

Trust, the Internet, and the digital divide

by H. Huang
C. Keser
J. Leland
J. Shachat

The Internet is expected to have a positive impact on economic growth, and its adoption rate will determine the extent of this impact. In this paper, we examine how differences in willingness to trust influence Internet adoption rates across countries. We show that trust has a statistically significant influence on levels of Internet penetration across countries. We also show that success in increasing Internet adoption rates through policies to promote trust will depend on a country's current level of trust, such that differences in trust may produce a *digital divide* among nations. Since low-trust countries tend to be of low or middle income, this digital divide between countries may translate into a *developmental divide*.

The Internet is expected to be an important source of economic growth in the 21st century. The Congressional Budget Office¹ predicts the U.S. economy will grow at an annual rate of 2.1 percent over the coming decade—an increase of 0.9 percent over U.S. growth for the period 1974 to 1995. Varian et al.² estimate that the Internet will account for 48 percent of this increase in growth. In a similar vein, Litan and Rivlin³ discuss research estimating Internet-driven productivity gains in U.S. manufacturing of 0.2 and 0.4 percent per year. Since the Internet dramatically reduces the cost of transmitting information, the costs associated with the distribution of goods and services between businesses, between businesses and consumers, and between businesses and their employees are reduced as well, accounting for these expected gains in productivity.

Whether predictions regarding the contribution of the Internet to economic growth come to pass depends upon whether people and firms choose to adopt the Internet and how fully they embrace the idea of conducting business over it. The degree to which people and firms adopt Web-based activities will depend on how willing they are to accept the greater anonymity and associated possibilities for opportunism inherent in Web-based transactions. This willingness may, in turn, depend on how much people trust each other. If trust does influence Internet adoption, it will have an indirect impact on economic growth rates among nations through its influence on the adoption of this growth-enhancing technology.

In addition to the possibility of an indirect impact of trust on growth, there is evidence that trust directly impacts economic growth and growth rate differences across countries. Prior to the late 1990s, economic growth rates were explained almost exclusively in terms of labor and capital endowments and differences in how these endowments are augmented by capacities for technological change. Differences in the prosperity of nations or regions relative to others are, in some cases, difficult to explain in terms of differences in these standard economic variables. During the 1990s, spurred largely by observations and arguments put forth by social theorists like Fukuyama⁴ and Putnam et al.,⁵ economists investigated the possibility that differences in economic

©Copyright 2003 by International Business Machines Corporation. Copying in printed form for private use is permitted without payment of royalty provided that (1) each reproduction is done without alteration and (2) the *Journal* reference and IBM copyright notice are included on the first page. The title and abstract, but no other portions, of this paper may be copied or distributed royalty free without further permission by computer-based and other information-service systems. Permission to *republish* any other portion of this paper must be obtained from the Editor.

growth might stem directly from differences in the extent to which members of different cultures were willing to trust each other. The arguments in favor of this possibility are straightforward. Almost all transactions involve some opportunities for misrepresentation, non-compliance, or outright fraud. Detailed contracts, extensive monitoring of perfor-

**Almost all transactions
involve some opportunities
for misrepresentation,
non-compliance,
or outright fraud.**

mance, and litigation are means of discouraging such behaviors, but they are all costly to implement. Empirical evidence suggests that mutual trust is an efficient substitute for these enforcement mechanisms. For example, Dyer and Chu⁶ examined differences in procurement costs in 453 supplier-automaker relationships in the U.S., Japan, and South Korea. Procurement costs incurred in situations where the suppliers trusted automakers the least were five times higher than those in which the suppliers trusted automakers the most, while the costs associated with negotiating contracts and post-contractual disputes were double.

Trust appears to have significant returns at the macroeconomic level as well. Knack and Keefer,⁷ for example, found that a very simple measure of how trusting inhabitants of different countries are was a significant explanatory variable in regressions of average annual growth rates in per capita income from 1980 to 1992. Moreover, the impact was very large—a 10 percent increase in the measure of trust translates into an increase of 0.1 percent in economic growth—a sizable increment, given world average growth rates of 1 to 3 percent in the latter half of the 20th century.

The fact that trust directly impacts economic growth through reductions in transaction costs, coupled with the possibility that it may impact growth indirectly to the extent that it impacts Internet adoption rates, raises a troubling possibility: namely, that low-trust countries, the majority of which tend to be of low and middle income, will take a double hit in terms

of economic growth in the coming years. They may be penalized for low trust by incurring higher transaction costs and by lower adoption rates of growth-enhancing technology. Knack and Keefer's⁷ findings suggest that the first effect, higher transaction costs, will surely come to pass. Whether the second, lower Internet adoption rates, does as well depends upon whether trust does, in fact, encourage Internet adoption. Our objective in this paper is to determine whether this proposition is true. To presage our findings, it is. This result would seem to suggest that efforts to increase trust in low and moderate trust countries are in order. Unfortunately, we show that the returns for any such policy will be greater for high-trust rather than for low-trust countries, so that differences in trust among countries, will promote an increasing *digital divide* between them. To the extent that contributions the Internet makes to economic growth accrue disproportionately to high trust countries, this *digital divide* will translate into a *developmental divide*.

Data

The specifics of our analyses of the impact of trust on Internet adoption are dictated by the availability of trust measures for different countries. In their examination of whether trust directly influences economic growth rates, Knack and Keefer⁷ used responses to a question involving trust posed to thousands of respondents from 29 countries with market economies in the 1981 and 1990–1991 World Values Survey (WVS).⁸ The question was, “*Generally speaking, would you say that most people can be trusted, or that you can’t be too careful in dealing with people?*” Knack and Keefer took the percentage of respondents from each country who answered that people could be trusted as a measure of how “trusting” that country’s populace was.⁹ Then they conducted regression analyses examining the impact of this measure of trust on average annual growth in per capita income for 1980 to 1992. They found that trust contributes significantly to economic growth, particularly in poorer countries without developed legal enforcement systems.¹⁰

The growth rates in Knack and Keefer⁷ were averages over the period 1980–1992. To minimize endogeneity problems, specifically, the possibility that economic growth rates have an impact on levels of trust, they computed trust values based on 1980 WVS responses where possible and 1990 responses otherwise. Knack and Zak¹¹ provide trust measures de-

