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# Economic growth – is openness to international trade beneficial?

*An empirical analysis of economic growth and trade policy*

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# Summary

This thesis attempts to answer the following research question:

*"To which degree, if any, does policy open to international trade lead to increased economic growth within a country?"*

The applied measure of openness to international trade is an index that increases as a country has less restrictions on trade, while annual growth in GDP per capita is the preferred measure of economic growth. There is a potential problem of endogeneity in the openness index, so four instrumental variables are suggested. These are the share of votes equal to the U.S. in the United Nations General Assembly, number of years as member of GATT/WTO, share of children that are immune to DPT and a country's distance to equator.

A panel data set for up to 91 countries for the time period 1970-2011 is analysed, with countries from all income-groups represented. First, openness is considered exogenous, and directly applied with both an ordinary least squares-estimator and a fixed effect-estimator. Second, the potential endogeneity bias is accounted for by use of instrumental variable regressions.

The main results of this thesis are that there exists a negative relationship between openness to international trade and economic growth. The result is robust to alterations of model specification, and high-income countries have the largest reported negative effects of a ceteris paribus increase in openness. The instrumental variables remain strong throughout the robustness tests, and especially share of votes equal to the U.S. in the United Nations General Assembly, number of years as member of GATT/WTO are reported as valid.

# 1 Table of Contents

# Part 1

## 1 Introduction

*"[...] our peace and prosperity depend in the long run on the well-being of others."* (Landes, 1999, p. xx)

### 1.1 Motivation

In his book "The Wealth and Poverty of Nations", David Landes (1999) asks why some countries are so rich, while others are so poor. There is no single correct answer to a question of that magnitude, and finding answers is difficult, but that should not discourage us from conducting further research into the field. Together with climate change, poverty and lack of growth in certain regions is today perhaps the most important issue for the world community to tackle, increasingly relevant since it induces large flows of refugees and emigrants looking for a better life (United Nations, 2009). If we agree that shutting the borders and keeping the unfortunate "out" is a poor solution in the long run, the answer must be to improve living conditions in the developing countries of the world. Consequently, we need knowledge of the efficiency and effectiveness of the possible remedies, and during the last decades, The World Bank, the International Monetary Fund (IMF) and other significant actors in the world economy have actively promoted increased international trade and liberal economic policy as drivers of economic growth. The mantra is that less tariffs and trade barriers lead to increased trade across borders, and that this induces growth and welfare in every country. Opponents of such changes are a diverse group, including for example labour unions, governments and interest groups. They may wish to protect important industries on domestic soil, they may believe that increased international trade is bad for the environment or they may simply oppose free trade on ideological grounds.

### 1.2 Objective and research question

There are different measures available, both regarding the degree of trade openness in a country, and its wealth. This thesis applies an index of openness that varies with tariff levels, capital controls, taxes on international trade and hidden import barriers. It is thus a measure of policy, capturing whether or not foreign suppliers face the same fees, taxes and obstacles as domestic suppliers, so that the market can differentiate between products on even grounds.

The index is increasing if the restrictions are decreasing[1]. The preferred measure of wealth is growth in expenditure-side GDP per capita in fixed 2005-US$, based on purchasing power parity (PPP)[2]. Henceforth, these measures will respectively be addressed as openness to trade and economic growth.

The thesis has primarily two purposes. First, we hope that it can be a contribution to the field, and shed some additional light on the issue of trade policy and its impact on welfare. Endogeneity is a significant challenge, where the problem is that regressions indicate causal effects while variations in fact are only correlations. This thesis will utilize several instrumental variables to try and account for the endogeneity, and hence avoid spurious results. Related to this, the second purpose is that we hope to nuance the strong conclusions other researchers have come to, and highlight the many challenges that arise when attempting to seek causal effects in macroeconomic data. Consequently, the main research question of the thesis is:

*"To which degree, if any, does policy open to international trade lead to increased economic growth within a country?"*

The research question may be analysed both within a quantitative and a qualitative framework. As the variables we seek to analyse are available in quantitative terms, we see it as natural to employ regression analysis as the main tool to answer the research question. If properly conducted, this will allow us to find causal relationships between welfare and openness to trade, if such a relationship indeed exists. However, a range of challenges may make it difficult coming to a firm conclusion, such as the mentioned endogeneity problem, and we will therefore also include a qualitative discussion of the topic.

## 1.3 Structure

This thesis consists of five parts. Part 2 provides an overview of the topic in question, including a quick look at the historical development, some previous research and a section summing up the theories providing a foundation for the analyses. In Part 3, quantitative methods are explained, and also their individual strengths and weaknesses. In addition, an overview of the data is provided, as well as justifications for the choice of variables. Part 4 consists of an empirical analysis, seeking a causal relationship between trade policy and economic growth. Several tests related to the different methods are conducted and their

[1] Please see appendix 1, table 3 for a detailed description of the elements in the index
[2] Data is taken from Penn World Table 8.1

consequences explained. Finally, Part 5 provides a qualitative discussion of the findings, as well as possible implications for international policy, before the thesis is concluded.

# Part 2

## 2 Background

### 2.1 Historical Development

Today, most people consider annual economic growth of at least one or two percent as the normal situation, and a year of negative growth is usually front-page news. Before the industrial revolution however, this would have been near unimaginable (Nye, 2008; The Maddison-Project, 2013). During the 17$^{th}$ and 18$^{th}$ century, mercantilism was the main paradigm, exports considered to be good and imports bad, naturally leading to import restrictions and export subsidies (Irwin D. A., 2001). During the years of The Industrial Revolution, influential writers strongly criticized such mercantilist practices, resulting in a downward pressure on trade restrictions. In fact, the greater part of the 19$^{th}$ century was later named "The first wave of globalization" (Nagdy & Roser, 2015). This was a period where trade increased heavily, from less than 10 percent of global GDP to nearly 40 percent. However, the outbreak of "The Great War" was followed by a period of protectionism and, some would say as a consequence, several economic crises. This had a severely cooling effect on global trade. After World War II, the world picked up the gauntlet where they had left it nearly 50 years earlier. After 1950, combined export and import as share of GDP has approximately tripled from about 20 percent to 60 percent today. This is definitely the period where the world has also progressed the fastest, with global GDP per capita today four times what it was some 60 years ago. Moreover, "The second wave of globalization" has also been a period of openness to trade, especially during the last 30-40 years, as visualised in figure 1.

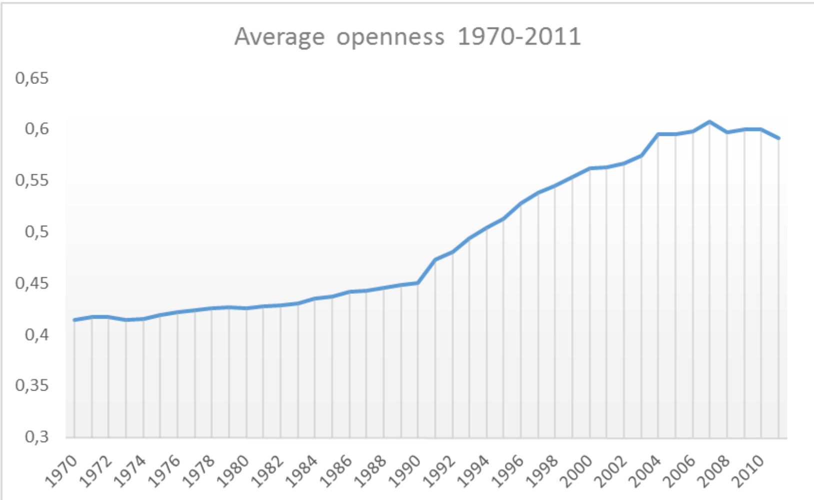


*Figure 1 - Average level of openness 1970-2011 (Dreher, 2006)*

Trade policy has been liberalized, both with regards to tariff rates and subtler trade restrictions such as import quotas. According to the World Bank (2002), the only two regions that on average have kept their tariff rates at relatively high levels are Africa and the Middle East, regions that have also seen less growth than most of the rest of the world.

