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THE MASSIVE INVESTMENT, IMMIGRATION AND  
PRODUCTIVITY BOOMS IN CANADA:  
WHICH CAME FIRST?

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# **The Massive Investment, Immigration and Productivity Booms in Canada: Which Came First?**

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## **Abstract**

This article examines the links between capital accumulation, productivity and immigration to determine which factor was the leading cause of the boom conditions in Canada over 1870 to 1929. The results of an econometric analysis using cointegration techniques and causality tests suggest that capital accumulation and productivity growth preceded the massive immigration boom in Canada during the years before the Great Depression. Domestic sources of investment played a leadership role in the accumulation of capital during the investment booms, and increased the incentives for labor to migrate to Canada. Foreign capital then chased immigrants to satisfy the additional demand for capital and served to prolong the investment booms.

*Suggested Running Head:* Investment, Immigration and Productivity Booms in Canada.

*Keywords:* Capital accumulation, migration, cointegration, causality testing.

*JEL Classification:* F20, N10, C32.

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## 1. Introduction

The period from 1850 to 1914 has been characterized as one of mass migration, with 55 million Europeans moving to the New World countries in the Americas and Australia (Hatton and Williamson, 1998: 3). At the same time, massive amounts of capital were sent overseas to the New World. During a period with no significant war activity and falling transportation costs, capital and labor were free to move. The chief reason for the migration of both factors of production was to exploit the cheap resources available in the New World.

The statement that “capital chased after the European migrants,” (Taylor and Williamson, 1994: 349) implies that labor moved first and then capital followed. In discussing capital accumulation, population movements have been generally regarded as exogenous, and capital as endogenous, reacting to labor flows (for example, Green and Sparks 1999; Wilson 2003). This view makes sense when we characterize the investment booms of the New World as being driven by population-sensitive investment with a focus on social overhead requirements. However, the dual scarcity problem of the New World nations first led to the increased demand for both capital and labor to exploit cheap resources. Once international labor flows reacted to the incentives found in the New World, the capital requirements related to infrastructure and overhead intensified further (Williamson, 1979).

Green and Urquhart (1976) separated the demand for physical capital into three essential components: (i) capital investment as a result of increases in the labor force, to equip new workers for production; (ii) population-sensitive investment to meet social overhead needs and; (iii) capital investment as a result of labor-augmenting technological

change. In (i) and (ii), capital flows are a response to labor flows that increase the returns to capital, but in (iii), technological change increases the returns to both capital and labor in use, and thus increases the incentives for both capital and labor to migrate and accumulate. Abramovitz (1993: 217) pointed out that in the nineteenth century, massive capital accumulation “was a consequence of scale-dependent and capital-using technological progress.” Technological advance in the 19<sup>th</sup> century was characterized by a bias towards physical capital and was a large source of labor productivity. In light of this assessment, much capital accumulation in the late 19<sup>th</sup> century also fits into category (iii). In all three cases, capital accumulates due to increased returns.

Labor also may migrate and accumulate as a result of changes in the return to labor. Labor-augmenting technological change and an increase in exploitable natural resources increase real wages. In addition, an increase in physical capital used by workers in production also raises labor productivity and wage rates. There is a large literature that deals with real wage differences as a motivator for labor migration, and real wage convergence between two countries as a result of migration. Of this literature, Hatton and Williamson (1994) showed that real wage differences between sending and receiving countries were important determinants of emigration rates in eleven European countries in the late nineteenth century. O’Rourke, Williamson and Hatton (1994) showed that migration was an important factor in reducing wage differences between the UK and the US.

Canada experienced several economic, investment, and immigration booms in the years from 1870 to 1929. The purpose of this article is to examine the relationships between investment, immigration and productivity in the six decades before the Great

Depression. This article presents an econometric model to empirically determine whether immigrant labor flows, capital investment or productivity improvements occurred first in Canada, and whether foreign capital chased migrants to Canada or vice-versa.

## **2. The Canadian Experience, 1870-1929**

In the decades from Confederation leading up to the Great Depression, Canada experienced tremendous development. In 1870, the population of Canada amounted to 3.6 million. By 1929, the population had increased to 10 million. Over this period, per capita real incomes more than tripled, from \$1,353, to \$4,144 in 1981 dollars. The ratio of gross domestic capital formation to gross national product increased from 16% of GNP to 22% of GNP. The domestic savings rate increased from 9% in 1870 to 17% in 1929.

Figure 1 shows the time pattern of real gross national product on a per capita basis. The average growth rate over 1870-1929 was 1.92%. Growth proceeded slowly in the three decades leading up to the twentieth century, averaging 1.04% from 1870-1896. Canadian development was dramatically altered around 1897. Real income per capita growth increased to an average of 2.61% from 1897-1929, the period more commonly described as the Wheat Boom Era in Canada.

After Confederation in 1867, Canada experienced high rates of emigration, as many Canadians moved to the United States in the pursuit of greater economic potential. However, Canada was still a nation with high gross immigration. Figure 2 shows the pattern of immigrant arrivals as a proportion of the total population. Gross immigration levels averaged 1.2% annually over the 1870-1896 period, then increased to an average of 1.9% over the 1897-1929 period.

The patterns of investment, domestic savings and foreign capital inflows are depicted in Figure 3. The rate of investment averaged 15% over the 1870-1896 period, then rose above 20% during the Wheat Boom Era. The figure shows the striking increase in the rate of capital accumulation after 1896. The rate of investment rose from 12% in 1896, to a peak of 34% in 1912, then settling to average 18% during the 1920s. The rate of domestic savings rose from an average of 8% before 1897, to 16% in 1912, then averaged 17% in the 1920s. Foreign capital inflows averaged 7% over 1870-1896, then grew to a peak of 18% in 1912. Canada experienced a massive investment boom in the first decade of the twentieth century, fuelled by both domestic and foreign sources of capital.

The patterns of migration and capital accumulation coincide very closely. Canada experienced mild investment, immigration, and productivity booms in the early 1870s when the Intercolonial Railway was built linking the Canadian Maritime Provinces to Central Canada, and in the mid-1880s with the completion of the Canadian Pacific Railway linking Central Canada to the west all the way to the Pacific Ocean.

