Trade Openness, Aggregate Saving and Investment: An Empirical Investigation

Lixin Tang*

October 2015

Abstract

Countries more open to international trade have higher level of capital accumulation (Levine and Renelt, 1992; Wacziarg and Welch, 2008). This can be due to a demand-side channel in which countries more open to trade have higher demand for capital associated with higher productivity, or due to a supply-side channel in which trade openness increases the aggregate saving rate. In this paper, I distinguish these two channels by studying the relationship between aggregate saving rate and trade openness, and that between aggregate investment rate and trade openness. I document a robust and strongly positive relationship between trade openness and the saving rate in a large sample of countries. First, I analyse the relationship among aggregate saving rate, aggregate investment rate and trade openness in a cross section of countries using the IV approach pioneered by Frankel and Romer (1999). I find trade openness to have a large effect on the aggregate saving rate, but not on the aggregate investment rate. Second, I extend the gravity-based IV approach pioneered by Frankel and Romer (1999) to a panel setting, and find large effects of trade openness on the saving rate. I find the saving-openness relationship to be stronger and more robust than the investment-openness relationship. Overall, my results suggest that higher aggregate saving rate following an increase in trade openness is responsible for the observed positive relationship between capital accumulation and trade openness.

JEL Code: F1, F4, F6, O1, O4

Key words: *aggregate saving rate, capital accumulation*

*Shanghai University of Finance and Economics. The materials in this paper were previously included in an early version of my job market paper (Tang, 2015). I thank Nuno Limão for his guidance and encouragement. I thank seminar participants at University of Maryland, College Park and the 2014 Midwest Economic Theory and Trade Conference for helpful comments. Any remaining errors are my own.

1 Introduction

Does international trade increase aggregate income of countries? What are the channels? A large literature, including Sachs and Warner (1995), Frankel and Romer (1999), Alcalá and Ciccone (2004) and Feyrer (2009) among others, has examined the empirical relationship between trade and income at the country level. Although there are methodological and measurement issues in the identification of a causal relationship between trade openness and income level, studies tend to find a positive relationship between trade openness and income level.

Broadly speaking, a causal effect of trade openness on income level may be due to two reasons, higher productivity, and higher factor accumulation including both human capital and physical capital.[1] Some studies of the trade-income relationship, including the influential study by Frankel and Romer (1999), help shed light on the relative importance of various channels. These studies find that higher capital accumulation plays a crucial part in the trade-income relationship. Both Wacziarg (2001) and Wacziarg and Welch (2008) conclude that higher capital accumulation accounts for as much as half of the income gains from trade openness. In a Solow (1956) growth model, any increase in productivity due to trade, naturally leads to an increase in capital accumulation (Baldwin, 1992). This is the demand-side channel of capital accumulation. In this paper, I demonstrate another channel responsible for the relationship between trade openness and capital accumulation. I document a robust and strongly positive relationship between trade openness and the saving rate, in both a cross-section and a panel of countries. I find the saving-openness relationship to be stronger and more robust than the investment-openness relationship. Overall, my results suggest that higher aggregate saving rate following an increase in trade openness is responsible for the observed positive relationship between capital accumulation and trade openness. This is the supply-side channel of capital accumulation.

Standard models of international trade tend to predict smaller welfare gains than those found in empirical studies (Costinot and Rodriguez-Clare, 2013). Recently, a number of papers, for example Ossa (2012), Edmond, Midrigan and Xu (forthcoming) and Sampson (2014) have proposed theoretical mechanisms that produce larger gains from trade. Tang (2015) proposes that international trade increases aggregate income partly through higher savings and high investment. In the paper, entrepreneurs have heterogeneous and stochastic productivity and face uninsurable income risk. Entrepreneurs with high productivity have higher income relative to their long-run income and save aggressively for the future.

[1] Trade may increase productivity through a number of channels, for example, through reallocation of resources among firms (Melitz, 2003; Pavcnik, 2002) or by increasing the variety of intermediate inputs (Goldberg, Khandelwal, Pavcnik and Topalova, 2010).

Therefore, cross-sectionally, the saving rate of entrepreneurs is increasing in their income. An increase in trade openness increases the share of total profits received by the most productive entrepreneurs ("the exporters") who have the highest saving rates. This leads to a large increase in aggregate saving and investment which contribute to the overall increase in aggregate income. Therefore, the empirical findings of this paper is consistent with the theoretical framework in Tang (2015).

I use data from a large number of countries to study the relationship between trade openness and the aggregate saving rate. To distinguish the supply-side channel from the demand-side channel, I also examine the relationship between the aggregate investment rate and trade openness. To begin, I study the relationship between aggregate saving and trade openness, and between aggregate investment and trade openness, in a cross section of countries using the IV approach pioneered by Frankel and Romer (1999). I find that trade openness has a large positive effect on the aggregate saving rate in a cross section of countries. I do not find a positive relationship between investment rate and trade openness in this approach. Additionally, I extend the gravity-based IV approach pioneered by Frankel and Romer (1999) to a panel setting, and find larger effects of trade openness on the saving rate than in the simple fixed-effects regressions. Crucially, the relationship between trade openness and aggregate saving rate is much stronger than the relationship between trade openness and aggregate investment rate. The results are supportive of a supply-side channel of capital accumulation associated with trade openness, while the demand-side channel is less evident in the data.

This paper is related to the large literature examining international capital flows (Lucas, 1990; Gourinchas and Jeanne, 2013). Many studies including Sandri (2014), Buera and Shin (2015) and Coeurdacier, Guibaud and Jin (forthcoming) focus on the interaction between credit market frictions and growth for the patterns of international capital flows. A smaller number of studies such as Jin (2012), Ju, Shi and Wei (2012) and Barattieri (2014) focus on the relationship between trade reforms and current account balances. The current study deviates from the existing studies in two ways. First, while these studies tend to contain a small and largely suggestive empirical component to support their theoretical propositions, the contribution of this paper is primarily empirical.[2] In particular, this paper borrows heavily from the large trade and income literature and employs an IV strategy to establish a causal relationship. Second, in contrast to the studies above which studies the relationship between trade openness and current account balance which is equivalent to the difference between the saving rate and the investment rate, I study the relationship between trade openness and the *level* of of the saving rate, and the relationship between

[2]Santos-Paulino and Thirlwall (2004) examines empirically the effects of trade liberalizations on imports, exports and trade balances. However, their empirical analysis covers only 20 developing countries.

trade openness and the *level* of the investment rate separately.[3] I find that the relationship between trade openness and the saving rate to be more robust. This is a novel finding in the literature and is consistent with theoretical framework in Tang (2015).