Table 1 Internet adoption rates, trust, demographics, and phone and PC access

Country	Percent of Households with Internet Access	Internet Subscribers per 100	Percent Trust	Per capita Income in Dollars (1,000s)	Average Internet Access Price in Dollars	Percent Population 60 and older	Average Years of Education	Percent Urban	Phone Lines per 1000	PCs per 1000 Population
	IP1	IP2	Trust	Income	Int. price	Age	Education	Urban	Lines	PC
Argentina	.	.	18	7.77	.	13	8	89	184	36
Austral.	28	13	40	21.17	38.65	16	10	85	510	367
Austria	19	6	32	27.19	73.51	21	8	64	482	207
Belgium	14	11	33	25.87	72.84	22	9	97	485	248
Brazil	.	.	3	4.35	.	8	4	80	112	26
Canada	35	20	52	19.97	29.93	17	11	77	625	286
Chile	.	.	21	4.62	.	10	8	85	174	46
Denmark	40	21	58	32.94	54.15	20	10	85	642	345
Finland	27	11	49	24.03	30.88	20	10	66	550	305
France	10	5	23	25.10	54.06	21	8	75	569	171
Germany	14	18	42	27.61	64.59	23	10	87	552	240
Iceland	.	18	44	27.34	32.71	15	8	92	614	289
India	.	.	38	0.41	.	8	4	27	19	2
Ireland	20	11	47	19.19	78.75	15	9	58	414	262
Italy	13	9	37	20.08	48.78	24	7	67	447	131
Japan	15	8	42	36.78	59.12	23	9	78	524	202
S. Korea	.	23	30	10.00	37.04	11	10	80	431	148
Mexico	3	2	28	3.92	65.09	7	6	74	100	34
Neth.	34	18	55	26.07	48.84	18	9	89	566	280
Norway	.	16	65	34.08	47.53	20	12	74	630	360
Portugal	.	5	21	10.86	66.75	21	5	60	398	74
S. Africa	.	.	16	3.54	.	6	8	50	112	42
Spain	.	9	30	14.91	78.32	22	7	77	401	94
Sweden	45	23	60	26.81	36.89	22	11	83	676	346
Switzerl.	.	13	37	41.48	66.40	21	10	68	665	380
Turkey	7	.	6	2.99	54.14	8	5	72	243	22
UK	27	12	44	21.36	49.65	21	9	89	538	246
USA	34	18	36	29.97	31.71	16	12	77	640	413
Mean	23	13	36	19.66	53.06	17	8	75	439	200
Maximum	45	23	65	41.48	78.75	24	12	97	676	413
Minimum	3	2	3	0.41	29.93	6	4	27	19	2
<i>n</i>	17	22								

rived from responses to the 1995 WVS for 17 of the 29 countries used in Knack and Keefer⁷ and 1990 values for 11 of the others. (No recent trust measure is available for Nigeria, the 29th country in the Knack and Keefer study.) Given that the Internet was not commercialized until 1995, endogeneity is not an issue in our analyses, so we use the most recent 1995 data where possible and 1990 values otherwise. None of the results reported in the ensuing sections are particularly sensitive to whether we employ a combination of values, or exclusively 1990 values. Values for this trust variable for each country in Knack and Keefer's original study (excluding Nigeria), as well as values for all other independent

and dependent variables considered in our analyses are shown in Table 1.

For each of the 28 countries for which we had a trust measure, we tried to collect two measures of Internet penetration. The Organisation for Economic Cooperation and Development (OECD) provides data on the percentage of households with Internet access in 1999 and/or 2000 for 17 countries. To maximize available degrees of freedom, we combined this data, taking the average for countries with 1999 and 2000 data and the single year data for the remaining countries, to create data on the percent of households with Internet access for 1999–2000, denoted

“IP1.”¹² OECD also provided data on the number of Internet subscribers per 100 inhabitants in 2000 for 22 of these countries (denoted “IP2”).¹³

The literature on the determinants of technology adoption suggests a number of economic, demographic, and infrastructural factors that might influence Internet adoption. Economic theory suggests

**A number of economic,
demographic, and infrastructural
factors might influence
Internet adoption.**

that the quantity of a product that is demanded depends on its own price, the buyers' income, and the price of substitutable and complementary goods. For our measure of income, we computed the average per capita national income for our sample of countries by averaging data provided by the World Bank for the period 1995–1999.¹⁴ This variable is denoted “Income.” Our measure of Internet access price, denoted “Int. Price,” is the average price of 20 hours of Internet access for 1995–2000 in dollars adjusted for purchasing power parity, as computed by OECD.¹⁵

In addition to variables suggested by economic theory, there are a host of demographic characteristics that have been found to influence the adoption of new technologies. Young people, those with more education, and those who are more cosmopolitan are all more disposed to new technologies. To examine the role of age, we collected data on the percentage of the population 60 and older, as reported by the United Nations.¹⁶ We denote this variable “Age.” The impact of education on adoption is captured by the variable “Education,” which reports the average number of years of schooling among the population 25 and older, and is taken from Barro and Lee.¹⁷ As a measure of cosmopolitanism, we average data from the World Bank on the urban population as a percent of the total population for years 1995 through 1999. This variable is denoted “Urban.”

In addition to explanatory variables generally found to influence the adoption of new technologies, there are others associated with the specific characteristics of the Internet. To use the Internet, one must have a personal computer or other device and a means of connecting to the Web—a phone line or