After a recession in the mid-1890s, the Canadian economy once again experienced strong growth in investment, immigration and productivity as Canada entered the Wheat Boom Era. The surge in population growth during the first decade of the twentieth century has been attributed primarily to the emergence of the wheat economy in Canada. The western provinces were rapidly settled during this period. The increase in western settlement has been attributed to a variety of factors, including the reduction of transportation costs due to rail expansion, the introduction of dry-farming techniques and intensive recruitment efforts of the Canadian Liberal Government (Norrie,

1975; Marr and Percy, 1978; and Borins, 1982). Lewis (1981) showed that the feasible region of cultivation expanded after 1896 due to the construction of rail lines and an increase in wheat yields. Farmers were also able to cultivate larger acreages with new and improved equipment (Ward, 1994). Settlers migrated to the Canadian Prairies as a result of improved economic incentives and better prospects for successful farming after 1896. The period from 1897 to 1913 was one of extensive growth in various sectors of the Canadian economy, and also marked the development of advanced manufacturing, for example, a modern iron and steel industry (Green and Urquhart, 1994). An investment boom was felt throughout the whole economy. The railways, construction, manufacturing, public sectors and other business sectors of the economy all contributed to the massive accumulation of physical capital. Green and Green (1993) also showed that the immigration boom before WWI was experienced across all sectors and provinces in Canada.

Immigration and the inflow of foreign capital both collapsed during WWI. Canada even became a net exporter of capital at the end of the war. Immigration, investment and output growth all recovered during the 1920s. Immigration and foreign capital inflows both increased in the first half of the 1920s, but real incomes did not significantly improve until the late 1920s.

Econometric analysis has suggested that the increases in investment in Canada were the result of increases in the population, and innovations to exports (Green and Sparks, 1999). The rise in the domestic savings rate during this period was due in part to the dramatic inflow of working age migrants and productivity improvements (McLean, 1994; Wilson, 2000). However, Canada, with a young population, still required foreign

capital inflows to meet the increased capital requirements during this period (Taylor and Williamson, 1994; Wilson, 2003).

These studies have treated population movements, and effectively, migration, as exogenous. However, Wilson (2003) supports the argument that the surge in domestic savings in Canada over 1896-1901 cannot be attributed to immigration, but to productivity improvements before the surge in immigration. The most likely explanation is that the Canadian economy pulled out of a recession in 1897, and labor productivity and the employment rate both increased at the start of the Wheat Boom Era. Unfortunately, labor and employment statistics are only available at census dates and this possible explanation cannot be easily verified. It is also commonly believed that capital is more mobile than labor, which would suggest that any improvements in technology or resource discovery would lead to capital accumulation and labor force growth, but with investment preceding immigration. World capital markets have been viewed as integrated in the years leading up to WWI, perhaps even better integrated than the capital markets of the 1980s (Zevin, 1992).

Did capital accumulation precede immigration and productivity improvements in Canada over the 1870-1929 period? Did capital chase migrants to Canada? Did capital and labor accumulate as a result of productivity improvements that increased returns to both factors of production? The following section provides a theoretical background for thinking about these questions.

### 3. Theoretical Considerations

The Solow growth model and its extensions provide a rich modeling environment in which to examine the relationships between labor force growth, capital accumulation, productivity improvements, and the incentives for migration and capital flows across borders.<sup>1</sup>

#### 3.1 Production

Consider a standard neoclassical constant returns to scale production function incorporating a third factor, resources:

$$Y_t = A_t K_t^\alpha R_t^\beta (H_t N_t)^{1-\alpha-\beta} . \quad (1)$$

In this context,  $Y$  denotes output,  $K$  denotes the stock of physical capital,  $N$  denotes the population size,  $H$  denotes human capital per capita (a weighted average of human capital in the aggregate),  $R$  denotes a third factor of production, resources, and  $A$  is a scale parameter representing the effect of total factor productivity improvements due to technology. This production function can be re-written, with  $L$  denoting effective labor, and equal to the population size times human capital per capita:

$$L_t = H_t N_t ; \quad (2)$$

$$Y_t = F(K_t, R_t, L_t) = A_t K_t^\alpha R_t^\beta L_t^{1-\alpha-\beta} . \quad (3)$$

In this description of production, effective labor may increase with improvements in the skills of the existing labor force (an increase in  $H$ , all else equal), with an increase in the

employment rate (an increase in  $H$ , all else equal), and with an increase in the working population (through immigration, an increase in  $N$ , all else equal).

Given this production function, the returns to the inputs to production are as follows, returns per unit of physical capital (the real interest rate,  $r$ , plus depreciation,  $\delta$ ), returns to the owners of resources on a per unit basis ( $\eta$ ), and wages per unit of effective labor,  $L$  (wage rate,  $w$ ):

$$r_t + \delta_t = F_1(K_t, R_t, L_t) = \alpha A_t K_t^{\alpha-1} R_t^\beta L_t^{1-\alpha-\beta}; \quad (4)$$

$$\eta_t = F_2(K_t, R_t, L_t) = \beta A_t K_t^\alpha R_t^{\beta-1} L_t^{1-\alpha-\beta}; \quad (5)$$

$$w_t = F_3(K_t, R_t, L_t) = (1 - \alpha - \beta) A_t K_t^\alpha R_t^\beta L_t^{-\alpha-\beta}. \quad (6)$$

It is assumed that resources are not mobile (as examples, land, or resources that need to be extracted locally). With perfectly competitive markets and mobile capital and labor, capital and labor will move to where they are most productive.

### 3.2 Capital Accumulation

Under the assumption of perfect capital mobility, and that capital can be used in production in two different economies, Economy A and Economy B, capital will flow where the returns are highest. At a certain point in time, assume that the returns to capital are equal in the two economies, so that there is no incentive for the migration of capital:

$$\alpha A_A K_A^{\alpha-1} R_A^\beta L_A^{1-\alpha-\beta} - \delta_A = r_A = r_B = \alpha A_B K_B^{\alpha-1} R_B^\beta L_B^{1-\alpha-\beta} - \delta_B. \quad (7)$$

Capital will then have an incentive to migrate from Economy B to Economy A if the return to capital increases in Economy A under the following circumstances: (i) there is an increase in total factor productivity in Economy A ( $A_A$ ) relative to that of Economy B

$(A_B)$ ; (ii) there is an increase in the resource endowment of Economy A ( $R_A$ ) relative to that of Economy B ( $R_B$ ); and (iii) there is an increase in effective labor in Economy A ( $L_A$ ) relative to that of Economy B ( $L_B$ ). If any of the above, or any combination of the above occurs, capital will flow from Economy B into Economy A, reducing the high returns to capital in Economy A, and increasing the low returns to capital in Economy B, and capital will migrate until returns are once again equal across the two economies.

### 3.3 Labor Growth

Similarly, under the assumption of perfect labor mobility, labor will flow where real wages are highest. Assuming that at some point in time, real wages are equal across the two economies, then there is no incentive for labor migration:

$$(1 - \alpha - \beta)A_A K_A^\alpha R_A^\beta L_A^{-\alpha-\beta} = w_A = w_B = (1 - \alpha - \beta)A_B K_B^\alpha R_B^\beta L_B^{-\alpha-\beta} \quad (8)$$

Labor will migrate from Economy B to Economy A if (i) there is an increase in total factor productivity in Economy A relative to that of Economy B; (ii) there is an increase in the resource endowment of Economy A relative to that of Economy B; and (iii) there is an increase in physical capital in Economy A relative to that of Economy B. If any of the above, or any combination of the above occurs, real wages in Economy A will be higher than those of Economy B, and labor will migrate until real wages are once again equated across economies.

