IMMIGRATION AND THE REAL WAGE: TIME SERIES
EVIDENCE FROM THE UNITED STATES, 1820–1977

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and
Cormac Ó Grada

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IMMIGRATION AND THE REAL WAGE: TIME SERIES

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by

Patrick T. Geary and Cormac Ó Gráda

ABSTRACT

How migration affects economic welfare in sending and receiving countries is an important issue. This paper deals mainly with one aspect, the relation between immigration and the real wage in the host country. Theory is ambivalent on the outcome. While it is plausible to see immigration depressing the real wage consequent on increased labour supply, consideration of scale economies and migrant selection bias argue for a rise, at least in the medium term. The hypothesis that immigration affects the real wage implies that the former 'precedes' or 'leads' the latter. This can be expressed in terms of the Granger-causal ordering of the series. We present bivariate and trivariate evidence on the ordering for U.S. immigration 1820-1977, and find that Granger-causality runs mainly from immigration to real wages, and not the reverse. Similar analysis of the relationship between immigration and GNP produced weak and inconclusive results. Investigation of the direction and magnitude of the immigration-real wage effect shows that it is negative, but modest.

JEL Classifications: 020, 042, 044, 210, 810, 820.

Keywords: Labour economics, migration, economic history.
NON-TECHNICAL SUMMARY

One of the most enduring issues in the economics of migration is the effect of migration on economic welfare in sending and receiving countries. The main focus of this paper is on just one aspect of this question, how immigration influences real wages in the host country. Economic theory is ambivalent here, since it is easy to construct models predicting either a rise or a fall in the real wage. Empirical work, too, is rather inconclusive. Of course wages and immigration may be linked in another way: if 'pull' factors are important in attracting migrants, then an influence in the opposite sense, from wages to migration might be expected.

The notion that immigration influences the real wage, and/or the other way round, can be expressed in terms of what is called "Granger-causality" or "precedence". A variable X is said to 'cause' Y if Y can be better predicted with past information on X than without it; this can be tested with regression methods. Once the direction of causality has been determined, the sign and magnitude of the effect of one variable on the other can be calculated.

In looking at these issues, we used time series data on United States immigration as a case study. Such data, and data on real wages and GNP, are available for the period 1820-1977. We investigated 'causality' for the period as a whole, and for two sub-periods (1820-1914 and 1900-1977), and found considerable evidence of influence from
immigration to the real wage, but not in the other direction. The influence was appreciably weaker in the first sub-period, even though migration rates were higher in that period. We also found some weak evidence for 'causation' from GNP to the immigration rate for the full period, and from the immigration rate to GNP in the first period. Finally, we found that immigration also tended to reduce the real wage in all periods, but this effect proved to have been rather small in size.
INTRODUCTION

How migration affects economic welfare in sending and receiving countries continues to be an important issue. This paper focuses primarily on the connection between immigration and real wages. It is often argued that immigration affects real wages, but there is no consensus on the direction of the influence (Geary and Ó Gráda, 1985). Against the claim that immigration depresses the real wage through its effect on labour supply (e.g. Chiswick, 1982; Mishan and Needleman, 1968), scale economies and immigrant selection bias argue for a rise in the real wage, at least in the medium term (Neal and Uselding, 1972; Roback, 1981; Simon, 1981, 1982; Bohning, 1984; Greenwood, 1983; Stark and Levhari, 1982). Evidence on these reduced form hypotheses is inconclusive. The immigration-real wage nexus also has a structural dimension. The difference between the real wage in sending and receiving countries is commonly argued to be a determinant of migration. However, if conditions in the host country - 'pull' factors - have a dominating effect, the host country's real wage might be expected to influence immigration. A connection between immigration and real GNP has also been proposed: immigration, by adding to labour supply, could bias income distribution away from wage earners towards those with high savings propensities, thereby promoting economic growth (Kindleberger, 1967). A 'pull' argument analogous that just outlined might also be posited.
The arguments that immigration influences the real wage imply that the former 'leads' or 'precedes' the latter, and correspondingly for GNP. 'Pull' arguments suggest that immigration lags real wages or GNP. These hypotheses can be expressed in terms of the Granger-causal orderings of the series.

