Has the Internet Increased Trade?

Evidence from Industrial and Developing Countries

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Abstract: If the Internet made it easier for firms to enter new markets by reducing communication and search costs then it may also have made it easier to export goods and services. We find that higher Internet penetration in developing countries is correlated with greater exports to developed countries, but not with trade between developing countries or with exports from developed countries. Interpreting the correlations is difficult because causation may run from Internet use to exports or from trade openness to Internet use. To test whether Internet use affects export behavior, we endogenize Internet use by using countries' regulation of data services and Internet provision as instrumental variables. The results are robust to endogenizing Internet penetration, suggesting that access to the Internet does affect export performance of firms in developing countries. In other words, Internet access appears to stimulate exports from poor countries to rich countries. Moreover, the analysis suggests that regulatory policies affecting telecommunications and Internet development indirectly affect trade, further emphasizing the importance of deregulating potentially competitive services in the telecommunications industry.

World Bank Policy Research Working Paper 3215, February 2004

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I. INTRODUCTION

Much of the excitement surrounding the 'New Economy' did not survive the economic slowdown in 2001. However, two dramatic and real changes did take place in the mid-late 1990s and early 2000s. The first was a large increase in the international flows of goods, services and investment. Total world exports increased from 20 percent of gross world product in 1994 ($5.9 trillion in 1995 US$) to 29 percent of gross world product (US$9.6 trillion) in 2001 (World Bank, 2003b). This increase is substantial considering that exports had consistently varied between 18 percent and 20 percent of gross world product for the previous fifteen years. The second was a revolution in Information and Communication Technologies (ICTs). Probably the most notable component of this was the dramatic growth of the Internet: about the number of Internet hosts soared from 17 per 10,000 people in 1994 to 231 in 2001 (International Telecommunication Union, 2003).

Although export and Internet growth appear to have occurred contemporaneously, the two changes are not necessarily linked – with a relatively small number of annual observations, the timing could simply be coincidence. However, cross-country evidence also suggests a relationship between the Internet and globalization: countries that export more tend to have higher Internet penetration than countries that export less.[1] The cross-country correlation suggests a possible causal relationship between Internet use and exports, but tells us little about the *direction* of causality. That is, even if the correlation is not spurious, we cannot determine whether trade openness encourages Internet use, Internet use stimulates trade, or both.

This paper contributes to the literature on the effect of the Internet on export behavior in two ways. First, it recognizes that the Internet may affect developing and developed countries differently. We find that Internet penetration is positively correlated with exports from developing countries to developed countries but not to other developing countries. Internet penetration does not appear to be correlated with exports from developed countries to other developed countries or to developing countries. Second, it assesses the extent to which Internet

[1] The correlation between exports (as share of GDP) and number of Internet users (as share of population) was 0.26

use affects exports, taking into account the endogeneity of Internet use. We do this through a two-stage approach using regulatory variables as instruments for Internet penetration. These instruments are correlated with Internet use, and hypothesis tests suggest that they are exogenous to aggregate exports.

Even after endogenizing Internet use, we find that it is positively correlated with exports from poor to rich countries. Thus, while it is likely that trade openness also affects Internet use, we find evidence that Internet use affects exports from developing countries. Moreover, our instruments suggest policy implications: regulatory policies in developing countries that affect telecommunications and Internet development also indirectly affect those countries' exports.

II. EXPORT BEHAVIOR AND INTERNET USE

Consistent with the country-level correlations, enterprises in developing and transition economies that export are far more likely than other enterprises to use the Internet to communicate with their clients and suppliers, according to surveys conducted by the World Bank (see Table 1). The difference between exporters and non-exporters appears to be true both in countries with high levels of Internet coverage (e.g., Slovenia, Estonia and Slovakia) and countries with very low levels of coverage (e.g., Tajikistan and Uzbekistan). Unfortunately, these enterprise surveys do not have detailed information on the destination of exports and, therefore, we cannot determine whether enterprises that export to developing countries differ from enterprises that export to developed countries.

The striking correlation between export behavior and Internet use at the enterprise level in developing countries has several plausible explanations. One possibility is that enterprises that are already exporting are more likely to connect to the Internet. Exporters might connect to the Internet because it provides a relatively cost-effective method for international communications relative to international telephone calls or faxes: the local or domestic long-distance charges necessary to connect to the Internet are far lower than international rates,

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(p-value = 0.00) across countries in 2001.

especially in developing countries.[2] A second possibility is that the benefits of Internet access increase as the firm's customers and suppliers connect (i.e., there are network externalities). Because Internet use is nearly universal among firms in most developed countries, firms in developing countries that do business in developed economies might benefit more from Internet access than would firms that do business only domestically. For both these reasons, Internet access might be higher for enterprises that export (especially those that export to developed countries).

Several recent studies have suggested that trade stimulates Internet use. For example, Onyeiwu (2002, p. 15) suggests that the 'extent to which a country is integrated into the global economy can play a role in its access to IT. Countries with greater contact, either via trade, tourism, or geographical location, with the outside world, are more likely to be advanced in digital technology than other countries.' Similarly, Caselli and Coleman (2001) argue that countries open to imports from high-income OECD economies will benefit from knowledge spillovers and, hence, be more likely to adopt new technologies.

Empirical studies of Internet adoption have found that Internet use is correlated with openness to trade even after controlling for other factors that might correlated with both.[3] For example, Wallsten (2003) and Baliamoune (2002) find that Internet users made up a greater share of the population in developing countries that are more open to trade. Other studies have also found that additional measures of ICT use and investment are correlated with various measures of openness.[4] In general, the correlation between ICT use and openness appears to be

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[2] In 2001, the average (median) cost of a three-minute call from an OECD country to the United States (average does not include US or Canada) was US$0.61 (US$0.33) for countries for which data were available, whereas the average for developing countries was US$11.35 (US$3.67). In contrast, on average a 3-minute local call cost US$0.07 (US$0.05) in developing countries and US$0.11 (US$0.11) in OECD countries. Data is from World Bank (2003b).

[3] In recent years, a large literature has developed that looks at the determinants of ICT use and investment. Early studies, which generally do not include measures of openness, include Dasgupta *et al*. (2000), Kraemer *et al*. (2000) and Kiiski and Pohjola (2002).

[4] For example, Onyeiwu (2002), which looks at the determinants of IT use in 54 countries in Africa, find that IT use tends to be higher in countries that are more open (i.e., that import more). The dependent variable in this study is a composite measure of 'digitalization' that is a weighted average of Internet users and hosts, personal computers, telephone lines and cell phones. Using data from a survey of 2,139 enterprises from 10 middle and high-income countries, Kraemer *et al*. (2002) show that enterprises that are more internationalized (in terms of operations, sales

stronger in developing countries. Several of the papers that find a positive correlation between measures of ICT use and openness focus on developing countries (Baliamoune, 2002; Onyeiwu, 2002; Wallsten, 2003), while others that have looked at both developed and developing countries find stronger results for developing countries.[5] These aforementioned studies have assumed, either explicitly or implicitly, that causation runs from openness to ICT use and investment.