Lastly, this paper is related to the empirical literature on the determinants of saving rates (Loayza, Schmidt-Hebbel and Servén (2000b), Loayza, Schmidt-Hebbel and Servén (2000a) and Li, Zhang and Zhang (2007)). Relative to these papers, I focus on one specific determinant, trade openness and employ an IV approach to address causality.

Section 2 presents the specification for both a cross section of and a panel of countries. Section 3 describe the data used in the study. Section 4 presents the results. Section 5 concludes.

2 Methodology

2.1 Cross Section

I first study the relationship between trade openness and aggregate saving rate in a large cross section of countries. Following Alcalá and Ciccone (2004) closely, the baseline cross-sectional regression of interest is

$$\mathrm{Y}_i = \beta_0 + \beta_1(\mathrm{Trade/GDP})_i + \beta_2\mathrm{Institution}_i + \beta_3 X_i + u_i \tag{1}$$

where Y_i is the gross national saving rate or the gross investment rate for country i, $(\mathrm{Trade/GDP})_i$ is the Trade/GDP ratio, $\mathrm{Institution}_i$ is a measure of institutional quality, and X_i is a vector of control variables, respectively.[4] The proxy of institutional quality, adapted by Alcalá and Ciccone (2004) from Kaufmann, Kraay and Zoido-Lobatón (1999), is designed to measure government effectiveness, rule of law and graft. Following Alcalá and Ciccone (2004), I control for the log of population and the log of total land area to capture any scale effects. Lastly, I include continent dummies in all regressions.

Trade openness can be correlated with many variables, such as income level and factor endowment. In a cross-section OLS regression with the aggregate saving rate as the dependent variable, it is difficult to sufficiently control for all potential variables. Additionally, reverse causality is also a concern. For example, a higher saving rate may allow a country to develop its tradable sector and have a higher level

[3] Suppose a 1-percent-point increase in trade openness increase the saving rate by x+y% and the investment rate by x% . The existing studies are interested in y as it is related to international capital flows. The current study is interested in both x and y as they are related to aggregate income of the economies.

[4] In Alcalá and Ciccone (2004), the dependent variable of interest is log output per worker. Since they are interested in estimating the elasticity of productivity with respect to openness, they use the log of real openness (instead of its level). I follow Frankel and Romer (1999) and use $(\mathrm{Trade/GDP})_i$ as the main measure of openness in this paper.

of openness. I employ the Frankel and Romer (1999) gravity approach to construct an instrument for trade openness. In the first step, I run a gravity regression to relate bilateral trade flows to variables capturing geography and population. Specifically, the gravity equation is

$$\log(\frac{\text{Trade}_{ij}}{\text{GDP}_i}) = \delta_0 + \delta_1 X_{ij} + w_{ij} \tag{2}$$

where Trade_{ij} is the sum of exports and imports between country i and country j. The X_{ij} term is a vector of geography variables include bilateral distance, total land area, landlocked status and bordering status. Bordering status is interacted with all other geographic features and population. This follows Frankel and Romer (1999) exactly.[5] For each country, I aggregate the (un-logged) predicted values of this gravity equation across all trade partners. The resulting variable is then used as an instrument for trade openness.

I instrument for institutional quality using the population share speaking one of five primary European languages since birth and distance from equator, following Hall and Jones (1999) and Alcalá and Ciccone (2004). Hall and Jones (1999) argue that these two variables capture the historical influence of European countries on institutional quality.

2.2 Panel Regressions

While I control for crucial variables such as institutional qualities and regional dummies in section 2.1, other potential confounding factors remain. To address the issue of unobservable differences, I examine the relationship between aggregate saving rate and trade openness in a panel of countries. The equation of interest is

$$Y_{it} = \beta_0 + \beta_1(\text{Trade/GDP})_{it} + \beta_2 X_{it} + c_i + \mu_t + v_{it} \tag{3}$$

where Y_{it} is the national saving rate or the national investment rate in country i over a five-year period t, $(\text{Trade/GDP})_{it}$ is the Trade/GDP ratio (the openness ratio), X_{it} is a vector of control variables, and c_i and μ_t are country and time fixed effects, respectively.

A concern about the fixed-effects results presented above is that openness might be endogenous with respect to saving. For example, a strong economy overall could simultaneously boost saving and trade. Alternatively, an increase in domestic saving could allow domestic firms to invest in export operations. To address issues of endogeneity, I again follow Frankel and Romer (1999) and Alcalá and Ciccone (2004)

[5] Specifically, the geography terms in the estimated gravity equation

in using gravity variables as instruments for openness, as in the previous cross-section analysis. Here, I extend the gravity-based methodology of Frankel and Romer (1999) to a panel setting.[6]