There are still large differences in how open countries are to trade, and on average high-income countries are most open, while low-income countries have the lowest degree of openness (figure 2).

| INCOME GROUP | AVERAGE OPENNESS |
|---|---|
| **HIGH-INCOME COUNTRIES** | 0.65 |
| **MIDDLE-INCOME COUNTRIES** | 0.57 |
| **LOW-INCOME COUNTRIES** | 0.51 |

*Figure 2 - Average levels of openness for different income groups in 2011 (Dreher, 2006)*

## 2.2 Empirical evidence

### 2.2.1 Trade policy and growth

When investigating previous research, a natural first step is to look at the results of Axel Dreher (2006) who constructed the openness index used in this thesis. The long time-period covered by the openness index is one of its strengths, but he admits that it may be endogenous in growth regressions. Dreher created what is called the KOF Globalization Index, consisting of social, political and economic globalization. The openness index employed in this thesis is one of two sub-indices together constituting economic globalization, the other being actual trade flows. When using a sub-index in a regression, the interaction between different forms of globalization should be controlled for. Dreher finds that the openness indicator has no statistically significant effect on economic growth. He argues that this could reflect the average of benefits from high developed countries with sound institutions and markets, combined with the cost of higher frequency of financial crisis in less developed countries. Garret (2001) suggests that capital account openness only promotes growth in high developed countries, and Dreher lends support to this claim, high income countries alone gaining significant positive effects of increased openness to trade. Still, interactions between different forms of liberalization may also have significant effects on less developed countries (Dreher, 2006).

A policy open to trade widens the list of possible trade partners and products, and one can assume that increased international trade is a given consequence. If this is correct, a possibility is to analyse whether or not trade increases economic growth, instead of finding a direct link between policy and growth. This is what Frankel & Romer (1999) tries in their paper "Does Trade Cause Growth?". GDP and trade are endogenously connected, especially with regard to reverse causality bias, inducing spurious effects in direct regressions. In their article, they therefore try to estimate every individual country's trade using instrument variables applied in a gravity equation. Their results indicate that the geographic characteristics of a country are good determinants of trade, and further that "natural openness" to trade has a positive impact on economic growth. However, individual variation in countries' trade policies, the "residual openness", is not included in the model and may have a different impact. They acknowledge this shortcoming, but maintain that their result suggests countries should pursue policies promoting international trade.

A different way to look at it is that there exists no simple relationship between trade barriers and growth, but rather that some "prerequisites" are needed. Characteristics such as comparative advantages in protected sectors, if we are looking at a developed or developing country or if it is big or small, all play their part in which effects trade policies have. Trade barriers may have gotten an unfair negative reputation after the failed export-subsidizing policies in Latin-America during the 80s and 90s, while the opposite is true for outward-oriented policies. If that is correct, it may also be that the benefits of openness are oversold in modern publications by the IMF and the World Bank (Rodriguez & Rodrik, 2000; Yanikkaya, 2003). Sound institutions overlooking the process might be imperative for a successful liberalization of trade policy. While many industrial countries might reap benefits from openness, as they are able to control the many aspects of their economy, other countries with more fragile and fragmented economies could have costs associated with openness. One such cost may be that open countries with bad institutions suffer greater losses associated with corruption (Wei, 2000). Consequently, open countries have greater incentive to develop good institutions, and countries already equipped with good institutions have greater incentive to open up. In addition, trade restrictions in a country should be transparent and uniform so that the market is as fair as possible. Without good institutions this is hard to sustain and corruption will often be an unwanted effect.

Most research indicates a positive relationship between openness and economic growth (Harrison A., 1996; Winters L., 2004; Sala-I-Martin, 1997; Dollar, 1992). The vast literature indicates a consensus that there is in fact a linkage between the two, but the conclusions are not definitive. One issue is that not all previous research has sufficiently taken into account the potential endogeneity problems, and the many cross sectional analyses also omit important time varying aspects. Sceptics exist, but it seems even they acknowledge that openness has some effect on economic growth, just that it is not clear-cut:

*"Our bottom line is that the nature of the relationship between trade policy and economic growth remains very much an open question. The issue is far from having been settled on empirical grounds. We are in fact sceptical that there is a general, unambiguous relationship between trade openness and growth waiting to be discovered."* (Rodriguez & Rodrik, 2000)

### 2.2.2 Measuring trade-policy

When searching for links between trade-policy and economic growth, correct measures of openness is vital. By replicating four of the more cited and well-known papers within the area, Rodriguez & Rodrik (2000) (RR) find discrepancies with most of the measures used as a proxy for trade-policy. Dollar (1992) constructs two indices, an "index of real exchange rate-distortions" and an "index of real exchange rate-variability" which, he argues, have a relationship with outward-oriented policies. The degree of real exchange rate distortions is affected by how far from free-trade the country is. A relatively high price level is assumed as an indication that a country has high trade-barriers, but the index is very sensitive to which types of trade restrictions are applied. Additionally, monetary policy and transport costs affect the index in ambiguous ways, inducing biased results. The variability index, according to RR, is more a measure of instability than trade policy, and any possible linkage to growth would be spuriously connected to trade openness.

Jeffrey Sachs and Andrew Warner (1995) developed a measure of openness (SW**)** which has been used in several later papers. It defines a country as either open or closed based on several information criteria[3]. The indicator seems to be robust, but the question is how good a measure of trade-policy it is. RR finds that the SW-indicator basically "[…] serves as a proxy for a wide range of policy and institutional differences, and that it yields an upward-biased estimate of the effects of trade restrictions." Most of its effect stem solely from existence of state-monopoly of major exports and the black-market premium, while the criteria more directly related to trade policy have no significant explanatory power. This suggests that the indicator is actually not directly connected to trade policy, but indirectly through other channels. Similar to the Dollar-index, the SW-indicator may actually be closer to a measure of poor institutions and macroeconomic instability than trade openness.

Interpreting econometric results is not very valuable without controlling for possible statistical problems such as endogeneity, autocorrelation and unit-root. Not accounting for such issues may result in biased estimates or incorrect standard errors. As econometric techniques have evolved, so has the possibility to conduct proper sensitive analyses and to extensively test the findings, also on panel data over long time periods. Perhaps it is necessary making relatively improbable assumptions, and perhaps only a sole ambiguous test is available, but if that is the case, one must be very critical toward the findings' robustness. Cross-country case studies are often used to bypass many of the econometric problems from time series, but the missing time factor also makes the results much less generalizable. This leaves us with no single, agreed-

[3] Criteria: 1. Average tariff higher than 40% 2. Nontariff-barriers covered on average more than 40% of imports 3. Had a socialist economic system 4. State-monopoly of major exports 5. Black-market premium exceeded 20% during either the 1970s or the 1980s

upon method for how to estimate openness' effect on economic growth, and consequently, more research is needed.