### 3.4 Per Capita Income Growth

The production function may be re-written as follows on a per capita basis:

$$\frac{Y_t}{N_t} = A_t \left( \frac{K_t}{N_t} \right)^\alpha \left( \frac{R_t}{N_t} \right)^\beta (H_t)^{1-\alpha-\beta}. \quad (9)$$

It follows that an increase in per capita income is a result of: (i) an increase in the parameter  $A$ , denoting total factor productivity improvements; (ii) an increase in per capita physical capital, as a result of increased investment per capita; (iii) an increase in per capita resources available for production; (iv) an increase in the average amount of human capital per person, which may be caused by an increase in the education and skills of workers, and/or an increase in the proportion of employed laborers in the population (which may be the result of massive migration of workers).

For multi-sector economies with sectors where resources are not a factor in production, scale factors associated with an inflow of labor and capital into some sectors may increase the demand for services from other sectors of the economy, and in turn, increase the returns to capital and labor in these other sectors of the economy. As an example, service professionals like doctors, or tradesmen like construction workers, may experience an increased demand for their services with an increase in the population. Their wages, as well as the returns to capital used by these individuals will increase. Foreign professionals, tradesmen, and capital will again have an incentive to migrate as a result of a population boom.

The “discovery” of new productive resources, including the opening up of land for agriculture, in the New World made it more attractive for both labor and capital to migrate. A productivity boom in the New World, as a result of technological improvements would also encourage capital and labor to migrate. Additionally, a massive inflow of capital to a country, all else equal, would increase the returns to labor in that country, and thereby increase the incentives for labor to immigrate. On the other hand, a

massive inflow of labor into an economy would increase the returns to capital in the receiving country, and increase the incentives for capital to migrate.

Which factor moved first? While it is generally assumed that capital is much more mobile than labor, the literature still often treats population and labor movements as exogenous, and treats investment as responding to population and labor movements. In the case of Canada, the massive immigration and investment boom at the dawn of the twentieth century has been attributed to the opening up of the west for settlement. There have been other immigration and investment booms associated with periods of strong growth in the early 1870s, mid-1880s, and after WWI. The following section presents an econometric model to examine which factor, capital or labor, was the first-mover. This study will also examine the role of improved productivity in providing incentives for investment and labor force growth.

#### **4. Econometric Analysis**

In the econometric studies of Taylor and Williamson (1994) and of McLean (1994), population changes and income growth were assumed to be exogenous factors in explaining the increase in domestic savings in Australia and Canada. Green and Sparks (1999) examined the massive population and investment boom in Canada at the beginning of the twentieth century using a vector autoregressive (VAR) model, where population movements were determined *a priori* to be exogenous in relation to the other variables in the analysis, including investment, which was considered endogenous with respect to population. Wilson (2000) examined the Canadian economy since 1870, using a VAR model with cointegrated processes. In this case, population movements had to be

treated as exogenous, and income was found to be weakly exogenous, indicating that changes in income were not influenced by changes in domestic savings over the sample period.<sup>2</sup> The relationship between labor migration and capital accumulation was also examined in Wilson (2003) using a dynamic general equilibrium overlapping generations lifecycle model. The model treated migration as exogenous, with capital accumulation responding to changes in the labor force.

Changes in population were deemed exogenous in all of the studies cited above. Population tends to change rather slowly and is less volatile relative to most economic variables. Under normal circumstances, changes in fertility and mortality occur over long periods of time. However, an important component of population growth is migration, and migration patterns can change rather abruptly. During the period of study, migration flows changed quickly with respect to the population size, and it was migration movements that dramatically shocked the Canadian economy, as opposed to the other factors influencing population growth. In this study, migration will be treated as endogenously determined *a priori*, along with the other variables of interest: income, investment, domestic savings, and foreign capital inflows. Causality testing will also be conducted to establish the nature of these relationships between these variables, and to determine which variable(s) moved first.

#### *4.1 Data*

Canadian income, investment, domestic savings, foreign capital inflows, gross immigration, and population data are all available annually over the 1870-1929 period of study. Unfortunately, labor force, capacity utilization, and human capital data are not available, nor are data relating to technological improvements or natural resources. For

the purpose of this study, the series of interest will be converted to per capita terms, in order to remove the effects of population size on the variables. Given the discussion in Section 3, in per capita terms, income, investment, and immigration may be described in the following functional forms:

$$\frac{Y}{N} = f\left(\frac{I}{N}, \frac{IM}{N}, X\right); \quad (10)$$

$$\frac{I}{N} = f\left(\frac{IM}{N}, X\right); \quad (11)$$

$$\frac{IM}{N} = f\left(\frac{I}{N}, X\right). \quad (12)$$

In this case,  $X$  represents other factors including technological developments, represented by the variable  $A$ , average human capital in the aggregate,  $H$ , available resources for use in production,  $R$ , on a per capita basis, and the amount of physical capital stock used in production,  $K$ , on a per capita basis. Income will be influenced by investment that increases the amount of physical capital stock used in production, by immigration that affects the amount of workers in the economy, and by the other factors denoted by  $X$ . Investment will be influenced by immigration that affects the amount of workers in the economy, which in turn affects the returns to physical capital used in production; investment is also influenced by changes in the variables described by  $X$  that affect the returns to physical capital. Immigration is a function of investment and the variables described by  $X$  that affect the returns to labor.

As stated earlier, data on the variables contained in  $X$  are not available. In the empirical studies referenced above, there is often feedback from measures of income to investment and immigration (e.g. income growth has been found to affect capital accumulation). Any change in technology, in average human capital (including any

change in labor force participation), and in the amount of usable resources will transfer to a change in productivity and income, and so, changes in income per capita may also serve as a proxy for changes in productivity, and influence investment and immigration. So, in Eqs (11) and (12), per capita income may serve as a proxy for the other factors described by  $X$ , factors that influence the productivity of the inputs to production, and it is now clear that we have a system of equations where it is not possible to determine *a priori* which of the variables are exogenous.

