WESLEYAN UNIVERSITY

The Effect of Internet Access on the Government Spending Multiplier and Non-Market Activity

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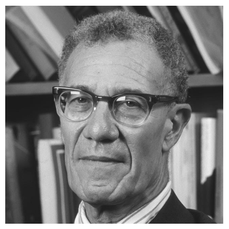


You can see the computer age everywhere but in the productivity statistics.
- Robert Solow, 1987

Introduction & Solow's Paradox

Previous technical revolutions (i.e. the steam engine and industrial age) caused notable gains in productivity growth, so why hasn't this happened with the internet? Economists have few answers, with some concluding the internet's effects simply aren't great enough to affect the economy.

However, the digital age is too disruptive to be economically inconsequential; perhaps the potential channels are complex and difficult to measure. So, there are two issues to tackle:

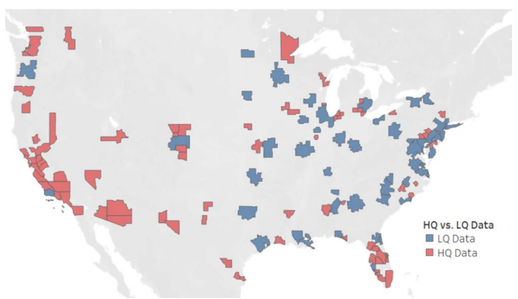
1. Define specific channels (even if they are indirect or non-business-sector) which could be causing the productivity slowdown… See: **Mismeasurement & The Non-Market**
2. Identify a 'canary in the coalmine' to serve as proxy to empirically detect changes in indirect, even non-business-sector, channels…See: **Internet & The Multiplier**

Mismeasurement & Non-Market Activity

Mismeasurement theory proposes the economic benefits of the internet cannot be fully captured by traditional measures and thus under-represents the internet's impacts. Meta-analysis from Syverson (2017) suggests the concept does not fully explain the productivity slowdown, but "US consumers benefited from this missing output… it just was not reflected in measured GDP."

Free digital services (FDS) generate a significant portion of these consumption benefits by providing low cost services which generate substantial utility gains through time cost rather than monetary cost (Nakamura, 2015). Examples include unpriced social networking sites, media players, and search engine results. Byrne et al. (2016) concludes that this consumer surplus represents "gains from non-market production using the consumer's time" which are *"conceptually distinct from the gains in market sector output."*

Connecting the market to the non-market was first done by Bacon and Eltis (1976), who proposed that relative growth in the non-market sector (compared to real market output) could cause problems for the British economy. Gemmell (1987) updated this analysis: with non-market increases "relative to [market output]" comes "reductions in… consumption and investment goods by market sector firms and workers."



This map displays the distribution of CBSAs covered by the data. The red CBSA are 'higher quality' data and used for the regressions, while the blue is 'lower quality' and omitted in the displayed results

Internet & The Multiplier

In this study, I use the Open Economy Relative Multiplier. By comparing regions under the same monetary and fiscal union, the model "differences out" the confounding effects.

If a relationship between the multiplier and internet is seen (see **Regression Results**), the key is the *implications* of this finding. The multiplier serves as a proxy to pick up possible economic changes, with two phenomena being most likely:

1. Substitution into non-local consumption: a rise in internet brings a rise in e-commerce, which may cause money to disproportionately flow out of the local economies (consumption leakage) and affect the *local* multiplier
2. Substitution into non-market consumption: with an increase in internet access, consumers generate utility via the non-market (mismeasurement theory). This causes a decrease in market consumption and reduces in market output, leading to a lower multiplier: government spending has less of an impact on *measured* output as consumer activity is substituting into unmeasured (non-market) output.

Data & Methodology

To estimate the internet's effect on the multiplier, three sources of data are required:

- Internet access: The Current Population Survey asked households in over 300 counties whether they had internet access in seven years between 1998-2010.
- Government spending: DOD contracts available at USAspending.gov were compiled into a dataset by Auerbach et al. (2019) at the CBSA level.
- Personal income: Bureau of Labor Statistics' QCEW survey provided county-level employee income. Employee income tracks closely to GDP, making it a suitable output variable.