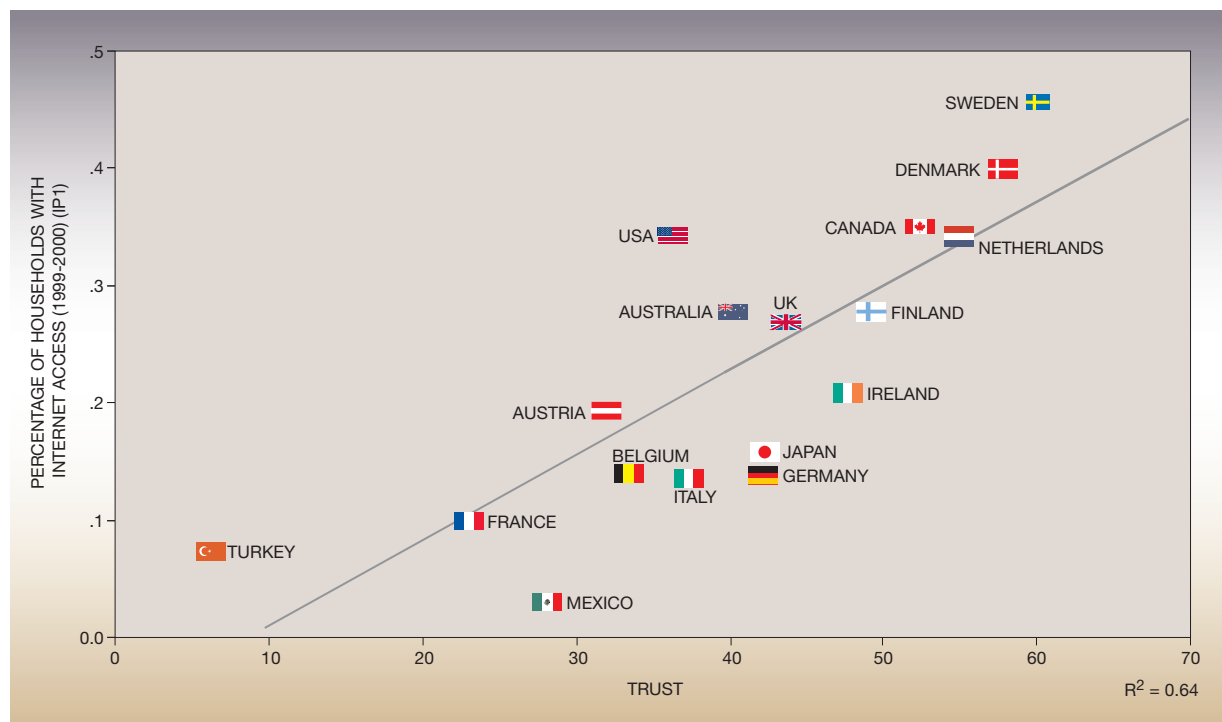
an alternative. As such, PC usage/availability and the level of infrastructure development as measured by main phone lines are other reasonable candidates for explaining Internet penetration. Our measure of PC penetration was derived from the estimated number of self-contained computers designed to be used by a single individual per 1000 inhabitants, obtained from the World Bank World Development indicators for the years 1995 through 1999.¹⁸ Data on each country was averaged over the five-year period to construct the average PCs per 1000 inhabitants, denoted “PC.” To gauge the ability of people in different countries to connect to the Internet, we collected data on the average number of telephone mainlines per 1000 population for the period 1995–1999 reported by the World Bank¹⁹ for each of our sample countries. This variable is denoted “Lines.”

Analysis

As a first attempt at testing the proposition that trust is an important factor in Internet adoption, we consider the simple linear regressions and scatter plots of IP1 and IP2 with respect to trust as shown in Figures 1 and 2. In the case of IP1, the correlation with trust explains 64 percent of the total variation in Internet adoption.

For Internet subscribers per 100 inhabitants (IP2), shown in Figure 2, the data point for South Korea is not plotted, as it would constitute an extreme outlier and would not be a fair comparison with other countries. The reason for this is that South Korea has the largest proportion of Internet subscribers in the sample (23/100) but a trust value slightly below the mean (30 versus 36). South Korea's front-runner position in terms of Internet subscribers has been attributed to the coincidence of a number of factors,^{20–22} most notably overcapacity in fiber-optic cable and a government policy promoting competition among Internet access providers. Fiber-optic overcapacity has been absorbed through provision of broadband Internet providing connection speeds roughly 20 times those achieved through traditional phone lines. Moreover, given the competition among providers and the peculiarities in the way charges for traditional phone usage are calculated, this broadband access is provided at low prices, roughly comparable to service over phone lines. When South Korea is dropped from the IP2 series, the fit of the regression shown in Figure 2 is comparable to that obtained using IP1.

Figure 1 Percentage of households with Internet access vs trust



These simple univariate linear regression results support the contention that trust is an important determinant of Internet adoption although, as noted earlier, there are a host of economic, demographic and infrastructural variables that might explain adoption as well. To flesh out what the determinants of Internet adoption are and rule out the possibility that the observed contribution of trust to adoption of this technology is spurious, we conducted multivariate regressions on IP1 and IP2. Because our dependent measures are proportions, we subjected both to the inverse-logit transformation $F^{-1}(y) = \ln(y/1 - y)$. Here F is the cumulative distribution function for the logistic distribution and F^{-1} is its inverse. The transformed dependent variables are regressed against the relevant independent variables by using ordinary least squares regression.^{23,24}

In light of the relatively small number of countries for which we have complete data, compared to the large number of potential explanatory variables, two sets of regression results are reported for each dependent measure. In the first set, all relevant regressors are run against the corresponding dependent

variables, and the results are examined to see whether trust is a significant factor when all other potentially relevant variables are controlled. In the second set of regressions, a stepwise procedure is employed to examine whether our trust variable explains Internet adoption across countries in equations containing only statistically significant explanatory variables.²⁵

Regressions of IP1 and IP2 are of the following general form:

$$F^{-1}(IP1(2)) = \alpha_0 + \alpha_1 Trust + \alpha_2 Income + \alpha_3 Int.Price + \alpha_4 Age + \alpha_5 Education + \alpha_6 Urban + \alpha_7 Lines + \alpha_8 PC$$

where α_0 is the intercept term and the remaining α_i 's are the values of the partial derivatives of the dependent variable resulting from unit changes in the independent variables, all else being equal. For regressions of IP1 (shown in the first two columns in Table 2), Lines, PC, and Trust enter at better than