Although openness to trade might affect Internet penetration, Internet access might also affect export behavior. If access to the Internet makes it less costly to find and communicate with potential customers in other markets, then, all else being equal, exports could be higher in countries where Internet penetration is greater. In practice, if the Internet merely substitutes for telephone calls or faxes, it is not likely to have a large impact on costs. Expenditures on telephone and postal services in Peru, for example, were only 1 percent of sales (or about 8 percent of labor costs) for the median enterprise in a 2002 survey of formal enterprises in Peru.[6] Since Internet access does not eliminate all other communications costs (e.g., the fixed costs associated with telecommunications services or even all telephone calls or postal deliveries), the total savings from Internet access will be relatively modest if it only substitutes for existing methods of communication.

On the other hand, Internet access might affect costs associated with exporting in other ways. In particular, Freund and Weinhold (2000, p. 4) argue that the Internet might help create global markets for traded goods by reducing the fixed costs associated with exporting. The

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and inputs) are more likely to engage in business-to-business (B2B) e-commerce, but not in business-to-consumer (B2C) e-commerce. Caselli and Coleman (2001) show that ICT investment is higher in countries that import more manufactured goods from countries in the OECD. Muller and Salsas (2003) find that the number of PCs, but not the number of Internet users and hosts, is correlated with imports. Finally, Clarke (2003), which uses enterprise level data on Internet use for Eastern Europe and Central Asia, fails to find a positive correlation between openness to imports at the country level and Internet use at the enterprise level. In fact, in some model specifications, Clarke (2003) finds a negative correlation. This negative result, however, be due to imports from low and middle-income countries. Imports from high-income countries are positively correlated with Internet connectivity.

[5] For example, Caselli and Coleman (2001) show that the correlation between openness and investment in ICT is stronger for countries that do not export computers – a sample that will probably include most low-income developing countries.

[6] These communications costs were only fractionally higher for exporters than for non-exporters (1.1 percent of sales for exporters compared to 1.0 percent of sales for non-exporters). Data comes from the 2002 Investment Climate Survey for Peru, which asked questions about costs associated with telecommunications services. The World Bank, in collaboration with Andean Development Corporation, conducted the 2002 Investment Climate

Internet could reduce costs "both directly via organized exchanges with numerous buyers and sellers and indirectly through powerful search engines, which enable sellers to notify buyers of prices instantaneously. This is very different from other recent innovations, such as the telephone or the fax, which only assist in bilateral communications." Daly and Miller (1998) present evidence from a 1998 survey of enterprises in 15 low and middle-income countries that suggests that firms in these countries do, indeed, use search engines to research market opportunities.[7] Of the 58 enterprises that reported having Internet access in their survey, 26 reported using search engines to look for marketing and production information. This was the second most common use of search engines, after looking for technical and computer information. To the extent that these uses reduce the fixed costs of finding markets and buyers, Internet access might therefore increase exports.

Most empirical studies have focused on whether openness to trade affects Internet penetration. However, several recent studies have asked whether Internet use affects trade. For example, using data from 20 low- and middle-income countries in Eastern Europe and Central Asia, Clarke (2001) shows that enterprises with Internet connections export more, as a share of their total sales, than enterprises without connections. In addition, using a gravity model of trade, Freund and Weinhold (2000) find that Internet use appears to be significantly correlated with trade after 1996, although they find only a weak correlation in 1995 and 1996. They also find that the Internet has a greater effect on trade in developing countries than it does in developed countries. In a second paper, Freund and Weinhold (2002) find that exports of services to the United States grew more quickly for countries with greater Internet penetration in a sample of 31 middle- and high-income countries. Freund and Weinhold (2000; 2002) control for the possibility of reverse causation only indirectly, by lagging the variable representing

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Survey. The survey is described in World Bank (2003a).

[7] Daly and Miller (1998) note that their sample, comprised of International Finance Corporation (IFC) client companies, was not random. In particular, they note that IFC clients are likely to be more technologically sophisticated than other enterprises in developing countries. Given the high level of Internet connectivity they report (about 75 percent of industrial firms), it seems likely that this is the case. However, Internet connectivity has increased greatly in recent years in developing countries and the technical sophistication of the 'average' enterprise has, therefore, also likely increased since 1998.

Internet penetration by two periods.[8] Given that exports and Internet use both persist over time, lagged values might not fully control for reverse causation.[9]

The benefits of Internet access may be especially pronounced for firms in developing countries. Indeed, the cross-country correlation between export behavior and Internet use noted above is almost entirely due to developing countries – the correlations between exports and Internet use are 0.51 (p-value = 0.00) and –0.05 (p-value = 0.81) for developing and developed countries respectively. Further, for developing countries, Internet use is correlated only with exports to developed countries - the correlations between Internet use and exports to developed and developing countries are 0.52 (p-value=0.00) and 0.18 (p-value=0.14) respectively.[10] In summary, although exports from developing countries are correlated with Internet use, this only appears to be true for exports to developed countries. This correlation seems reasonable. Internet access is ubiquitous among enterprises in developed countries, and small differences in country-level Internet penetration probably reflect differences in access by individuals or households, not businesses. In contrast, surveys reveal Internet access to be less common at even the enterprise level in developing countries (see Table 1), suggesting that reported differences in Internet penetration reflect differences in coverage at the enterprise level, as well. Indeed, Internet use at the individual level is highly correlated with Internet use at the enterprise level in the developing countries for which we have information on both (the correlation is 0.71 with a p-value=0.00).[11]

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[8] Freund and Weinhold (2002, p. 239) acknowledge the potential for reverse causation, noting: "[h]owever, causality probably runs both ways: increasing trade in services leads firms to adopt the Internet to facilitate that trade and greater Internet penetration causes firms to use the Internet for trade in services."

[9] For example, the correlation between Internet users as share of the population in 1995 and 2001 was 0.73. The correlation remains statistically significant after controlling for per capita income. Similarly, exports as share of GDP are also highly correlated over time. The correlation between exports as share of GDP in 1990 and 2001 was 0.81.

[10] For developed countries, the correlations between Internet use and exports to developed and developing countries are 0.01 and 0.02 respectively. Both correlations are statistically insignificant.

[11] See Table 1 for sources of data. Unfortunately, we do not have comparable information on Internet use in developed countries.

In the next section, we test how the correlation between exports and Internet use differs among developing and developed countries, and explore whether it is robust to controlling for other variables and to allowing Internet use to be determined endogenously.

III. EMPIRICAL ESTIMATION

III.1 Cross-Sectional Estimation

To test whether Internet use affects exports, we use country-level data to estimate equation (1):

$$Exports_{ij} = \alpha + \beta_1 Internet\,Use_i + \gamma\, Control\ Variables + \varepsilon_{ij} \qquad (1)$$

The dependent variable is exports from country *i* to country group *j*. Based upon the simple correlations, we look at exports to three different country groups: developing countries, developed countries, and total exports (i.e., to all countries). In addition, we also estimate separate regressions for high and low-income countries and test whether the two samples can be pooled into a single regression. The test is reasonable given that exports from developing countries appear correlated with Internet access, whereas exports from developed countries do not. Export data comes from the United Nations Statistical Division (UNSD) Commodity Trade (COMTRADE) database. The data is for 2001 and countries for which all data were available are listed in Table 2.