To construct my instrument, I run the following panel regression on the bilateral trade share:

$$\log(\frac{\text{Trade}_{ij\tau}}{\text{GDP}_{i\tau}}) = \gamma_0 + \gamma_1 \text{Freight}_\tau \cdot \ln(Dist_{ij}) + \gamma_2 X_{ij} + \gamma_3 Z_{ij\tau} + u_\tau + \epsilon_{ij\tau} \tag{4}$$

where $\text{Trade}_{ij\tau}$ is the sum of exports and imports between country i and country j, Freight_τ is an index of shipping costs (common to all countries) from Hummels (2007), $\ln(Dist_{ij})$ is the log of bilateral distance between the two countries, X_{ij} is a vector of geography variables (including $\ln(Dist_{ij})$), $Z_{ij\tau}$ are the time-varying gravity terms related to population, and u_τ is a year fixed effect.[7] Specifically, X_{ij} includes bilateral distance, total land area, landlocked status, bordering status, and the interaction of bordering status with all other geographic features; and $Z_{ij\tau}$ includes population and its interaction with bordering status. These gravity terms follow Frankel and Romer (1999) closely. Aside from the year fixed effect in Equation (4), the resulting predicted trade shares are time-varying for two reasons. First, the gravity terms involving population are time varying. Second, advances in shipping technology, as reflected in the decrease in the index of shipping costs, increase bilateral trade more for country pairs with greater bilateral distance.[8] In other words, $\gamma_1 < 0$ in Equation (4). This is the key variation I exploit in the IV strategy. In practice, both sources of time variation are necessary to have a relatively strong first stage in the 2SLS regression. Since the population size of a country may have a direct effect on its national saving rate, I include log of population as a control variable in the 2SLS regression. The identifying assumption is that the shipping cost index (common to all countries), and the populations of a country's trade partners, are exogenous with respect to its gross national saving rate and gross investment rate.

3 Data

The conventional openness ratio (the Trade/GDP ratio) is defined as the sum of exports and imports over GDP, where each term is calculated based on the nominal exchange rate. Alcalá and Ciccone (2004) argue that the real openness ratio, defined as the sum of real exports and real imports over purchasing power

[6] Feyrer (2009) and Felbermayr and Gröschl (2013) use gravity-based IV in a panel setting to study the relationship between income and trade openness. Feyrer (2009) exploits the fact that improvement in aircraft technology increases bilateral trade more for country pairs with relatively short air routes compared to sea routes. Felbermayr and Gröschl (2013) use natural disasters as a source of exogenous variation.

[7] I experiment with a specification with bilateral fixed effects to control for all time-invariant factors. I find that the 2SLS results from the resulting IV are very sensitive to exclusions of particular subsamples.

[8] Hummels (2007) documents that the cost of freight shipping decreased by half from 1962 to 2000.

parity (PPP) GDP, is theoretically preferred to the conventional measure. According to the model in Alcalá and Ciccone (2004), greater trade openness can reduce the price level in the tradable sector relative to the price level in the non-tradable sector as a result of a productivity increase in the tradable sector. This may cause a distortion in the conventional openness ratio. While Alcalá and Ciccone (2004) do not adjust the sum of exports and imports for PPP prices, presumably due to data availability, the most recent Penn World Table (Mark 8.0) (Feenstra, Inklaar and Timmer, 2013) has made this adjustment possible. I use the *real* openness ratio from PWT (Mark 8.0), which adjusts the sum of exports and imports for PPP prices, throughout this paper.

My main measure of national saving is the gross national saving rate from the World Development Index (WDI), which is defined as national income plus net transfers less consumption, as a percentage of gross national income. Figure 1 plots the gross national saving rate against the Trade/GDP ratio in 1985 for the 99 countries for which I have data on all variables in Equation (1).[9] The slope of the fitted line in Figure 1 is 0.0877 and is statistically significant at 5%.

My measure of investment rate is gross fixed capital formation as a percentage of GDP, available from the WDI database. A summary of these main variables and data sources is provided in Appendix Appendix I.

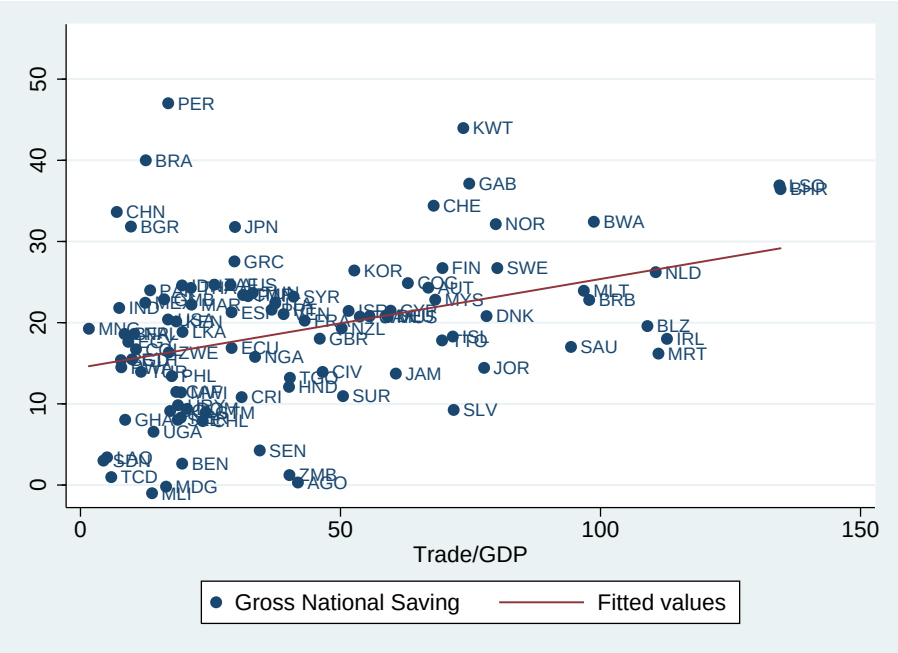
For the cross-sectional regressions, I focus on data from 1985 to facilitate comparison with Frankel and Romer (1999) and Alcalá and Ciccone (2004), both of which use data from 1985. I exclude small countries with a population of less than 1.5 million in the regression analysis. The resulting cross-sectional sample includes 84 countries.

To construct the sample for the panel regressions, I group the years 1961-2005 into nine non-overlapping five-year intervals and use the averages of yearly data in the regressions. This reduces the influence of outliers. I exclude the years after 2005 in view of the global recession starting in 2007. I exclude countries whose population in 1961 is smaller than 1.5 million, because the aggregate variables of small states are more prone to large fluctuations.[10] The final sample includes 110 countries for the FE regressions without IV, and 82 countries for the FE regressions with IV.

