

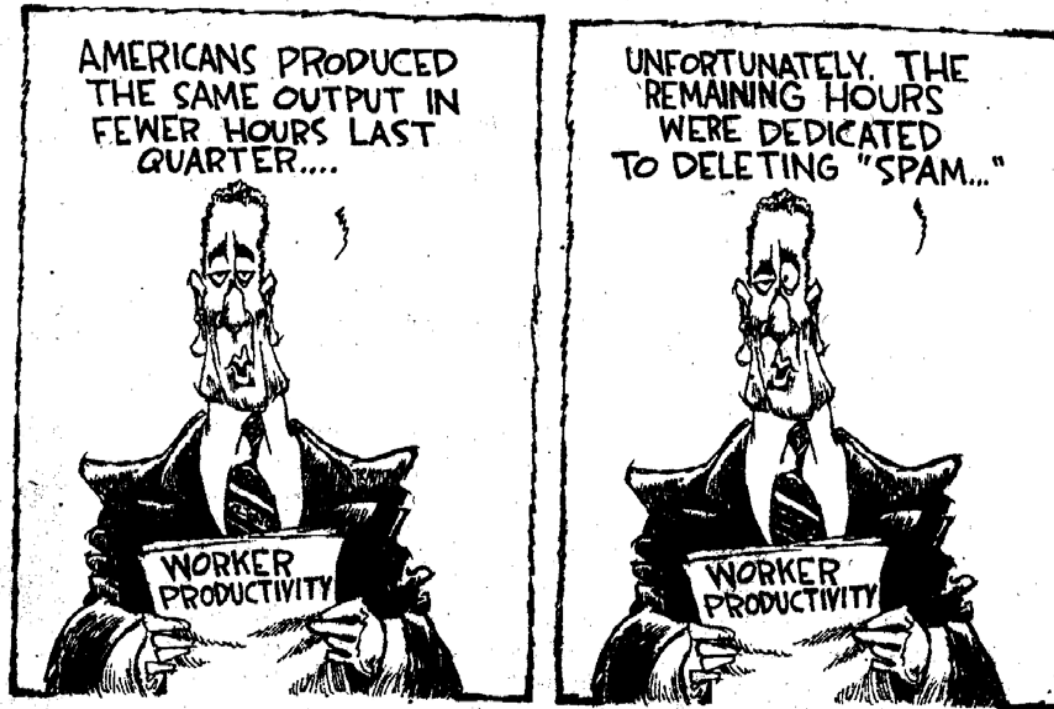
# Information Technology Use and Productivity at the Individual Level

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# The Conventional Wisdom



**Nick Anderson**  
The Louisville Courier-Journal  
Washington Post Writers Group

# Literature - Economics

Firm-level Evidence on the Returns to Information Systems Spending

*Brynjolfsson & Hitt (1996)*



The Effects of HRM Practices on Productivity

*Ichniowski, Shaw & et al. (1997)*

IT and Productivity Evidence from Country Level Data

*Dewan & Kraemer (2000)*

US Econ. Growth at the Industry Level

*Jorgenson & Stiroh (2000)*



- No study that links IT to productivity at individual level.
- Focus on why/how information matters.

# Literature – Social Network

The Strength of Weak Ties

*Granovetter (1973)*



Social Resources and Strength of Ties: Factors in Status Attainment

*Lin & Ensel (1981)*



The problem of search & deliberation in economic action:  
When social networks really matter.

*Rangan (2000)*



The search-transfer problem: Weak tie roles in sharing  
knowledge across org. subunits

*Hansen (1999)*

Making invisible work visible: Using SNA to support  
collaboration

*Cross, Borgatti & Parker (2002)*



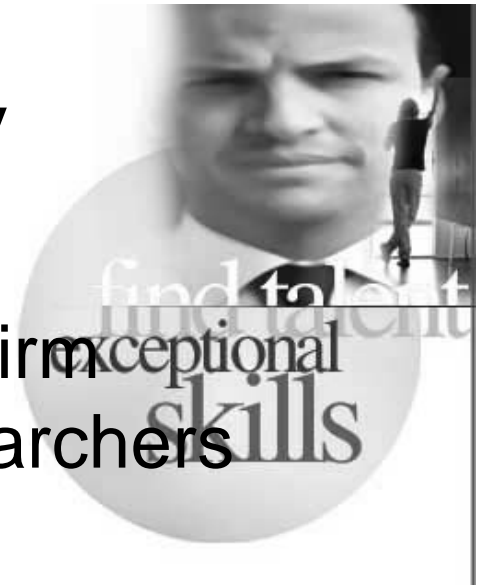
- No output measures

# Four mechanisms that potentially link information use & output

- Exposure to more accurate or newer information increase productivity
- Exchanging coordination details that foster economic co-specialization
- Occupying advantageous social network position affords arbitrage
- Control over key resources provide incentives to “push news” of opportunity