Figure 2 Internet subscription rate vs trust

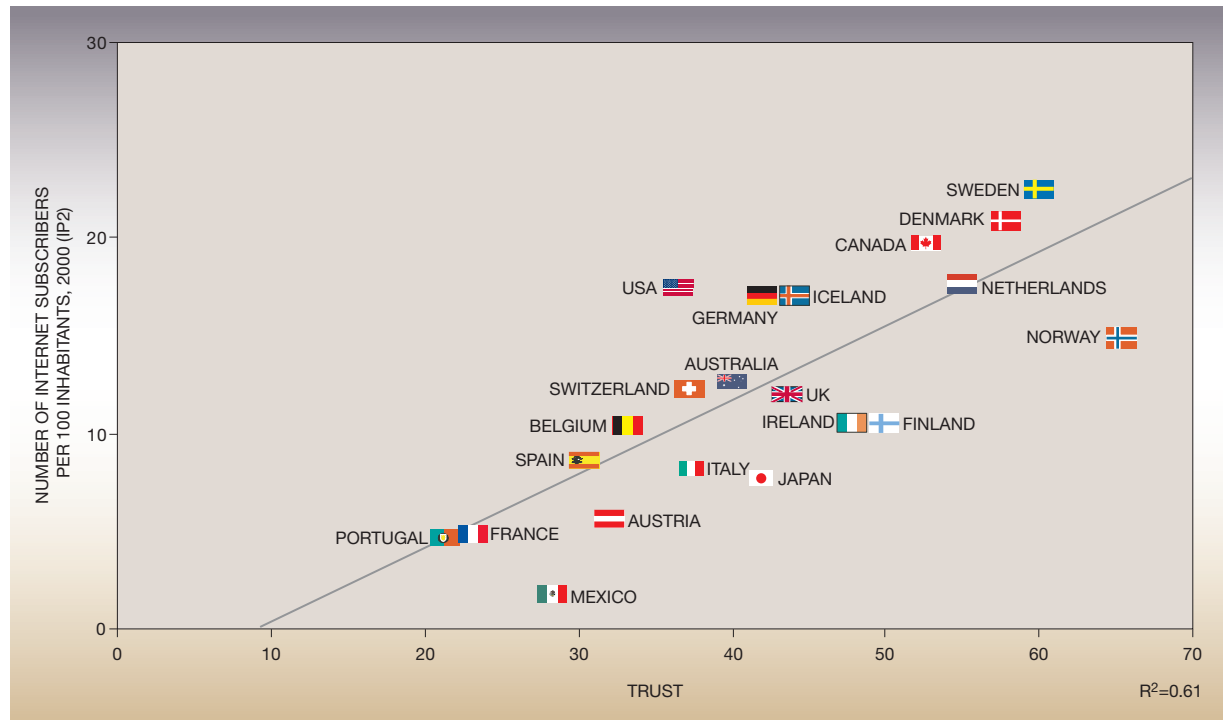


Table 2 Internet penetration regression results

	Average Percentage of Households with Internet Access (IP1)		Internet Subscribers per 100 (IP2)		Internet Subscribers per 100 (IP2, Excluding Korea)	
	All Regressors	Stepwise	All Regressors	Stepwise	All Regressors	Stepwise
(Constant)	-2.308	-4.015	-6.5410	-4.8590	-6.0500	-5.4380
Trust	0.0223	<i>0.0176</i>	0.0128		0.0199	0.0215
Income	-0.0124	<i>-0.0302</i>	-0.0456	-0.0375	-0.0345	
Int. Price	-0.0024		0.0084		0.0066	
Age	-0.0315		-0.0086		0.0206	
Education	-0.2170		0.1310	0.1480	-0.0233	
Urban	-0.0062		0.0133		<i>0.0125</i>	<i>0.0119</i>
Lines	0.0043	0.0036	0.0052	0.0046	0.0034	0.0030
PC	0.0052	0.0033	-0.0005		0.0027	
N	17	17	22	22	21	21
Adj. R ²	0.87	0.87	0.70	0.69	0.85	0.82

Coefficients in bold are significant at .05 level.

Coefficients in italics are significant at .10 level.

the .05 significance level in the “all regressor” estimation. In the stepwise regression, Lines and PC enter significantly at the .05 level, while Trust and

Income (with an unanticipated negative sign) enter at $p = .055$ and $p = .071$, respectively. The proportion of the total variation in IP1 accounted for in these

estimations is quite high, with adjusted R^2 (coefficient of determination) for both equal to .87.

The “all regressor” estimations for IP1 and IP2 both exhibit high multicollinearity. This is not surprising, given the small number of observations compared to the number of independent variables and the relatively high correlation between many of the independent variables. Multicollinearity is not a problem in the stepwise regressions reported. Residuals in all of the regressions reported tend to be randomly dispersed.

Regression results for IP2 (shown in the center two columns of Table 2) reflect some similarities to those obtained for IP1 but also important differences. Regarding the similarities, Lines and Income are selected as significant explanatory variables in both “all regressor” and stepwise regressions. PC is not, however, significant in explaining IP2 nor does Trust enter as significant in either of the IP2 equations. Instead, Education enters significantly in the stepwise regressions of IP2. The adjusted R^2 s for these equations, .70 and .69, are high, although lower than those for IP1.

Many of the discrepancies between results obtained for IP1 and IP2 are due to the presence of South Korea in the IP2 series. Withholding South Korea from the estimation of IP2 produces several consequences as shown in the right-hand columns in Table 2. First, the fit of the equations to the data improves substantially—making them comparable to those obtained using IP1. Second, the importance of Average PCs per 1000 ($p = .137$ versus $p = .823$) increases, although this variable is still shy of significance. Third, education becomes an insignificant explanatory variable in the stepwise as well as “all regressors” estimation. Finally, trust becomes a statistically significant explanatory variable in both regressions.

In summary, regression results obtained for the average percentage of households with Internet access suggest that Internet adoption depends not only upon technological preconditions—PCs and phone lines—but also on trust. If we are willing to exclude South Korea as an anomaly from observations of Internet subscribers, the results obtained using IP2 corroborate the importance of trust and phone lines.

Our findings regarding the importance of needed infrastructure are consistent with results reported in Hargittai²⁶ and Robison et al.²⁷ in which the number of main phone lines per 1000 inhabitants was

found to be an important explanatory variable in regressions of Internet hosts per 1000 inhabitants across nations.²⁸ Diez-Picazo²⁹ reports regression results from an analysis of pooled cross-sectional and time series data on hosts per 1000 inhabitants, in

**Internet adoption depends not only
upon technological preconditions—
PCs and phone lines—
but also on trust.**

which the number of personal computers per capita in the previous year enters significantly. Finally, there is some evidence consistent with the importance of trust. In their analysis of hosts, Robison et al.²⁷ found that the level of “political openness,” (an index measuring how democratic different countries are in terms of elective government and constitutional constraints on political power), positively influences Internet penetration. It seems reasonable to expect that people in societies characterized by “fair” institutions will be more willing to trust than people living in societies in which the government is less accountable. Knack and Keefer⁷ report regression results to this effect.