These issues are analyzed using data on the greatest voluntary mass movement of people in history, that to the United States in the nineteenth and twentieth centuries. A long time-series of immigration statistics is available, and economic historians have produced time-series data on other relevant variables. We conclude that Granger-causality runs mainly from the immigration rate to real wages, and not the reverse. This conclusion holds in both bivariate and trivariate frameworks, but displays some sensitivity to a partitioning of the data period. We find only weak evidence of an immigration-GNP relationship. To establish the direction and magnitude of the effect of migration on the real wage, we regressed real wages on current and lagged migration, and lagged GNP. We found that the effect is negative, but modest in size; the implications of this are discussed below.

2. ESTIMATION AND RESULTS

Annual data on U.S. immigration, population, wages, consumer prices, and GNP are available from 1820 on; they are fully described in an appendix. For the purposes of analysis, all variables are measured in logs, except for the
immigration rate. Standard deviations of the raw, detrended, and differenced data are presented in Table A.1, for the full data period (1820-1977) and two sub-periods, 1820-1914 and 1900-1977.[1]

The Granger-causal orderings of immigration, real wages, and GNP are obtained by estimating a three-variable vector autoregression (VAR), including linear and quadratic trends. VARs were estimated for lag lengths ranging from one to twenty years, using both differenced and undifferenced real wages and GNP. Throughout, the Box-Pierce Q-statistic indicated the absence of autocorrelation among the residuals. Lag lengths of one year and more than ten years were rejected throughout, on the basis of the usual chi-squared test. Accordingly, results for three, five and ten lags are presented, both for the full data period and the two sub-periods.

The proposition that variable X is Granger-caused or preceded by variable Y can be tested by conducting an F-test on the exclusion of the lagged Y-terms in the X-equation in the VAR. The critical levels of such F-tests for our data are reported in Table 1.[2] The table shows that causality from real wages to immigration is rejected in almost all

[1] Correlations between the detrended variables and correlations between their innovations obtained from a four-five lag vector autoregression are given in Table A.2. The results for real wages are yielded by adding an identity to the system of four variables. The most noticeable feature of the correlations is that the GNP-CPI and, to a lesser extent, GNP-RW correlations are negative and significant in the first sub-period, and positive and significant in the second.
cases. It should be noted that this does not imply the absence of 'pull' factors in determining total immigration, since due to lack of reliable data we could not control for wage rates in sending countries, and we are using the rate rather than the level of immigration. However, replacing the rate by the level leaves our conclusion completely unaltered: this holds whether or not population is added to the VAR.

Causality from immigration to real wages cannot in general be rejected. Over the full sample, and especially the period 1900-1977, there is strong evidence that immigration precedes real wages. This holds whether undifferenced or differenced real wages and GNP are used. The results are slightly stronger when the variables are differenced, but show limited sensitivity to lag length. The results for the first sub-period (1820-1914) are much weaker. Since immigration rates were substantially higher before 1914, this may seem somewhat surprising. Generally, immigration affects real wages with a lag of at least two years; in no case did a one-lag VAR reveal significant causality in this direction.[3]

Few other consistent patterns of significant Granger-causality can be detected from Table 1. There is some evidence of causality from GNP to the immigration rate for the full period at three lags, and of causality from GNP to real wages in both sub-periods, but not for the period as a whole. Evidence for causality from immigration to GNP in the first period exists at ten but not at shorter lags.[4]
It is worth noting from the results using differenced data that the hypothesis that real wages follow a random walk with drift is strongly rejected at all lag lengths, over the whole period and in the first sub-period. However, in the twentieth century sub-period, the hypothesis cannot be rejected at the five percent level.

The finding that the immigration rate Granger-causes real wages is consistent with the conflicting hypotheses about the effects of immigration summarized at the outset. Clearly, it tells us nothing about the direction and magnitude of these effects. To investigate this issue, we calculated the sum of the coefficients of the immigration rate terms in the real wage equations of the VAR's. Versions which included the current immigration rate were

[2] See, for example, Greenberg and Webster (1983), ch. 5. The term 'preceded' is due to Leamer (1985). He argues that tests of precedence suffer from the fact that they may be sensitive to set of control variables employed. In our analysis of immigration and real wages, our sole control variable is real GNP, since it is the only theoretically relevant one for which a complete series is available. Results of tests taking the variables two at a time are presented in Tables A.3 to A.5 in the appendix; they conform to the results in Table 1.