# The Current Study

- 33 people in an Executive Search firm
  - Partners, Consultants, and Researchers
- Three Data Sets per individual
  - Survey
  - Data on E-Mail use (Many variables – see below)
  - Accounting (Revenues, Number of Contracts, Salary)
- 300+ projects and 22,000+ email messages
- Of all info gathering modes, average 20% time on email
- Measurable Inputs – Rich measures of IT use,
- Measurable Outputs: (i) Revenues (ii) number of completed contracts



# The Survey

- 52 Questions on information sources, perceptions, time/value, background, etc.
- All java based, sliding answers & associated calculator

Survey Questions - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Forward Stop Search Favorites History Print

Address <http://www.ipresearch.net/cgi-bin/sample.cgi?user=guest&index=4> Go Links >>

Google  Search Web Search Site PageRank Page Info Up >>

University of Michigan and Harvard University  
Executive Recruiting Online Survey

Section One:

5 For valuable information that never makes it into the company database the main reasons are that it is  %  %  % **65 % still left**  
*fields between 0 and 100% Keep in mind that all of your entries must total 100%* [? more help](#)  
*This is the amount of percentage points you have left to allocate to each field*

Too time consuming, tedious:  %  
Too valuable to me personally:  %  
No place to put unusual data :  %

6 My job tasks are highly inter-dependent with other people's tasks. I must often coordinate with other team members. Answer by clicking and dragging anywhere on the grey area below [? more help](#)  
0 1 2 3 4 5 6  
Completely independent Completely inter-dependent

7 We use information systems to coordinate schedules, deadlines, and project hand-offs. Answer by clicking and dragging anywhere on the grey area below [? more help](#)  
0 1 2 3 4 5 6  
Strongly Disagree Neutral Strongly Agree

Continue >>

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start  finish  
Section One Section Two Section Three

Applet reasonpersonal\_target started Internet

# E-mail Data

- the number of email messages sent and received,
- whether messages were sent from or received by people inside or outside the firm.
- the size of an individual's internal network in terms of unique email contacts inside the firm
- the size of the individual's external network in terms of unique contacts outside of the firm
- the topological structure of information flows,
- the size of email messages sent and received,
- whether an email contains an attachment, and
- proxies for the perceived amount of time spent on email



# Gaining access to live e-mail

To: Marshall Van Alstyne <mvanalst@umich.edu>  
Subject: Re: YOUR PROPOSAL  
Date: Sun, 17 Nov 2002 09:54:23 -0500  
Cc: averhey@umich.edu, Geoffrey Parker <gparker@tulane.edu>  
X-Originating-IP: 68.41.189.43

Ok, i will look for all the pieces today then and try to get everything in Fastlane tonight.

Meeting is up to you. I have to go to DRDA first thing in the morning to hand them all the PAFs so they can process all the proposals. The meeting is to give you one last chance to view the entire proposal package before DRDA pushes the "Send" button. We could also try to do this virtually so neither of us has to travel to the other site.

As far as footers go, let's not worry about it as long as you are page numbering each section individually. I usually add more information to the footer but I don't have time to worry about this detail.

Ann

Stop words are dropped; then the raw text is root-stemmed (e.g. "are"->"is", "pieces"->"piece"), counted, and hashed.

# This is what we “see”

AnnMessage-ID:  
00000000C74E9F197619354B912FA038789E97DD070095FBFC9E5C710C45AD83BE1BA97654F30000025D7D7000095FBFC9E5C710C45AD83BE1BA97654F30000015D02090000  
Date: 11/17/2002 09:54:23 PM  
From: ChiUserWWW2  
To: ChiUserWWW34  
CC: ChiUserWWW2 , ChiUserEEE137  
Subject: 2234380046220310381 -4543232654336644202 3187911263930032313 -  
8725299062034745550 6646063218832296471  
Content: -7488330257252326972<8>; 3461049762598860849<5>; -4469441121190040841<4>; 4122472038465781083<4>; -  
2485003116886841409<3>; 8003219831352894262<3>; 1698764591947117759<2>; 5894537654329429962<2>; - 9076192449175488644<2>;  
7750988586697557362<2>; 8871153132300476476<2>; - 7527789141644698404<2>; 8763687632651980147<1>; 3129683954660429336<1>; -  
6916544271211441138<1>; 6293576012604293570<1>; - 320692498224125839<1>; 8934872354483414290<1>; -6836405471713717833<1>; -  
5975878511407257679<1>; -3014223241434893634<1>; - 8934856908841293615<1>; -857818984403519253<1>; 1344343662225282497<1>;  
965941123633882107<1>; -3147930629716878416<1>; 7137519577624117188<1>; 7523708256417630601<1>; -6946268052250097500<1>;  
Attachment Number: 0  
Attachment list:

