Information Technology and Economic Change

The Impact of the Printing Press

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References

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Agenda

1. Historical context
2. Model
3. Data
4. Analysis
5. Conclusions

Historical Context

- Johannes Gutenberg, Mainz, circa 1450
- Key role in business development
  - Numeracy, accounting, education
- Particular benefits to port cities

Mainz's location in today's Germany

Historical Context, cont.

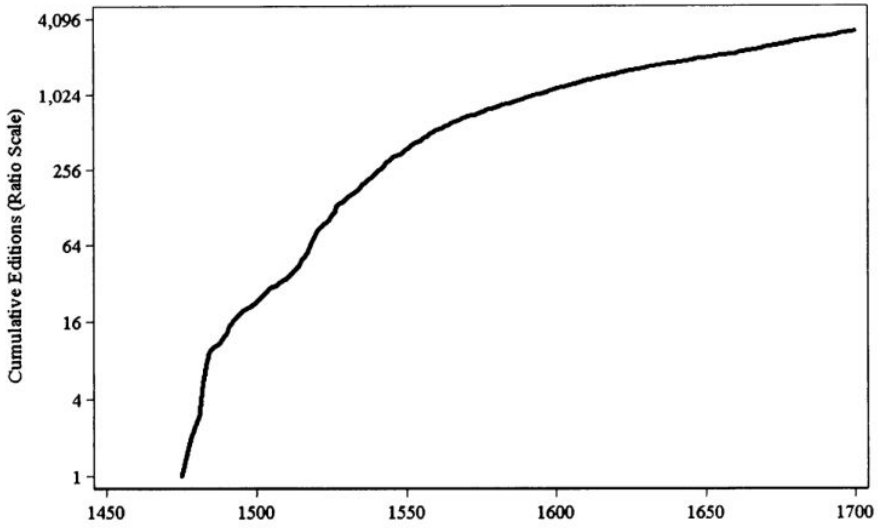

FIGURE I

Cumulative Output of Merchants' Manuals in Europe

Cumulative output (editions) of printed merchants' manuals in Europe, including commercial arithmetics, treatises on bookkeeping, guides to commercial law and business practice. Data from Hoock and Jeannin (1991, 2001, 2007).

Historical Context, cont.

- Luther's Bible & the printing press (1534)
  - Printing copies of the Bible in the vernacular
  - Expanded access to scripture, reading, and standardized German language

The question at hand...

- “Western progress owed much to the superior means of storing and disseminating information,” - Jones (1981)
- Baten & van Zanden (2008) found association between wages and aggregate book production

vs.

- Clark (2001) found no evidence of aggregate productivity growth associated with the expansion of printing
- Mokyr (2005) found such aggregate effects to be very small

To what extent, if any, did the printing technology have on city growth?

Data & Model

$$(1) \qquad Y_{i,t} = \theta_i + \delta_t + \sum_{t=1300}^{1700} \alpha_t D_t T_i + X'_{i,t}\gamma + \epsilon_{i,t}.$$

Yi,t : log city growth for city *i* in time *t*

θi : city fixed effects

δt : time fixed effects

Dt: indicator variable for each time period

Ti : indicator variable - whether city *i* was an early adopter of print technology

Xi,t : vector of covariates (controls for universities, capitals, country fixed effects, interactions, etc.)

ϵi,t: error term

αt: growth advantage in printing cities in time period *t*

Data & Model, cont.

Print x Yr1400: estimate of relative growth percentage of print cities during 1400-1500

Print x Yr1500: estimate of relative growth percentage of print cities during 1500-1600, etc.