The variables of interest for this investigation are: (1)  $y$ , which will be equal to the natural logarithm of GNP divided by the GNP deflator and the population size (the log of real income per capita); (2)  $i$ , equal to the natural logarithm of gross domestic capital formation divided by the GNP deflator and the population size (the log of real investment per capita); (3)  $s$ , equal to the natural logarithm of gross domestic capital formation less foreign capital inflows (the log of real domestic savings per capita); (4) real net long-term foreign capital inflows per capita,  $f$ , in its natural logarithmic form; and (5)  $im$ , equal to the natural logarithm of the ratio of immigrant arrivals to the total population.<sup>3</sup>

Investment is split into the two components, domestic savings and foreign capital inflows, to uncover any differences in the movements of these variables over time. The net long-term foreign capital inflow series is used instead of the net foreign capital inflow series (including net short-term flows) due to the complicated time-series properties of the net foreign capital inflow series.<sup>4</sup> The net long-term foreign capital inflow series is also a better indicator of foreign investment in physical capital for use in production. The gross immigration series is used instead of the net immigration series due to similar problems. The net immigration series is often negative from 1870 to 1899, and cannot be

converted to a logarithmic form to be used in the methodology described below. The net immigration series does however exhibit swings very similar to those of the gross immigration series, with exceptions during 1880s and from 1910-1913 when net immigration remained steady while gross immigration rose.

#### *4.2 Methodology*

Many economic time-series, including income and investment, are non-stationary and exhibit a pattern of growth over time. Econometric investigations require that the time-series of interest are stationary before proceeding with regression analysis. Non-stationary series are transformed into stationary series, either by removing a linear time trend, or by taking first differences of the logarithmic forms of the original series to examine growth rates. In many cases, series are still non-stationary when a linear time trend is removed, and are only stationary in the form of first-differences.<sup>5</sup> As an example, income and investment are normally non-stationary series, but the growth rates of income and investment are normally stationary series. The long-run relationships between non-stationary variables cannot be examined in traditional linear regressions, in the fear of mistaking a spurious regression between two trending variables for a stable long-run relationship.<sup>6</sup> As an example, the long-run income elasticity of investment cannot be established by a traditional linear regression of investment on income. However, the long-run relationships between non-stationary variables may be explored with new econometric techniques, namely cointegration analysis.

Granger and Engle introduced cointegration analysis in the 1980s which has been viewed as one of the most important contributions to time series econometrics.<sup>7</sup> If a long-

run relationship exists between non-stationary variables, then deviations from this long-run relationship are stationary, and these variables are said to be cointegrated. There are a few methods used to test for cointegrated variables. An approach pioneered by Soren Johansen uses the maximum likelihood technique to identify long-run equilibrium relationships between non-stationary variables, and uses the vector autoregressive framework.<sup>8</sup> The VAR framework is applied to the full-system estimation model with the variables in levels:

$$z_t = \sum_{i=1}^k \Omega_i z_{t-i} + \varepsilon_t, \quad \varepsilon_t \sim Niid(0, \Omega), \quad (13)$$

where  $z_t$  is an  $n \times 1$  matrix of the  $n$  variables of interest in the system of equations. The model is then reparametrized, to account for the non-stationarity of the variables in levels, as follows:

$$\Delta z_t = \sum_{i=1}^{k-1} \Gamma_i \Delta z_{t-i} + \Pi z_{t-k} + \varepsilon_t, \quad \varepsilon_t \sim Niid(0, \Omega). \quad (14)$$

All of the first-differenced variables ( $\Delta z$ ) must be stationary.  $\Pi z_{t-k}$  must also be stationary. The matrix  $\Pi$  will determine the extent of cointegration. If  $\Pi$  is a null-matrix, then no stationary long-run relationships exist amongst the variables in  $z$ . If  $\Pi$  is non-zero, then  $\Pi z_{t-k}$  is stationary, and the rank,  $r$ , of the matrix will indicate the number of cointegrating relationships between variables.  $\Pi$  is then unpacked as  $\Pi = \alpha \beta^T$ , where  $\beta$  is an  $n \times r$  matrix of parameters denoting the  $r$  cointegrating relationships amongst the  $n$  variables in  $z$ , and  $\alpha$  is an  $n \times r$  matrix of parameters denoting the speed of adjustment of a dependent variable towards a long-run equilibrium (cointegrating) relationship. It is in this

framework that the long-run relationship between per capita income, investment and immigration will be examined.

If long-run relationships may be established using the VAR framework with cointegrated processes, these relationships do not imply any direction of causality. One of the motivations for this paper is to identify, where possible, a direction of causality. Sims, Stock, and Watson (1990) showed that the standard Granger-causality tests can be used in VARs when the variables are in their levels (instead of first-differences) in cases where a single cointegrating relationship exists in three-variable systems. Accordingly, the long-run relationships between income, investment, and immigration in per capita terms will be examined, and block exclusion tests in the system of equations described by Eq. (13) will be conducted when a single cointegrating relationship exists in a three-variable system of the variables of interest. As an example, assuming that one long-run relationship exists between income, investment and immigration, then to test if income,  $y$ , does not Granger-cause immigration,  $im$ , in the regression,

$$im_t = \alpha + \sum_{i=1}^k \phi_i im_{t-i} + \sum_{i=1}^k \mathcal{G}_i y_{t-i} + \sum_{i=1}^k \gamma_i i_{t-i} + \varepsilon_t, \quad (15)$$

the null hypothesis that  $\mathcal{G}_i$  is equal to zero for all  $i$  is tested. If the null hypothesis is rejected, then one may infer that  $y$  Granger-causes  $im$ , and that increased productivity led to increased immigration during the study period. This methodology was used by Rousseau and Wachtel (1998) and by Rousseau (1999), to examine the relationships between financial indicators and income in per capita terms, for many countries in the decades leading up to the Great Depression.

The first step in proceeding with this empirical investigation is to determine whether or not the series of interest in this study are non-stationary in their logarithmic

forms, and whether or not they are stationary in their first differences. The standard Augmented Dickey-Fuller Tests were conducted for this purpose.<sup>9</sup> The test results are presented in Table 1. All series in levels appear to be non-stationary, while all series in first differences appear to be stationary.

#### 4.3 Application: Capital Accumulation, Income and Immigration

Equation (14) will be estimated, where  $z = [s \ y \ im]^T$ ,  $[i \ y \ im]^T$ , or  $[s \ i \ im]^T$ , and in each case,  $\Pi = \alpha\beta^T$ . In this context,  $\beta$  is a  $3 \times r$  matrix of parameters denoting the  $r$  cointegrating relationships amongst variables in  $z$ , and  $\alpha$  is a  $3 \times r$  matrix of parameters denoting the speed of adjustment of a dependent variable towards a long-run equilibrium (cointegrating) relationship. The unrestricted VAR analysis indicated that a value of  $k$  set to three for Eq. (14) generated satisfactory residuals for the multivariate systems. Tests were then conducted to identify the rank of the matrix  $\Pi$ . The Johansen L-max rank test results, presented in Table 2 suggested that there exists only one cointegrating relationship amongst the variables in two of the three-variable systems.<sup>10</sup> A cointegrating relationship does not exist between  $i$ ,  $y$ , and  $im$ .