The main independent variable, *Internet Use*$_i$, is Internet users in country *i* as percent of the population. This variable represents Internet penetration and comes from International Telecommunication Union (2003). The ITU estimates the number of Internet users using data from various sources including subscriber counts from Internet access providers and estimates based upon the number of Internet hosts in each country. Although the variable is far from perfect, it is highly correlated with other measures of Internet use, including estimates of the percentage of enterprises in developing countries with access to the Internet ($\rho = 0.71$). As a

robustness check, we also estimate equation (1) replacing Internet users as percent of the population with Internet hosts per 100 persons.[12]

A statistical correlation between Internet use and exports at the firm level may arise from omitting relevant variables that affect both of them from the analysis. For example, more efficient or technologically advanced firms might be more likely to have access to the Internet because they have greater resources available for investment in information technology or because investing in IT improves productivity.[13] Since more efficient firms in developing countries also appear to be more likely to export, the correlation between export behavior and Internet access could simply be spurious.[14] If small enterprises are less likely to export and also less likely to have access to the Internet, then omitting variables to control for enterprise size could lead to biased results.[15] Similarly, cross-country differences between industry structure and performance could also result in a spurious correlation in country-level correlations if the analysis does not adequately control for factors that affect both access and export behavior.

Thus, in addition to the main independent variable (Internet use), we also include several additional variables to control for natural openness. These include population, area, per capita GDP, per Capita GDP squared and a dummy variable representing whether the country is a major oil exporter. Pritchett (1996) uses similar variables, without a measure of Internet use, in regressions explaining trade openness.[16] These variables come from World Bank (2003b). Table 3 shows means and variances for the dependent and independent variables.

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[12] The measure of Internet hosts also comes from International Telecommunication Union (2003), using data collected by the Internet Software Consortium (http://www.isc.org) and RIPE (http://www.ripe.net). It is based upon the country code in the Internet host address (rather than actual physical location).

[13] Using enterprise-level data from Eastern Europe and Central Asia from 1999, Clarke (2003) shows that better performing enterprises were more likely to have Internet access.

[14] Many studies have found that enterprises that export are more efficient than enterprises that do not – see Tybout (2000) for a summary of the literature. This result could be because efficient enterprises self-select into exporting (i.e., the *self-selectivity hypothesis*) or because the discipline of exporting directly improves efficiency (i.e., the *learning-by-exporting hypothesis*).

[15] Several studies of small manufacturing enterprises in developing countries are less likely to export than larger enterprises. Biggs (2003) provides a summary of this literature.

[16] In addition to adding Internet use, we also omit one variable used in Pritchett (1996), the CIF/FOB (cost, insurance and freight/free on board) ratio, since this was not available for most countries in the sample.

As discussed previously, even if export behavior is correlated with Internet use, the direction of causality remains unclear. We use an instrumental variables approach to address this issue. Our main instrument for Internet access is a variable obtained from International Telecommunication Union (2002) representing whether a single company has a legal monopoly over data transmission services in a given country.

We believe the instrument is appropriate. If companies with legal monopolies over data transmission restrict access to data lines, as we would expect a monopoly to do (i.e., by setting prices above the competitive price), Internet access might be lower in those countries. One extreme example of this is in Malawi. Prior to telecommunications reform in 1998, the monopoly telecommunications provider in Malawi, Malawi Post and Telecommunications Corporation (MPTC) had a monopoly of both data and leased lines.[17] It used this monopoly to prevent ISPs (including companies that had managed to get licenses to do so) from entering the market by refusing to provide them with the lines that they requested (Article 19, 1998). Moreover, regulatory rules regarding entry into communications services are unlikely to affect exports other than through their effect on exporting firms' communications with their customers.

This instrument also performs well statistically. In first-stage regressions of Internet access on the instrument and the other included variables the coefficient on the regulatory variable is negative and significant at the 5 percent level (see Table 4). In other words, as we expected, Internet access is lower in countries with monopolies over data lines.

While we believe this variable to be a good instrument, we also use alternate instruments to test over-identifying assumptions and as a robustness check. In particular, we use two additional dummies; one indicating whether a single firm had a legal monopoly over Internet Service Provision, and another indicating whether a firm had a legal monopoly over leased lines. Although the first variable is intuitively appealing, it does not perform as well as the dummy representing monopoly provision of data lines; in a first-stage regression, the coefficient on the dummy variable representing monopoly provision of Internet Service Provision is statistically

[17] Clarke *et al*. (2003) describes telecommunications reform in Malawi

insignificant (see Table 4).[18] One plausible reason for the statistical insignificance is that Internet Service Providers are monopolies in only a few countries in our sample (10 percent of the sample). In contrast, data lines are monopolies in 24 percent of the countries in our sample. Further, the ISP information is available for fewer countries than is the information on data lines (80 and 91 countries respectively).

As a final robustness check, we also use an additional instrument – a dummy variable representing whether ISPs are required to get formal approval from the telecommunications regulator before starting operations. Wallsten (2003) shows that countries that require formal approval for ISPs have lower Internet penetration. Unfortunately, this variable, which comes from a World Bank survey of regulatory agencies in developing countries, is available for only a small sub-sample of the countries for which export data were available (26 countries) and is not available for any high-income countries.[19]

Although the variables included in Pritchett (1996) seem to be a reasonable set of country controls, we also test whether the results are robust to including additional variables. One concern is that countries that liberalize their trade policies might also be more likely to liberalize other parts of their economies, including their telecommunications sectors, potentially leading to omitted variable bias. In particular, countries that are members of the World Trade Organization (WTO) might be more likely to liberalize their telecommunications sectors – for example by joining the optional WTO agreement on basic telecommunication services or agreeing to liberalize during accession negotiations. Further, countries that join the WTO might also export more – although recent studies have failed to find strong evidence that countries that belong to the WTO have more liberal trade policies than other countries.[20] Consequently, as a robustness check, we add a variable indicating that the country is a member of the WTO and a variable indicating that it has signed the WTO agreement on basic telecommunication services to the base

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[18] Recent studies have shown that coefficients on endogenous variables can be biased when weak instruments are used (see, for example, Staiger and Stock, 1997).

[19] Wallsten *et al*. (2003) describe the data and the survey.

[20] In particular, Rose (2003b) fails to find strong evidence that countries that are members of the WTO actually have more liberal trade policies, while Rose (2003a) fails to find evidence that membership increases trade.

regression. In addition to the dummies representing WTO membership, we also add a variable representing the average (weighted) tariff in the country as an additional measure of liberalization.

In addition to concerns about liberalization, another concern is that countries that are more politically open might be more likely to allow easy Internet access, because they are less concerned about citizens accessing information critical of them that might be available on the Internet, and be more open to trade and investment. Consequently, we also add a variable to control for political openness to the base regression to check robustness. The variable is the index of 'voice and accountability' from Kaufmann *et al*. (2003), which is a measure of political and civil rights in the country.