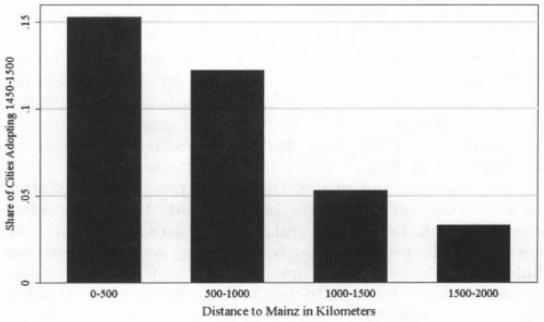

FIGURE IV

Distance from Mainz and Adoption of the Printing Press, 1450–1500

This figure documents the relationship between distance from Mainz, Germany and the proportion of historic cities that adopted the printing press 1450–1500. Historic cities are those identified in Bairoch, Batou, and Chèvre (1988).

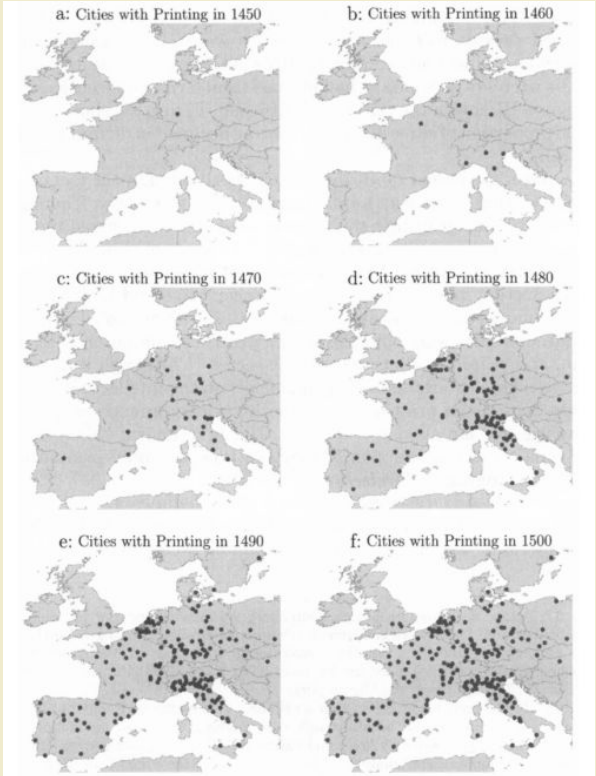

FIGURE III

The Diffusion of the Movable Type Printing Press

Data & Model, cont.

TABLE I

THE DIFFUSION OF THE PRINTING PRESS 1450–1500

(1) 20th-Century Polity	(2) Cities Adopting Printing Press	(3) Total Number of Historic Cities	(4) Share Adopting (%)
Austria	1	17	6
Belgium	9	72	13
Czechoslovakia	5	36	14
Denmark	2	10	20
England	3	165	2
France	39	341	11
Germany	40	245	16
Hungary	1	47	2
Italy	56	406	14
Netherlands	11	60	18
Poland	3	55	5
Portugal	6	53	11
Spain	24	265	9
Sweden	1	20	5
Switzerland	4	19	21
Total	205	1,811	11

Notes. See text for the sources identifying printing cities. Data on total cities represent the historical cities identified in Bairoch, Batou, and Chèvre (1988).

Data & Model, cont.

TABLE II

PRINT TECHNOLOGY AND LOG CITY GROWTH 1500–1600

(1)	Press Adopted 1450–1500			Press Not Adopted 1450–1500			
20th-Century Polity	(2) No. of Cities	(3) Urban Pop. 1500	(4) Weighted Average Growth	(5) No. of Cities	(6) Urban Pop. 1500	(7) Weighted Average Growth	(8) Print City Growth Advantage
Austria	1	20	0.92	7	43	−0.03	0.95
Belgium	8	202	−0.08	15	136	−0.27	0.19
Czechoslovakia	2	85	0.23	6	25	0.25	−0.02
Denmark	1	10	1.39	1	3	0.51	0.88
England	2	55	1.16	38	166	0.21	0.95
France	21	662	0.20	28	347	0.04	0.16
Germany	27	360	0.16	53	318	0.12	0.04
Italy	34	1,119	0.26	62	442	0.24	0.02
Netherlands	9	104	0.34	17	119	0.53	−0.19
Poland	3	77	0.60	14	96	0.08	0.52
Portugal	4	87	0.56	3	19	0.04	0.52
Spain	19	359	0.37	55	554	−0.15	0.51
Sweden	1	7	0.25	17	27	0.06	0.20
Switzerland	3	27	0.25	3	8	0.00	0.25
Totals	135	3,174	0.27	319	2,303	0.07	0.20