The parameter estimates that describe the long-run stationary equilibrium relationship for two of the three-variable systems are presented in Table 3. These relationships are:

$$cv_1 \quad \hat{\beta}_1^T z_{1,t-3} = s_{t-3} - 0.142im_{t-3} - 1.742y_{t-3}; \quad (16)$$

$$cv_2 \quad \hat{\beta}_2^T z_{2,t-3} = i_{t-3} - 0.120im_{t-3} - 0.714s_{t-3}. \quad (17)$$

These relationships may be re-written to focus on savings and its relationship with immigration and income, and to focus on investment, and its relationship with immigration and domestic savings. It must be noted, however, that a direction of causality cannot be established yet in this estimation framework, but restructuring these relationship as follows provides an easier way to think about these results:

$$cv_1 \quad s_t = 0.142im_t + 1.742y_t; \quad (18)$$

$$cv_2 \quad i_t = 0.120im_t + 0.714s_t. \quad (19)$$

The results for the first cointegrating relationship suggest that, in the long run, increases in the rate of immigration and in income coincided with increases in domestic savings, in per capita terms. The results for the second cointegrating relationship suggest that increases in investment coincided with increases in immigration and domestic savings.

In light of the model and findings presented in Wilson (2003), an increase in immigration can increase domestic savings as the wealth of immigrants is transferred to the receiving country. This automatically increases the measured amount of domestic savings in the national accounts of Canada as presented in Urquhart (1993). Immigrant wealth was treated as immigrant receipts in Canada's balance of international payments. This treatment of immigrant wealth serves to reduce the capital account surplus, as compared to the current method of treating immigrant wealth as a foreign capital inflow. The domestic savings series is calculated as the difference between investment and foreign capital inflows, and so, an increase in immigrant wealth serves to increase domestic savings, by reducing net foreign capital inflows. It is also possible that an increase in domestic savings can increase the returns to labor, and provide incentives for labor to immigrate.

Productivity improvements can lead to increased domestic savings. If more income flows in the economy then more is available for both consumption and savings, and if productivity increases because of an increase in the employment rate, then more individuals in the economy are able to save out of their incomes. Alternatively, it is possible that increased domestic savings can lead to increases in productivity as savings increase domestic physical capital for use in production, and increase the returns to labor, providing more jobs for workers, including immigrants.

The second cointegrating relationship supports the suggestion that when immigration increases, more workers need to be equipped for production and the incentives for investment increase because capital becomes more productive in light of more labor in the economy. Increases in investment also corresponded with increases in domestic savings. Again, a direction of causality cannot be established yet using these methods, but the methods have established that long-run relationships exist between these variables. With this in mind, causality tests may now be conducted.

Since VARs in levels may be used to test for causality in three-variable systems with one cointegrating relationship, block exclusion tests are conducted for each dependent variable using Eq. (15). The results for the block exclusion tests are presented in Table 4. The Granger-causality test results suggest that increases in both domestic savings and productivity caused increased immigration, but that it is not possible to establish a direction of causality between domestic savings and productivity. The results also suggest that increased investment caused increased immigration, and that increased domestic savings caused increased investment in Canada in the years leading up to the Great Depression. One may infer from these results that investment from domestic

sources of savings, along with productivity improvements, preceded immigration booms in Canada over the 1870-1929 period.

#### *4.4 Application: Foreign Capital Flows, Income and Immigration*

Traditionally, international capital flows in the years leading to WWI, especially in the case of British capital flows to Canada, were geared to social infrastructure and overhead needs. Bloomfield (1968) and Edelstein (1982) presented results suggesting that capital flows from Great Britain to Canada and to the US were positively related to railroad development. Simon (1970: 242) showed that over 80% of money calls were directed to government and government-backed debt, and for social overhead requirements. It would be very useful and instructive to use the same methodology to investigate the relationships between foreign capital flows, investment, income, and immigration. Did foreign capital chase migrants to Canada?

Long-term net foreign capital inflow data is used in the methodology described above to answer this question, by examining the trios,  $(f, y, im)$ , and  $(f, i, im)$ , where  $f$  denotes the logarithm of per capita long-term foreign capital inflows. Unfortunately, in 1928, long-term net foreign capital inflows are negative, and so the sample must be shortened to the 1870-1927 period. All relevant time series were found to be difference stationary over this shortened period. Table 5 presents the Augmented Dickey-Fuller test results for the foreign capital inflow series.

For each trio, one long-run equilibrium relationship was found to exist. The Johansen Rank test statistics are presented in Table 6, and the equilibrium relationships are presented in Table 7. These relationships are:

$$cv_3 \quad \hat{\beta}_3^T z_{3,t-3} = f_{t-3} - 0.818im_{t-3} - 0.316y_{t-3}; \quad (20)$$

$$cv_4 \quad \hat{\beta}_4^T z_{4,t-3} = f_{t-3} - 0.538im_{t-3} - 0.484i_{t-3}. \quad (21)$$

Once again, these relationships may be re-written for convenience, however, a direction of causality cannot be established yet in this estimation framework:

$$cv_3 \quad f_t = 0.818im_t + 0.316y_t; \quad (22)$$

$$cv_4 \quad f_t = 0.538im_t + 0.484i_t. \quad (23)$$

These results suggest that, in the long run, increases in net foreign capital inflows coincided with increases in immigration, with increases in investment, and with increases in income.

Causality testing in these three-variable systems allows us to identify a direction of causality. The test results are presented in Table 8 and show that immigration Granger-caused foreign capital inflows, and that foreign capital inflows Granger-caused investment. These results suggest that foreign capital was a strong contributor to the massive investment booms in Canada, and that foreign capital did indeed chase migrants to Canada in the six decades before the Great Depression.

#### *4.5 Discussion*

Canada experienced several productivity, investment, and immigration booms over the six decades before 1930. Long-run economic relationships were found between productivity, immigration, and investment, and between productivity, immigration, and investment in the form of domestic savings and in the form of foreign capital inflows. During the period of study, increases (or decreases) in investment were associated with similar movements in incomes and immigration. The same may be said for the

components of investment based on the sources of supply: increases (or decreases) in domestic savings were correlated with similar movements in incomes and immigration; and increases (or decreases) in foreign capital inflows were associated with similar movements in incomes and immigration.

Block exclusion tests were then used to establish directions of causality between the variables of interest in an attempt to identify the leading cause or causes of these coinciding booms. The results suggest that the immigration and investment booms in Canada started as a result of improvements in productivity combined with increases in domestic savings that were funnelled into the investment in physical capital. Foreign capital flows then followed migrants into Canada in search of profitable investment opportunities, which in turn prolonged the investment booms.