The final additional control that we add is an additional control for natural openness, representing the distance of the country from the rest of the world. This variable, constructed by Rose (2003b), is defined for country i as the inverse of the mean of log real GDP for the export partner, country j, divided by the log of the distance between countries i and j.

III.2 Empirical Results

Results from OLS Regressions. Table 5 presents results from regressions of total exports, exports to high-income countries and exports to low-income countries on Internet use and additional control variables suggested in the literature on trade openness. The table presents results from separate regressions for high- and low-income countries. Since Internet use might affect enterprises in developing and transition countries differently than enterprises in developed countries, this approach seems appropriate. Furthermore, we reject at conventional significance levels the null hypothesis that the two sets of countries can be pooled in a single regression for both total exports and exports to high-income countries.[21]

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[21] The χ^2 [7] statistics for the test of the null hypothesis that the two sets of countries can be pooled for total exports and exports to high-income countries are 16.4 (p-value=0.02) and 28.6 (p-value=0.00) respectively. Pooling is also rejected for exports to high-income countries (χ^2[7]=12.4, p-value==0.08), but not total exports (χ^2[7]=6.4, p-value=0.51), in the 2SLS regressions shown in Table 6. The null hypothesis cannot be rejected at conventional significance levels for exports to developing countries. Greene (2000, pp. 292-293) describes the test used to test the hypothesis. The test does not require the variances of the disturbance terms to be equal in the two equations.

For high-income countries, the coefficients on Internet users as share of the population are statistically insignificant and economically small in all equations after controlling for other factors that might affect openness. According to the point estimates, a one-percentage point increase in the percent of the population that uses the Internet would increase exports as share of GDP by about 0.1 percentage points and would increase exports to high-income countries by about 0.05 percentage points. Given the widespread adoption of the Internet in most developed countries, the relatively modest impact of increased access might not be surprising.

For developing countries, contrarily, the coefficients on Internet users as share of the population are statistically significant and economically large. Assuming for now that causality runs from internet use to exports, the point estimates suggest that a one-percentage point increase in the share of the population with access to the Internet would increase total exports as percent of GDP by 1.4 percentage points and would increase exports to high-income countries by 1.3 percentage points. In contrast, increased Internet access does not appear to have a statistically significant impact on exports to developing countries.

For the most part the coefficients on the additional control variables are statistically insignificant. The only exceptions are the coefficients on area in the regressions for exports from high-income countries and the coefficients on area and population in the regression for exports to developing countries from developing countries. Although the coefficients on per capita GDP and per capita GDP squared are generally statistically insignificant at conventional significance levels (both singly and jointly), consistent with Pritchett (1996) the coefficients on the linear terms are positive while the coefficients on the squared term are negative.[22]

Results from 2SLS Regressions. Although the OLS results suggest that the correlation between Internet use and exports is robust to the inclusion of additional variables that might affect both Internet use and openness, reverse causation remains a concern. When we test the null hypothesis that the variable representing Internet users as percent of the population is exogenous in the equations where the coefficients are statistically significant, we reject the null

[22] In most cases, the coefficient on per capita income remains statistically insignificant after dropping the squared term. The one exception is in the regression for exports to high-income countries for the sample of high-income

hypothesis in the regression for total exports from developing countries and fail to reject the null hypothesis in the regression for exports to high-income countries from developing countries.[23] Given that Hausman-type tests are typically relatively weak in small samples, this favors the results from the 2SLS regressions and suggests that Internet use is probably determined endogenously with exports.

To address this issue, we re-estimate the base regression shown in Table 5 allowing variable representing Internet use to be endogenous. To instrument for Internet use, we use the regulation dummy variable discussed above, which indicates whether the government allows a single firm to maintain a monopoly over data lines. We use this variable rather than any of the other variables (or a combination of dummies) due to concerns about missing data – including additional instruments can sharply reduce sample size. In the next subsection, as a robustness check, we test other combinations of plausible instruments. This variable seems to be appropriate instrument in that it is highly correlated with the endogenous variable, Internet users as percent of the population. In a first stage regression, the coefficient has an expected negative sign (i.e., Internet use is lower in countries where a single firm has a monopoly over data lines) and is statistically significant at a 5 percent significance level (see Table 4). The point estimate of the parameter suggests that, on average, there are 3.6 fewer Internet users per 100 people in countries that maintain legal monopolies over data lines.

The results from the 2SLS regressions are qualitatively similar to results from the OLS regressions (see Table 6). In particular, the coefficient on Internet users as percent of population is statistically insignificant and relatively small in all the regressions for exports from high-income countries, and in the regressions on exports from developing countries to other developing countries. In contrast, the coefficients are large and statistically significant in the regressions for total exports from low-income countries and exports from low-income countries to high-income countries. The coefficients are larger in the 2SLS regression than in the OLS regressions – the point estimates of the parameters suggest that a 1 percentage point increase in

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countries.

[23] The χ^2 (1) statistic is 3.80 in the regression for total exports and negative in the regression for exports to high-income countries. In small samples, negative test-values are not uncommon in Hausman-type tests. This is a

the number of Internet users increases total exports by 4.3 percentage points and exports from low-income countries to high-income countries by 3.8 percentage points. Although this might suggest that the effect is very large, it is important to keep in mind that there are very few Internet users per 100 people in many developing countries (see Table 3). Consequently, a 1-percentage point increase in the number of Internet users as percent of the population is large. Evaluated at the mean values for exports and Internet use in developing countries, the elasticity of total exports with respect to Internet use is about 0.8 and the elasticity of exports to high-income countries is about 1.0.

III.3 Robustness Checks for Cross-Sectional Results

Additional Control Variables. The variables included in the base regression, which were based upon the set of variables included in Pritchett (1996) do not include some variables that might potentially affect both Internet use and trade. One concern is that countries that are especially open to trade might also be more likely to liberalize their economies in other ways, including liberalizing telecommunications services. To try to reduce the possibility that the omission of variables that proxy for openness to trade might affect results, we add several additional control variables to the base regression. As a first test, we add dummy variables indicating that the country is a member of the World Trade Organization and that the country had signed the optional WTO agreement on basic telecommunication services to the base regression. The dummies are both statistically insignificant and to not appear to affect the main results (i.e., the coefficient on Internet use remains statistically significant at a 5 percent level and about the same size as before – see Table 7). As a second test, we add an alternative control for trade policy to the base regression – the average weighted tariff in 2001. The coefficient on this variable is also statistically insignificant and does not appear to affect the coefficient on Internet use.

In addition to adding variables to control for trade policy, we add two other variables to the base regression as additional checks. The first variable is a measure of political openness – countries that are more politically open might be more likely to allow their citizens free access to

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particular problem in regressions that use robust standard errors (see Baum *et al.*, 2003, p. 27).

the Internet and also might be more open to trade and investment. The second variable is a measure of 'remoteness' – how far the country is from other markets.[24] Adding these variables also does not appear to affect any of the main results – the coefficient on Internet use remains statistically significant at a 5 percent level and the coefficients on the additional control variables are statistically insignificant at conventional significance levels.

