{TR}^{s,t} = LPG_{N,L}^{s,t} = \frac{a^t}{a^s}.$$

Thus, when the Canadian-born and the immigrant workers are equally productive and earn the same wages, the same correct answers will result from using a traditional or a new style measure of labour productivity growth.

Case 2. Next, suppose the Canadian-born and immigrant workers earn different wages and suppose their wages mirror their true productivity.[25] Now the new style and traditional LPG measures will not give the same answers.

In this case, an influx of immigrants like those born in the United States or United Kingdom who have higher earnings on average than their Canadian-born counterparts will cause the traditional labour input measure to rise less than the true one, and the traditional LPG index will overestimate the labour productivity growth compared with the results from a new style LPG measure. Similarly, given an influx of immigrants with lower wage rates and lower per hour rates of production, a traditional LPG measure will tend to overestimate the immigrant addition to labour services and will underestimate the resulting labour productivity growth.

Of course, the direct evidence on immigrant earnings shows only that their earnings are lower on average. This could be because the immigrants have lower productivity on their jobs compared with Canadian-born, or it could be that the immigrant workers are paid smaller shares of their full productive value compared with the Canadian-born workers. For instance, the newer immigrants might only be able to get temporary jobs, with temporary workers being paid less for the same work than those hired on a continuing basis. Also, newer immigrants usually have less information about the Canadian labour market than Canadian-born workers, and Canadian employers tend to have less good information about the credentials of immigrant workers, with their information deficit being more severe for immigrants from countries with which Canadian employers are less familiar.

[25]In studies that use the new "constant quality" labour aggregates, there is often an implicit or explicit acceptance of the proposition that the productive value to the employer of an added dollar of expenditure on each of the types of workers is the same. Economists have worked out conditions under which this would be expected to be true. For example, this would be expected when the markets for labour are perfectly competitive and employers have perfect information about worker productive attributes. Also, pay for performance compensation arrangements, including piece rate pay and straight commission pay, equalize, on an ongoing basis, the productive value to the employer of different workers, regardless of their type.

In Scenario II, the hourly wages of workers are assumed to represent differing fractions of what they produce: say, γ_C^t for the Canadian-born workers and γ_I^t for the immigrant workers.

Now the Laspeyres approximation of the total true productive use value of the work time of the Canadian-born and immigrant workers for any given period t is

$$(13) \qquad (w_C / \gamma_C)x_C^t + (w_I / \gamma_I)x_I^t = a_C x_C^t + a_I x_I^t$$

where w_C and w_I are the observed wage rates, γ_C and γ_I are the proportions of their productive contributions that the workers of each type capture as wages, and x_C^t and x_I^t are the period t hours of work for the Canadian-born and immigrant workers for t=1,...,T. If period s wages and payout proportions are used in computing the aggregate, as in (12), this will be a Laspeyres-type aggregate. (Note that for Laspeyres-type aggregates, we will also have period s output-input coefficients on the right-hand side of (13) whereas we would have period t output-input coefficients here if this were a Paasche-type aggregate.) The Laspeyres-type (L) wage capture adjusted (WC) labour productivity growth is now given by

$$(14) \qquad LPG_{WC,L}^{s,t} = \frac{\left(a_C^t x_C^t + a_I^t x_I^t\right) / \left(a_C^s x_C^s + a_I^s x_I^s\right)}{\left(a_C^s x_C^t + a_I^s x_I^t\right) / \left(a_C^s x_C^s + a_I^s x_I^s\right)} = \frac{\left(a_C^t x_C^t + a_I^t x_I^t\right)}{\left(a_C^s x_C^t + a_I^s x_I^t\right)}.$$

If a new style wage-weighted LPG index is used, what it will show can be seen from the following:

$$(15) \qquad LPG_{N,L}^{s,t} = \frac{\left(a_C^t x_C^t + a_I^t x_I^t\right) / \left(a_C^s x_C^s + a_I^s x_I^s\right)}{\left(w_C^s x_C^t + w_I^s x_I^t\right) / \left(w_C^s x_C^s + w_I^s x_I^s\right)} = \frac{\left(a_C^t x_C^t + a_I^t x_I^t\right) / \left(a_C^s x_C^s + a_I^s x_I^s\right)}{\left(\gamma_C^s a_C^s x_C^t + \gamma_I^s a_I^s x_I^t\right) / \left(\gamma_C^s a_C^s x_C^s + \gamma_I^s a_I^s x_I^s\right)}.$$