Migration was found to be endogenous in relation to income and investment in physical capital (satisfied by domestic sources of supply first). As a result, population movements should be treated as an endogenous factor in Canadian economic development. It appears that migrants were attracted to Canada when economic and labor market conditions improved in Canada. However, it cannot be stated that past studies that treated population as exogenous are completely misleading. Immigration was found to be motivating factor inducing the inflow of foreign capital. Capital did indeed chase migrants into Canada, and served to prolong the investment booms. British capital flows to Canada, were geared to social infrastructure and overhead needs (Simon, 1970: 242). Immigrants also brought much capital along with them, which was treated as immigrant receipts in Canada's balance of international payments in Urquhart (1993), and served to increase the measure of domestic savings. Thus, in the case of foreign capital inflows and

domestic savings, the treatment of migrant flows as exogenous to capital accumulation is not entirely misconceived, however, this study has shown that surges in investment supplied by domestic sources, along with productivity improvements, led to increased immigration.

These findings support the following sequence of events: (i) the Canadian investment booms from 1870 to 1929 were first the result of increased investment in physical capital due to technological change, resource development, and productivity improvements; (ii) the demand for investment funds was first met by domestic sources of supply; (iii) in the early stages of the investment booms, the incentives for labor to migrate to Canada increased, leading to immigration booms; (iv) as migrant flows to Canada increased, foreign capital followed, to help satisfy the increased demand for capital to equip workers for production and to satisfy social overhead needs; and (v) foreign capital inflows prolonged the investment booms. This sequence of events seems natural and is not in itself surprising. A contribution of this article is in presenting empirical evidence, using recently developed techniques, that backs up this sequence of events. This article also presents evidence that population change as a result of migration, must be viewed as endogenous to changes in per capita incomes (which serves as a proxy for productivity) and investment when supplied by domestic sources, and that foreign capital flows must be viewed as endogenous with respect to migration flows.

This study has not examined the effect of these booms on the returns to the factors of production. Green (1994) and Greasley, Madsden, and Oxley (2000) examined the effect of immigration on the returns to labor in Canada. Green used a counterfactual exercise to show that immigration in the 1920s depressed real wage growth on the

Canadian Prairies. Greasley, Madsden, and Oxley, armed with the new real wage series for Canada, provided in Williamson (1995), also concluded that immigration slowed down the growth rate of real wages over 1870-1913. These results are expected given the theoretical background based on the Solow model, provided in Section 3. Unfortunately, data on the returns to capital in Canada are sparse.<sup>11</sup>

The analysis of early Canadian economic development is constrained since labor force and capacity utilization data are not available, nor are data that adequately quantify technological improvements, human capital or natural resources. For example, it would be very useful to have annual labor force data to examine the effect of the business cycle on local labor markets, to explore how slack and tight labor markets affect migration patterns, and to determine the associated time lags for migrants to respond to Canadian labor market conditions.

## **5. Conclusion**

In the six decades leading to the Great Depression, Canada experienced several coincident productivity, savings, foreign investment, and immigration booms. The existing literature on Canadian economic development has examined the reasons for economic growth, western settlement and immigration. The literature has also examined the effects of population on capital accumulation and foreign capital inflows. It has been unclear, however, if growth preceded investment and immigration, if investment preceded growth and immigration, or if immigration preceded growth and investment. In addition, the traditional view during the mass migrations before WWI is that “capital chased after European migrants” (Taylor and Williamson, 1994). However, foreign

capital has also been traditionally seen as more mobile than labor. Did foreign capital chase after migrants into Canada, did they both move together into Canada seeking out profitable opportunities, or did foreign capital lead migrants to Canada?

This article presented a theoretical framework based on the Solow model that illustrated the relationships between productivity growth, capital accumulation, labor growth, and factor migration. Given these theoretical relationships, an econometric model using cointegration and vector autoregression techniques was estimated to define the long-run relationships between income, immigration, investment, domestic savings, and foreign capital inflows for Canada over the 1870 to 1929 period. Causality test procedures were then used to help sort out the factors leading to the massive booms in Canadian development.

The causality test results presented in this paper suggest that changes in productivity and domestic savings led to changes in immigration, and that changes in immigration patterns led to changes in foreign capital flows to Canada. Population changes as a result of migration were endogenous with respect to changes in per capita incomes and investment supplied by domestic sources. In turn, foreign capital flows were endogenous with respect to migration flows. These results support a sequence of events whereby surges in domestic savings coincided with surges in productivity. These forces then caused migrants to flow into Canada looking for profitable employment and business opportunities. Foreign capital then chased these immigrants to satisfy the increased demand for capital in production and to meet infrastructure requirements.

## Appendix: Data Sources

The data was taken from Urquhart (1993), Urquhart and Buckley (1965), and Dick and Floyd (1993). The number of immigrant arrivals and the population figures are from Urquhart and Buckley (1965). The income series was constructed using the GNP series from Urquhart (1993) from 1870 to 1926, and from Urquhart and Buckley (1965) from 1926 to 1929. In 1926, the series was spliced, taking averages of the overlapping series. The investment series corresponds to the gross domestic capital formation series in Urquhart (1993) from 1870 to 1926, and in Urquhart and Buckley (1965) from 1926 to 1929. In 1926, the series was spliced, using the average of the two overlapping series. The domestic savings series was calculated as a residual of gross domestic investment less the capital account balance (or plus the current account balance). The capital account balance is derived from Urquhart (1993) from 1870-1926, and from Urquhart and Buckley (1965) from 1926-1929, and spliced accordingly in 1926. Long-term foreign capital inflows were taken from Dick and Floyd (1994: 190-1) for 1871-1913, from Urquhart (1993: 19-23), for 1870, and 1914-1926, and from Urquhart and Buckley (1965), series G98, for 1927. Series were converted into real values using the GDP deflator provided in Urquhart (1988), with 1981 as the base year.