Notes. Urban populations are given in thousands. At the country level, weighted average growth (columns 4 and 7) is calculated using city populations in 1500 as the weights on log city growth. At the city level, log growth 1500–1600 is $\ln\left(\frac{POP_{1600}}{POP_{1500}}\right)$, where POP_t is city population in year t. The print growth advantage (column 8) is the difference between average growth for adopting and nonadopting cities (column 4 − column 7). Across all countries, total weighted average growth is calculated using urban populations in 1500 as the weights. Hungary is omitted because Buda was the lone Hungarian print city and the Bairoch data do not record Buda's population in 1600.

Data & Model, cont.

Pros of this approach:

- Controls aid in focusing on impact of print technology presence
- Incorporates fixed effects of cities, countries, and time

Cons of this approach:

- Printing technology presence is not clearly defined
- Degrees of printing technology (e.g. volume, costs) are not as prevalent, Dittmar notes this data is difficult to find

TABLE V

LOG CITY GROWTH: THE TIMING OF THE PRINT ADVANTAGE

(1) Variable	(2) All Cities Balanced Sample	(3) Exclude German Cities	(4) Exclude Italian & Dutch Cities	(5) Exclude If East of Elbe River	(6) Only Port Cities	(7) Only Cities Without Ports
Print × Yr1400	0.09	0.10	0.09	0.11	0.27	−0.04
	(0.16)	(0.18)	(0.20)	(0.17)	(0.38)	(0.16)
Print × Yr1500	0.34**	0.39**	0.41**	0.34**	1.39***	0.10
	(0.15)	(0.17)	(0.18)	(0.16)	(0.42)	(0.15)
Print × Yr1600	0.13	0.22	0.08	0.16	0.73**	−0.01
	(0.16)	(0.17)	(0.20)	(0.16)	(0.34)	(0.17)
Print × Yr1700	0.19	0.25	0.16	0.22	0.84**	0.00
	(0.14)	(0.16)	(0.17)	(0.14)	(0.42)	(0.15)
Atlantic × Yr1400	0.12	0.27	0.13	0.12	−0.32	—
	(0.31)	(0.33)	(0.37)	(0.31)	(0.52)	—
Atlantic × Yr1500	0.43*	0.55**	0.38	0.44*	−0.24	—
	(0.25)	(0.28)	(0.28)	(0.25)	(0.52)	—
Atlantic × Yr1600	0.42*	0.49*	0.33	0.45**	0.47	—
	(0.22)	(0.25)	(0.24)	(0.22)	(0.38)	—
Atlantic × Yr1700	0.60***	0.73***	0.64***	0.62***	0.32	—
	(0.19)	(0.20)	(0.21)	(0.19)	(0.38)	—
R squared	0.55	0.57	0.58	0.54	0.77	0.53
Observations	1,010	875	710	850	225	785
Adopting Cities	83	71	53	78	16	67
Nonadopting Cities	119	104	89	92	29	90

Note. This table presents estimates of Equation (1) using the balanced panel of cities with population data observed every 100 years 1300–1800. The dependent variable is log population growth: $\ln\left(\frac{POP_{t+100}}{POP_t}\right)$, where POP_t is city population in year t and $t = 1300, \ldots, 1700$. Print is an indicator variable for cities that adopted the printing press 1450–1500. The variables Yr1400, . . . , Yr1700 are indicators for 100-year periods starting $1400, \ldots, 1700$. Atlantic is an indicator variable for cities that were historic ports on the Atlantic Ocean. Regressions control for city, country, and year fixed effects; country cross year fixed effects; Mediterranean port cross-year fixed effects; and log population. See Data Appendix for details on the construction of the control variables. Heterskedasticity-robust standard errors clustered by city are in parentheses. Significance at the 90%, 95%, and 99% confidence levels are indicated by *, **, and ***, respectively.