Reconstructing semantics is difficult. We do not read attachments but do record type & size information (e.g. 157kb .doc file)



# Variables Used in Study

**PARTNER, CONSULTANT** - dummy variables

**EDUCATION, EXPERIENCE, GENDER, AGE**

**REVENUES** - Revenues in \$ billed by the individual for completed contracts in 2002.

**SALARY** – 2002 salary in \$. (correlation with revenues: 0.26)

**COMPLETED CONTRACTS** – Number of contracts that were completed during the August 2002-June 2003 period.

**AVERAGE DURATION** – Mean length in days of projects handled by a given recruiter.

# Variables Used in Study

- **INTERNAL (EXTERNAL) IN-NET** - Number of unique individuals within the firm (from the outside) who *sent email to* the relevant individual. This includes cc messages.
- **INTERNAL (EXTERNAL) OUT-NET** – Number of unique individuals within the firm (from the outside) who *received email from* the relevant individual. This includes cc messages.
- **BETWEENNESS** – A normalized count of the number of times an individual appears on the shortest path between all agent pairs including staff.
- **MULTITASK** – The total number of projects that an individual is working on
- **SEARCH TOOLS** – A variable that that takes on a value of 0 to 500,
- **PFTF VALUE** – The perceived value from face to face contacts
- **PEMAIL TIME** – The declared percent of time spent on email

# Model Specification

$$Q_i = \alpha + \beta' H_i + \gamma' X_i + \delta Y_i + e_i$$

$Q_i$  – Output (\$, Completed Contracts )

$H_i$  – Job Level (Partner, Consultant)

$X_i$  – Human Capital (Ed., Exp., Labor)

$Y_i$  – Treatment (Email & Perception Variables)

Same additive form as Ichniowski, Shaw et al. '97 data in AER.

# Baseline Regression

## Dependent Variable: REVENUES

Independent Variables	Dependent Variable: REVENUE	
	Coefficient	T-statistic
CONSTANT	232,917.4	0.47
GENDER	-33,699.0	-0.61
AGE	-4,786.2	-1.24
EDUCATION	-13,910.3	-0.61
EXPERIENCE	-3,244.8	-0.79
PARTNER	271,795.8	1.80
CONSULTANT	264,978.5	2.21
N of observations	32	
R-squared	0.24	
Adjusted R-squared	0.06	

# Main Results

## Dependent Variable Revenues

Independent Variables	Regression 1: Preferred Model		Regression 2: Preferred Model With Perception Variables		Regression 3: With Traditional Variables	
	Coefficient	T-stat	Coefficient	T-stat	Coefficient	T-stat
CONSTANT	-355,896.3	-2.49	-527,067.2	-3.18	-291,308.6	-0.95
INTERNAL IN-NET	6,024.4	3.39	7,925.1	4.45	6,505.9	2.83
BETWEENNESS	104.8.5	2.40	77.5	1.79	85.5	1.57
MULTITASK	28,316.7	4.12	23,636.1	3.51	26,377.8	3.34
PARTNER	148,431.1	2.40	183,064.8	2.79	236,096.5	2.34
CONSULTANT	277,978.3	4.31	333,460.6	4.83	334,201.1	4.11
SEARCH TOOLS			168.79	1.13		
PFTF VALUE			890.31	0.93		
PTEL VALUE			1542.91	0.125		
GENDER					-36,608.2	-0.96
AGE					-1586.3	-0.64
EDUCATION					-1744.3	-0.11
EXPERIENCE					-1270.5	-0.44
N of observations	33		33		33	
R-squared	0.73		0.80		0.75	
Adjusted R-squared	0.68		0.73		0.65	



# Replacing Internal Net With...

<i>Variable included in first preferred regression</i>	<i>T-Statistic</i>	<i>Adj R<sup>2</sup></i>
INTERNAL IN-NET	4.45	0.68
<i>Internal In-Net excluded and replaced by</i>	<i>T-Statistic</i>	<i>Adj R<sup>2</sup></i>
INTERNAL OUT-NET	2.34	0.62
EXTERNAL IN-NET	-1.35	0.57
EXTERNAL OUT-NET	-0.20	0.55
INTERNAL IN-VOL	2.46	0.62
INTERNAL OUT-VOL	0.91	0.55
EXTERNAL IN-VOL	-0.80	0.55
EXTERNAL OUT-VOL	0.45	0.54
INCOMING INTERNAL MESSAGE SIZE	-0.62	0.55
INCOMING EXTERNAL MESSAGE SIZE	0.28	0.54
INTERNAL EMAILS WITH ATTACHMENT	1.45	0.57
PEMAIL	-0.42	0.54
NO OTHER VARIABLE INCLUDED		0.57

When included with each of other variables (separately),

- INTERNAL IN-NET is statistically significant.
- Other variable is insignificant.