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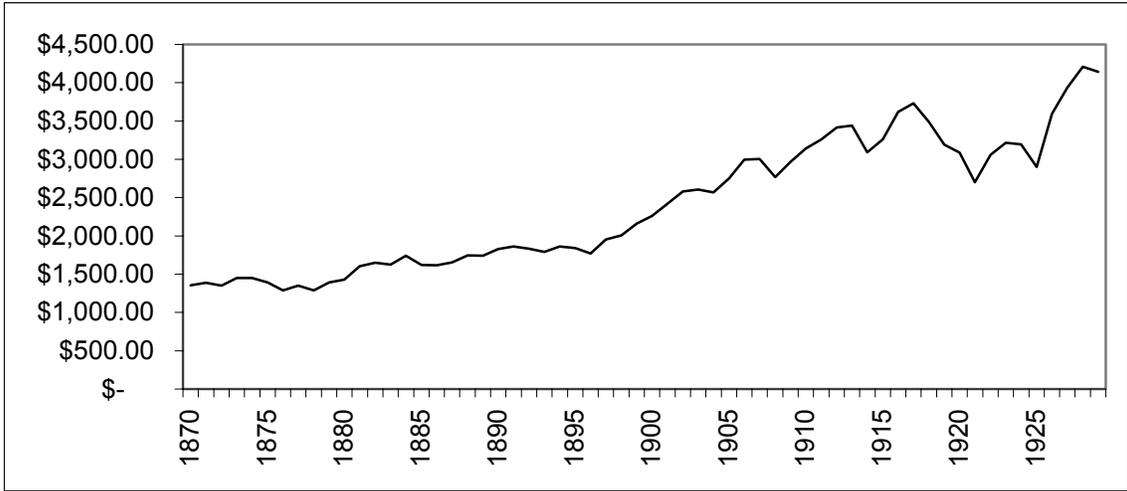
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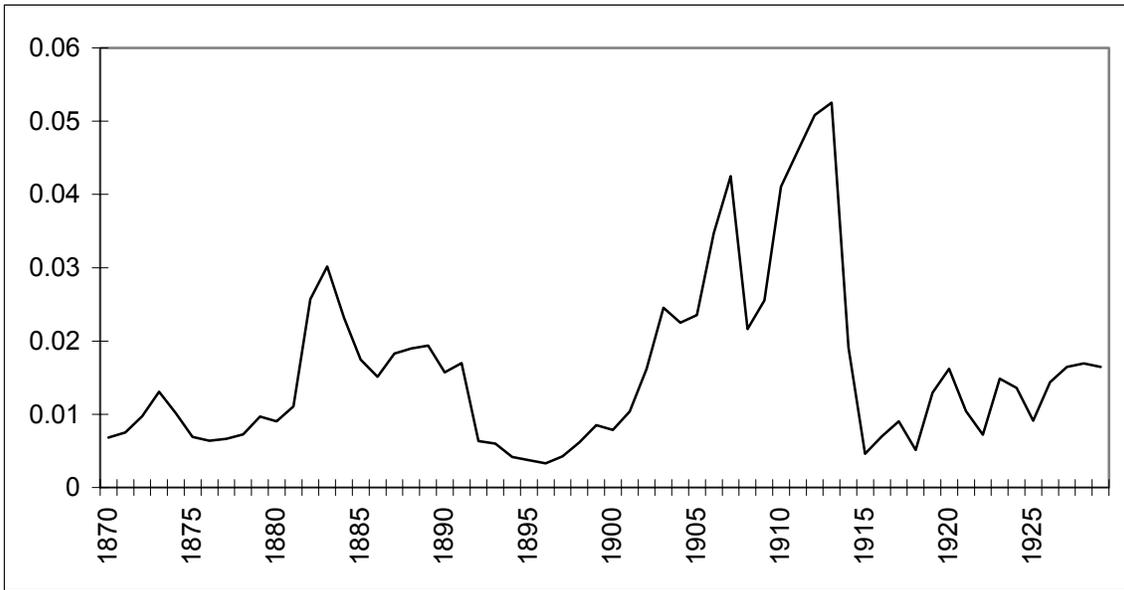
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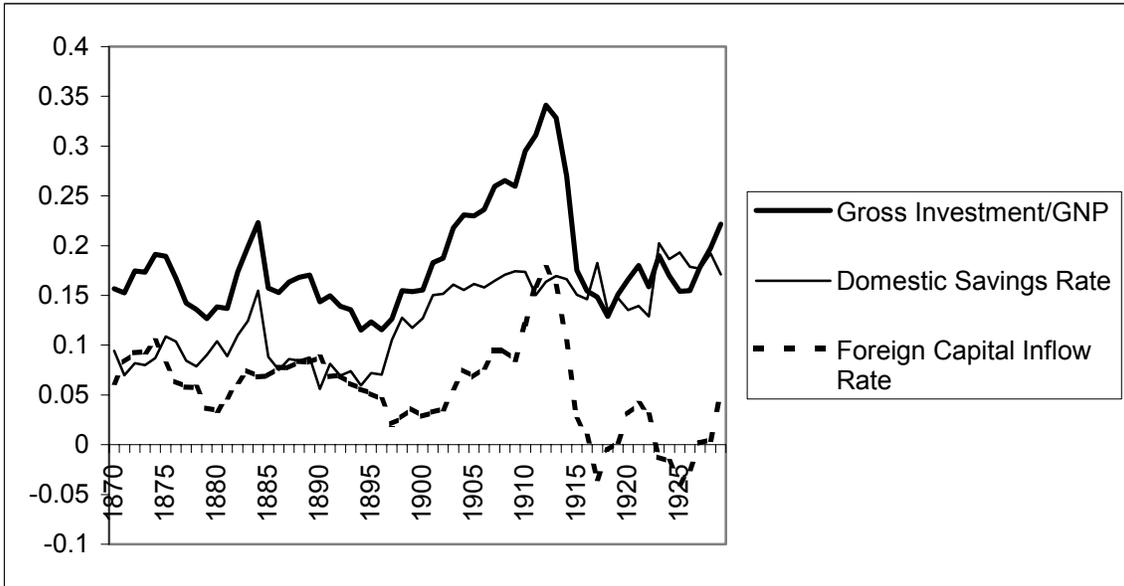
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**Figure 1: Real GNP per capita, Canada, 1870-1929**



**Figure 2: Gross Immigration as a proportion of the population, Canada 1870-1929**



**Figure 3: Gross Investment, Domestic Savings and Foreign Capital Inflow Rates, as a proportion of GNP, Canada 1870-1929**

**Table 1: Augmented Dickey Fuller Tests (1870-1929)**

Variable	ADF(2) Test Statistics
<i>s</i>	-2.24
<i>i</i>	-2.33
<i>y</i>	-2.63
<i>im</i>	<u>-2.91</u>
$\Delta s$	<b>-5.29</b>
$\Delta i$	<b>-3.75</b>
$\Delta y$	<b>-5.15</b>
$\Delta im$	<b>-3.79</b>

Notes: Test statistics in bold are significant at the 0.05 significance level. The critical value for a significance level of 0.05 is  $-3.50$ , for a sample size of 50 (Fuller, 1976). In most cases two lags were required to remove serial correlation. Underline indicates an ADF(4) test statistic was calculated, with four lags required to remove serial correlation in the residuals. An insignificant test statistic indicates that the null hypothesis of non-stationarity cannot be rejected at the given significance level. Statistics in bold indicate rejection of the null hypothesis at a significance level of 0.05.