Analysis, cont.

TABLE VI

DISTANCE FROM MAINZ AND ECONOMIC OUTCOMES BEFORE AND AFTER GUTENBERG

(1) Regression Model	(2) Log Growth 1400–1500	(3) University in 1450	(4) Log Size in 1500	(5) Log Growth 1500–1600
Log Distance to Mainz	−0.05	0.00	−0.11	−0.03***
	(0.04)	(0.01)	(0.08)	(0.01)
Observations	269	410	410	410
R Squared	0.23	0.12	0.31	0.22

Note. The dependent variable in column (2) is log city growth 1400–1500: $\ln\left(\frac{POP_{1500}}{POP_{1400}}\right)$. The dependent variable in column (3) is an indicator variable recording the presence of a historic university in 1450. The dependent variable in column (4) is log city population in 1500: $\ln(POP_{1500})$. The dependent variable in column (5) is log city growth 1500–1600: $\ln\left(\frac{POP_{1600}}{POP_{1500}}\right)$. Controls include city latitude, longitude, the interaction between latitude and longitude; the DeLong-Shleifer index of institutions; indicators for sea ports, navigable rivers, capitals, and cities on Roman sites; and log city population. (Log population is not a control for the regression reported in column 4.) Sample restricted to balanced panel of cities with population observed 1500–1800 in economies with at least one print city. Heteroskedasticity-robust standard errors clustered by country in parentheses. Significance at the 99% confidence level is indicated by ***.

TABLE VII

INSTRUMENTAL VARIABLE ANALYSIS OF PRINTING AND LOG CITY GROWTH

(1) Regression Model	(2) 1st Stage Adopt Print 1450–1500	(3) 2nd Stage City Growth 1500–1600
Log Distance to Mainz	−0.06***	
	(0.01)	
Adopt Print 1450–1500		0.58**
		(0.29)
Observations	410	410
R squared	0.34	0.15
F Statistic (IV)	20.74***	82.07***

Note. The dependent variable in the first stage is an indicator variable that takes the value of 1 for cities that adopted the printing press 1450–1500. The dependent variable in the second stage is log population growth: $\ln\left(\frac{POP_{1600}}{POP_{1500}}\right)$. Distance from Mainz in log kilometers is the instrumental variable for print adoption 1450–1500. Regressions control for: log city population in 1500, port location, navigable rivers, location on Roman sites, political capitals, city latitude, city longitude, the interaction between latitude and longitude, and the DeLong–Shleifer freedom index of regional institutions. The Data Appendix provides detailed descriptions of these variables. Sample restricted to balanced panel of cities with population observed 1500–1800 in economies with at least one print city. Heteroskedasticity-robust standard errors clustered by country in parentheses. Significance at the 90%, 95%, and 99% confidence levels are indicated by *, **, and ***.

Analysis, cont.

TABLE VIII

PLACEBO TEST OF INSTRUMENTAL VARIABLE IDENTIFICATION

(1) IV Employs Distance From	(2) IV Estimate of Print Effect	(3) IV Estimate t Statistic
Mainz	0.58	2.03**
Amsterdam	−3.00	0.95
London	1.20	0.34
Paris	−14.25	0.12
Venice	0.08	0.55
Wittenberg	2.21	0.64

Note. The dependent variable is log population growth 1500–1600: $\ln\left(\frac{POP_{1600}}{POP_{1500}}\right)$. All regressions have the controls noted in Table VII. The sample is restricted to balanced panel of cities with population observed 1500–1800. The t statistics are heteroskedasticity robust and clustered by country. Significance at the 95% confidence level is indicated by **.

Why Mainz?