[9] Singapore and Bahamas appear to be outliers in terms of openness and are excluded from Figure 1 and the regression analysis. Inclusion of these two countries would strengthen the results.

[10] Mankiw, Romer and Weil (1992) argue that the determination of real income in small countries may be dominated by idiosyncratic factors, and they exclude small countries from one of their samples in their test of the Solow growth model. The population cutoff of 1.5 million for small states in this paper is taken from the World Bank (`http://www.worldbank.org/en/country/smallstates/overview`).

Figure 1: National Saving Rate and Trade Openness in 1985



WDI Database

4 Results

4.1 Cross-sectional Results

The OLS results from the cross section are reported in Column (1) of Table 2. Consistent with Figure 1, the national saving rate is positively correlated with trade openness at 10% significance level.

The first-stage regressions are presented in Table 1. The first-stage coefficients on the excluded IVs have the expected signs. The first-stage excluded-IV F-statistics for the two instruments are 7.64 and 14.8 respectively. The results from the 2SLS regressions for saving are presented in Column (2) of Table 2. According to the point estimate, a one-percentage-point increase in the Trade/GDP ratio raises the national saving rate by 0.398 percentage point. The coefficient is statistically significant at 10%. Institutional quality does not appear to have a significant effect on the aggregate saving rate. To alleviate weak-instrument-bias concerns, I re-estimate all specifications using the Limited Information Maximum Likelihood (LIML) Estimator. The results from LIML in Column (3) are very similar to the 2SLS estimates.[11]

In Columns (4)-(6) of Table 2, I repeat the regression with the investment rate as the dependent

[11]The Limited Information Maximum Likelihood (LIML) estimator is more robust in over-identified models. It is less efficient but also less biased than 2SLS (Angrist and Pischke, 2008, p.213).

Table 1: First Stages of 2SLS Cross-sectional Regressions

	(1) Trade/GDP	(2) Institution
Predicted Trade Share	0.551***	0.00907*
	(0.155)	(0.00466)
European Languages	8.404	0.834***
	(9.741)	(0.277)
Distance to Equator	0.207	0.0275***
	(0.206)	(0.00636)
Log Population	-5.280	0.0446
	(3.276)	(0.0531)
Log Area	1.279	0.0143
	(2.816)	(0.0532)
Excluded IV F-stat	7.635	14.82
R^2	0.467	0.725
N	84	84

Robust standard errors are reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively. The data are from 1985. The variable "Predicted Trade Share" is constructed using population and geography as determinants of bilateral trade flows in the gravity equation. We then aggregate the predicted values for each country. The variable "Europrean Languages" refers to the population share speaking one of five primary European languages since birth.

Table 2: The Effects of Trade on Aggregate Saving and Investment

Cross-sectional Regressions with IV

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Saving			Investment			Output		
	OLS	2SLS	LIML	OLS	2SLS	LIML	OLS	2SLS	LIML
Trade/GDP	0.0644*	0.398*	0.400*	-0.00185	-0.118	-0.128	0.00784**	0.0224*	0.0224*
	(0.0379)	(0.229)	(0.231)	(0.0604)	(0.150)	(0.161)	(0.00386)	(0.0124)	(0.0125)
Institutional	1.589	-4.660	-4.702	3.095**	6.041*	6.264*	0.592***	0.424*	0.423*
Quality	(1.511)	(4.708)	(4.741)	(1.393)	(3.549)	(3.765)	(0.120)	(0.230)	(0.231)
N	84	84	84	84	84	84	84	84	84

The dependent variables are the gross national saving rate (Columns (1)-(3)), the gross investment rate (Columns (4)-(6)) and log of GDP per capita (Columns (7)-(9)), respectively. Robust standard errors are reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively. The data are from 1985. I instrument for the Trade/GDP ratio and institutional quality. The instruments used are predicted trade shares (Frankel and Romer, 1999), the population share speaking one of five primary European languages since birth, and distance from the equator. All regressions include log population, log total land area, and continental dummies as right-hand side variables.

Table 3: Robustness Checks on Cross-sectional Regression with IV

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Saving			Investment			Output		
	D-graph	No-Oil	10-Years	D-graph	No-Oil	10-Years	D-graph	No-Oil	10-Years
Trade/GDP	0.328*	0.354*	0.389**	-0.118	-0.106	0.0818	0.0181**	0.0187	0.0237**
	(0.172)	(0.202)	(0.172)	(0.130)	(0.148)	(0.119)	(0.00867)	(0.0115)	(0.0104)
Institutional	-8.252	-5.056	-4.170	6.560	5.888	2.464	0.250	0.444**	0.427*
Quality	(6.526)	(4.404)	(3.795)	(5.208)	(3.595)	(3.090)	(0.299)	(0.224)	(0.240)
N	84	81	84	84	81	84	84	81	84

Robust standard errors are reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively. The basic specification follows Column (1) of Table 2. Columns (1), (4) and (7) control for young and old age dependency ratios; Columns (2), (5) and (8) exclude major oil exporters in the sample; Columns (3), (6) and (9) uses data averaged over 1981-1990.

variable. If the saving-openness relationship is driven primarily by a higher return to investment, we would expect the investment-openness relationship to be stronger than the saving-openness relationship, since at least some of the investment would be financed by capital inflows. I do not find a positive effect of trade openness on the investment rate in the 2SLS results in Column (5). I interpret the results as supportive of the supply-side channel of capital accumulation.

To provide a comparison to the trade-growth literature, Columns (7)-(9) of Table 2 repeat the regressions with log of GDP per capita as the dependent variable. In the 2SLS results in Column (8), the coefficient on the Trade/GDP ratio is 0.0224 and statistically significant at 10%. The log of GDP per capita increases by 0.527 standard deviation, compared to an increase of 1.099 standard deviation for the gross national saving rate, if the openness measure increases by one standard deviation.

