The influence of technology on trade

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Abstract: The article give information about the influence of technology on trade.
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1. Introduction

In the modern era, technological advancements continue to shape and revolutionize various aspects of our lives. As countries become more interconnected, it's clear that technology doesn't merely affect individuals and businesses, but also the dynamics of global trade. As such, understanding the correlation between technology and trade is a critical question for both economists and policymakers.

Technology impacts trade in numerous ways, by increasing efficiency, changing the nature of goods and services traded, and opening up new markets. However, quantifying this relationship is a complex task due to the multifaceted nature of technology and the intricacies of global trade.

1.1. Motivation

Despite existing literature, there remains a gap in understanding how technology influences trade, especially considering rapid technological advancements in recent years. Moreover, the use of mobile cellular subscriptions and internet users as instrumental variables in assessing the effect of technology on trade has not been thoroughly explored in past studies.

1.2. Objective

The objective of this paper is to empirically investigate the relationship between technology and trade of all 217 countries using panel data. Moreover, to unravel the causal relationship, this paper will employ an instrumental variable approach, using mobile cellular subscriptions and internet users as instruments.

The remaining parts of the paper are as follows: After this introduction, a review of the existing literature is provided to position our work in the broader context. The third section explains the methodology, including the data description and econometric model. The fourth section discusses the results obtained from the analysis.

2. Literature Review

A considerable amount of literature has been devoted to studying the relationship between technology and trade. Among them, the work of Bas (2008) is particularly

noteworthy. In their research, they highlight the significant impact of technology, in terms of both production and distribution capabilities, on international trade flows. The study further showed that countries that are more technologically advanced tend to have more substantial international trade volumes, highlighting the important role that technology plays in enhancing trade competitiveness.

In terms of the relationship between GDP per capita and trade, Frankel and Romer (1999) conducted an empirical study that highlighted a significant positive correlation. Their findings indicated that an increase in GDP per capita often led to an increase in trade volume, substantiating the argument that countries with higher income levels tend to trade more.

On the relationship between population and trade, a study conducted by Alesina, Spolaore, and Wacziarg (2000) found that larger countries, in terms of population, tend to trade less with other countries. They suggested that bigger populations offer larger domestic markets that can fulfill the demand for various goods and services, thus reducing the dependency on international trade.

3. Methodology

To evaluate the impact of technology on trade, we employed two econometric techniques: Ordinary Least Squares (OLS) and Two-Stage Least Squares (2SLS). The OLS estimation provides initial insights into the relationship between the variables. The 2SLS method, an instrumental variable technique, is used to address potential endogeneity of the high-technology exports variable. We also conducted a test of overidentifying restrictions (Sargan test) and endogeneity test (Durbin-Wu-Hausman test) to verify the validity of our instruments and the necessity of an IV approach.

To examine the relationship between technology and trade of all 217 countries using panel data over the period 1969-2021, and to estimate OLS estimation we use the following model:

$$y_{it} = \beta_0 + \beta_1 hitech_{it} + other\ control\ variables + u$$

where, y_{it} - trade, $hitech_{it}$ - high-technology exports as a proxy of technology, i - 1,2,3,…,217 countries, t - 1960,1998,…,2021 years and u - error term.

As control variables we use the follows: GDP per capita and total population.

- “gdp” - GDP per capita. It can be a useful control variable when investigating the impact of technology on trade, as it represents the overall economic status of a country. Higher GDP per capita often corresponds to higher levels of trade, because wealthier countries tend to have more resources for imports and produce more valuable goods for export.

- “popul” - Total population. When studying the influence of technology on trade, total population can be an important control variable. Larger populations might generate greater demand for goods and services, potentially increasing both domestic

and international trade. Furthermore, larger populations may result in more diverse markets, which can influence trade dynamics.

The estimation procedures of the two stage least square (2SLS). At stage 1, we regress the suspected endogenous variable on all of the exogenous variables in the model, including the instrumental variables. To get the predicted value for technology, we estimate the following model using OLS:

$$hitech_{it} = \pi_0 + \pi_1 hitech_{it} + \pi_2 gdp_{it} + \pi_3 popul_{it} + \pi_4 Z_{1it} + \pi_5 Z_{2it} + error$$

where, Z_{1it} - mobcel and Z_{2it} - ininter are instrumental variables.

Here, we assume that hitech is endogenous, the others are exogenous variables.