Internet Hosts. As discussed above, the measure of Internet use, Internet users as percent of the population, is based upon ITU estimates. Therefore, we replace this variable with the number of Internet hosts (per 100 people) as a robustness check. The results are broadly similar to the results using Internet users. The coefficient on Internet hosts is not statistically significant in the regression for exports from high-income countries to other high-income countries but is statistically significant and positive in the regression for exports from low-income countries to high-income countries. According to the parameter estimates, increasing the number of Internet hosts by one per 100 residents would increase exports from developing countries to high-income countries as a share of GDP by 2.2 percentage points. Coefficients on the control variables generally appear similar whether Internet hosts or Internet users are used as a proxy for Internet penetration.

Alternative Instruments. In addition to the instrument used above, we also re-estimate the 2SLS regressions using alternate sets of instruments. The main concern regarding the alternate instruments is that they are available for fewer countries and using them sharply reduces sample size. On the other hand, adding additional instruments allows us to test over-identifying assumptions. In the first regressions, we add additional instruments representing whether ISPs and leased lines are provided by legal monopolies in each country (see Table 8). In the regression for exports from high-income countries to other countries, the coefficient on Internet users becomes larger and becomes statistically significant at a 1 percent significance level. The point estimate suggests that increasing the number of Internet hosts by one per 100 inhabitants, exports to other high-income countries would increase by nearly two percentage points. In the regression for exports from low-income countries to high-income countries, the

[24] This measure comes from Rose (2003b)

coefficient remains statistically significant but become smaller than it was when the variable representing monopoly over data lines was the only instrument.

One advantage of adding additional instruments is that it becomes possible to test over-identifying assumptions. Using Hansen's J statistics as the test, the χ^2 (2) statistics are 0.5 (p-value=0.77) and 3.7 (p-value=0.15) for exports from high- and low-income countries respectively. Therefore, we fail to reject the null hypothesis that the instruments are exogenous, suggesting that the instruments are appropriate.

As a final robustness check, we replace the instruments with a dummy variable from a alternative source that represents whether ISPs need formal approval to operate in the country. The results are, once again, broadly similar to the results with the other sets instruments, although the point estimate of the parameter is modestly smaller.

IV. CONCLUSIONS

Developing countries with higher Internet penetration export more to high-income countries than do developing countries where penetration is lower. However, they do not appear to export more to other developing countries and high-income countries with greater Internet penetration do not appear to export more to either developing or developed countries. These results make intuitive sense. First, Internet access is so common among manufacturing enterprises in high-income countries that differences in the number of Internet users (or hosts) as a percent of the population probably reflects differences at the consumer, rather than the enterprise, level in developed countries (i.e., most manufacturing enterprises will be connected to the Internet in developed countries). In developing countries, contrarily, many manufacturing enterprises remain unconnected (see Table 1). Second, because Internet access is less common in developing countries than in developed countries, being connected to the Internet would seem to be a greater advantage for enterprises in developing countries with respect to exporting to developed countries (i.e., to countries where their counterparts are likely to have access). Finally, because of strong regional differences in income, and taking into account the fact that most exports from developing countries to other developing countries will be within the same region, communication costs will presumably be greater (and therefore Internet access a greater

benefit) for exports to distant developed countries than it would be for exports to neighboring developing countries.

The results are robust to controlling for the possibility that Internet use is endogenous (i.e., that causation also runs in the opposite direction). We use a dummy variable representing whether data lines are a monopoly in the country as an instrument for Internet access. Previous work has shown that regulation has a significant impact on Internet access in developing countries (Wallsten, 2003). Since Hausman tests confirm that Internet use is endogenous in some specifications and the instrument is negatively correlated with Internet use, even after controlling for other factors that might affect Internet use, the two-stage approach appears to be appropriate. As a final robustness check, we re-run the regressions using additional instruments related to the regulatory environment. In these regressions, tests of over-identifying assumptions confirm that the regulatory variables are valid instruments. These results strongly suggest that the correlation between Internet use and aggregate exports from developing countries to developed countries is not simply due to enterprises and individuals being more likely to use the Internet in countries that are more open to trade.

The results in this paper do not necessarily imply that causation runs in only one direction (i.e., they do not imply that openness to trade does not affect Internet penetration). Although greater Internet use appears to result in increased exports at the country level, it is possible that causation also runs in the opposite direction. Indeed, the results from the Hausman test for endogeneity suggest that this is the case: Internet use appears to be endogenous in the estimated model.

While trade openness is likely to affect Internet development, our results suggest that causality also runs the other direction. Even when we endogenize Internet use by using regulatory variables as instruments, we find that Internet penetration in developing countries is positively correlated with exports to developed countries. In other words, our analysis suggests that Internet use may, in fact, help stimulate exports from poor countries to rich. As a result, our analysis suggests that when countries block competition in telecommunications, something that is crucial to Internet development, the country suffers not just in reduced Internet penetration, but also in lower exports to rich countries.

V. TABLES

Table 1: % of Manufacturing Enterprises with Internet Access

Country	Year	ALL	Exporters	Non-Exporters	Difference between exporters and non-exporters
Albania	2002	38.2%	65.3%	26.9%	38.4%
Algeria	2002	41.5%	78.9%	39.6%	39.3%
Armenia	2002	43.3%	84.6%	31.1%	53.6%
Azerbaijan	2002	34.1%	63.0%	28.2%	34.8%
Bangladesh	2002	70.6%	86.0%	58.9%	27.1%
Belarus	2002	56.0%	79.2%	46.6%	32.5%
Bosnia and Herzegovina	2002	60.4%	75.4%	52.6%	22.8%
Bolivia	2001	56.3%	86.0%	50.8%	35.2%
Bulgaria	2002	63.2%	95.9%	49.1%	46.8%
China	2001	71.2%	81.8%	64.7%	17.0%
Croatia	2002	79.7%	89.0%	72.1%	16.9%
Czech	2002	77.2%	90.5%	69.6%	20.9%
Estonia	2002	91.8%	98.6%	86.0%	12.5%
Ethiopia	2001	39.2%	93.8%	35.1%	58.7%
FYR of Macedonia	2002	50.0%	70.6%	41.0%	29.6%
Georgia	2002	41.4%	72.7%	30.8%	42.0%
Hungary	2002	75.2%	92.8%	66.3%	26.5%
Kazakhstan	2002	45.6%	75.6%	38.7%	36.8%
Kyrgyz Republic	2002	34.1%	58.1%	27.6%	30.5%
Latvia	2002	63.1%	93.0%	53.8%	39.2%
Lithuania	2002	72.0%	98.4%	60.1%	38.2%
Moldova	2002	38.5%	65.5%	25.0%	40.5%
Morocco	1999	49.3%	59.0%	35.9%	23.1%
Mozambique	2002	73.8%	95.0%	70.6%	24.4%
Pakistan	2002	33.8%	74.9%	23.7%	51.2%
Peru	2002	57.5%	77.0%	40.4%	36.6%
Poland	2002	69.0%	88.5%	60.3%	28.2%
Romania	2002	59.2%	84.4%	50.8%	33.6%
Russia	2002	57.3%	88.2%	49.1%	39.1%
Slovakia	2002	84.7%	91.5%	78.4%	13.1%
Slovenia	2002	92.6%	97.1%	87.2%	9.8%
Tajikistan	2002	13.1%	25.7%	10.1%	15.6%
Turkey	2002	54.3%	77.8%	45.1%	32.6%
Ukraine	2002	60.0%	85.2%	51.0%	34.2%
Uzbekistan	2002	23.1%	60.6%	17.6%	43.0%
Yugoslavia	2002	71.2%	88.4%	62.2%	26.2%

Source: Investment Climate Surveys, The World Bank.