I subject the baseline cross-sectional IV regressions to a number of robustness checks. Results are shown in Table 3. An important determinant of national saving rate is the demographics of the country, as younger households tend to have higher saving rates. In Columns (1), (4) and (7) of Table 3, I control for both young age dependency ratio and old age dependency ratio of a country. With the demographic controls, the coefficient on the Trade/GDP ratio decreases to 0.328 but remains significant at 10%. On the other hand, the estimated effect of Trade/GDP ratio on the investment rate remains negative and insignificant (Column (4)). Lastly, the effect of Trade/GDP on output per capita decreases but remains significant at 5% level (Column(7)).

Countries rich in natural resources, such as members of Organization of the Petroleum Exporting Countries (OPEC), tend to have higher export revenue and thus higher Trade/GDP ratio. These countries may have higher saving rate due to volatility in commodity prices. The countries may also have a higher

investment rate as the extraction of natural resources such as petroleum is capital intensive. Consequently, the results in Table 2 may be driven by major oil exporters in the sample. In Columns (2), (5) and (8) of Table 3, we exclude the major oil exporter from the sample and find that the results are not substantially affected.

In our baseline results, I use data from 1985 to facilitate comparison with Frankel and Romer (1999) and Alcalá and Ciccone (2004), both of which use data from 1985. However, one concern is that the results might be driven by data anomalies from one particular year. In Columns (3), (6) and (9), I take the ten-year average of all relevant variables over 1981-1990 and repeat the regressions. Table 3 indicates that the results are not driven by one particular year alone.

4.2 Results from Panel Regressions

Fixed-Effects Panel Regressions without IV

It is instructive to first look at the panel regressions without IV. Table 4 reproduces Table 9 of Tang (2015). Columns (1)-(3) demonstrate a strong correlation between trade openness and the saving rate. Column (1) includes the Trade/GDP ratio as the only right-hand-side variable aside from the fixed effects. Column (2) controls for income by including the log of GDP per capita and its square. Column (3) controls for financial development using the Credit/GDP ratio. I lag he log of GDP per capita and its square, and the Credit/GDP ratio by five years due to concerns of endogeneity.

A higher level of openness may be a result rather than a cause of a higher aggregate saving rate. For example, a positive shock to the national saving rate may allow a country to build up infrastructure conducive to international trade, resulting in a higher measured level of openness. To address this issue, I include the five-year lag and lead of the Trade/GDP ratio in the panel regression in Column (4).

The strong correlation between the Trade/GDP ratio and the saving rate may be driven by demand-side factors, as a higher return to investment after a trade liberalization induces households to save more. In Column (5), I control for the gross investment rate in the regression. The results show that, conditional on the gross investment rate, there is still a strong and positive correlation between the Trade/GDP ratio and the national saving rate.

In Panel B of Table 4, I repeat the analysis with the gross investment rate as the dependent variable. The coefficient on the Trade/GDP ratio is positive and statistically significant at 1% in Columns (2) and (3), but it is not statistically significant in Column (1). According to Column (3), the gross investment rate increases by 0.166 standard deviation following a one-standard-deviation increase in the Trade/GDP

Table 4: The Effect of Trade on Aggregate Saving and Investment

Fixed-Effects Panel Regressions

	(1) No-Covar	(2) Lag-Y	(3) Fin-Dev	(4) Lag-Lead	(5) Inv/Sav
Panel A.			Gross Saving Rate		
Trade/GDP	0.0728***	0.0906***	0.0918***	0.0811**	0.0592*
	(0.0275)	(0.0331)	(0.0330)	(0.0313)	(0.0331)
Trade/GDP (Lag)				-0.00679	
				(0.0314)	
Trade/GDP (Lead)				0.0395	
				(0.0495)	
Investment Rate					0.653***
					(0.0797)
Within R^2	0.0793	0.119	0.120	0.127	0.320
Panel B.			Gross Investment Rate		
Trade/GDP	0.0163	0.0472***	0.0499***	0.0604***	0.0180
	(0.0149)	(0.0140)	(0.0151)	(0.0190)	(0.0166)
Trade/GDP (Lag)				0.0126	
				(0.0183)	
Trade/GDP (Lead)				-0.0213	
				(0.0266)	
Saving Rate					0.348***
					(0.0702)
Within R^2	0.0438	0.140	0.149	0.170	0.343
N Countries	110	110	110	106	110
N Observations	556	556	556	452	556

Robust standard errors are clustered at the country level and reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively. I group the years 1961-2005 into nine five-year intervals and use the averages of yearly data in the regressions. Time and country fixed effects are included in all regressions. Column (1) ("No-Covar") includes only time and country fixed effects as controls; Column (2) ("Lag-Y") adds log income and its square (both lagged) as controls; Column (3) ("Fin-Dev") additionally controls for the Credit/GDP ratio (lagged); Column (4) controls for the five-year lag and lead of the Trade/GDP ratio, in addition to the controls in Column (3); Column (5) ("Inv/Sav") controls for the investment rate in the saving regression, and for the saving rate in the investment regression, in addition to the controls in Column (3).

ratio, compared to an increase of 0.221 standard deviation for the national saving rate. Column (4) shows that the investment rate is positively correlated with contemporaneous trade openness but is not correlated with past or future trade openness. Column (5) shows that conditional on the saving rate, there is no statistically significant relationship between trade openness and the gross investment rate. Tang (2015) shows that the results above are robust to additional controls, and exclusion of any single region from the sample.

Table 5: The Effect of Trade Openness on Current Account

	(1) No-Covar	(2) Lag-Y	(3) Fin-Dev	(4) Lag-Lead
	Capital Outflow: (Saving Rate-Investment Rate)			
Trade/GDP	0.0565*	0.0434	0.0419	0.0206
	(0.0333)	(0.0323)	(0.0329)	(0.0215)
Trade/GDP (Lag)				-0.0194
				(0.0282)
Trade/GDP (Lead)				0.0608
				(0.0552)
Within R^2	0.0838	0.0927	0.0947	0.0914
N Countries	110	110	110	106
N Observations	556	556	556	452

Robust standard errors are clustered at the country level and reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively. I group the years 1961-2005 into nine five-year intervals and use the averages of yearly data in the regressions. Time and country fixed effects are included in all regressions.