**Table 2: Johansen Rank Test (L-max Test)**

L-max Test	$(s, y, im)$	$(i, y, im)$	$(s, i, im)$	90% Critical Value
$H_0: r = 0$ (no cointegrating relationships)	<b>16.45</b>	9.44	<b>19.54</b>	13.39
$H_0: r = 1$ (at most one cointegrating relationship)	10.55	5.39	7.36	10.60

Notes: The Johansen Rank Test is used to identify the rank of the matrix  $\Pi$ . The rank of this matrix indicates the number of cointegrating relationships amongst the variables included in the study. Interested readers may refer to Juselius (1991) for further explanation of the test procedure. Statistics in bold indicate rejection of the null hypothesis at a significance level of 0.10.

**Table 3: Estimates for  $\beta$  (Cointegrating Vectors)**

Variable	( <i>s, y, im</i> )	( <i>s, i, im</i> )
<i>s</i>	1.00	-0.714 (0.050)
<i>i</i>	-	1.00
<i>y</i>	-1.742 (0.112)	-
<i>im</i>	-0.142 (0.064)	-0.120 (0.059)

Notes: Standard errors are in parentheses. Standard errors are not available for the parameter that is scaled and restricted to 1.

**Table 4: Granger Causality Test Results**

Variable	$H_o: s$ does not	$H_o: y$ does not	$H_o: im$ does not
( $X$ )	Granger-cause $X$	Granger-cause $X$	Granger-cause $X$
$s$	-	2.11 (0.11)	0.79 (0.50)
$y$	1.52 (0.22)	-	1.74 (0.17)
$im$	<b>3.79 (0.02)</b>	<b>4.06 (0.01)</b>	-

Variable	$H_o: s$ does not	$H_o: i$ does not	$H_o: im$ does not
( $X$ )	Granger-cause $X$	Granger-cause $X$	Granger-cause $X$
$s$	-	1.33 (0.28)	1.50 (0.23)
$i$	<b>4.36 (0.01)</b>	-	0.60 (0.62)
$im$	<b>7.14 (0.00)</b>	<b>6.22 (0.00)</b>	-

Note: The test statistics reported above are block exclusion F(3,46) tests, p-values in parentheses.

**Table 5: Augmented Dickey Fuller Tests (1870-1927)**

Variable	ADF(2) Test Statistics
$f$	-2.35
$\Delta f$	<b>-5.82</b>

Notes: Test statistics in bold are significant at the 0.05 significance level. The critical value for a significance level of 0.05 is  $-3.50$ , for a sample size of 50 (Fuller, 1976). An insignificant test statistic indicates that the null hypothesis of non-stationarity cannot be rejected at the given significance level. Statistics in bold indicate rejection of the null hypothesis at a significance level of 0.05.

**Table 6: Johansen Rank Test (L-max Test)**

L-max Test	$(f, y, im)$	$(f, i, im)$	90% Critical Value
$H_0: r = 0$ (no cointegrating relationships)	<b>17.98</b>	<b>19.35</b>	13.39
$H_0: r = 1$ (at most one cointegrating relationship)	9.16	8.01	10.60

Notes: The Johansen Rank Test is used to identify the rank of the matrix  $\Pi$ . The rank of this matrix indicates the number of cointegrating relationships amongst the variables included in the study. Interested readers may refer to Juselius (1991) for further explanation of the test procedure. Statistics in bold indicate rejection of the null hypothesis at a significance level of 0.10.

**Table 7: Estimates for  $\beta$  (Cointegrating Vectors)**

Variable	$(f, y, im)$	$(f, i, im)$
$f$	1.00	1.00
$i$	-	-0.484 (0.182)
$y$	-0.316 (0.267)	-
$im$	-0.818 (0.143)	-0.538 (0.151)

Notes: Standard errors are in parentheses. Standard errors are not available for the parameter that is scaled and restricted to 1.

**Table 8: Granger Causality Test Results**

Variable ( $X$ )	$H_0: f$ does not Granger-cause $X$	$H_0: y$ does not Granger-cause $X$	$H_0: im$ does not Granger-cause $X$
$f$	-	0.54 (0.65)	<b>6.64 (0.00)</b>
$y$	0.19 (0.90)	-	0.77 (0.52)
$im$	1.85 (0.15)	1.77 (0.17)	-

Variable ( $X$ )	$H_0: f$ does not Granger-cause $X$	$H_0: i$ does not Granger-cause $X$	$H_0: im$ does not Granger-cause $X$
$f$	-	1.64 (0.19)	<b>3.13 (0.03)</b>
$i$	<b>2.91 (0.04)</b>	-	0.12 (0.95)
$im$	2.22 (0.10)	1.24 (0.31)	-

Note: The test statistics reported above are block exclusion F(3,44) tests, p-values in parentheses.

## Endnotes

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<sup>1</sup> Interested readers may consult the seminal paper by Solow (1957), and the extensions by Romer (1986), Lucas (1988), and Rebelo (1991). Summary treatments made be found in Barro and Sala-i-Martin (1995), and in Romer (1996).

<sup>2</sup> Savings and output were both found to follow unit root processes over the period of study, however, population movements were trend stationary, and had to be treated as exogenous processes with respect to savings and income, given the methodology.

<sup>3</sup> Please see the Appendix for a complete description of the data sources.

<sup>4</sup> Net foreign capital flows are negative in 1917, 1918, and the mid-1920s, and any investigation using net foreign capital flows would have to be shortened to the 1870-1916 period. Using this shortened data series, augmented Dickey-Fuller test results suggest that the per capita net foreign capital inflow series, in its natural logarithmic form, is an I(2) process, meaning the series in levels and in first differences appears to be non-stationary, but the series in second differences is stationary, for the 1870-1916 period.

Unfortunately, this does not allow the use of the methodology to examine the relationships between net foreign capital flows and the other variables. Instead, net long-term foreign capital inflows are used in this study.

<sup>5</sup> There are cases when even series in their first-differences are not stationary, and further differencing is required to construct a stationary series.

<sup>6</sup> Please see Davidson and McKinnon (1993: 669-673) or Charemza and Deadman (1992: 124-127) for further discussion of spurious regressions.

<sup>7</sup> See Granger (1981), and Engle and Granger (1987).

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<sup>8</sup> Please see Johansen (1988), Johansen and Juselius (1994), and Juselius (1991) for further explanation of the empirical framework.

<sup>9</sup> Please see Davidson and McKinnon (1993: 700-715) or Charemza and Deadman (1992: 130-136) for further discussion of procedures used to test for stationarity.

<sup>10</sup> The Johansen L-max test procedure is described in Juselius (1991).

<sup>11</sup> Canadian data on the returns to capital is generally limited to yields on Canadian government and municipal bonds beginning in 1868, as presented in Neufeld (1972), and some data on yields of Canadian corporate bonds are available after 1907 as presented in Rich (1988).