All data was aggregated onto the CBSA level and dollar-denominated variables are expressed in nominal, per-capita terms. Since internet access could suffer from endogeneity, I implemented a Bartik, or Shift-Share, instrument. This prevents endogeneity flowing from income and spending to internet access and gives yearly data, which the CPS did not have available.

By interacting government spending with internet access and regressing against personal income, I can directly observe how internet access affects the open economy relative multiplier. Specifically, the focus is the magnitude, direction, and significance of the coefficient corresponding to the interaction term: β2 in the baseline specification shown below.

$$\frac{Y_{it}-Y_{i,t-h}}{Y_{i,t-h}} = \beta_0 \frac{G_{it}-G_{i,t-h}}{Y_{i,t-h}} + \beta_1 Internet_{it} + \beta_2 \frac{G_{it}-G_{i,t-h}}{Y_{i,t-h}} \times Internet_{it} + \alpha_t + \gamma_i + \varepsilon_{it}$$

Regression Results

Regressions (1) and (5) present the open economy relative multiplier, estimated at 0.0284 and 0.190. The central regressions presented in this table are 3-4 and 7-8. Regressions (3) and (7) perfectly match the baseline specification shown in the **Data & Methodology** section. The results of each regression indicate that internet access has an inverse relationship on the multiplier; the two-year time horizon returns a value of -0.588 at the p<0.10 significance, while the four-year time horizon is stronger with a value of -1.189 at the p<0.05 significance.

Output: Income	Time Horizon = 2				Time Horizon = 4			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Military Spending Change	0.0284		0.463*	0.477*	0.190		1.089***	1.275***
	(0.45)		(2.21)	(2.23)	(1.56)		(3.60)	(4.92)
Internet Access Instrument		0.145	0.139	0.160		0.233	0.194	0.0686
		(1.49)	(1.44)	(1.44)		(0.87)	(0.74)	(0.19)
Spending × Internet			-0.558*	-0.591**			-1.189***	-1.371***
			(-2.62)	(-2.69)			(-3.67)	(-5.16)
Lagged Change in Income				0.146***				-0.230***
				(3.91)				(-4.70)
Observations	1215	1215	1215	1053	1053	1053	1053	729

*** p<0.01, ** p<0.05, * p<0.1
Robust standard errors in parentheses; Constants are estimated but not reported
Place- and time-fixed effects; Clustered by CBSA

h	Spending	Spending × Internet
1	0.128	-0.167
	(0.130)	(0.135)
2	0.384*	-0.425*
	(0.193)	(0.197)
3	0.697**	-0.797**
	(0.240)	(0.266)
4	0.988***	-1.143**
	(0.285)	(0.349)
5	1.196***	-1.428***
	(0.301)	(0.376)

A modified Jordà projection is also useful to trace how the multiplier changes over an extended period. I observe coefficients have greater predictive power as the time horizons increase (as more data is accounted for) and the impulse responses again show that full internet access is associated with a completely nullified (and even negative) spending multiplier.

Interpretation and Conclusion

Direct interpretation of the two-year time horizon (regression (3)) provides a compelling narrative:

- In the presence of 0% internet access in a city, a 10% increase (relative to local income) of DOD spending over two years is associated with a 4.63% increase in local earnings over two years
- At 100% internet access, a 10% increase in spending is associated with income *decreasing* by 0.95%

Since existing empirical research finds that mismeasurement theory is unlikely to be the complete answer to Solow's paradox, perhaps the concept of mismeasured output is not the *source* of the sluggish productivity.... instead, a *symptom* of the real cause: increased non-market activity. Even if mismeasurement isn't the key, a core piece of the theory is worth holding on to. If the internet can lead to increases in non-market activity (relative to the market), it follows that non-market activity can lead to macroeconomic changes which are hindering productivity growth. The proposed internet/multiplier relationship serves as a tool to gauge the validity of this theory, and this thesis finds there is statistically significant signal toward an association. With that, non-market theory is given its first concrete evidence, moving us one step closer to answering Solow's paradox.