# Affect of IT Use on Ave Duration

Independent Variables	Average Duration	
	Coefficient	T-stat
CONSTANT	142.16	0.49
INTERNAL IN-NET	0.14	0.18
BETWEENNESS	-0.028	-1.55
PARTNER	9.78	0.38
CONSULTANT	-15.47	-0.59
MULTITASK	15.02	5.40
N of observations	31	
R-squared	0.60	
Adjusted R-squared	0.52	

# Robustness Checks

Independent Variables	Preferred Regression Without Perception Variables		Preferred Regression With Perception Variables	
	Coefficient	T-stat	Coefficient	T-stat
CONSTANT	-2.71	-0.98	-7.56	-2.35
INTERNAL IN-NET	0.042	1.21	0.79	2.29
BETWEENNESS	0.0021	2.46	0.0016	1.95
PARTNER	1.86	1.55	2.49	1.96
CONSULTANT	4.03	3.23	4.80	3.59
MULTITASK	0.49	3.64	0.37	2.80
SEARCH TOOLS			0.0059	2.05
PFTF VALUE			0.022	1.20
PTEL VALUE			-0.087	-0.37
N of observations	32		32	
R-squared	0.62		0.71	
Adjusted R-squared	0.55		0.62	

Completed Contracts as a Measure of Productivity

# Summary of Additional Results

- Misperception of Information Overload
- Slightly higher productivity for those familiar with internal database
- Perceived benefits from FTF contacts lead to slightly higher productivity
- Other perception variables don't affect productivity
- In regressions with Salary as dependent variable, IT variables not significant

# Conclusions

- Heavier users of information technology have higher output as measured by billings revenues and completed contracts.
- While magnitudes of the effects may be industry specific, we anticipate that the importance of information technology & network factors will prove robust in diverse contexts involving white-collar project-based work.

# Further Work

- Does someone with a bigger social network generate more revenues or are people who bring in more revenues more “popular?” (Causality vs. Correlation)
- Do people work in the same groups over time?
- Both questions can be answered by looking at disaggregated data.

# Correlations between variables

	REVENUE	INTERNAL IN NET	BETWEENNESS	MULTITASK
REVENUE	1.00			
INTERNAL IN-NET	0.43	1.00		
BETWEENNESS	0.43	0.46	1.00	
MULTITASK	0.54	0.28	0.13	1.00
SEARCH TOOLS	0.13	-0.15	-0.13	0.24

# Descriptive Statistics

Variable	Mean	Standard Dev.	Minimum	Maximum
AVERAGE DURATION	209.99	44.97	125.75	317.86
REVENUES	435,695	140,119	211,353	773,280
SALARY	249,028	117,489	70,783	510,027
GENDER	0.58	0.50	0	1
AGE	47.09	9.06	28	64
EDUCATION	17.78	1.36	16	21
EXPERIENCE	15.91	9.14	3	39
PARTNER	0.45	0.51	0	1
CONSULTANT	0.48	0.51	0	1
INTERNAL IN-NET	69.15	10.04	43	87
INTERNAL OUT-NET	47.67	15.26	13	83
EXTERNAL IN-NET	879.03	709.71	131	2483
EXTERNAL OUT-NET	297.61	295.07	35	1439
INTERNAL IN-VOL	7.08	2.68	3.21	12.03
INTERNAL OUT-VOL	4.51	2.52	0.69	10.82
EXTERNAL IN-VOL	15.54	10.17	3.61	47.3
EXTERNAL OUT-VOL	4.91	3.50	0.4	15.07
INTERNAL IN SIZE	37.02	13.36	11.5	75.89
EXTERNAL IN SIZE	33.95	12.93	15.58	62.08
INTERNAL IN ATTACH	4.29	1.57	1.4	8
BETWEENNESS	378.32	364.43	0	1625.72
SEARCH TOOLS	318.58	98.66	86	467
MULTITASK	4.70	2.13	1.5	10.22
COM CONTRACTS	6.04	2.29	1.15	10.38
INFOVERLOAD	33	205.15	12	406
PFTF VALUE	33.96	19.48	0	80
PTEL VALUE	35.37	15.08	10	70
PEMAIL VALUE	20.81	11.51	0	50
PFTF TIME	19.61	15.80	0	75
PTEL TIME	43.61	16.81	10	70
PEMAIL TIME	22.88	11.97	5	50