To the extent that Internet usage promotes economic growth, our findings would seem to suggest that policy makers, particularly those in low-trust countries, should consider formulating programs to increase trust. Whether this is advisable depends first on the extent to which the crude measure of trust we use really reflects differences in how much people trust in different cultures. If it does, the next question concerns what to do—what programs can a government implement to encourage trust? Finally, there is the question of impact—assuming trust-enhancing policies exist, what kind of return can a society expect to receive by investing in them? We address each of these questions in turn.

Measuring trust. Trust is clearly a difficult variable to measure, and it is natural to ask whether responses to the simple survey question contained in the WVS provide a good measure. An obvious issue here concerns what people have in mind when they respond to the WVS survey question. The hope is that the responses reflect a general willingness to put oneself at risk or a general expectation regarding others, and not a willingness to trust some specific group or to

trust others in a specific circumstance. To the extent that the WVS question is silent regarding groups or circumstances, the latter seems less likely. Moreover, Knack and Keefer⁷ note that the correlation between the WVS question concerning trust in one's family members and the general trust question is low. They also discuss evidence from a Readers Digest study reported in *The Economist* (June 22, 1996) in which wallets containing 50 dollars and the owner's address were "lost" in 14 European and 12 U.S. cities. The percentage of wallets returned by country correlates highly (.67) with the WVS-based trust measure.

The Knack and Keefer trust measure also tends to agree with results from experiments comparing how trusting people from different countries are when playing simple trust games. In these games, one player (the sender) is given some amount of money, for example, ten dollars, and may send any portion of it to a second player (the receiver). Any amount sent is increased by a known multiple (e.g., doubled) before it is given to the receiver. The receiver then decides how much, if any, to send back to the sender. The amount sent by the sender is a measure of trust, while the amount sent back is a measure of trustworthiness. Willinger et al.³⁰ find Germans more trusting than the French in these games, while Buchan et al.³¹ find that mainland Chinese participants (with a value of 56 for the Knack and Keefer trust measure) are more trusting than U.S. participants who are, in turn, more trusting than Japanese and Korean players. All of these orderings, except for the ranking of the U.S. above Japan, are consistent with the ordering reflected in the Knack and Keefer measure.

Recent studies that compare subjects' survey responses with their behavior in trust games have produced conflicting results. Glaeser et al.³² examined the extent to which Harvard undergraduates' responses to the WVS trust question predicted the amount they sent to a counterpart in a trust game. They found that responses to the trust question didn't predict the amounts sent (i.e., how trusting players are) but did predict amounts sent back when respondents were in the position of the receiver (i.e., how trustworthy they are). Fehr et al.³³ conducted a similar study in the context of a representative survey of German households. They report the opposite results—that responses to the WVS question are a significant predictor of trusting but not trustworthy behavior in the trust game.

Building trust—an open question. To the extent that trust impacts economic growth directly by reducing transaction costs and indirectly by encouraging Internet adoption, policies aimed at increasing trust would seem in order. What these policies are and, indeed, whether they exist, depends on the factors that lead people to trust others. It may be that people responding to the question of whether others can be trusted answer affirmatively because they live in societies where formal mechanisms (e.g., property rights and legal statutes) and/or informal conventions (e.g., widely shared norms regarding the sanctioning of unfair or unethical behavior) assure that in potentially contentious situations it is, in fact, best for the parties involved to behave cooperatively.^{34,35} Such environmental factors are subject to influence through policies. In this vein, Zak and Knack³⁶ examine prospects for increasing trust (and thus growth) through measures designed to build civic culture, enhance contract performance, increase freedom of association, reduce income inequality, and raise educational levels.

An alternative, and not mutually exclusive, reason people in some nations may be more trusting than others is because they are simply psychologically or culturally predisposed to expect others to behave benevolently.^{37,38} It is not obvious what sorts of policies might be pursued to implement changes in such cultural propensities. The fact that WVS responses regarding trust are highly correlated over time (e.g., from 1980 to 1990 and 1995) may suggest that these cultural propensities are quite stable and not amenable to either unintended or intended manipulation.^{39,40}

Yet a third, and again not mutually exclusive, interpretation of responses to the WVS question about trust is that it indicates not only an attitude regarding willingness to trust people but also a willingness (or unwillingness) to trust technologies. The product adoption literature⁴¹ classifies groups of individuals according to their propensity to adopt new products. "Innovators" are characterized as venturesome and as risk-taking, whereas those people in the "late majority" and "laggard" groups are described as skeptical and suspicious. To the extent that these attitudes toward risk and propensities to suspicion apply generally, as assumed, for example, in the standard models of decision-making under uncertainty, propensity to trust and willingness to adopt new technologies will be positively correlated.^{42,43} Once again it is not obvious how general propensities of this type would be altered through governmental policies.

The comparative static analysis of trust and Internet adoption. Determining what policies to pursue to promote trust within a country is a difficult proposition. In contrast, ascertaining the impact of such policies and how the impact varies across countries is fairly straightforward. To demonstrate this, imagine that all countries invest an equal amount of funds in policies to promote greater trust and receive the same proportionate increment to their trust score as a consequence. To calculate the impact of these proportionate changes in trust on Internet adoption rates, we use the models obtained from the stepwise regression exercises for IP1 and IP2 (excluding South Korea). For each dependent variable y_i , let $y_i^* = F(\alpha x_i)$ be our predicted value. In this case, the proportional impact on y resulting from a percentage change in trust (i.e., the elasticity of y with respect to trust) is:

$$\eta_{y_i, \text{Trust}}(\alpha x_i) = \frac{\partial y_i^*}{\partial \text{Trust}_i} \times \frac{\text{Trust}_i}{y_i^*} = \frac{\partial F(\alpha x_i)}{\partial \text{Trust}_i} \times \frac{\text{Trust}_i}{F(\alpha x_i)}$$

$$= \alpha_{\text{Trust}} \text{Trust}_i$$

Notice that under the logistic distribution, the estimated trust elasticity for any country is simply the estimated coefficient for trust multiplied by that country's level of trust. The estimated elasticities of Internet penetration with respect to trust for all countries except South Korea are shown in Table 3, where countries are sorted from low to high in terms of their trust levels, with the mean responses shown at the bottom. This sorting of the scores highlights the basic implication of this comparative static exercise regarding how increases in trust translate into increases in adoption: High-trust countries will benefit proportionately much more from their investments in trust than will low-trust countries.