Table 2: Countries in the sample

High Income Countries	Developing Countries		
Australia	Albania	Indonesia	Sri Lanka
Austria	Argentina	Iran, Islamic Rep.	Swaziland
Bahrain	Azerbaijan	Jordan	Tanzania
Belgium	Barbados	Latvia	Thailand
Canada	Belarus	Lithuania	Togo
Cyprus	Benin	Macedonia, FYR	Trinidad and Tobago
Denmark	Bolivia	Malawi	Tunisia
Finland	Botswana	Malaysia	Turkey
France	Brazil	Mauritius	Uganda
Germany	Burkina Faso	Mexico	Uruguay
Greece	Burundi	Moldova	Venezuela, RB
Iceland	Cameroon	Mongolia	Zambia
Ireland	Cape Verde	Morocco	
Italy	Chile	Mozambique	
Korea, Rep.	China	Namibia	
Malta	Colombia	Niger	
Netherlands	Costa Rica	Pakistan	
New Zealand	Czech Republic	Paraguay	
Norway	Ecuador	Peru	
Portugal	Egypt, Arab Rep.	Philippines	
Singapore	Estonia	Poland	
Slovenia	Fiji	Romania	
Spain	Georgia	Russian Federation	
Sweden	Grenada	Rwanda	
Switzerland	Guatemala	Saudi Arabia	
United Kingdom	Guinea	Senegal	
United States	Hungary	South Africa	

Table 3: Means and Standard Deviations of Variables Included In Model

Variable	Source	High-Income Countries			Low-Income Countries		
		Obs.	Mean	Std. Dev.	Obs.	Mean	Std. Dev.
Exports (% of GDP)	COMTRADE	31	37.0%	27.0%	76	26.2%	20.8%
Exports to high-income countries (% of GDP)	COMTRADE	31	27.9%	18.9%	76	16.1%	16.7%
Exports to low-income countries (% of GDP)	COMTRADE	31	9.1%	14.2%	76	10.0%	10.0%
Internet Users (% of population)	ITU (2003)	31	35.4%	13.3%	68	4.7%	6.1%
Internet Hosts (Per 100 population)	ITU (2003)	30	66.4%	77.9%	76	3.1%	6.3%
Entry Restrictions for ISPs (Dummy)	Wallsten *et al*. (2003)	---	---	---	30	56.7%	50.4%
Monopoly for Data Lines (Dummy)	ITU (2002).	26	7.7%	27.2%	74	24.3%	43.2%
Monopoly for ISPs (Dummy)	ITU (2002).	28	3.6%	18.9%	59	10.2%	30.5%
Monopoly for Leased Lines (Dummy)	ITU (2002).	27	11.1%	32.0%	70	54.3%	50.2%
Population (Natural Log)	World Bank (2003b)	31	15.8	1.8	76	15.9	1.9
Area (Natural Log)	World Bank (2003b)	27	11.5	2.6	75	11.8	2.4
GDP per Capita (000s of US$, PPP adjusted)	World Bank (2003b)	30	24.8	7.5	75	5.6	3.7
Oil Exporter [a] (Dummy)	COMTRADE	31	6.5%	25.0%	76	9.2%	29.1%
Member of WTO (Dummy)	WTO website [b]	31	96.8%	18.0%	76	85.5%	35.4%
Member of WTO Agreement on Telecommunications	WTO website [c]	31	87.1%	34.1%	76	56.6%	49.9%
Average Tariff	COMTRADE [d]	25	3.4	1.9	73	10.7	5.7
Political Openness	Kraay *et al* (2003)	30	1.2	0.4	69	-0.1	0.8
Remoteness from rest of world (inverse of the mean of log GDP for trading partners divided by log distance)	Rose (2003b))	31	0.5	0.0	75	0.5	0.0

Notes: COMTRADE is United Nations Statistical Division (UNSD) Commodity Trade (COMTRADE) database.
[a] Oil Exporters are countries for whom oil makes up more that 30% of exports. High-income countries are countries with per capita income over US$10,000. [b] Data is available on http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm [c] Includes countries that were signatories of the original basic telecommunication services and those that had subsequently reached agreement on telecommunications services by the end of 2000 (including those that reached agreement based upon the accession agreements). [d] Data was supplemented with data from Heritage Foundation (2003) for most recent year available.

Table 4: First Stage Regressions of Internet Use on Regulatory Variables (OLS).

	OLS	OLS	OLS	OLS
Dependent Variables	**Internet Users** (as Percent of Population)			
Observations	91	80	88	26
Monopoly for Data Lines	-0.0362**			
(Dummy)	(-2.25)			
Monopoly for ISPs		-0.0187		
(Dummy)		(-0.82)		
Monopoly for Leased Lines			-0.0477***	
(Dummy)			(-3.03)	
Entry Restrictions for ISPs				-0.0660**
(Dummy)				(-2.26)
Population	-0.0061	-0.0052	-0.0116	-0.0297**
(Natural Log)	(-0.59)	(-0.47)	(-1.02)	(-2.31)
Area	0.0001	-0.0013	0.0031	0.0060
(Natural Log)	(0.02)	(-0.20)	(0.48)	(0.80)
GDP per Capita	0.0128***	0.0140**	0.0114**	0.0386***
(000s of US$, PPP adjusted)	(2.73)	(2.48)	(2.32)	(3.24)
GDP per Capita Squared	0.0001	0.0001	0.0001	-0.0020**
(000s of US$, PPP adjusted)	(0.57)	(0.33)	(0.64)	(-2.57)
Oil Exporter	-0.0015	-0.0058	-0.0004	-0.0018
(Dummy)	(-0.06)	(-0.14)	(-0.02)	(-0.12)
Constant	0.0839	0.0772	0.1623	0.3938*
	(0.71)	(0.59)	(1.20)	(2.09)
R-Squared	0.80	0.79	0.80	0.62

*** Sig. at 1% level ** Sig. at 5% level * Sig. at 10% level.
Note: T-statistics are in parentheses. Standard errors are Huber-White robust standard errors.

Table 5: Effect of Internet on exports (OLS).