- Falsification test using major European cities
- Wittenberg included due to its role as Protestant hub
    - Response to Becker & Woessmann (2009)

Analysis, cont.

Note. The balanced panel comprises 202 cities with populations observed every 100 years 1300–1800. The unbalanced panel comprises 498 cities with population observed in 1300, 400 cities in 1400, 631 cities in 1500, 897 cities in 1600, 1,169 cities in 1700, and 2,113 cities in 1800. For time-invariant city characteristics, summary statistics for the unbalanced panel are calculated over 2,202 cities. City populations are in thousands. Distances are in kilometers. Editions per capita measures editions published 1450–1500 per 10,000 inhabitants in 1500.

TABLE IX

DISTANCE TO MAINZ (GUTENBERG) AND WITTENBERG (LUTHER)

	All Cities		German-Speaking Cities	
(1)	(2)	(3)	(4)	(5)
Regression Model	Adopt Print 1450–1500	Log Growth 1500–1600	Adopt Print 1450–1500	Log Growth 1500–1600
Log Distance to Mainz	−0.06***	−0.03**	−0.04***	−0.03***
	(0.01)	(0.01)	(0.01)	(0.00)
Log Distance to Wittenberg	0.03	−0.03	−0.05	0.10
	(0.02)	(0.02)	(0.04)	(0.07)
Observations	410	410	85	85
R squared	0.34	0.22	0.41	0.29

Note. The dependent variable in columns (2) and (4) is an indicator variable that records whether a printing press was established in a given city 1450–1500. The dependent variable in columns (3) and (5) is log city growth 1500–1600: $\ln\left(\frac{POP_{1600}}{POP_{1500}}\right)$. Controls and t statistics are as in Table VII. European sample restricted to balanced panel of cities with population observed 1500–1800. German sample restricted to cities with population observed 1500 and 1600. Heterskedasticity-robust standard errors clustered by country in parentheses. Significance at the 95%, and 99% confidence levels are indicated by ** and ***.

TABLE X

PROTESTANTISM AS DEMAND SHIFTER FOR PRINT MEDIA IN GERMANY

	Cities from Balanced Panel		Cities from Unbalanced Panel	
(1)	(2)	(3)	(4)	(5)
Regression Model	Adopt Print 1517–1600	Log Growth 1600–1700	Adopt Print 1517–1600	Log Growth 1600–1700
Log Distance to Mainz	0.33***	−0.05***	0.16*	−0.05***
	(0.07)	(0.01)	(0.08)	(0.01)
Log Distance to Wittenberg	−0.08	0.04	0.02***	0.06
	(0.05)	(0.05)	(0.00)	(0.05)
Observations	54	86	106	87
R Squared	0.28	0.33	0.18	0.33

Note. The dependent variable in columns (2) and (4) is an indicator variable that records whether a printing press was established in a given city 1517–1600. The estimates in these columns examine cities without printing presses in 1517. The dependent variable in columns (3) and (5) is log city growth 1600–1700: $\ln\left(\frac{POP_{1700}}{POP_{1600}}\right)$. The balanced sample comprises German-speaking cities with population observed 1500–1800. The unbalanced sample comprises cities with population observed in 1500. Controls and t statistics as in Table VII. Significance at the 90%, 95%, and 99% confidence levels are indicated by *, **, and ***. Data on post-1517 presses from Reske (2007). Among German cities adopting the press 1517–1700, the mean adoption year was 1591.

Conclusions

- Cities that adopted the printing press in the late 1400s enjoyed no growth advantages prior to adoption, but grew between 20 - 78% more than similar cities that didn't over the 1500-1600.
- Implication: printing technology had substantial impact on European city growth between 1500-1600.

But...

- While Protestantism is commonly associated with increased demand for printing, study found little compelling evidence of city growth in Protestant cities between 1600-1700.
- Thirty Years War (1618-1648) was a major disruption to economic activity and city growth that hit Protestant Europe (and Protestant cities).