To see how these results translate in terms of growth rates in Internet adoption, suppose each country adopts a policy that improves its trust scores by 5 percent per year.⁴⁴ For a country with the average number of Internet subscribers (IP2), this policy produces the series of growth rates depicted by the center line in Figure 3. As depicted, the growth rate in Internet subscribers increases from approximately 4 percent to 6¼ percent. This translates into an increase from a current subscription level of 13 percent to a subscription level of 21 percent by 2010. In Norway, the most trusting country in the sample, trust reaches 100 percent by the year 2010 with an associated Internet subscription level increasing from

Figure 3 Internet subscriber growth rate resulting from a trust growth rate of five percent per year

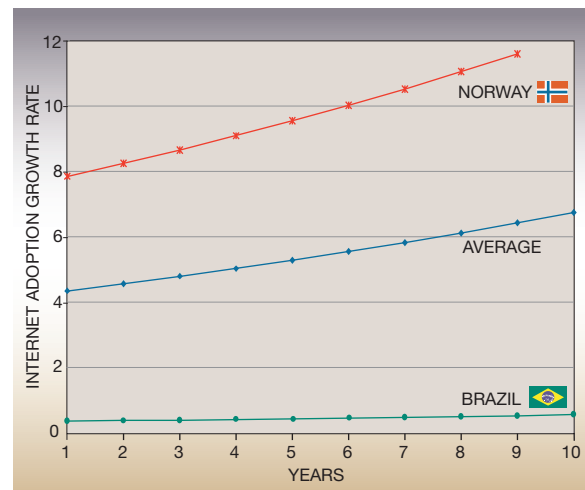


Table 3 Elasticities of adoption with respect to trust

Country	Percent Trust	IP1 Elasticity	IP2 Elasticity
Brazil	3	0.053	0.064
Turkey	6	0.105	0.129
S. Africa	16	0.281	0.343
Argentina	18	0.316	0.386
Chile	21	0.369	0.450
Portugal	21	0.369	0.450
France	23	0.404	0.493
Mexico	28	0.492	0.601
Spain	30	0.527	0.644
Austria	32	0.562	0.686
Belgium	33	0.579	0.708
USA	36	0.632	0.772
Switzerl.	37	0.650	0.794
Italy	37	0.651	0.794
India	38	0.667	0.815
Austral.	40	0.702	0.858
Germany	42	0.738	0.901
Japan	42	0.738	0.901
Iceland	44	0.773	0.944
UK	44	0.773	0.944
Ireland	47	0.825	1.008
Finland	49	0.860	1.051
Canada	52	0.913	1.115
Neth.	55	0.966	1.180
Denmark	58	1.018	1.244
Sweden	60	1.054	1.287
Norway	65	1.141	1.394
Mean	36	0.632	0.772
Maximum	65	1.141	1.394
Minimum	3	0.053	0.064

16 percent to 35 percent. In contrast, for the lowest-trust country, Brazil, this policy only stimulates the growth rate from 0.35 percent to 0.5 percent over the 10-year period. The impact of this 10-year policy of 5 percent annual growth in trust is to increase Internet subscription from 1.6 percent to 1.67 percent!

Whether it makes sense for countries to promote Internet adoption through policies to enhance trust or through investment in main phone lines depends upon how the costs of the different policies compare with their relative benefits. Our analyses enable us to characterize the benefits side of this equation. To demonstrate, note that the impact of a unit change in the level of trust on our dependent measures is given by:

$$\frac{\partial y_i^*}{\partial \text{Trust}_i} = \frac{\partial F(\alpha x_i)}{\partial \text{Trust}_i} = \frac{\alpha_{\text{Trust}} e^{\alpha x_i}}{1 + e^{\alpha x_i}} = \alpha_{\text{Trust}} F(\alpha x_i)$$

Similarly, the impact of a unit change in the number of main phone lines is given by $\alpha_{\text{Lines}} F(\alpha x_i)$. These expressions indicate a property of the logistic model; namely, that countries with larger predicted levels of Internet adoption reap larger absolute benefits from unit changes in any independent variable. The ratio of the benefits accruing from a unit change in trust versus a unit change in main lines is simply the ratio their corresponding regression coefficients, $\alpha_{\text{Trust}}/\alpha_{\text{Lines}}$.⁴⁵ As such, to justify investments in trust so as to increase Internet subscribers (our IP2 measure) by 1 unit (1 percent), the cost of doing so must be less than 77 percent (i.e., $\alpha_{\text{Trust}}/\alpha_{\text{Lines}}$ equals 0.023/0.030) of the cost of increasing Lines by 10 units. Similar computations can be made for our other dependent measures with respect to their relevant policy variables.

Conclusions

Trust has been found to have a direct influence on economic growth across countries through its impact on the cost of transactions. In this paper, we hypothesized that trust may also have an indirect impact on economic growth across nations with the Internet impacting growth rates and trust impacting adoption of the Internet. Our results suggest that trust does, in fact, influence Internet adoption. Since low-trust countries tend to be low- or middle-income countries, this will result in a digital divide between these countries and higher-trust, higher-income ones. To the extent that the level of Internet adoption in-

fluences economic growth, this digital divide will translate into a developmental divide.

How large this divide will be is, at present, unknowable. It seems safe to assume that any growth dividend accruing from the Internet increases at least linearly as Internet adoption rises. If network effects are relevant, then the relationship between Internet penetration and a growth dividend will be stronger for greater levels of adoption. While policies designed to encourage trust among low-trust nations would seem to be a means of mitigating these digital and developmental divides, the implications of our comparative static analyses are not encouraging: High-trust countries benefit more from such policies. Of course, it is possible that there are policies that might effectively and significantly increase trust at low cost. Further research to understand the implications of trust measures will be needed to determine what such policies might entail.

