Bigger Establishments and Thicker Markets: Can We Explain Early Productivity Differentials Between Canada and the United States?

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Motivation – Why Compare Productivity?

- link between welfare, GNP, and TFP

- persistent GNP/capita gap between Canada and the US

Canada / US GNP/capita
(PPP adjustment: Prados 2000)

Year	Ratio
1870	0.828
1890	0.809
1913	0.968
1929	0.900
1950	0.882
1970	0.938
1990	0.939
2000	0.888

- economic theory predicts convergence between Canada and US

- economic theory predicts that manufacturing drives/leads convergence

Objective

- measure productivity of L, M, K, and TFP for a sample of Canadian manufacturing establishments relative to a matching sample of US manufacturing establishments

- investigate the possibility that there is a relationship between productivity performance and establishment size or market density measures

- manuscript from 1871 Canadian census of manufacturing (90 Ontario counties)

- manuscript from 1870 US census of manufacturing (38 counties in eastern Michigan, northern New York, northern Ohio, and northern Pennsylvania)

Why Only the Lower Great Lakes Region?

- isolate performance differences that are not due to aggregate compositional differences

Why 1870/71?

- 20th century policy debates focused on tariffs, market size, and market density

- 1870 is prior to National Policy tariffs, and contrast between Canadian and US market size and density even more dramatic

- economic history literature and "stylized facts" about Canadian manufacturers during late 19th century

- very little quantitative evidence and no Canada-US comparisons

<u>Data</u>

- establishment level data: proprietor
  location
  employees (men, women, children)
  total wage bill
  value fixed capital
  power (type, horsepower)
  cost materials, fuel, misc.
  gross value production
  value added
  months in operation

- exclusions and filters: unreliable, questionable, incomplete records

  reconstitution of multi-product establishments

  Canadian establishments with PQ < $400

- 14 466 Canadian establishments and 10 265 US establishments remain after exclusions and filters

- industry selection: 2 approaches
  - largest industries = gross output

  problem = representative?

  statistical power?

  - largest industries = # establishments

problem = bias size measure downward

objective = compare similar industries, not
maximize coverage

only industries with # establishments > 50
(in both nations)

5 industry groups (=58% Cdn manufacturing)

25 industries (= 53% 5 industry groups)

(= 31% Cdn manufacturing)

- 13 126 Canadian establishments and 8 705 US establishments in sample

Methodological Issues

- partial factor productivity: Q vs. VA
                                    L aggregation, months in operation
                                    value fixed K vs. power
                                    cost of materials, fuel, misc.
                                    currency conversion
                                    output price conversion
                                    capital price conversion
                                    material price conversion

- total factor productivity: weighted average of partials

= Tornqvist index

$$\frac{A_{CDA}}{A_{US}} = \left(\frac{Q/L_{CDA}}{Q/L_{US}}\right)^{0.5\,(SLC+SLU)} \cdot \left(\frac{Q/K_{CDA}}{Q/K_{US}}\right)^{0.5\,(SKC+SKU)} \cdot \left(\frac{Q/M_{CDA}}{Q/M_{US}}\right)^{0.5\,(SMC+SMU)} \quad (1)$$

reconstructed cost shares

sensitivity analysis on TFP

Results

- L productivity: $Q/L_{cda} < Q/L_{us} \rightarrow$ 24 of 25
  Canadian industries

  avg. $(Q/L_{cda})/(Q/L_{us}) = 0.721$

  considerable variation among 25
  industries

  low Q/L associated with low K/L
  and M/L

- M productivity: $Q / M_{cda} < Q / M_{us} \rightarrow$ 20 of 25 Canadian industries

avg. $(Q / M_{cda}) / (Q / M_{us}) = 0.809$

considerable variation among 25 industries

low Q / M associated with high M / K and M / L

M share largest in TFP calculations

- K productivity: $Q / K_{cda} < Q / K_{us} \rightarrow$ 2 of 25 Canadian industries

avg. $(Q / K_{cda}) / (Q / K_{us}) = 3.148$

considerable variation among 25 industries

very low K / L and very high M / K

US establishments relatively K intensive

- TFP:

$TFP_{cda} < TFP_{us} \rightarrow$ 17 of 25 Canadian industries

avg. $(TFP_{cda}) / (TFP_{us}) = 0.928$

again, considerable variation among 25 industries

only 8 industries have TFP differential > 15%

- conclusions: 1870 productivity results consistent with early 20th c

no substantial productivity differential

considerable variation among industries

why? - establishment size, market density?