In Table 5, I use the current account, as measured by the difference between saving rate and investment rate, as the dependent variable and repeat the analysis. I find that openness is positively correlated with current account improvement, although the coefficient on the Trade/GDP ratio is statistically insignificant except in Column (1). This is consistent with the differences between Panel A and Panel B of Table 4 and suggests that the supply-side channel of capital accumulation dominates the demand-side channel.

Fixed-Effects Panel Regressions with IV

I estimate Equation 4 using fixed-effects panel regression.[12] I then aggregate the predicted bilateral trade shares (unlogged) from Equation (4) over trade partners to obtain the predicted trade share for country i in year τ. The predicted trade shares are then averaged over each five-year intervals before being employed as an IV for the Trade/GDP ratio in Equation (3).[13]

[12] I also experiment with the Poisson Pseudo Maximum Likelihood estimator (PPML) proposed in Santos Silva and Tenreyro (2006), and find the resulting instrument to be too weak.

[13] Since I have bilateral trade data from 1962 to 2000, the average predicted trade shares for 1962-1965 are used in place of the average for 1961-1965.

The estimation results of Equation 4 are reported in Table 6. The key coefficient of interest γ_1, on the interaction between the index of shipping cost and log bilateral distance, is negative and statistically negative from 0 at 1%. Bilateral distance has a strong and negative effect on bilateral trade, and the effect is stronger when the cost of shipping is higher. The Freight Cost Index from Hummels (2007) decreases from a value of 2.03 in 1962 to the normalized value of 1.00 in 2000. Therefore, the effect of distance on bilateral trade has decrease by 10.4% ($\frac{-0.820+2.03\times(-1.04)}{-0.820+1.00\times(-1.04)} - 1$) over the period according to the estimates. This is the key variation I exploit in the IV strategy. Additionally, the time-varying population terms in Equation 4 also contribute to the time variation in the constructed IV.[14] In practice, both sources of time variation are necessary to have a relatively strong first stage in the 2SLS regression.

Table 6: Results from Estimating a Panel Gravity Equation

	Log (Bilateral Trade /GDP$_i$)
Log Distance	-0.820***
	(0.0155)
Freight Cost Index	0.504***
	(0.0838)
Freight Cost Index * Log Distance	-0.104***
	(0.00974)
Log Population (Country i)	-0.155***
	(0.00358)
Log Population (Country j)	0.968***
	(0.00348)
Log Population * Border Status (Country i)	-0.185***
	(0.0244)
Log Population * Border Status (Country j)	-0.0626***
	(0.0241)
R^2	0.352
Observations	334663

Robust standard errors are reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively. The panel gravity equation also include total land area, landlocked status, bordering status and its interaction with total land area and with landlocked status, and year dummies.

Since the sample is reduced by the use of trade flow data, I report the fixed-effects OLS estimates for the smaller sample in Column (1) of Table 7. The results from the fixed-effects 2SLS regressions are presented in Column (2). The first-stage F-statistic for the excluded instrument is 4.34, lower than the

[14] In Table 6, the populations of Country i and Country j have different effects on bilateral trade shares. This is consistent with the cross-section estimates in Frankel and Romer (1999).

rule-of-thumb critical value of 10. According to the 2SLS results, a one-percentage-point increase in the Trade/GDP ratio raises the national saving rate by 0.224 percentage point, larger than the increase of 0.0903 percentage point in the fixed-effects OLS regression. On the other hand, I do not find a positive effect of trade openness on the gross investment rate in the 2SLS regression.

Table 7: The Effect of Trade on Aggregate Saving and Investment: FE Regressions with IV

	(1)	(2)
	FE-OLS	FE-2SLS
Panel A.	Gross National Saving Rate	
Trade/GDP	0.0903***	0.224**
	(0.0313)	(0.110)
Panel B.	Gross Investment Rate	
Trade/GDP	0.0585***	-0.0560
	(0.0195)	(0.0863)
Panel C.	First Stage of 2SLS	
Predicted Trade Share		2.905**
		(1.394)
Excluded IV F-Stat		4.340
N Countries	82	82
N Observations	432	432

Robust standard errors are clustered at the country level and reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively. I group the years 1961-2000 into eight five-year intervals and use the averages of yearly data in the regressions. Time and country fixed effects are included in all regressions. The control variables are log income and its square (both lagged), the Credit/GDP ratio (lagged) and log population. The instrument in 2SLS regressions is the predicted trade share from a panel gravity regression (see text).

The finding of a robust positive relationship between openness and the aggregate saving rate in a panel setting is consistent with the theoretical results in Tang (2015). However, the mechanism in Tang (2015) is not the only potential explanation for the observed saving-openness relationship. I subject to the results in Table 7 to additional robustness tests. The results are presented in Table 8.

One important concern with the baseline results is that the coefficient on Trade/GDP is simply picking up the effects of capital account openness. In Column (1) of Table 8, I include the Quinn Index (Quinn and Toyoda, 2008) as an additional regressor to control for capital account openness. The sample of countries is reduced substantially by data availability. Nevertheless, the coefficient on trade openness

remains positive and significant.[15]

In Table 7, I lag the income terms by five years, as the current income level is clearly endogenous with respect to the saving rate in the model. In Column (2) of Table 8, I use current income terms in place of lagged income terms, despite the endogeneity concerns. In Column (3), I control for the GDP growth rate. In Column (4), I include old and young dependency ratios as additional regressors to capture the effects of demographic changes. Column (5) includes the inflation rate as an additional regressor.

The national accounting identity implies that $S - I = X - M$, where S, I, X and M are saving, investment, exports and imports, respectively. This may suggest controlling for the trade balance. In Column (6) of Table 8, I include the trade surplus as an additional regressor. The point estimate of the coefficient on the Trade/GDP ratio decreases to 0.0664 but remains statistically significant at 1%. Since I am holding $(S - I)$ constant in this regression, the results in Column (6) are consistent with the finding that a substantial part of the openness-induced saving translates into higher investment.