# 3 Theory

## 3.1 The evolution of trade theory

The basic framework of international trade theory has evolved over time. In its most fundamental form it can be explained by theories developed some two centuries ago. The microeconomic foundations in trade theory stem from the work by Adam Smith (1776) in his well-known book "*Wealth of Nations",* but David Ricardo (1821) was the British banker and economist that first provided theoretical proof that international trade was beneficial for all. He showed that countries always have an incentive to trade with each other, as it allows them to exploit their comparative advantages (Krugman, Melitz, & Obstfeld, 2012, p. 64). This implies that even in the event that a country is inferior in productivity of producing all goods, it can still find relative advantages to other countries. Consider for example the tourist industry in Norway, where coaches from countries such as Estonia drive passengers around the fjords of the western coast. Assume that Norwegian bus drivers could handle 500 000 passengers per season. Alternatively, Norway could produce 10 000 tons of salmon, which then constitute the alternative cost of driving 500 000 passengers. The high level of education and experience in Norway means that Norwegians are more efficient in producing salmon. Estonians could either drive these 500 000 passengers or produce 7 000 tons of salmon, that is the demand in the home market. If Norway sticks to the salmon, while Estonians handle the sightseeing tourists, one has the following changes in production:

| | TOURISTS | TONS OF SALMON |
|---|---|---|
| NORWAY | -500 000 | +10 000 |
| ESTONIA | +500 000 | -7 000 |
| TOTAL | 0 | +3 000 |

*Figure 3 - Production changes with trade*

In other words, Estonia is less or equally efficient in the production of both goods, but the sum of produced goods and services still increases when the two countries trade. It is thus the *comparative* advantage in productivity levels between countries that makes trade an additional source of economic gain for all countries.

Ricardo's model is intuitive and sensible, but at the same time, it assumes labour as the only factor of production. The Heckscher-Olin-model is named after two Swedish economists, and it includes capital in the equation. The Heckscher-Olin-theorem is that: *"Countries tend to export goods whose production is intensive in factors with which the countries are abundantly endowed."* (Krugman, Melitz, & Obstfeld, 2012, p. 121). The result is much the same as in the Ricardian model, with all countries being better off than if they pursued autarky, but is a little more complex.

Paul Krugman (2008) observed that, even though the traditional theory implied capital-rich countries should trade most with countries that had less capital and cheaper labour, the opposite was usually the case. This inspired him to come up with the "New trade theory", where he allowed for the presence of economies of scale, probably the most important addition to the earlier models. The example used in this article is that making an airplane factory in every country in the world hardly seems efficient. Instead, there are only a few such factories worldwide, and they can run much more cost efficiently because of it. Initial advantages also play a role in determining which countries that are allowed to gain from economies of scale. As the world market become more integrated, new low-cost countries achieve comparative advantages in production of certain goods, but the current, established producers have power to prevent new entrants due to their economies of scale (Krugman, Melitz, & Obstfeld, 2012, p. 179). Even though this theory better fit the empirics, it did not radically change economists view on trade, or the main conclusion of trade theory, that trade allows for universal gains.

## 3.2 Restricting international trade

International trade is not unambiguously good, and one important aspect is its effect on distribution of income within a country. As input factors change in production so does demand for different goods, which in turn affects the industries. Also, certain sectors will incur losses after a country liberalises its trade policy. The general outcome is that "Trade benefits the factor that is specific to the export sector of each country, but hurts the factors specific to the import-competing sectors, with ambiguous effects on mobile factors." (Krugman, Melitz, & Obstfeld, 2012, p. 93) . This might be one of the reasons why politicians, unions and other stakeholders may promote trade barriers; they wish to protect certain sectors in the domestic market. The most direct tool is perhaps tariffs, but there are also subtler tools, such as import quotas, subsidies or laws favouring local producers.

### 3.2.1 The effect of a Tariff

A tariff is defined as a tax on an imported good, making the foreign goods more expensive in the domestic market. It can be a fixed amount on each unit or an "ad valorem" tariff, taxing a fraction of the value of the imported good. Tariffs distorts prices, hence demand and supply is affected. One can analyse a tariffs partial effect on a specific good using a partial equilibrium framework (Krugman, Melitz, & Obstfeld, 2012, p. 225). Suppose there are two countries, Home and Foreign, where both consume and produce the same good and there are no transportation costs. Let's also assume that the exchange rate between the countries' currencies are not affected by whatever trade-policies the countries have so the prices quoted for the good are in Home's currency[4]. If trade initially is absent and the countries' individual equilibrium-prices are different, then immediately after trade is introduced, supply would be shifted to the market where the demand is higher. If Home have the higher demand, $D_h$ and Home producers supply, $S_h$, then Home have an import demand of $D_h - S_h$. Suppose at the same time that Foreign have a higher supply, $S_f$, than consumers in Foreign demand, $D_f$, then Foreign have an export-supply of $S_f - D_f$. With trade and no tariffs Home would import the excess supply from foreign and prices would settle at a world equilibrium price, $P_w$, such that:

$$Home\ demand + Foreign\ demand = Home\ supply + Foreign\ supply$$

The world equilibrium price would be $P_w$ for both Home and Foreign, and is illustrated at point 1 in figure 4:

[4] Perfect competition is assumed, and the market clears in equilibrium.

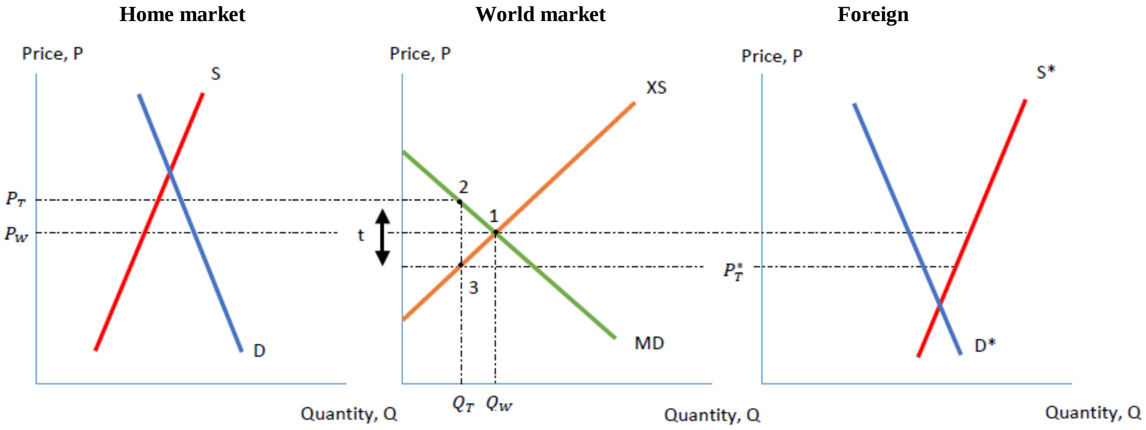


Figure 4 – Effects of a tariff

A tariff raises the price in Home while lowering the price in Foreign. This lead to a decline in the traded volume. The demand curves (D, D*, MD) are downward sloping as quantity demanded rises with lower prices. The supply-curves (S, S*, XS) are upward sloping as quantity supplied are rising with increasing prices.

Now suppose that Home introduces a specific tariff that taxes every unit of the imported good by a fixed amount. In other words, $t$ is added to the price of Foreign if they sell the good to Home. Now Foreign exporters will only sell the good to Home if $P_{home} \geq P_{foreign} + t$.

A tariff will raise the price in Home to $P_T$, while lower the Foreign export price to $P_T^* = P_T - t$. The higher price at Home will reduce demand (moves from point 1 to 2). The lower price in Foreign, due to excess supply, will reduce supply and increase demand of the good in Foreign. This will lead to a decrease in export supply from Foreign (move from point 1 to 3), while overall demand decrease from $Q_W$ to $Q_T$. The market is again in equilibrium, where Home imports equals Foreign exports and the price difference is $P_T^* - P_T = t$. The tariff has reduced imports and caused a higher price at Home and a lower price in Foreign. The costs and benefits of the tariff for the importing country is illustrated in figure 5.