	OLS	OLS	OLS	OLS	OLS	OLS
Sample	**High Income Countries**			**Developing Countries**		
Dependent Variables	**Exports (% of GDP)**	**Exports to high-income countries (% of GDP)**	**Exports to low- and middle-income countries (% of GDP)**	**Exports (% of GDP)**	**Exports to high-income countries (% of GDP)**	**Exports to low- and middle-income countries (% of GDP))**
Observations	27	27	27	66	66	66
Internet users	0.1146	0.0523	0.0623	1.4311**	1.2869**	0.1442
(As Percent of Population)	(0.27)	(0.16)	(0.41)	(2.08)	(2.27)	(0.57)
Population	0.0434	0.0124	0.0309	-0.0314	-0.0035	-0.0279***
(Natural Log)	(1.03)	(0.43)	(1.52)	(-0.89)	(-0.10)	(-2.77)
Area	-0.1051**	-0.0586**	-0.0465*	0.0242	0.0049	0.0193**
(Natural Log)	(-2.33)	(-2.59)	(-1.78)	(0.88)	(0.18)	(2.31)
GDP per Capita	0.0629	0.0301	0.0327	0.0271	0.0208	0.0063
(000s of US$, PPP adjusted)	(0.92)	(0.52)	(0.74)	(1.28)	(1.16)	(0.53)
GDP per Capita Squared	-0.0010	-0.0003	-0.0007	-0.0015	-0.0013	-0.0002
(000s of US$, PPP adjusted)	(-0.66)	(-0.21)	(-0.79)	(-1.06)	(-1.14)	(-0.24)
Oil Exporter [a]	0.0468	-0.1413	0.1881	0.0369	-0.0041	0.0410
(Dummy)	(0.57)	(-1.09)	(1.21)	(0.61)	(-0.06)	(1.16)
Constant	-0.0672	0.1894	-0.2566	0.3358	0.0496	0.2861**
	(-0.08)	(0.29)	(-0.45)	(1.17)	(0.19)	(2.19)
R-Squared	0.47	0.38	0.50	0.30	0.28	0.13

*** Sig. at 1% level ** Sig. at 5% level * Sig. at 10% level.
Note: T-statistics are in parentheses. Standard errors are Huber-White robust standard errors.

Table 6: Effect of Internet on exports (2SLS).

	2SLS	2SLS	2SLS	2SLS	2SLS	2SLS
Sample	**High Income Countries**			**Developing Countries**		
Dependent Variables	**Exports (as share of GDP)**	**Exports to high-income countries (as share of GDP)**	**Exports to low- and middle-income countries (% of GDP)**	**Exports (as share of GDP)**	**Exports to high-income countries (as share of GDP)**	**Exports to low-and middle-income countries (% of GDP)**
Instruments	Monopoly for data lines (Dummy)	Monopoly for data lines (Dummy)	Monopoly for data lines (Dummy)	Monopoly for data lines (Dummy)	Monopoly for data lines (Dummy)	Monopoly for data lines (Dummy)
Observations	26	26	26	65	65	66
Internet users	0.7643	0.9098	-0.1456	4.3504**	3.7510**	0.5994
(As Percent of Population)	(0.40)	(0.65)	(-0.09)	(2.07)	(2.38)	(0.46)
Population	0.0534	0.0258	0.0277	-0.0309	-0.0029	-0.0280***
(Natural Log)	(1.07)	(0.67)	(0.80)	(-0.73)	(-0.07)	(-2.71)
Area	-0.1141**	-0.0697**	-0.0444	0.0248	0.0053	0.0195**
(Natural Log)	(-2.14)	(-2.32)	(-1.34)	(0.76)	(0.17)	(2.43)
GDP per Capita	0.0685	0.0347	0.0338	-0.0214	-0.0202	-0.0012
(000s of US$, PPP adjusted)	(1.10)	(0.61)	(0.84)	(-0.65)	(-0.86)	(-0.05)
GDP per Capita Squared	-0.0012	-0.0006	-0.0007	-0.0001	-0.0001	0.0000
(000s of US$, PPP adjusted)	(-0.84)	(-0.47)	(-0.62)	(-0.07)	(-0.12)	(0.02)
Oil Exporter [a]	0.0089	-0.1882	0.1971	0.1311	0.0756	0.0555
(Dummy)	(0.05)	(-1.41)	(1.40)	(1.51)	(1.11)	(1.10)
Constant	-0.3253	-0.1256	-0.1996	0.3794	0.0855	0.2939**
	(-0.33)	(-0.19)	(-0.22)	(1.13)	(0.27)	(2.54)

*** Sig. at 1% level ** Sig. at 5% level * Sig. at 10% level.

Note: Instrument is a dummy variable indicating that data lines are (legally) a monopoly in that country. T-statistics are in parentheses. Standard errors are Huber-White robust standard errors.

Table 7: Effect of Internet use on exports from developing countries to high-income countries with additional control variables included in the analysis.

Sample	**Developing Countries**			
Dependent Variables	**Exports to high-income countries**			
Instruments	Monopoly for data lines (Dummy)			
Observations	65	63	65	65
Internet users	3.9135**	4.4399**	3.9014**	3.7120**
(As Percent of Population)	(2.27)	(2.14)	(2.23)	(2.45)
Population	0.0052	0.0004	-0.0073	-0.0031
(Natural Log)	(0.15)	(0.01)	(-0.16)	(-0.07)
Area	0.0011	0.0045	0.0071	0.0061
(Natural Log)	(0.04)	(0.11)	(0.21)	(0.19)
GDP per Capita	-0.0169	-0.0291	-0.0199	-0.0187
(000s of US$, PPP adjusted)	(-0.62)	(-1.01)	(-0.86)	(-0.88)
GDP per Capita Squared	-0.0003	0.0001	-0.0001	-0.0002
(000s of US$, PPP adjusted)	(-0.21)	(0.11)	(-0.09)	(-0.21)
Oil Exporter [a]	0.0613	0.0993	0.0679	0.0730
(Dummy)	(1.27)	(1.26)	(1.05)	(1.15)
Member of WTO	-0.0023			
(Dummy)	(-0.03)			
Member of WTO Agreement on Telecommunications	-0.0558			
(Dummy)	(-0.68)			
Average Tariff Rate		0.0038		
		(0.79)		
Political Openness			-0.0197	
(higher values mean more open)			(-0.61)	
Remoteness				-0.3232
(Average Distance from markets)				(-0.25)
Constant	0.0220	0.0030	0.1249	0.2273
	(0.08)	(0.01)	(0.34)	(0.31)
R-Squared	-0.20	-0.42	-0.21	-0.15

*** Sig. at 1% level ** Sig. at 5% level * Sig. at 10% level.

Note: T-statistics are in parentheses. Standard errors are Huber-White robust standard errors. [a] Oil Exporters are countries for whom oil makes up more that 30% of exports. High income countries are countries with per capita income over US$10,000.

Table 8: Effect of Internet on exports to high-income countries (Robustness Checks).

