

# Discussion: “The Impact of Potatoes on Old World Population and Urbanization”

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By Nathan Nunn and Nancy Qian.  
*The Quarterly Journal of Economics*, May 2011.

# The Impact of Potatoes on Old World Population and Urbanization<sup>1</sup>

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Why potatoes?

- We are not particularly interested in potatoes - instead, we want to know, what is the effect of a positive (permanent) shock on agricultural productivity on economic growth?
- Is there a casual relationship?

Positive agricultural shock  $\overset{?}{\implies}$  Population Growth & Urbanization.

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<sup>1</sup>Also titled as “The potato’s contribution to population and urbanization: Evidence from an historical experiment”, Nunn & Qian (2009).

## Main Contributions

They have successfully provided quantitative answers to these questions:

- ① Improved nutrition and population growth
  - Jia (2011) confirms that “sweet potatoes stabilize the society and increase population growth” using historical data from China.
- ② Agricultural productivity and the aggregate economic growth
  - difficulty in identification: reverse causality, omitted variables.
- ③ Columbian Exchange for Old World living standards
  - Has the discovery of the New World benefited the Old World? As argued partly by Hersh & Voth (2009) “the average Englishman would have been willing to forego 15% or more of his income in order to maintain access to sugar and tea alone.”
  - Later Nunn & Qian (2010) further conclude that

*The production of these products also resulted in large inflows of profits back to Europe, which some have argued fueled the Industrial Revolution and the rise of Europe.*

# Main Methods and Results

## Method:

- Data:
  - suitability for growing potatoes in each region (from FAO's GAEZ)
  - population and urbanization
  - other controls.
- Identification strategy: simple DD (Difference in Difference), using a continuous measure of the treatment (suitability for growing potatoes) with controlling for other potential shocks/factors.

## Results:

- the introduction of the potato explains
  - ① 25-26% of the increase in Old World population between 1700 and 1900.
  - ② 27-34% of the increase in urbanization during the same time period.<sup>2</sup>

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<sup>2</sup>Estimates vary a little according to different versions of their working paper. Here I abstract the numbers from the latest version (August, 2010).

# Virtues of the Potato

First of all, why do we need potatoes?

- Nutrients: important vitamins (C, B6, etc.)
- Energy source: starch  $\Rightarrow$  glucose  $\Rightarrow$  ATP

Second, what are the advantages of potatoes compared to other crops?

- Require less land to produce the same amount of calories: an acre of potatoes yields approximately three times more energy than the other crops.
- Possible to plant potatoes between the growing seasons of other crops, easy to store, and provide additional means of crop diversification (an insurance for food supply under various climates).

Finally, how did potatoes enter our lives?

- 17th century: potatoes remained a botanical curiosity in Europe (poisonous? cause the disease leprosy?).
- Europe: late 17th century to early 18th century.
- China, India: during the seventeenth century.
- Africa: the end of the 19th century

# Conceptual Framework

## Positive agricultural productivity shock on population

How may the introduction of the potato, as a positive agricultural productivity shock, affect population and urbanization?

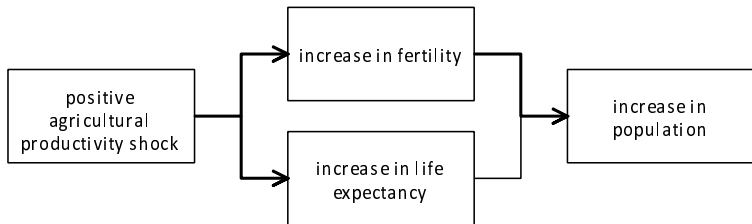


Figure: Positive agricultural productivity shock on population

# Conceptual Framework

## Positive agricultural productivity shock on urbanization

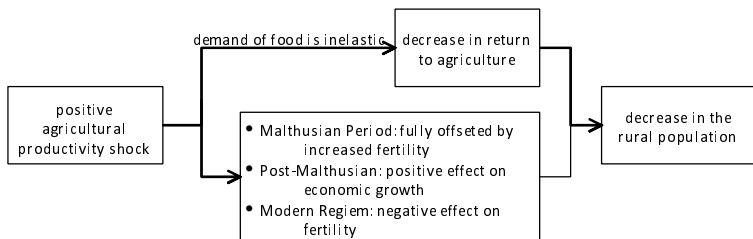


Figure: Positive agricultural productivity shock on urbanization

- Analysis ends at in 1900 (before the Modern Regiem).
- However, this mechanism may not be that ideal, as Jia (2011) argues, “peasants in the places with sweet potatoes might lack the incentives to move to urban areas since they can survive well when there are serious weather shocks. The popularity of sweet potatoes is negatively correlated with urbanization rates in modern China.”