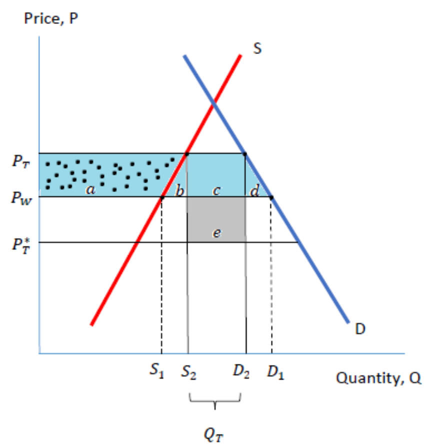


*Figure 5*

Before the tariff is introduced, demand and supply is $D_1$ and $S_1$, with a world equilibrium price $P_W$. Home`s import volume is $D_1 - S_1$. Imposing the import tariff shifts the price of the good to $P_T$ at Home and the Foreign export price falls to $P_T^*$. Foreign's exporters will only transport their goods at this price or above. The implications of the higher price are that demand and supply shift to $D_2$ and $S_2$ respectivly. The Home producer surplus rises by the dotted area labelled $a$, showing that Home producers gain from the tariff. Home consumers is worse of, since they face higher prices, and the loss of consumer surplus is indicated by the areas $(a + b + c + d)$. The government gets tax-income equal to the tariff rate multiplied with units of the good that are imported from Foreign, $D_2 - S_2$. This tax gain is indicated by the areas $(c + e)$ . The net cost of a tariff on welfare is:

$$Net\ effect = (a + b + c + d) - a - (c + e) = b + d - e \quad (1)$$

The efficiency loss of a tariff is $b + d$ due to distorted incentives for producers and consumers, as they are led to act as if imports are more expensive than they really are. The gain from the tariff, $e$, arises due to the lower Foreign export price. Whether or not the net welfare effect is positive depends on who the consumers are, who the producers are and what the government spends the money on, among other things.

If, on the other hand, Home's market was not large enough to affect the world price, the case for most countries, the conclusion would not be the same. To grasp the effect of a tariff on a small country`s demand and supply, let's look at Home before and after the tariff is imposed.

In this case, the market in Home is small and have no effect on the Foreign export price. From figure 6, the full effect of a tariff will now increase the Home price to $P_w + t$ and demand will fall from $D_1$ to $D_2$. Supply at Home will increase from $S_1$ to $S_2$ due to the price increase, and imported goods after the tariff is in place will fall. This protects the domestic producers, which is often the primary objective of a tariff. Contrary to the case where Home is a price influencer, the importer has now no direct gains from imposing a tariff.

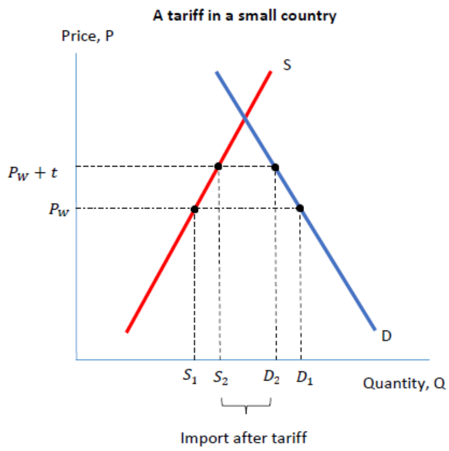


*Figure 6*

#### *3.2.1.1 The optimal tariff argument*

It is established that a tariff can improve a country's "terms of trade", since there are possible areas between full openness and autarky where countries are willing to trade with each other. If the distortions on producers and consumers are less than the gains from the improved terms of trade, then a country can gain from a tariff. Edgeworth (1894) showed that as long as the countries tariff did not make the exporter change its quantity supplied, then the country would gain from a tariff (Irwin D. A., 1996). The search for an optimal tariff is not part of this thesis, but the argument that it exists provides another argument as to why countries are not fully open.

### 3.2.2 Non-tariff barriers

There is a range of different trade policy instruments available to a government (Krugman, Melitz, & Obstfeld, 2012, p. 232). A country can subsidise the export industry, or any industry at all for that matter, making their good relatively cheaper than foreign. It can introduce import quotas, direct public procurement toward domestic suppliers or require a certain fraction of final goods to be domestically produced. Or it can act even more subtle, just twisting regulations so that they are practically impossible for foreign suppliers to fulfil. A modern and relevant example of the latter is the “sell-by” date of milk in Greece (CNBC, 2015). While other countries let the milk producers determine the “sell-by” date, the Greek government has decided that the permitted shelf-life of milk should be five days, effectively shutting foreign competition out of the Greek milk market. That this reportedly has resulted in higher milk prices comes as no surprise to an economist, as it is exactly the effect one would expect from what is in practice an import barrier (Krugman, Melitz, & Obstfeld, 2012, p. 226). One could add to this the fact that some customers might prefer milk from one of the foreign producers, which means this customer gets less satisfaction than what is actually possible. Both higher prices and lack of options result in a loss of individual utility, and is a cost to society as direct consequences from trade barriers.

There are also the distortionary effects stemming from the fact that countries that have comparative advantages over Greece in milk production. According to the theory, they could have used more resources on producing milk, Greece could have produced something else, resulting in gains for both parts. That is exactly why nearly all economists agree that free trade is good, and tariffs and other hidden trade barriers are bad. It has even been proposed that the restrictions on international trade imposed in USA as the Smoot-Hawley tariff *caused* the Great Depression (Krugman P. , 1996). The arguments are sensible, and the benefits of free trade seem obvious, but they still seem remarkably hard to prove empirically.

# Part 3

## 4 Method and data

There is a range of different econometric challenges when trying to tease out causal effects in macroeconomic data. To get a trustworthy result, we will therefore employ different types of regressions, and then discuss how and why the results differ.

### 4.1 Pooled Ordinary Least Squares (OLS)

When running a pooled OLS, all observations are lumped together, and we assume that there is a linear relationship that is common for all countries. To make meaningful inference about the regressions we run using OLS, we have to rest our conclusions on a set of assumptions. If these are violated, the results cannot be trusted unless measures are taken to correct the present problems[5].

#### 4.1.1 Unbiasedness of OLS

We assume that the model is linear in parameters. In other words, the relationship between the variables must either be linear, or possible to capture with squared or log-transformed terms. Population growth is possibly a variable showing exponential growth, which leads us to use the natural log of population instead. Another necessary assumption for the estimator to be unbiased is that perfect collinearity is not present. In other words, no independent variable can be close to perfectly predicted by the other variables, because this can cause a bias in the estimate. Also, the so-called Zero Conditional Mean-assumption states that:

$$E(u_{it}|X_{it}) = 0 \quad (2)$$

Consequently, the level of country $i$'s error term cannot be affected by any of the explanatory variables at any point in time, $t$. This assumption is very strict, and sometimes one can assume that a weaker assumption is sufficient, namely that the error term is unaffected by explanatory variables in the *same* time period.

If we assume that the error term consists of two parts, such as:

$$u_{it} = a_i + e_{it} \quad (3)$$

[5] All information about the necessary assumptions are taken from Wooldridge (2014, pp. 279-285)

where the independent and identically distributed error term $e_{it} \sim N(0, \sigma^2)$, then $a_i$ captures unobserved, country specific fixed effects. This could be for example geographic variations or the culture in a country, which is not controlled for in the model. Such effects will usually be present in a macroeconomic panel data set, and if they influence both the dependent and independent variables, the zero conditional mean-assumption is violated. Eliminating such constant, country-specific effects from the data is possible, and will be discussed in the section about panel data methods.