Cited references and notes

1. *The Budget and Economic Outlook: An Update*, Congressional Budget Office (August 2001).
2. H. Varian, A. Elder, J. Shutter, and R. Litan, *The Net Impact Study—The Projected Benefits of the Internet in the United States, United Kingdom, Germany, and France, Version 2.0*. Available at <http://www.netimpactstudy.com/>.
3. R. Litan and A. Rivlin, *The Economy and the Internet: What Lies Ahead*, Brookings Institute, Conference Report No. 4 (December 2000).
4. F. Fukuyama, *Trust: The Social Virtues and the Creation of Prosperity*, Free Press, New York (1995).
5. R. Putnam, R. Leonardi, and R. Y. Nanetti, *Making Democracy Work*, Princeton University Press, Princeton, NJ (1993).
6. J. Dyer and W. Chu, *The Determinants and Economic Outcomes of Trust in Supplier-Buyer Relations*, Working Paper, International Motor Vehicle Program (November 1997).
7. P. Knack and S. Keefer, "Does Social Capital Have an Economic Payoff? A Cross-Country Investigation," *The Quarterly Journal of Economics* **112**, No. 4, 1251–1288 (1997).
8. Available at <http://wvs.isr.umich.edu/samp.shtml>. For a discussion of the WVS, see <http://ssdc.ucsd.edu/ssdc/icp02790.html>.
9. In their paper, Knack and Keefer (Reference 7) examine the broader question of whether "social capital" influences economic growth. Social capital is a composite term reflecting attributes shared within groups that promote cooperative behavior. Trust, loosely defined as the expectation that others will abide by their commitments and act benevolently, is one component of social capital. Civic-mindedness, again loosely defined as willingness to subscribe to norms promoting socially, though not necessarily individually, preferred outcomes, is a second component.
10. Knack and Keefer (Reference 7) used other questions from the WVS to construct an index of civic-mindedness created largely from responses to questions regarding dealings with federal or local government. They found that civic-mindedness also promotes economic growth. This construct seems

- less relevant to the adoption of the Internet. Consistent with this view, preliminary analyses suggested that civic-mindedness does not influence Internet adoption.
11. S. Knack and P. Zak, "Trust and Growth," *The Economic Journal* **III**, No. 470, 295–321 (2001); available at http://www.worldbank.org/research/growth/social_capital.htm.
 12. OECD data is available at <http://www1.oecd.org/publications/e-book/92-2001-04-1-2987/B.5.2.htm>. For Denmark, Ireland, the Netherlands and the United Kingdom, access to the Internet is via a home computer; for the other countries, access to the Internet is through any device (e.g. computer, phone, TV, etc.). U.S. data for 1999 is, instead, from 1998. U.K. data is for the last quarter of 2000. Data for Mexico is only for households in urban areas with more than 15 000 inhabitants. Data for Turkey is for households in urban areas only.
 13. OECD Science, Technology and Development Scoreboard at <http://www1.oecd.org/publications/e-book/92-2001-04-1-2987/B.5.1.htm>.
 14. World Bank, at <http://devdata.worldbank.org/data-query>.
 15. These average prices include line rental, public switched telephony network (PSTN) usage charges and the ISP (Internet service provider) fee and VAT (value-added tax) and cover both peak and off-peak periods. See OECD Science, Technology and Development Scoreboard at <http://www1.oecd.org/publications/e-book/92-2001-04-1-2987/B.6.htm>.
 16. United Nations, *World Population Prospects, the 2000 Revision*. Available at <http://www.un.org/esa/population/publications/wpp2000/annex-tables.xls>.
 17. R. J. Barro and J.-W. Lee, *International Data on Educational Attainment: Updates and Implications*, CID Working Paper No. 42, April 2000 (data available at <http://www.korea.ac.kr/~jwlee/> and <http://www2.cid.harvard.edu/ciddata/barrolee/Appendix.xls>).
 18. The World Bank data (<http://devdata.worldbank.org/data-query>) is provided by International Telecommunications Union.
 19. World Bank: World Development Indicators database at <http://devdata.worldbank.org/data-query/>. Data supplied by International Telecommunication Union, World Telecommunication Development Report and database.
 20. For further discussion of these and other factors impacting Internet penetration in South Korea see Shameen (Reference 21) and OECD (Reference 22).
 21. A. Shameen, "Ground Zero When It Comes to Broadband, South Korea is Where the Action Is," *Asiaweek* **26**, No. 39 (Oct. 6, 2000). Available at <http://www.asiaweek.com/asiaweek/technology/2000/1006/tech.net.html>.
 22. "The Development of Broadband Access in OECD Countries," OECD DSTI/ICCP/TISP(2001)2/FINAL (Oct. 29, 2001). Available at www.oecd.org/pdf/M00020000/M00020255.pdf.
 23. Using the transformed dependent measures yields higher adjusted R^2 's than those obtained using Ordinary Least Squares. For further discussion of this logit form of regression analysis, see Intriligator (Reference 24).
 24. M. Intriligator, *Econometric Models, Techniques, and Applications*, Prentice-Hall, New Jersey, pp. 173–175 (1978).
 25. In stepwise regression, independent variables are entered into the regression equation sequentially—first the one most highly correlated with the dependent variable, next the one with the highest partial correlation, and so forth until the variable to be included next would not enter significantly. For further discussion, see the work of Nau at <http://www.duke.edu/~rnau/regstep.htm>.
 26. E. Hargittai, "Weaving the Western Web: Explaining Differences in Internet Connectivity Among OECD Countries," *Telecommunications Policy* **23**, Nos. 10–11, 701–718 (1999).
 27. K. K. Robison and E. M. Crenshaw, *Post-Industrial Transformations and Cyber-Space: A Cross-National Analysis of Internet Development*, Working paper, Ohio State University Dept. of Sociology (February 2001).
 28. Host counts by country provide an estimate of the number of computers in that country that are connected to the Internet. This dependent measure is not ideal for our purposes, to the extent that there are vagaries in the way the origin of the host is determined. Where possible, hosts are attributed to countries according to their two-level ISO (International Standards Organization) country codes (i.e., according to their "country code Top Level Domain" or ccTLD). Unfortunately, the fact that a host's ccTLD is, say, Germany (i.e., ".de") does not necessarily mean the computer resides in Germany. Moreover, many hosts are not classified by country code but by generic Top Level Domains (gTLD) like ".com," ".edu," ".org," ".net," and ".int." Accurate counts of computers connected to the Internet by country require that these gTLDs be somehow allocated to specific countries.
 29. G. F. Diez-Picazo, *An Analysis of International Internet Diffusion*, Masters of Science in Technology and Policy thesis, Massachusetts Institute of Technology, (June 1999).
 30. M. Willinger, C. Keser, C. Lohmann, and J. Usunier, "A Comparison of Trust and Reciprocity between France and Germany: Experimental Investigation Based on the Investment Game," *Journal of Economic Psychology*, forthcoming.
 31. N. R. Buchan, R. T. A. Croson, and R. M. Dawes, "Swift Neighbors and Persistent Strangers: A Cross-Cultural Investigation of Trust and Reciprocity in Social Exchange," *American Journal of Sociology* **108**, No. 1, 168–206 (2002).
 32. E. Glaeser, D. Laibson, J. Scheinkman, and C. Soutter, "What is Social Capital? The Determinants of Trust and Trustworthiness," *Quarterly Journal of Economics* **65**, 811–846 (August 2000).
 33. E. Fehr, U. Fischbacher, G. von Rosenblatt, J. Schupp, and G. Wagner, *A Nation-Wide Laboratory Examining Trust and Trustworthiness by Integrating Behavioral Experiments Into Representative Surveys*, University of Zurich, Institute for Empirical Research in Economics, Working paper No. 141.
 34. In the context of game theory, we can think of these societies as having created institutions which solve social dilemmas and other problems of opportunistic behavior through mechanisms that afford opportunities for side payments and/or side penalties or, to use Yamagishi and Yamagishi's (Reference 35) terminology, mechanisms that provide assurance.
 35. T. Yamagishi and M. Yamagishi, "Trust and Commitment in the United States and Japan," *Motivation and Emotion* **18**, 129–166 (1994).
 36. P. Zak and S. Knack, "Building Trust: Public Policy, Interpersonal Trust, and Economic Development," Working paper, Supreme Court Review.
 37. Yamagishi and Yamagishi (Reference 35) posit, for example, that Americans are more prone than the Japanese to trust, in the sense of expecting people to behave benevolently even when it is not in their interest to do so (that is, even when the structure of the situation does not assure benevolence will also be individually rational). Also see Buchan (Reference 31). Hofstede (Reference 38) also identifies what appear to be culturally shared traits (for example, individualistic versus collectivist attitudes) which could promote or discourage willingness to trust.
 38. G. Hofstede, *Cultures and Organizations: Software of the Mind*, McGraw-Hill Book Co., Maidenhead, Berkshire, UK (1991).