# Data

## Crop Suitability

### Crop Suitability

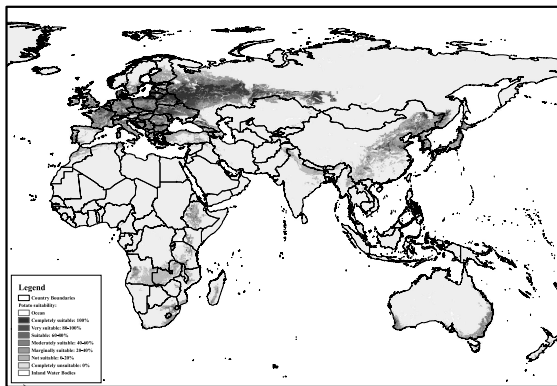
- Data source: FAO's *Global Agro-Ecological Zones* (GAEZ) 2002 database.
- Data construction considers information on the characteristics of 154 different crops, the physical environment (climate constraints, soil constraints and terrain slope constraints) of 2.2 million grid-cells.
- Suitable for cultivation: if it is classified in the database as being either "very suitable", "suitable" or "moderately suitable".

### Potential Problems

- Other underlying causes of the Big Divergence: include controls; robustness check.
- Is the measure calculated today same as two hundred years earlier? It is based on climatic characteristics.
- Potato varieties evolved overtime: Historical evidence shows that the focus was not on developing varieties that could be grown in climates with rapid population growth.
- Also control for other New World and Old World staple crops.

## Data

## Crop Suitability



The darker the area is, the more suitable for planting potato.

Figure: Average potato suitability in the Old World

# Data

## Population and Urbanization Data

### Population and Urbanization

- Total population, which is measured as the number of individuals living on land that is a modern country today, are taken from McEvedy and Jones [1978];
- Urbanization is measured as a country's total urban population, defined as people living in locations with 40,000 or more inhabitants, divided by the total population (from Chandler [1987], Bairoch [1988], and Modelski [2003]). Here urbanization is used as a measure of historic per capita GDP.
- Their study includes twelve time periods between 1000 and 1900.

# Identification Strategy

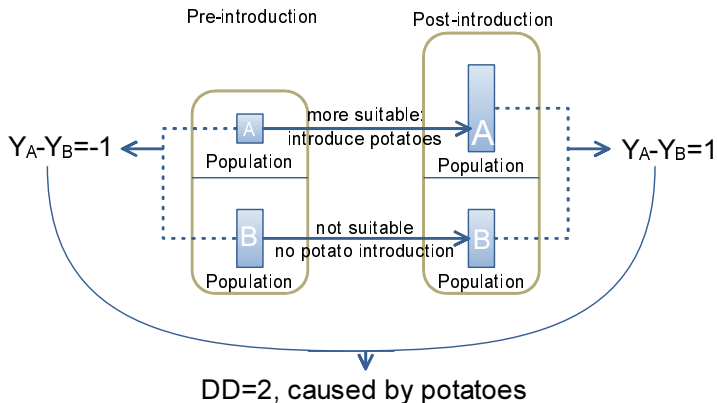


Figure: Differences-in-differences

- The same date of initial adoption for all countries  $\Rightarrow$  cutoff: 1700 (checked later).

# Identification Strategy

## Baseline Specification

- Main Regression:

$$y_{it} = \beta \ln Potato Area_i \cdot I_t^{Post} + \sum_{j=1100}^{1900} X_i' I_t^j \Phi_j + \sum_c \gamma_c I_i^c + \sum_{j=1100}^{1900} \rho_j I_t^j + \varepsilon_{it}$$

- $i$ : index of countries, and  $t$ : index of time periods.
- $\ln Potato Area_i$ : the natural log of the total amount of land that is suitable for potatoes.
- $I_t^{Post}$ : indicator variable that equals one for the periods after 1700.
- $y_{it}$ : either the natural log of total population or the urbanization rate.
- $X_i' I_t^j$ : country-specific characteristics interacted with time period fixed effects.
- $I_i^c$  and  $I_t^j$ : country and year fixed effects.

Wait... before analyzing the results, is 1700 a proper cutoff year?

# Identification Strategy

## Flexible Estimates

Examine the cutoff date: whether the patterns in the data are consistent as assumed (1700).

- A Fully exible estimating equation

$$y_{it} = \sum_{j=1100}^{1900} \beta_j \ln Potato Area_i \cdot I_t^j + \sum_{j=1100}^{1900} X_i' I_t^j \Phi_j + \sum_c \gamma_c I_i^c + \sum_{j=1100}^{1900} \rho_j I_t^j + \varepsilon_{it}$$

- Interact the suitability measure with each of the time period fixed effects.
- The relationship between potato suitable land and population is constant over time and small in magnitude during 1000-1700 and then steadily increases in magnitude from 1750-1900.