#### 4.1.2 Unbiasedness of variance

To be able to trust the reported standard errors, and hence make meaningful inference, two additional conditions must be satisfied. First, we assume homoscedasticity in the error term, meaning that its variance is the same for all periods and levels. Formally, the assumption is:

$$Var(u_{it}|X_{it}) = Var(u_{it}) = \sigma^2 \tag{4}$$

If the standard errors are suspected to be heteroskedastic, inference is not possible without correcting them. There are available methods in Stata, and we will report the tests we run and the measures we take as we progress.

There is also the assumption of no serial correlation, or autocorrelation. This state that, conditional on X, the error terms in two different time periods, $t$ and $s$, are not correlated over time. Formally, the notation of no serial correlation is:

$$Cov(u_t, u_s|X) = 0, \qquad where\ t \neq s \tag{5}$$

If this is not the case, the errors suffer from serial correlation, even though the conditioning on X is often ignored in practice. This is also the case if constant, country specific effects $a_i$ are present, since they by definition will be present in all periods, and differ for each country. Even though the estimated coefficients are still consistent in the presence of serial correlation, the standard errors renders inference pointless (Wooldridge J. , 2014, p. 331).

### 4.2 Instrument Variable Regression

We might be worried that openness to trade is endogenous, since it is probably affected by both economic, political, cultural, geographic and demographic features of a country, which in turn may be tied to wealth. Applying openness directly in a regression will thus result in a spurious relationship with growth. In such cases, it is possible to use a two-stage least squares (2SLS) estimator to obtain unbiased estimates. This estimator is less efficient than OLS if the explanatory variables are exogenous, and one should therefore test for the presence of endogeneity[6]. In such a test, the null hypothesis is that the suspected endogenous regressor can be treated as exogenous[7] (Baum, Schaffer, & Stillman, 2007).

The procedure for the 2SLS, as indicated by the name, consists of two stages. The first stage is a regression on the endogenous variable, where fitted values hopefully free from endogenous variation are obtained. This is done by using instruments to explain the endogenous variable. The second stage is a regression on the independent variable, including the fitted values instead of the endogenous variable. There are two conditions for a valid instrument, the first that it must be correlated with the endogenous variable, so that the instrument is *relevant* in predicting it. The second condition is that the instrument should be uncorrelated with the dependent variable, or that it is *exogenous*.

### 4.2.1 Instrument relevance

The relevance condition can formally be written like equation (6),

$$COV(x, z) \neq 0 \tag{6}$$

Consider the following example of a linear 2SLS-model for panel data:

$$Y_{it} = \alpha + \beta_1 X_{it} + \theta_1 C_{it} + u_{it} \tag{7}$$

Where $Y_{it}$ is the dependent variable, $X_{it}$ the endogenous regressor, $C_{it}$ is a vector of control variables and $u_{it}$ is the error term assumed to have zero mean and constant variance, $u_{it} \sim \mathrm{N}(0, \sigma^2)$. Equation (7) is the structural equation where $\beta_1$ is the parameter of interest. To get an unbiased estimate of $\beta_1$ a reduced-form equation is first estimated:

$$X_{it} = \alpha + \pi_1 Z_{it} + \theta_2 C_{it} + v_{it} \tag{8}$$

---

[6] The asymptotic variance of the 2SLS-estimator is computed according to the following formula: $\sigma^2 / n\sigma_x^2 \rho_{x,z}^2$, where $\sigma_x^2$ is the population variance of the endogenous variable x, $\sigma^2$ is the population variance of u and $\rho_{x,z}^2$ is the square of the population correlation between x and the instrument z. The last term is what causes the variance of the 2SLS-estimator to be larger than for OLS, and thus less efficient, since it is between zero and unity.

[7] The endogeneity-test compares the difference between two Sargan-Hansen statistics, one for the equation with the smaller set of instruments, where the suspected regressor is treated as endogenous, and one equation with the larger set of instruments, where the suspect regressor is treaded as exogenous, is tested. The test is robust to different violations of conditional homoscedasticity. In Stata, this test [endog(var)], is available after xtivreg2 (Baum, Schaffer, & Stillman, 2007).

Equation (8) relates the instruments, $Z_{it}$, to the endogenous regressor, $X_{it}$. The instruments should at least have a statistically significant effect explaining $X_{it}$. In the case where $\pi_1$ is zero, the instruments are unusable and irrelevant (Stock, Wright, & Yogo, 2002)**.** Preferably they should have a high t-value and F-value, the latter if more than one instrument is applied, indicating that the instruments are relevant. A common rule of thumb is that the F-value should be at least 10, but there are also more complex methods for evaluating the strength the instruments. A particularly useful method is that of Stock & Yogo (2002)[8]. They point out that weak instruments may produce biased estimates and one should be careful to only interpret the F-statistic.

To control for the presence of weak instruments, one may use the test by Stock & Yogo (2002) to produce an F-statistic, and compare this to the appropriate critical values[9]. These values are constructed to test for weak instruments, and give an indication of whether or not the instruments are useable.

"*The critical value is determined by the IV estimator the researcher is using, the number of instruments K2, the number of included endogenous regressors N, and how much bias or size distortion the researcher is willing to tolerate."* (Stock & Yogo, 2002, s. 32)

The relative bias threshold is set at how much bias the researcher can accept relative to the bias in the OLS-estimator. With relevant, exogenous and strong instruments the 2SLS-estimator is consistent compared to the biased OLS-estimator with the endogenous regressor. The strength of the instruments decides this bias, and the weaker the instruments, the higher the bias in the 2SLS-estimator and the closer its estimate is to the OLS-estimate (Stock, Wright, & Yogo, 2002). The second threshold is size distortions. With weak instruments, the actual size of a five percent 2SLS t-test is actually higher, thus making the researchers reject true null hypotheses more frequently than indicated by the p-value. To account for this, the researcher has to decide at which level of size distortion one should reject the null hypothesis. Weak instruments are also not a small sample problem, as studies show that it persists in large samples (Bound, Jaeger, & Baker, 1995). Where we use IV-regressions, we will report these test statistics and critical values, and watch for signs of our instruments being too weak.

[8] These test-statistics are available in Stata with xtivreg2
[9] See Stock & Yogo (2002) for critical values

### 4.2.2 Instrument exogeneity

The second condition, that the instrumental variable must be plausibly exogenous, can formally be stated like this:

$$COV(z, u) = 0 \quad (9)$$

The implication of equation (9) is that the instrumental variable must be uncorrelated with the independent variable beyond the indirect correlation through the endogenous variable. Factors that the instruments indirectly affect, which in turn may affect our dependent variable, must be controlled for. The exogeneity condition cannot usually be tested formally; one must argue by economic sense why it is plausible that the instrument is exogenous. However, if there is more than one instrument explaining the endogenous variable, one may conduct an overidentification test. Using one instrument at a time in the structural equation, one obtains the different estimates of the coefficient of interest, and test if these estimates are the same when each instrument is applied. If two instruments are tested, and the coefficients are equal, that is an indication that both instruments are exogenous. One drawback is that if the null hypothesis is rejected, and the estimates are statistically different, the conclusion is that either one of the instruments or neither are exogenous (Wooldridge J. , 2014, pp. 428-431).