One related question is whether the relationship between the gross national saving rate and openness is working through public saving. To shed light on this question, Column (7) includes total government expenditure as a share of GDP as a control variable. The results in Table 8 are in line with those presented in Table 7, and suggest that private saving is responsible for the relationship between openness and the aggregate saving rate.

One concern is that the results in Table 7 are driven by a handful of countries. The World Bank classifies countries into seven regions: East Asia and Pacific, Europe and Central Asia, Latin America and Caribbean, Middle East and North Africa, North America, South Asia, and Sub-Saharan Africa. To address the concern of outlier countries, I drop each region one by one from the full sample and repeat the analysis in each column of Table 9. The results are robust to the exclusion of any single region.

In each column of Table 9, I drop a different region from the full sample and repeat the baseline panel regression. As shown in Table 9, the results are robust to the exclusion of any single region.

5 Conclusion

In this paper, I study the empirical relationship between trade openness on one hand, and aggregate saving rate and investment rate on the other hand, using country-level data. I find a strong relationship between openness and the saving rate in a cross section and a panel of countries. I find a much weaker

[15] Neither controlling for capital account openness nor changing the sample of countries have an impact on baseline results.

Table 8: Robustness of Fixed-Effects Panel Regressions with IV: Alternative Specifications

	(1) K-Open	(2) Current-Y	(3) Growth	(4) D-graph	(5) Inflation	(6) Balance	(7) Gov-Size
Panel A:			Gross National Saving Rate				
Trade/GDP	0.303***	0.0941	0.213*	0.230**	0.214**	0.0511	0.132
	(0.112)	(0.129)	(0.113)	(0.113)	(0.104)	(0.156)	(0.115)
Panel B:			Gross Investment Rate				
Trade/GDP	-0.0104	-0.0931	-0.0681	-0.0560	-0.0373	0.0584	-0.0442
	(0.0707)	(0.0893)	(0.0864)	(0.0853)	(0.0773)	(0.0928)	(0.0797)
N Countries	67	82	82	82	82	82	82
N Observations	364	432	430	432	431	432	430

Robust standard errors are clustered at the country level and reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively. I group the years 1961-2000 into eight five-year intervals and use the averages of yearly data in the regressions. Time and country fixed effects are included in all regressions. The instrument is the predicted trade share from a panel gravity regression (see text). The standard set of control variables include log income and its square (both lagged), the Credit/GDP ratio (lagged) and log population. Column (1) controls for capital account openness; Column (2) replaces the lagged income terms with current income terms; Column (3) controls for the GDP growth rate; Column (4) controls for old and young dependency ratios; Column (5) controls for the inflation rate; Column (6) controls for the trade balance; Column (7) controls for total government expenditure as a share of GDP.

Table 9: Robustness of Fixed-Effects Regressions with IV

Exclusion of Subsamples

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Subsample Excluded				
	None	E. Asia & Pacific	Europe & C. Asia	L. America & Caribbean	M. East & N. Africa	N. America	S. Asia	S.S. Africa
Panel A:				Gross National Saving Rate				
Trade/GDP	0.224**	0.282	0.381**	0.113	0.233**	0.236*	0.189*	0.326***
	(0.110)	(0.656)	(0.174)	(0.103)	(0.101)	(0.122)	(0.0996)	(0.119)
Panel B:				Gross Investment Rate				
Trade/GDP	-0.0560	-0.429	0.0258	-0.0975	-0.0154	-0.0463	-0.0738	-0.0309
	(0.0863)	(0.636)	(0.100)	(0.0856)	(0.0678)	(0.0919)	(0.0883)	(0.0720)
N Countries	82	72	65	66	74	80	77	58
N Observations	432	378	332	350	392	418	405	317

Column (1) reproduces Column (2) of Table 7. Robust standard errors are clustered at the country level and reported in parentheses. *, **, and *** denote statistical significance at 10%, 5% and 1%, respectively.

relationship between openness and the investment rate. Taken together, these results provide evidence that higher aggregate saving rate following an increase in trade openness is responsible for the observed positive relationship between capital accumulation and trade openness.

References

Alcalá, Francisco and Antonio Ciccone, "Trade and Productivity," *Quarterly Journal of Economics*, 2004, *119* (2), 613–646.

Angrist, Joshua and Jörn-Steffen Pischke, *Mostly harmless econometrics: An empiricist's companion*, Princeton University Press, 2008.

Baldwin, Richard, "Measurable Dynamic Gains from Trade," *Journal of Political Economy*, February 1992, *100* (1), 162–74.

Barattieri, Alessandro, "Comparative advantage, service trade, and global imbalances," *Journal of International Economics*, 2014, *92* (1), 1–13.

Buera, Francisco J and Yongseok Shin, "Productivity Growth and Capital Flows: The Dynamics of Reforms," 2015.

Coeurdacier, Nicolas, Stephane Guibaud, and Keyu Jin, "Credit constraints and growth in a global economy," *American Economic Review*, forthcoming.

Costinot, Arnaud and Andres Rodriguez-Clare, "Trade Theory with Numbers: Quantifying the Consequences of Globalization," *NBER Working Paper Series*, 2013, *18896.*

Edmond, Chris, Virgiliu Midrigan, and Daniel Yi Xu, "Competition, markups, and the gains from international trade," Technical Report forthcoming.

Feenstra, Robert, Robert Inklaar, and Marcel Timmer, "PWT 8.0–A User Guide," 2013.

_ , Robert Lipsey, Haiyan Deng, Alyson Ma, and Hengyong Mo, "World trade flows: 1962-2000," *NBER Working Paper Series*, 2005, *11040.*

Felbermayr, Gabriel and Jasmin Gröschl, "Natural disasters and the effect of trade on income: A new panel IV approach," *European Economic Review*, 2013, *58*, 18–30.