The traditional LPG index takes no account of the worker-type productivity differences. Moreover, now the new wage-adjusted LPG index will also give systematically biased estimates because it ignores the fact that the workers capture differing proportions in wages of their true productive values. These implications are illustrated in our final two example cases:

Case 3. Suppose that the Canadian-born and immigrant workers have differing rates of production per hour, and also the two types of workers capture different proportions of their productive values in wages.

If a traditional LPG measure is applied, the results will be the same as for Case 2 above.

Alternatively, if a new style wage-weighted LPG measure is used, it reduces to the following for this case:

$$(16) \quad LPG^{s,t}_{TR,L} = \frac{a^t_C x^t_C + a^t_I x^t_I}{a^s_C x^t_C + a^s_I x^t_I} \ .$$

This is the case where relative wage rates reflect true worker productivity without any discrimination effects, and the wage-weighted LPG gives the correct results. The only way the value of $LPG^{s,t}_{N,L}$ can be greater (less) than 1 in this case is through increases (decreases) in the rate of production for the Canadian-born or the immigrant workers or both.

Case 4. Suppose, finally, that the Canadian-born and immigrant workers have differing rates of production per hour and also capture differing proportions of their productive labour services in wages.

If a traditional LPG measure is used, the results will be just as for Case 2 above.

If a new style wage-weighted LPG measure is used, the results can be determined by comparing the second line of (15) with the second line of (14), which is now "the truth".

Suppose there is an influx of immigrants who are more productive (i.e., $a_I > a_C$). Suppose also that they have greater bargaining power because their skills are in short supply in the domestic economy and their hourly wage represents a higher share of the output produced. We see from (15) that with $\gamma_I > \gamma_C$, the contribution to labour services of an influx of more productive immigrants will be incorrectly assessed, though in the opposite way from the contribution of the Canadian-born workers. For this situation, we cannot say whether this will lead to too low or too high an estimate of LPG.

Now suppose instead that the immigrants are less productive than the Canadian-born on average (i.e., $a_I < a_C$) and have lower bargaining power (i.e., $\gamma_I < \gamma_C$). This is what many people believe is happening, on average, for the more recent immigrants. In this case, the relative contribution to the supply of productive services owing to an immigrant influx will tend to be underestimated by a new style labour aggregate and the new style LPG index will lead to an overestimate of the labour productivity growth, defined as the growth in output divided by the growth in the use value of the labour input.

The new wage-weighted LPG index no longer can be thought of as the ratio of the output growth rate to the rate of growth in productive labour services. However, it will probably give answers closer to "the truth" than the traditional LPG measure. Also, it will still be the case that $LPG^{s,t}_{N,L}$ gives the ratio of the growth rate in output to the rate of growth in constant dollar labour costs.

If we had empirical or *a priori* estimates of the extent of discrimination, then the effects of this could be corrected for in measuring labour productivity growth as the ratio of the growth in total output to the growth in the productive value of labour services.

Concluding Remarks

We have discussed alternative ways of representing the labour input in labour productivity growth measures. These alternatives have different

implications for measured labour productivity growth in any period when immigrants enter the workforce in substantial numbers who have productivity attributes that differ on average from the incumbent Canadian workforce.

On balance, our analysis suggests that the use of a wage-weighted aggregate for the labour input of workers of different types rather than a simple sum of hours of work will be an improvement for considering the impact of immigrants on the productivity of the nation. Thus, we support the Statistics Canada move to this type of labour aggregates.

We demonstrate that the new wage-weighted measure of labour supply and the labour and total factor productivity indexes incorporating these measures provide a useful framework for addressing "what if" type questions as well as for incorporating available empirical information about immigrant versus Canadian-born worker productivity and wage bargaining differences.

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