## 4.3 Panel data methods

The pooled OLS and the 2SLS regressions rely crucially on the unobserved, country specific effects to be independent of all the explanatory variables, an assumption that in many cases is not very realistic. The unobserved characteristics of a country often impact both economic growth and several of its explanatory variables, in which case the reported slope coefficients will be biased. To account for such effects, also taking advantage of the fact that panel data are used, either a first difference model or a fixed effect model can be employed.

A fixed effect (FE) model subtracts the mean for each individual in the dataset, such that only slope coefficients are measured. A simple way to think of it is that by using an FE-model, all the countries observations are plotted relative to their own mean, so that they are lumped together around origin. Assume equation (10) is your pooled OLS-model:

$$y_{it} = \beta x_{it} + a_i + e_{it} \quad (10)$$

You suspect the unobserved, constant individual specific parameter $a_i$ is correlated with both the dependent and independent variable, and you want to use the FE-procedure to eliminate it from the model. Hence, the mean over time for each individual is removed, which can be formally stated like this:

$$y_{it} - \overline{y_i} = \beta(x_{it} - \overline{x_i}) + (a_i - a_i) + (e_{it} - \overline{e_i}) \quad (11)$$

The troubling parameter $a_i$ is removed in equation (11), and will hence not induce any biases. The downside is that all other time invariant effects also are removed, even though you would perhaps want to keep them in the model. If so, the random effect (RE) estimator is the correct tool, but this requires that the unobserved fixed effects are uncorrelated with the independent variables. An easy way to figure out which of FE and RE is the correct estimator, is to use the Hausman-test to check whether or not they produce identical estimates. If so, the RE-estimator produces more efficient estimates, but if the coefficients are different, RE is biased and one should choose the FE-estimator.

An alternative is to use the first-difference (FD) estimator, where the model in period t-1 is subtracted from period t. Since the problematic term $a_i$ is constant in every period, it is also here removed from the model. The equation for the FD-estimator is:

$$y_{it} - y_{i,t-1} = \beta\left(x_{it} - x_{i,t-1}\right) + (a_i - a_i) + \left(e_{it} - e_{i,t-1}\right) \quad (12)$$

$$\Delta y_{it} = \beta \Delta x_{it} + \Delta e_{it} \quad (13)$$

If there are only two periods, the FE- and FD-estimator will produce the same results, but for any $T \geq 3$, the estimates will not be equal. The most important aspect when choosing between the two is whether or not $e_{it}$ is serially correlated. If it is, while $\Delta e_{it}$ is not, FD is the better choice. If there is no serial correlation, or $\Delta e_{it}$ is in fact serially correlated, you are probably better off using FE (Wooldridge J. , 2014, p. 392). Alas, it is often unclear whether or not the serial correlation is sufficiently large to render FD the best choice. In such cases, it might be best to use both models and examine the difference in your estimates. Best case scenario is if the results are not sensitive. Worst case, they differ substantially, and the challenge is to determine why.

Cross-sectional dependence may also be present in a panel data setting, a challenge that has become more relevant as datasets with larger N and T are available. The more integrated global economy of the later decades means a higher degree of common shocks. Cross-sectional dependence reduces the efficiency of the estimator as shocks in one country affects the disturbances in another. It also violates the assumption that the errors should be uncorrelated over time, also leading to less efficient estimations (Hoyos & Sarafidis, 2006).

Pesaran (2004) propose a test for dependency across clusters that are robust to unbalanced datasets including structural breaks in slope coefficient and errors. The power of the test is also good when T is small and N large. The null hypothesis is that the error terms $\varepsilon_{it}$ and $\varepsilon_{jt}$ for all countries $i \neq j$, are independently distributed and serially uncorrelated with zero mean and constant variance. Testing the pairwise correlation between panels indicates if the null hypothesis holds[10]. We report the p-values from tests of cross-sectional dependence in each regression, but accounting for it is beyond the scope of this thesis.

## 4.4 Unit-root processes

If a shock to a variable persists over time, so that the variable does not revert back to its mean or trend-line, we say that the time series contains a unit root, or that it is non-stationary (Wooldridge J. , 2014, p. 318). In macroeconomic datasets such as ours, GDP is one variable we could suspect of having a unit root. In that case, a positive shock in Norwegian GDP in 1970 would still be present, affecting todays level of GDP. Running least squares-regressions on series containing unit root can lead to spurious results, and consequently it is not possible to make meaningful inference. If the time series on change form, for example:

$$\frac{\Delta\text{GDP}}{\text{cap}}_t = \frac{\text{GDP}}{\text{cap}}_t - \frac{\text{GDP}}{\text{cap}}_{t-1} \tag{14}$$

are stationary, but it is a unit-root process on level form, we say that the time series is integrated of order one, or I(1). The differenced term can then be used in a regression, and the results will be consistent. Otherwise, the use of non-stationary time series in regressions usually lead to spurious results. However, there is one exception to this rule, and that is when the variables in use are all I(1), and they are cointegrated (Wooldridge J. , 2014, p. 512). Consider the following equation:

$$e_t = Y_t - \beta X_t \tag{15}$$

If there exists a value of $\beta$ that makes $e_t$ a stationary process, in other words that $e_t$ is I(0), then Y and X are cointegrated, and they may be used in a regression on level form.

[10] The test can be used in Stata using the following commands: “ssc install xtcsd”, “xtcsd, pesaran”.

## 4.5 Data and descriptive statistics

Appendix 1 provides descriptive statistics for the variables of interest. The dataset is unbalanced and includes variables over a maximum time period of 41 years (1970-2011) for 146 countries. Real GDP per capita is our preferred measure of economic wealth[11]. We choose to log-transform this variable, since GDP in many cases grows exponentially, meaning a log-transformed variable will be a better fit in a linear model. The main explanatory variable is openness to trade, an index that ranges from 0.043 – 0.98. Variables that possibly correlate with both openness and GDP need to be controlled for. The main input factors from the Solow-model, capital and labour, are included[12]. We also include population, as it is reasonable to assume that change in population and number of persons engaged have individual partial effects. With the same argument as for GDP, both capital, labour and population are log-transformed. To capture the productivity in the work force, we also include a measure of human capital per worker and life-expectancy at birth[13]. Year-specific dummy variables are included to control for common shocks and crises. It is assumed that poor and rich countries have different growth rates, so that GDP-levels converge over time. To control for this, the initial level of GDP per capita in 1970 is also included. These are the main control variables used throughout the analyses[14].

In addition to the main control variables, other variables will be included to test the robustness of the findings. These are variables that potentially correlate with growth and openness, but that we have omitted in the main specification to reduce the possibility of multicollinearity and endogeneity bias. These variables include price level, government expenditure, degree of social and political globalisation, international trade as share of GDP, the international oil price, a polity index, a dummy variable for left-oriented government and a dummy variable for the period after 1990. The latter variable is included because average level of openness has increased at a higher pace after 1990[15].

[11] Expenditure-side real GDP per capita at chained PPPs (in mill. 2005US$)
[12] The measure of capital is the capital stock at current PPPs (in mill. 2005US$). The capital stock is measured from series on investment in buildings and different types of machinery, and is converted with relative prices for structures and equipment that are constant across countries (Feenstra, Inklaar, & Timmer, The Next Generation of the Penn World Table, 2013). The measure of labour is the number of persons engaged (in millions).
[13] The index is based on linearly interpolated average years of schooling, and an assumed rate of return for primary, secondary and tertiary education (Barro & Lee, 2013; Caselli, 2005; Feenstra, Inklaar, & Timmer, The Next Generation of the Penn World Table, 2013).
[14] To save space, the regression output will not always explicitly report these variables, but only an indication that they are included.
[15] See figure 1, page 8

We will also conduct an IV-regression, and apply four instrumental variables. Voting alignment with the United States in the UN General Assembly is an index ranging from 0 to 1, where 1 indicates that a country, in any given year, always voted the same as the United States[16]. Percentage of children immune to DPT[17] is a measure ranging from 0 to 1, that takes the value 1 if all children in a country are immune to DPT in the given year. Years as a GATT/WTO member is a variable indicating how many years a country have been a member of GATT/WTO, starting at unity the year after entry. Lastly, the distance from equator is measured with absolute latitude.