Feyrer, James, "Trade and Income-Exploiting Time Series in Geography," *NBER Working Paper Series*, 2009, *14910.*

Frankel, Jeffrey and David Romer, "Does Trade Cause Growth?," *American Economic Review*, 1999, *89* (3), 379–399.

Goldberg, Pinelopi Koujianou, Amit Kumar Khandelwal, Nina Pavcnik, and Petia Topalova, "Imported Intermediate Inputs and Domestic Product Growth: Evidence from India," *Quarterly Journal of Economics*, 2010, *125* (4), 1727–1767.

Gourinchas, Pierre-Olivier and Olivier Jeanne, "Capital flows to developing countries: The allocation puzzle," *Review of Economic Studies*, 2013, pp. 1484–1515.

Hall, Robert and Charles Jones, "Why Do Some Countries Produce So Much More Output Per Worker Than Others?," *Quarterly Journal of Economics*, 1999, *114* (1), 83–116.

Hummels, David, "Transportation Costs and International Trade in the Second Era of Globalization," *Journal of Economic Perspectives*, 2007, *21* (3), 131–154.

Jin, Keyu, "Industrial structure and capital flows," *American Economic Review*, 2012, *102* (5), 2111–2146.

Ju, Jiandong, Kang Shi, and Shang-Jin Wei, "Trade Reforms and Current Account Imbalances: When Does the General Equilibrium Effect Overturn a Partial Equilibrium Intuition?," *NBER Working Paper Series 18653*, 2012.

Karabarbounis, Loukas and Brent Neiman, "The Global Decline of The Labor Share," *Quarterly Journal of Economics*, 2014, *61*, 103.

Kaufmann, Daniel, Aart Kraay, and Pablo Zoido-Lobatón, "Aggregating governance indicators," *World Bank Publications*, 1999, *2195.*

Levine, Ross and David Renelt, "A Sensitivity Analysis of Cross-Country Growth Regressions," *American Economic Review*, 1992, *82* (4), 942–63.

Li, Hongbin, Jie Zhang, and Junsen Zhang, "Effects of longevity and dependency rates on saving and growth: Evidence from a panel of cross countries," *Journal of Development Economics*, 2007, *84* (1), 138–154.

Loayza, Norman, Klaus Schmidt-Hebbel, and Luis Servén, "Saving in developing countries: an overview," *The World Bank Economic Review*, 2000, *14* (3), 393–414.

_ , _ , and _ , "What drives private saving across the world?," *Review of Economics and Statistics*, 2000, *82* (2), 165–181.

Lucas, Robert E, "Why doesn't capital flow from rich to poor countries?," *American Economic Review*, 1990, pp. 92–96.

Mankiw, Gregory, David Romer, and David Weil, "A Contribution to the Empirics of Economic Growth," *Quarterly Journal of Economics*, 1992, *107* (2), 407–437.

Melitz, Marc, "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity," *Econometrica*, 2003, *71* (6), 1695–1725.

Ossa, Ralph, "Why Trade Matters After All," *NBER Working Paper 18113*, May 2012.

Pavcnik, Nina, "Trade liberalization, exit, and productivity improvements: Evidence from Chilean plants," *Review of Economic Studies*, 2002, *69* (1), 245–276.

Quinn, Dennis and Maria Toyoda, "Does capital account liberalization lead to growth?," *Review of Financial Studies*, 2008, *21* (3), 1403–1449.

Sachs, Jeffrey D and Andrew Warner, "Economic reform and the process of global integration," *Brookings papers on economic activity*, 1995, pp. 1–118.

Sampson, Thomas, "Dynamic selection: an idea flows theory of entry, trade and growth," 2014.

Sandri, Damiano, "Growth and capital flows with risky entrepreneurship," *American Economic Journal: Macroeconomics*, 2014, *6* (3), 102–123.

Santos-Paulino, Amelia and Anthony P Thirlwall, "The impact of trade liberalisation on exports, imports and the balance of payments of developing countries," *Economic Journal*, 2004, *114* (493), F50–F72.

Silva, Joao Santos and Silvana Tenreyro, "The log of gravity," *Review of Economics and statistics*, 2006, *88* (4), 641–658.

Solow, Robert, "A CONTRIBUTION TO THE THEORY OF ECONOMIC GROWTH," *Quarterly Journal of Economics*, 1956, *70* (1), 65–94.

Tang, Lixin, "Entrepreneurial Income inequality, Aggregate Saving, and the Gains from Trade," 2015.

UNU-WIDER, "World Income Inequality Database (WIID3.0b)," 2014.

Wacziarg, Romain, "Measuring the Dynamic Gains from Trade," *World Bank Economic Review*, 2001, *15* (3), 393–429.

_ and Karen Welch, "Trade Liberalization and Growth: New Evidence," *World Bank Economic Review*, June 2008, *22* (2), 187–231.

Appendix

Appendix I Data Sources

Table A1: Data Sources for the Empirical Exercises in Chapter 3

Variables	Sources
Gross National Saving Rate	WDI
Gross Investment Rate	WDI
("Gross Fixed Capital Formation, as % of GDP")	
GDP per capita	PWT (Mark 8.0.)
Population	WDI
Age Dependency Ratios	WDI
Credit/GDP Ratio	WDI
Inflation	WDI
GDP Growth	WDI
Government Expenditure	WDI
Capital Account Openness	Quinn and Toyoda (2008)
Labor Share of Income	Karabarbounis and Neiman (2014)
Private Saving Rate	Loayza, Schmidt-Hebbel and Servén (2000b)
Top 10% Income Share	UNU-WIDER (2014)
Institutional Quality	Kaufmann, Kraay and Zoido-Lobatón (1999) (As adapted by Alcalá and Ciccone (2004).)
Trade/GDP (PPP)	PWT (Mark 8.0.)
(Sum of PPP export and PPP import over PPP GDP)	
European Languages	Hall and Jones (1999); IV for institutional quality
(Population share speaking one of five European Languages at birth)	
Bilateral Trade Flows	Feenstra, Lipsey, Deng, Ma and Mo (2005)
Geography Variables	CEPII
(Used in estimating the gravity equation)	