Establishment Size (Gross Output)

- Canadian establishments were smaller than US establishments

mean Q_{cda} / mean Q_{us} = 0.505

median Q_{cda} < median $Q_{us} \rightarrow$ 21 of 25 industries

20% more "small" Canadian establishments, 7% fewer "large" Canadian establishments

- "small" Canadian establishments had lower TFP

small TFP < mid TFP and large TFP $\rightarrow$ 18 of 25 industries
(and on average)

- CF # 1:   give Canadian industries US size distributions

TFP gap narrows: 0.928 $\rightarrow$ 0.938

TFP_{cf1} > $TFP_{cda} \rightarrow$ 16 of 25 industries

- establishment size was a disadvantage for Canadian manufacturers, but not dramatic

Population Density (Population / Mile^2)

- Canadian establishments were located in thinner markets

    mean pden$_{cda}$ / mean pden$_{us}$ = 0.926

    median pden$_{cda}$ < median pden$_{us}$ $\rightarrow$ 19 of 25 industries

    33.3% more Canadian establishments in "thin" markets, 22.6%
    fewer Canadian establishments in "thick" markets

- Canadian establishments in "thin" markets had lower TFP

    thin TFP < mid TFP and thick TFP $\rightarrow$ 19 of 25 industries
                             (and on average)

- CF # 2: give Canadian industries US population density distributions

    TFP gap narrows: 0.928 $\rightarrow$ 0.936

    TFP$_{cf2}$ > TFP$_{cda}$ $\rightarrow$ 20 of 25 industries

- diffuse domestic market was a disadvantage for Canadian
  manufacturers, but again not dramatic

<u>Industrial Activity Density (Manufacturing VA / Mile^2)</u>

- Canadian establishments were located in thinner markets

    mean $iden_{cda}$ / mean $iden_{us}$ = 0.577

    median $iden_{cda}$ < median $iden_{us}$ → 25 of 25 industries

    81.1% more Canadian establishments in "thin" markets, 27.4% fewer
    Canadian establishments in "thick" markets

- Canadian establishments in "thin" markets had lower TFP

    thin TFP < mid TFP and thick TFP → 11 of 25 industries
                            (and on average)

- CF # 4:   give Canadian industries US industrial activity density
        distributions

    TFP gap narrows: 0.928 → 0.935

    TFP_{cf4} > TFP_{cda} → 17 of 25 industries

- diffuse domestic market was a disadvantage for Canadian
  manufacturers, but not dramatic

<u>Establishment Density (Manufacturing Establishments / Mile^2)</u>

- Canadian establishments were located in markets with more competitors

    mean eden$_{cda}$ / mean eden$_{us}$ = 1.170

    median eden$_{cda}$ < median eden$_{us}$ $\rightarrow$ 4 of 25 industries

    3% fewer Canadian establishments in "thin" markets, 103% more Canadian establishments in "thick" markets

- Canadian establishments in "thin" markets had lower TFP

    thin TFP < mid TFP and thick TFP $\rightarrow$ 15 of 25 industries
                                (and on average)

- CF # 3: give Canadian industries US establishment density distributions

    TFP gap widens: 0.928 $\rightarrow$ 0.917

    TFP$_{cf3}$ > TFP$_{cda}$ $\rightarrow$ 5 of 25 industries

- diffuse domestic competition was an advantage for Canadian manufacturers, but not dramatic

Conditional Effects

- problem = CF # 1 – CF # 4 all consider unconditional internal and
                external scale effects

        but, establishment size and market density measures are
        related to each other

        conditional establishment size and market density effects

$$\ln (TFP_{ijcda} / TFP_{jus}) = C + e_Q \ln (q_{ijcda}) + e_{PD} \ln (pd_m) + e_{ED} \ln (ed_m) + e_{ID}$$
$$\ln (id_m) + \delta 1 \; urban_m + \delta 2 \; border_m + \delta 3 \; RR_m + \delta 4$$
$$\ln(duty_{jcda}) + \varepsilon_{ijcda}$$

- results: locating near urban centre ↑ TFP
        locating near RR trunk line ↑ TFP
        locating in border county ↑ TFP
        receiving generous tariff protection ↓ TFP
        ↑ establishment size ↑ TFP (strongest result–Sokoloff '84)
        ↑ population density ↑ TFP (with urban dummy removed)
        ↑ industrial activity density ↑ TFP
        ↑ establishment density ↑ TFP

        statistical and economic importance of market density
        measures is weak

- CF # 5:   simultaneously provide Canadian
    establishments with US
        median establishment size and market density measures

        TFP gap narrows: 0.928 → 0.972

        $TFP_{cf5} > TFP_{cda}$ → 21 of 25 industries

Conclusions

- productivity performance evidence from early 20th century consistent
  with 1870 (pre-National Policy)
  eg. L and M productivity low, K productivity high, little difference in TFP

- Canadian establishments were smaller and located in thinner markets
  (except for establishment density)

- establishment size and market density was a disadvantage for Canadian
  manufacturers

- however, unconditional and condition counterfactual experiments
  illustrate that TFP gap cannot be fully explained by establishment size of
  market density differences and very little of the inter-industry variation
  in performance can be explained by establishment size and market
  density differences

- how to explain absence of convergence?