[16] The following countries have a smaller gap of missing values (1-2 years) in their data that have been linearly interpolated: Burundi (1990), Dominican Republic (1994-1995) and Mauritania (1999).
[17] DPT is short for diphtheria, pertussis (also known as whooping cough) and tetanus

# Part 4

## 5 Analysis

### 5.1 Testing variables for non-stationarity

If variables are non-stationary, they may not be used in regressions unless cointegrated. Testing for unit-root should be first in line when considering which variables to include in the structural model. The test results are presented in appendix 2, where we most importantly note that the natural log of GDP per capita exhibits non-stationarity. Since it is an I(1) process, it may only be used on first differenced form, meaning that we analyse the effect of the independent variables on GDP per capita annual *growth*, and not level. After all, there is nothing a country can do about its present level of wealth, it may only affect growth to reach higher levels in the future, so this is not a big problem for our analyses. Henceforth, the annual growth rate of GDP per capita is denoted $\Delta Y_{it}$. The control variables that are I(1) will only be used in first-differenced form.

Openness is the explanatory variable of main interest, and as explained earlier, it is an index ranging from a minimum value of 0.043, to a maximum value of 0.983. The test indicates that this is a non-stationary I(1) process for some of the countries in the data set. This is also true for social globalisation, a variable employed in robustness tests. However, unit-root tests have been shown to be biased towards indicating unit-root when the time series contain structural breaks (Stock J. H., 1994, p. 2818). The definition of a stationary process is that it reverts back to its mean, or to its trend-line, which hardly make any sense for a policy variable, politicians rarely aiming to reverse their own policy after a few years. The openness indicator has little or no explanatory power on change form, understandably given that it shows several periods with little change. Consequently, openness is applied on level form in the regressions, while instead the residuals from our preferred model are tested for unit-root for each country. The weakness of unit-root tests for panel data is that rejecting the null of non-stationarity implies that at least *one* country has stationary residuals, which is not very informative. Since we run several regressions, the residuals of each country for each regression are tested for unit-root. To be able to trust the results from different regressions, countries that have non-stationary residuals at a five percent significance level are omitted.

## 5.2 Regression analysis by pooled OLS

A natural first step is to use pooled Ordinary Least Squares (OLS). The potential problem of endogeneity in the openness index will be handled at a later stage. We start out by testing the residuals of the countries for non-stationarity in the main specification of the model, removing those which time series are not stationary[18]. This leaves us with 92 countries. It is previously shown that the presence of autocorrelation in the error term lead to biased standard errors, and even biased estimates if the sample is small[19]. To test for this, the Wooldridge test for serial correlation in panel data is applied (Wooldridge J. M., 2002, p. 282; Drukker, 2003). The test rejects the null hypothesis of no serial correlation in the pooled OLS-model, with a p-value of 0.063. The null hypothesis of homoskedasticity is rejected with a p-value of 0.007, meaning that the standard errors are heteroskedastic[20]. We conduct the regressions with clustered standard errors, robust to autocorrelation and heteroskedasticity.

All regression results are presented in appendix 3, where the pooled OLS-regressions are presented in table 1. The OLS regression equation is:

$$\Delta Y_{it} = \alpha + \beta_1 openness_{it} + \theta_2 C_{it} + u_{it} \qquad (16)$$

Where $u_{it} = a_{i,} + v_{it}$ is the random error term, $\Delta Y_{it}$ is the growth rate of GDP per capita for country $i$ at time $t$ and $C_{it}$ is a vector of control variables including year specific effects. In order to obtain unbiased estimates, the unobserved, fixed effects, $a_{i,}$ need to be uncorrelated with the explanatory variables, which is assumed in this case.

First, only openness is included in the regression (1), and then control variables are incrementally included to see their individual effects on openness[21]. We find that the coefficient on openness is significantly different from zero in two cases. One is the case where no control variables are included (1), where it takes the value 0.0204, significant on a 1 percent significance level. This implies that a one-unit increase in the openness indicator corresponds with an increased growth rate of 0.02 percentage points. As soon as year-specific effects are controlled for, the coefficient becomes insignificant (2), but when capital is also included (3), the coefficient is significantly different from zero on a 10 percent significance level. When additional control variables are included (4-8), it stays insignificant. In the

[18] An Augmented Dickey-Fuller unit-root test is run on each individual country, and a Phillips-Perron unit-root test are run for the whole panel data set, to test for presence of non-stationarity in the residuals (one lag).
[19] Test results for all estimators are presented in appendix 4, table 5
[20] Heteroskedasticity is tested using a Breusch-Pagan/Cook-Weisberg test, conducted in Stata 14.0 by the "estat hettest"-command
[21] All regression coefficients imply a ceteris paribus effect, assuming all other variables are held constant

regression where all control variables are included (8), the coefficient takes the value -0.0013. It is not significantly different from zero, with a p-value of 0.811. That the coefficient changes when the different control variables are included indicates that they are relevant in the regression, and they all have the expected signs. The results confirm that there exists some positive relationship between economic growth and openness (1), but this relationship disappears as other effects are controlled for.

To test the robustness of this finding, we include several additional control variables (table 1.1). The coefficient remains insignificant in all but one occasion, and this is when the index measuring social globalization is included, inducing a positive shift in the openness-coefficient (3). Openness and social globalisation is positively correlated, and the coefficient on social globalisation is negative, causing a negative bias on openness in the initial regressions. By including this variable, openness again has a positive relationship with economic growth, albeit only significant at a 10 percent significance level. There is also some concern that social globalisation index is endogenous. While both change in price level and the oil price are significant (1 and 7), the coefficient on openness remains insignificant.

We find no effect of openness on growth that is statistically different from zero, and robust to changes in specification, and there are several possible reasons for why this is the case. It could be that pooling all observations together, an action that implies a common intercept, simply is a poor fit for the data. It could also be that there are important omitted variables affecting both openness and economic growth, or that there is a reverse causality bias. We therefore choose to test other estimators to see if the results differ.