-"mobcel" - Mobile cellular subscriptions. It represents the number of subscriptions to a public mobile telephone service, including both post-paid and pre-paid contracts, expressed per 100 individuals within a population (World Bank, 2023). This measure is suitable as an instrumental variable in the analysis of the impact of technology on trade, because it could impact the level of technological adoption in a country, but it isn't directly related to trade. Mobile subscriptions could influence a country's ability to adopt high-tech products and services, without being directly related to the level of trade itself.

-"ininter" - Internet users. It represents the percentage of individuals who have used the internet from any location in the last three months (World Bank, 2023). This variable is a valid instrumental variable because it likely affects the level of technological adoption in a country, but isn't directly related to trade levels. Internet usage could signify a greater potential for the adoption of high-tech products and services, without being directly tied to the level of trade itself.

At stage 2, we replace hitech with preditcted value $\widehat{hitech}$, then estimate the following model using OLS:

$$y_{it} = \beta_0 + \beta_1 \widehat{hitech}_{it} + \beta_2 gdp_{it} + \beta_3 popul_{it} + u$$

In this way, we use the 2SLS approach to try to remove the bias caused by endogeneity in our regression model.

Data was sourced from the World Development Indicators (WDI) dataset, spanning from 1960 to 2021 and encompassing 217 countries. The dependent variable, trade, is represented as a percentage of GDP. The independent variable is high-technology exports as a percentage of manufactured exports. The control variables are GDP per capita (in current US$) and total population. The instrumental variables used are mobile cellular subscriptions (per 100 people) and internet users (per 100 people). Data on all variables (dependent, independent, instrumental and control) are gathered from the available cite https://databank.worldbank.org/source/world-development-indicators# and data descriptive is shown table 1.

Table 1

Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
trade	8566	78.184	54.34	.021	863.195
hitech	2040	14.808	123.403	0	4943.811
gdp	10346	9200.697	18094.409	12.787	234317.08
popul	13424	24697849	1.036e+08	2646	1.412e+09
mobcel	10063	35.055	50.999	0	420.853
ininter	6444	24.745	30.246	0	100
year	13454	1990.5	17.896	1960	2021

4. Result

From the results of the OLS and 2SLS regression analyses, we see different effects for the technology on trade (see table 2).

Table 2

Results of simple OLS and 2SLS

	(1)	(2)
VARIABLES	OLS	2SLS
hitech	0.0288***	1.375***
	(0.0106)	(0.346)
gdp	0.000880***	0.000753***
	(8.95e-05)	(0.000194)
popul	-5.77e-08***	-6.07e-08**
	(5.89e-09)	(2.53e-08)
Constant	77.53***	59.53***
	(1.405)	(7.246)
Observations	1,882	1,849
R-squared	0.155	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In the OLS model, a unit increase in high-technology exports results in a 0.0288 unit increase in trade. However, in the 2SLS model, which accounts for potential endogeneity by using instrumental variables, the effect is larger: a unit increase in high-technology exports results in a 1.37 unit increase in trade.

An interesting point to note is that the Durbin and Wu-Hausman tests for endogeneity show a p-value of 0.00, which provides strong evidence against the null hypothesis that the variables are exogenous. This indicates that high-technology exports may indeed be endogenous, thus justifying the use of the 2SLS approach (see table 3).

Table 3.

Hausman test

Tests of endogeneity

H0: Variables are exogenous

Durbin (score) chi2(1) = 171.385 (p = 0.0000)

Wu-Hausman F(1,1844) = 188.383 (p = 0.0000)

The 2SLS estimates suggest a significantly larger effect of high-technology exports on trade compared to the OLS estimates. This implies that high-tech exports have a more substantial role in driving trade than what would be inferred from OLS estimates alone.

As for the control variables in both models, the coefficient of GDP per capita is positive, indicating a positive relationship with trade. On the other hand, population size shows a negative relationship with trade, as indicated by the negative coefficient. Our findings related to GDP per capita also align with Frankel and Romer's (1999) results, confirming that economic prosperity is positively associated with trade. However, the negative relationship between population and trade found in our study is in direct agreement with Alesina, Spolaore, and Wacziarg's (2000) research, suggesting that larger populations may indeed reduce a country's reliance on international trade.

The Sargan and Basmann tests of overidentifying restrictions produce p-values of 0.3622 and 0.3628 respectively, failing to reject the null hypothesis that the instruments are valid. This suggests that mobile cellular subscriptions and internet users are valid instruments in this model (see table 4).

Table 4.

Sargan test

Tests of overidentifying restrictions:
Sargan (score) chi2(1) = .830126 (p = 0.3622)
Basmann chi2(1) = .828253 (p = 0.3628)

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