39. Inglehart (Reference 40), notes that cultural characteristics reflected in the WVS are stable over time, although he also notes exceptions. For example, in the U.S. in 1960, 58 percent of respondents to the WVS thought people could be trusted, whereas in 1995, the percentage had declined to 35 percent.
40. R. Inglehart, "Trust, Well-Being and Democracy," in *Democracy and Trust*, M. Warren, Editor, Cambridge University Press, New York and Cambridge (1999), pp. 88–120. Available at <http://wvs.isr.umich.edu/papers/trust.html>.
41. M. Rogers, *Diffusion of Innovations*, Free Press, New York (1995).
42. Hofstede (Reference 43) presents evidence showing that adoption of communication technologies is influenced by some of the same cultural characteristics thought to influence expectations regarding the benevolence of others.
43. G. Hofstede, "Adoption of Communication Technologies and National Culture," *Systèmes d'Information et Management* 6, No. 3, 55–74 (January 2001).
44. This 5 percent increase is the proportional increase from current trust levels (i.e., if a country's trust score is 20 percent, it increases to 21 percent next year, whereas if its score is 40 percent, it increases to 42 percent).
45. Adjusting for the fact that our trust measure indicates those trusting out of 100 people whereas our lines measure indicates lines per 1000 people.

Accepted for publication April 21, 2003.

Hai Huang *Fuqua School of Business, Duke University, Box 90120, Durham, NC 27708 (hai.huang@duke.edu)*. Ms. Huang is a Ph.D. candidate in finance at Duke University. She received a B.S. degree in chemistry from the University of Science and Technology of China in 1994, an M.S. degree in chemistry from Brown University in 1997, and an M.B.A. degree and an M.S. degree in statistics from Georgia Institute of Technology in 2001. From June 2001 to August 2001, Ms. Huang held an internship position with IBM at the Thomas J. Watson Research Center. Ms. Huang's research interests include asset pricing and corporate strategy.

Claudia Keser *IBM Research Division, Thomas J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY 10598 (ckeser@us.ibm.com)*. Dr. Keser is a research staff member at the IBM Thomas J. Watson Research Center, Associate Fellow of CIRANO (Centre Interuniversitaire de Recherche en Analyse des Organisations) in Montreal, and Privatdozentin at the Technical University of Karlsruhe. She received her doctoral degree in Economics in 1992 at the Rheinische Friedrich-Willhelms University of Bonn, working with Nobel laureate Reinhard Selten on experimental duopolies with demand inertia. Her research in experimental game theory has been focused on issues of incentives, trust, and cooperation.

Jonathan W. Leland *IBM Research Division, Thomas J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY 10598 (jleland@us.ibm.com)*. Dr. Leland is a research staff member in the Business Research Group at IBM's Thomas J. Watson Research Center and a professor in IBM's Advanced Business Institute. Topics of his recent research include the determinants of Internet adoption, the evolution of e-business, and the efficacy of computer-mediated communication. Dr. Leland also has extensive expertise in the area of individual decision-making with particular emphasis on the origins of irrational behavior and the influence of emotions on decision-making. He has published re-

search in the *Journal of Risk and Uncertainty*, *Economic Inquiry*, and *Management Science*. Prior to joining IBM, Dr. Leland directed the Decision, Risk, and Management Science program at the National Science Foundation, worked as a defense analyst at the Center for Naval Analyses, and was a professor in the Department of Social and Decision Sciences and Graduate School of Industrial Administration at Carnegie Mellon University. Dr. Leland received a Ph.D. and Masters degree in economics from UCLA in 1986 and 1982, respectively, and an A.B. in economics from Occidental College in 1979.

Jason Shachat *IBM Research Division, Thomas J. Watson Research Center, P.O. Box 218, Yorktown Heights, NY 10598 (jshachat@us.ibm.com)*. Dr. Shachat received his Ph.D. in economics from the University of Arizona in 1996. From 1996 to 2001 he was an assistant professor of economics at the University of California, San Diego. While at UCSD he helped establish the experimental and computational economics laboratory (EEXCL). In the summer of 2001, he joined the Business Research Group at IBM's Thomas J. Watson Research Center. Dr. Shachat is a member of the American Economic Association and the Economics Science Association.