	Internet hosts replacing Internet users		Additional Instruments		Instrument from Wallsten (2003)
Sample	**High-income countries**	**Developing Countries**	**High-income countries**	**Developing Countries**	**Developing Countries**
Dependent Variables	**Exports to high-income countries**	**Exports to high-income countries**	**Exports to high-income countries**	**Exports to high-income countries**	**Exports to high-income countries**
Instruments	Monopoly for data lines (Dummy)	Monopoly for data lines (Dummy)	Monopolies for data lines, leased lines and ISPs (Dummies)	Monopolies for data lines, leased lines and ISPs (Dummies)	Entry Restrictions for ISPs (Dummy)
Observations	26	72	25	48	26
Internet hosts (Per 100 Population)	-0.2165 (-0.67)	2.2103** (2.20)			
Internet users (As Percent of Population)			1.9507*** (3.62)	2.3222*** (2.71)	1.7642** (2.47)
Population (Natural Log)	-0.0052 (-0.14)	0.0059 (0.17)	0.0420 (0.81)	0.0387 (1.51)	0.0471 (1.26)
Area (Natural Log)	-0.0350 (-1.02)	-0.0022 (-0.08)	-0.0828*** (-3.06)	-0.0255 (-1.15)	-0.0315 (-1.27)
GDP per Capita (000s of US$, PPP adjusted)	-0.0431 (-0.41)	0.0175 (1.25)	0.0370 (0.45)	-0.0158 (-0.82)	-0.0182 (-0.69)
GDP per Capita Squared (000s of US$, PPP adjusted)	0.0017 (0.61)	-0.0017* (-1.72)	-0.0009 (-0.48)	0.0007 (0.63)	0.0009 (0.58)
Oil Exporter [a] (Dummy)	-0.2318 (-1.34)	0.0330 (0.59)	-0.2369* (-1.81)	-0.0097 (-0.21)	0.0396 (1.10)
Constant	0.9820 (0.77)	0.0005 (0.00)	-0.4880 (-0.47)	-0.2057 (-1.08)	-0.2649 (-0.72)
Hansen's J-Test (p-value)	---	---	0.52 (0.77)	3.73 (0.15)	---
R-Squared	0.30	-0.12	-0.87	0.51	0.62

*** Sig. at 1% level ** Sig. at 5% level * Sig. at 10% level.

Note: T-statistics are in parentheses. Standard errors are Huber-White robust standard errors. [a] Oil Exporters are countries for whom oil makes up more that 30% of exports. High income countries are countries with per capita income over US$10,000.

VI. REFERENCES

Article 19, 1998. *Malawi: Communications Reform and Freedom of Expression*. Article 19, London, UK.

Auriol, Emmanuelle and Michael Warlters, 2003. "Priorities for Tax Reform in Africa." Mimeo, ARQADE and IDEA, Toulouse, France.

Baliamoune, Mina N., 2002. "The New Economy and Developing Countries." *WIDER Discussion Paper* # 2002/77, World Institute for Development Economics Research, Helsinki, Finland.

Baum, Christopher F.; Mark E. Schaffer and Steven Stillman, 2003. "Instrumental Variables and Gmm: Estimation and Testing." *Department of Economics Working Paper* # 545, Boston College, Boston, MA.

Caselli, Francesco and Wilbur John Coleman, 2001. "Cross-Country Technology Diffusion: The Case of Computers." *American Economic Review Papers and Proceedings* **91** (2), 328-335.

Clarke, George R.G., 2001. "Does Internet Connectivity Affect Export Performance? Evidence from the Transition Economies." Mimeo, World Bank, Washington DC.

Clarke, George R.G., forthcoming. "The Effect of Enterprise Ownership and Foreign Competition on Internet Diffusion in the Transition Economies." *Comparative Economic Studies.*

Clarke, George R.G.; Frew A. Gebreab and Henry R. Mgombelo, 2003. "Telecommunications Reform in Malawi." *Policy Research Working Paper* # 3036, World Bank, Washington DC.

Daly, John and Robert R. Miller, 1998. "Corporations' Use of the Internet in Developing Countries." *Discussion Paper* # 35, International Finance Company, Washington DC.

Dasgupta, Susmita; Somik V. Lall and David Wheeler, 2000. "Policy Reform, Economic Growth, and the Digital Divide: An Econometric Analysis." *Policy Research Working Paper* # 2567, World Bank, Washington DC.

Freund, Caroline and Diana Weinhold, 2000. "On the Effect of the Internet on International Trade." *International Finance Discussion Paper* # 693, Board of Governors of the Federal Research System, Washington DC.

Greene, William, 2000. *Econometric Analysis. 4th Edition*. Prentice-Hall, Upper Saddle River, NJ.

Heritage Foundation, 2003. *Index of Economic Freedom*. Heritage Foundation, Washington DC.

International Telecommunication Union, 2002. *Trends in Telecommunications Reform*. International Telecommunication Union, Geneva, Switzerland.

International Telecommunication Union, 2003. *World Telecommunication Indicators Database*. International Telecommunication Union, Geneva, Switzerland.

Kaufmann, Daniel; Aart Kraay and Massimo Mastruzzi, 2003. "Governance Matters Iii: Governance Indicators for 1996-2002." *Policy Research Working Paper* # 3106, World Bank, Washington DC.

Kiiski, Sampsa and Matti Pohjola, 2002. "Cross-Country Diffusion of the Internet." *Emergo: Journal of Transforming Economies and Societies* **9** (3), 25-36.

Kraemer, Kenneth L.; Jason Dedrick and Eric Shih, 2000. "Determinants of It Investment at the Country Level." *Working Paper* # 233, Center for Research on Information Technology and Organizations, University of California, Irvine, CA.

Kraemer, Kenneth L.; Jennifer Gibbs and Jason Dedrick, 2002. "Impact of Globalization on E-Commerce Adoption and Firm Performance: A Cross-Country Investigation." Mimeo, Irvine, CA.

McMillan, John and Christopher Woodruff, 2002. "The Central Role of Entrepreneurs in Transition Economies." *Journal of Economic Perspectives* **16** (3), 153-170.

Muller, Patrice and Pau Salas, 2003. "Internet Use in Transition Countries: Economic and Institutional Determinants." *TIGER working paper* # 44, Transformation, Integration, and Globalization Economic Research Center, Warsaw, Poland.

Onyeiwu, Steve, 2002. "Inter-Country Variations in Digital Technology in Africa." *WIDER Discussion Paper* # 2002/72, World Institute for Development Economic Research, Helsinki, Finland.

Pritchett, Lant, 1996. "Measuring Outward Orientation in Ldcs: Can It Be Done?" *Journal of Development Economics* **49** (2), 307-335.

Rose, Andrew K., 2003a. "Do We Really Know That the Wto Increases Trade?" *American Economic Review*, forthcoming.

Rose, Andrew K., 2003b. "Do Wto Members Have More Liberal Trade Policy." Mimeo, University of California, Berkeley, Berkeley CA.

Staiger, Douglas and James H. Stock, 1997. "Instrumental Variables Regression with Weak Instruments." *Econometrica* **65** (3), 557-586.

Tybout, James R., 2000. "Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?" *Journal of Economic Literature* **38** (1), 11-44.

Wallsten, Scott, 2003. "Regulation and Internet Use in Developing Countries." *Policy Research Working Paper* # 2979, World Bank, Washington DC.

Wallsten, Scott; George Clarke; Luke Haggarty; Roger Noll; Mary Shirley; Lixin Colin Xu; Frew Gebreab and Rosario Kaneshiro, 2003. "New Tools for Studying Network Industry Reforms in Developing Countries: The Database of Telecommunications Regulators and Regulations." Mimeo, World Bank, Washington DC.

World Bank, 2003a. *Peru: Microeconomic Constraints to Growth Study*. The World Bank, Washington DC.

World Bank, 2003b. *World Development Indicators*. World Bank, Washington DC.