[3] Even here, we obtained some evidence (at fifteen lags) of causality from immigration to real wages.

[4] It has been suggested that the pre-World War I data in particular suffer from measurement error and that this contributes to the weakness of some of the results. Sims (1977) has pointed out that if there is severe measurement error in one variable, not the others, the latter variables will tend to fail to Granger-cause the former. However, it is difficult to gauge whether any one of our variables is more error-ridden than the others.
also examined. The results are presented in Table 2. In general the effects are negative, and in most cases statistically insignificant. They are also modest in size, although they increase with lag length. Since the mean of the immigration rate in the full period was about 0.5 percent (or 0.2 percent at the end of the period) a unit increase in IMR implies a trebling (or a quintupling) of the immigration rate. The sum of the lagged real wage terms is about 0.85, regardless of the number of lags. Therefore a coefficient of, say, -0.015 means that a three hundred (or five hundred) percent rise is associated with, in the long run, a fall of eleven percent in the real wage. With differenced real wages, a coefficient of -2.5 means that a three hundred (or five hundred) percent rise in the immigration rate reduces real wage growth in the long run by 2 percent (not percentage points), since the sum of the lagged differenced real wage terms is about 1.2. The scale of the effects found here echoes in an interesting way the findings of Williamson (1974) on the effects of immigration into the U.S. between 1870 and 1914.[5]

CONCLUSION

In this paper we have presented evidence on the relationship between the immigration rate, real wages, and

[5] Williamson (1974: 248-9) suggests that a 'closed door' to migrants after 1870 would have produced an eleven percent rise in real earnings in the U.S. by 1910. We have reservations, however, about the estimation methods yielding Williamson's results (Geary and O Grada, 1985).
real GNP, using U.S. data for the period 1820-1977. We found that Granger-causality runs from immigration to the real wage. This held in the full period, and especially in the twentieth-century data, but was much weaker in pre-World War I data. We found no evidence for causality in the opposite direction, and only weak evidence of both immigration-GNP and real wage-GNP relationships. The effect of immigration on real wages was shown to be negative but small, and typically not significant.

Data limitations in the full period prevented us from using a larger set of control variables in our analysis. These limitations are less severe for the more recent past, however. Further examination of the experience of the U.S. and other countries since 1900 will shed light on the robustness of our conclusions.
### TABLE 1. GRANGER CAUSALITY TESTS: CRITICAL LEVELS OF F-STATISTICS

**1820-1977**

<table>
<thead>
<tr>
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<th>(II) FROM</th>
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<td></td>
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<tr>
<td></td>
<td>RW</td>
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<td>.000</td>
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<td>RW</td>
<td>.053</td>
<td>.000</td>
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<tr>
<td></td>
<td>GNP</td>
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<td></td>
<td>RW</td>
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<td>.000</td>
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<td></td>
<td>GNP</td>
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**1831-1914**

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<th>(II) FROM</th>
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**1900-1977**

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<td>GNP</td>
<td>.616</td>
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*Note: In (I) levels of the logs of RW and GNP were used; in (II) differences were used.*
### TABLE 2: COEFFICIENT Sums

#### (A) 1831-1977

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#### (B) 1831-1914

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<td>.139</td>
<td>.262</td>
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#### (C) 1900-1977

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<tr>
<td>C.L.</td>
<td>.302</td>
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<tr>
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<td>.028</td>
<td>.559</td>
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**Note:** C.L. denotes critical level of t-test.
REFERENCES


Approach" (Cato Institute Policy Analysis paper).


APPENDIX: A Note on the Data.

The shortcomings of the immigration data are well known (Hutchinson, 1958; U.S. Department of Commerce, 1960: 48-9; Neal and Uselding, 1972). Overland immigrants are not included before 1900, and no allowance is made for illegal immigration. The latter problem has become more serious in recent years; for this reason we chose, rather arbitrarily, to halt the series at 1977. Besides, the numbers reflect gross movements, whereas the impact on the real wage should ideally be tested on net data. However, historians consider none of these faults serious enough to discard the series. In the absence of reliable information on the labour force status of immigrants and of the U.S. population, we are forced to calculate the immigration rate in terms of total immigration and population.