# Identification Strategy

## Rolling Estimates

- Rolling Estimates: a check similar in spirit to tests for structural breaks.
  - Systematically examine 400-year segments of the full panel.
  - For each window, we estimate the baseline specification, defining the later two centuries as the post-adoption period.
  - Expect the estimates to be close to zero until the cutoff begins to coincide with the historical description of the approximate date of potato adoption.
- Findings:
  - Starts before 1500: no evidence of a differential relationship between potato suitability on population and urbanization in these early pre-adoption time periods.
  - 1500 to 1800: a positive but small and statistically insignificant coefficient for  $Potato\ Area_i \cdot I_t^{Post}$ .
  - 1600 to 1900: much larger positive coefficients, that are now highly significant.
- The results confirm the finding from the flexible estimates.

# Identification Strategy

## Baseline Estimates

Table IV: The impact of the potato: Baseline estimates.

	Dependent Variable									
	In Total Population					City Population Share				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
In Potato Area x Post	0.059 (0.009)	0.044 (0.011)	0.032 (0.012)	0.034 (0.011)	0.043 (0.014)	0.0044 (0.0009)	0.0046 (0.0009)	0.0036 (0.0012)	0.0039 (0.0011)	0.0039 (0.0011)
Baseline Controls (x Year FEs):										
In Old World Crops Area	N	Y	Y	N	Y	N	Y	Y	N	Y
In Elevation	N	N	Y	Y	Y	N	N	Y	Y	Y
In Ruggedness	N	N	Y	Y	Y	N	N	Y	Y	Y
In Tropical Area	N	N	Y	Y	Y	N	N	Y	Y	Y
Other Controls (x Year FEs):										
In All Crops Area	N	N	N	Y	N	N	N	N	Y	N
In Maize Area	N	N	N	N	Y	N	N	N	N	Y
In Silage Maize Area	N	N	N	N	Y	N	N	N	N	Y
In Sweet Potatoes Area	N	N	N	N	Y	N	N	N	N	Y
In Cassava Area	N	N	N	N	Y	N	N	N	N	Y
Observations	1552	1552	1552	1552	1552	1552	1552	1552	1552	1552
R-squared	0.99	0.99	0.99	0.99	0.99	0.38	0.39	0.44	0.44	0.48

- The introduction of the potato explains
  - 26% of the observed increase in Old World population.
  - 34% of the observed increase in Old World urbanization.
- With other baseline control variables, the results remain similar.
- Moreover, sensitivity check to variable definitions shows that the results remain robust to the choice of slightly different adoption dates and different suitability thresholds, as well as the use of this alternative measure of suitability.

# Robustness Check

## Controlling for Additional Determinants of Population and Urbanization

Consider a host of additional factors:

- Differences in geography: a country's distance from the equator, country-average of malaria stability.
- Legal institutions: indicator variables that identify each country's legal origin, the identity of the colonizer among former colonies.
- Other factors that have been cited as causing the rise of Western Europe: Atlantic traders; part of the Roman Empire; and majority Protestant in 1600.
- Impacts of globalization: countries' natural openness to overseas trade.
- Other omitted geographic characteristics: geographic characteristics (used by the FAO as inputs in the construction of their GAEZ crop suitability variables).

# Robustness Check

## Examining Within Continent Variation & City Populations

- Another concern left: their results may be simply capturing the fact that Europe is, on average, more suitable for potatoes, and that European population and urbanization diverged from the rest of the world for reasons other than the adoption of potatoes.
  - Apart from controlling for factors that may have caused Europe divergence, they arise an alternative way and estimate the effect of potatoes using within continent variation only - by adding continent fixed effects interacted with time-period fixed effects to the baseline specification. Thus,  $\beta$  is identified from within-continent variation only.
  - Point estimates are reduced slightly, they remain positive and significant. The slightly smaller point estimates may reflect a loss of precision arising from the fact that there are relatively few countries within each continent.
- Also, they examine variation in city populations: consider all land that is within 100 kilometers of the centroid of the city and calculate the natural log of the land within this area that is suitable for potato cultivation (since no long-distance trade in potatoes). All regressions measured at the city-level.
  - The estimate decreases slightly, but remains positive and significant.

# Robustness Check

## Adult Soldier Heights within France

- An even finer level of variation: examine the adult heights of soldiers that were born in France between 1658 and 1770.
  - sample includes 13,646 soldiers that were born in France between 1658 and 1770.
  - whether potatoes had an effect on adult height, with controlling for other factors, such as age.

The estimates provide evidence of a positive effect of potatoes on adult height, as well as evidence for the mechanisms underlying the population estimates - potatoes had a positive impact on long-term health.

- Overall, the estimates provide reassurance that their baseline estimates of the effect of potatoes are not biased by other factors responsible for the rise of Europe during the period.

# Conclusions

- According to their estimates, the introduction of the potato explains
  - 25-26% of the increase in Old World population between 1700 and 1900
  - 27-34% of the increase in urbanization.
- The adoption of potatoes spurred city growth.
- The importance of nutritional improvements over the past three centuries: the availability of potatoes also played an important role in spurring economic growth in the 18th and 19th centuries.

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