Our real wage series combines the money wage rates for 'common' labour drawn together and reported in David and Solar with their newly-constructed cost-of-living index (David and Solar, 1977: 16-7 and 59-60).

Table A.1: Standard Deviations

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<tr>
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<th>W</th>
<th>P</th>
<th>GNP</th>
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<tbody>
<tr>
<td>1821-1977</td>
<td>0.41</td>
<td>91.00</td>
<td>75.74</td>
<td>122.90</td>
<td>51.33</td>
<td>173.81</td>
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<tr>
<td>1821-1914</td>
<td>0.41</td>
<td>69.25</td>
<td>30.04</td>
<td>31.18</td>
<td>17.13</td>
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<tr>
<td>1900-1977</td>
<td>0.37</td>
<td>30.30</td>
<td>55.61</td>
<td>105.99</td>
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<td>10.54</td>
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<td>18.80</td>
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<td>3.27</td>
<td>6.43</td>
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### A. Correlations between non-deterministic components

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|        | 1826-1914 |        | 1826-1914 |
|        | 1.00      |        | 1.00      |
| EW     | 0.20      | 1.00   | 0.05      | 1.00    |
| W      | -0.03     | -0.12  | 0.10      | 0.77    |
| CPI    | -0.16     | -0.69  | -0.10     | -0.35   |
| GDP    | 0.38      | 0.63   | 0.00      | 0.12    |
|        | -0.39     | -0.81  | 0.12      | -0.43   |

|        | 1900-1977 |        | 1900-1977 |
|        | 1.00      |        | 1.00      |
| EW     | 0.01      | 1.00   | -0.24     | 1.00    |
| W      | 0.06      | 0.18   | 0.27      | 0.63    |
| CPI    | -0.16     | -0.56  | 0.19      | 0.18    |
| GDP    | 0.25      | 0.15   | 0.01      | 0.31    |
|        | 0.44      | 0.34   | 0.31      | 0.20    |

### B. Correlations between innovations

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|        | 1826-1914 |        | 1826-1914 |
|        | 1.00      |        | 1.00      |
| EW     | -0.01     | 1.00   | 0.06      | 0.76    |
| W      | 0.22      | -0.18  | 0.17      | 0.78    |
| CPI    | 0.06      | 0.12   | 0.26      | -0.19   |
| GDP    | 0.12      | -0.15  | 0.04      | 0.16    |
|        | -0.43     | 1.00   | 0.06      | -0.33   |

<p>|        | 1900-1977 |        | 1900-1977 |
|        | 1.00      |        | 1.00      |
| EW     | -0.13     | 1.00   | -0.14     | 1.00    |
| W      | -0.20     | 0.69   | -0.08     | 0.31    |
| CPI    | -0.18     | 0.21   | 0.32      | 0.32    |
| GDP    | 0.14      | 0.47   | 0.39      | 0.32    |
|        | 1.00      |        | 1.00      |</p>
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**1900-77**

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### TABLE A.4: BIVARIATE CAUSALITY RESULTS FOR GNP AND IMR, 1831-1977 AND SUB-PERIODS

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| 1831-1914 |     |      |      |      |
| 3    | IMR | .000 | .030 | .000 | .030 |
|      | GNP | .856 | .000 | .858 | .454 |
| 5    | IMR | .000 | .172 | .000 | .117 |
|      | GNP | .997 | .000 | .928 | .756 |
| 10   | IMR | .000 | .287 | .000 | .408 |
|      | GNP | .106 | .217 | .015 | .875 |

| 1900-77 |     |      |      |      |
| 3    | IMR | .000 | .534 | .000 | .613 |
|      | GNP | .284 | .000 | .430 | .006 |
| 5    | IMR | .000 | .613 | .000 | .769 |
|      | GNP | .589 | .000 | .754 | .031 |
| 10   | IMR | .000 | .921 | .000 | .946 |
|      | GNP | .699 | .000 | .764 | .036 |
TABLE A.5: BIVARIATE CAUSALITY RESULTS FOR IMR AND RW, 1831-1977 AND SUB-PERIODS

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Note: the results under (I) refer to levels, those under (II) to differences.
Working Papers


Policy Papers


15. Assar Lindbeck: "What is Wrong with the European Economies?" January 1985.