## 5.3 Regression analysis by FE-estimator

It could be that country-specific effects that are unobserved in the model have explanatory power on both GDP-growth and the openness indicator, and an FE-regression is a natural second step. After removing countries that show signs of unit-root in the residuals from the main specification of the model, 89 countries remain in the FE-regressions. Testing for serial correlation and heteroskedasticity gives the same conclusion as in the pooled OLS-model, and the standard errors are clustered in the FE-model as well [22]. We could use the First Difference-estimator, but there are several countries with little variation in openness over time. Hence, we prefer the FE-model because it keeps more of the within-country variation. An F-test

[22] Heteroskedasticity is tested using a modified Wald-test (Baum C. F., 2001), and serial correlation with the Wooldridge test.

rejects the null hypothesis that there are no fixed effects in the model, with a p-value of 0.00, implying that a pooled OLS-estimator is not preferable. The Hausman-test rejects the null hypothesis stating that a random effect model yields the same results as a fixed effect model, at all significance levels, which leads us to use the FE-estimator since it is consistent. We proceed allowing each country to have their own intercept. Formally, the equation for the FE-model is:

$$\Delta Y_{it} - \overline{\Delta Y_{it}} = \beta_1 (openness_{it} - \overline{openness_i}) + \theta_2 (C_{it} - \overline{C_i}) + (a_i - \overline{a_i}) + (e_{it} - \overline{e_i}) \quad (17)$$

Equation (17) shows that the omitted constant, country-specific effects $a_i$ is removed, and $e_{it}$ is the remaining random error term. The FE-regressions are presented in table 2. As in the former analysis, the coefficient is positive and statistically different from zero on a 1 percent significance level when no control variables are included (1). As soon as year-specific effects are included in the regression, the coefficient becomes insignificant (2). It changes marginally when additional control variables are included, and it remains statistically insignificant (3-7). When the main control variables are included, the coefficient on openness, that was -0.0013 in the pooled OLS-model, turns positive, and is 0,024 in the FE-regression (7). Since initial wealth is time-invariant, it is omitted from the FE-regression. That the coefficient becomes more positive compared to the pooled OLS-model indicates that the omitted, country-specific fixed effects correlate oppositely with openness and growth, inducing a negative bias in the openness-coefficient when not removed. One puzzle that is worth mentioning is how the coefficient on human capital turns negative and significant in the FE-regression. This is counterintuitive, but reportedly not unique to our regression (Arcand & d'Hombres, 2007; De la Fuente & Doménech, 2002). The problem might stem from lack of variation in the variable or econometric specification problems. It seems that cross-sectional analyses get the expected positive coefficient, and that it is the time-series aspect of the model that results in the negative value. We find that whether or not human capital is included in the model have a slight effect on the coefficient on openness.

When including additional control variables (table 2.1), the result is in line with the findings in the pooled OLS-model. Openness is significantly different from zero at a ten percent significance level when social globalisation is included. The coefficient indicates that a one-unit increase in the openness index corresponds with a 0.035 percentage point increase in annual growth.

The FE-estimator yields two coefficients on openness that are statistically significant from zero. This is where no control variables are included and when social globalisation is controlled for. These are not reliable due to omitted variables and endogeneity respectively, and we will therefore proceed with a different approach.

## 5.4 Regressions analysis by instrument variables

There are some worries that the openness indicator is not exogenous, leading to suspicion that the estimates cannot be trusted where openness is used directly. It could be that richer countries are more open, perhaps because they expect more gains due to their high level of trade or strong institutions. This is a classic case of reverse causality, and it will induce a biased coefficient on openness. It could also be that there are omitted variables that affect both openness and growth. In such a case, the direction of the bias depends on the correlation between the omitted variables, openness and growth. If such variables are constant over time, the FE-estimator takes care of the problem. We assume that the time period in question is sufficiently short that social characteristics are removed in an FE-model. This applies to institutions as well, perhaps to a smaller degree, but for some countries, that is not the case. We suspect that these and other omitted variables affect the level of openness, and that there possibly is reverse causality. To see whether or not we can single out an exogenous effect of openness on growth, we continue with the 2SLS-estimator.

### 5.4.1 The instrumental variables for openness

To measure the effect of openness on growth we will use several instruments. The four instruments applied are number of years as a GATT/WTO member, the percentage of children immune to DPT, the absolute latitude of a country and voting similarity with the U.S. in the United Nations General Assembly. For these instruments to be plausibly exogenous they should have no effect on the dependent variable. In equation (18), a simple model explaining the exclusion restriction is presented:

$$\Delta Y_{it} = \beta_1 openness_{it} + \gamma_1 GATT_{it} + \gamma_2 DPT_{it} + \gamma_3 Vote_{it} + \gamma_4 Latitude_{it} + u_{it} \qquad (18)$$

For the $k$ instrumental variables to be exogenous, $\gamma_k$ should be zero. If this is true, they are exogenous. In equation (19), we need $\delta_k \neq 0$, for the instruments to have explanatory power.

$$openness_{it} = \lambda + \delta_1 GATT_{it} + \delta_2 DPT_{it} + \delta_3 Vote_{it} + \delta_4 Latitude_{it} + v_{it} \qquad (19)$$

### 5.4.2 Arguments for choice of instrumental variables

#### *5.4.2.1 Years as member of GATT/WTO*

That a variable initially was correlated with the dependent variable, but ex post is uncorrelated with it, makes it more plausible to assume it exogenous. We argue that this is the case for the number of years as a member of GATT/WTO. GATT was the trade agreement that later turned into an organization, the WTO, both aiming to reduce tariffs and promote trade. As such, it may be reasonable to assume that member states over time are influenced to reduce trade barriers, opening up the country to foreign goods. At the time of admission, there may have been transitory effects correlating with GDP-growth in a country, possibly in both directions, but over time they should disappear or be marginal.

It is not random which countries joined in the earliest years of GATT's existence, but a variable for initial wealth or the FE-estimator will remove most of the possible endogeneity resulting from this. We further assume that, if endogeneity is indeed present, this will mostly be county-specific and time-invariant. Using an FE-model instrumental variable approach will remove the most worrisome effects, leaving us with the exogenous variation. When a country has remained member for years, there is likely no connection between additional years of membership and economic growth, beyond the possible linkage through attitude towards trade barriers.

Davis and Wilf (2013) claims that countries generally don't liberalize their trade policy before becoming members, but that democracy and foreign policy similarity plays the most important role. If this is correct, there is little need for worrying about reverse causality. We have also found that the direct impact of GATT/WTO on trade policy has been limited for many years, due to the challenge of making a very diverse group agree on such important matters. This has led to an explosion in regional and bilateral trade agreements, while GATT/WTO have played a minor role (Rose, 2002). We interpret this as a sign that the number of year as a member says more about how much time the individual country has had to "mature" towards trade openness, limiting any other possible effects on economic growth. In other words, the variable captures the attitude towards openness more than actual policy change, and hence GDP-growth should not be directly influenced.

#### *5.4.2.2 Share of children immune to DPT*

The percentage of children immune to DPT is to a very large degree determined by whether or not people have been vaccinated, and it is our second suggested instrument for openness.

The vaccination program began in 1949 and WHO expanded it in 1974 to hike the levels of immunization in in developing countries (Immunization Action Coalition, 2015). Our measure of immunization to DPT is from 1980-2011, and is percentage of children in a country that is immune. The fact that the program started in 1974 and is not measured until 1980 makes it predetermined, so it should have little or no direct effect on GDP in the years it is measured. The same is the case since the share of immune children will not immediately increase as vaccinations are handed out, but rather with a delay. That it correlates with openness might be down to factors such as trust in international science and healthcare, and admission to foreign knowledge and products. When a country accepts vaccination programs, they effectively open up to the world, an effect likely to persist. Vaccination could be correlated with GDP through higher life expectancy and human capital, hence we control for this. Epidemic outbreaks could have an effect on labour force participation, and consequently a negative effect on economic growth. One of the more severe outbreaks of DPT came in the former Soviet regions, where around 5,000 deaths were reported in the period 1990-1995 (Dittmann, et al., 2000). In macroeconomic terms, it is hard to see that this would heavily influence such a large economic system as the Soviet Union. Also, by controlling for persons engaged in a country we pick up most of this effect. As immunization reaches a high level, these kind of occurrences are few and relatively small. We draw the conclusion that the share of children immune to DPT does not correlate with the error term, and is hence exogenous after controlling for various effects discussed above.

#### *5.4.2.3 Share of votes equal to the U.S. in the United Nations General Assembly*

A third instrument is voting alignment with United States in the UN General Assembly. This is an indicator of how closely aligned to the U.S. a country is politically in international matters. Such an alignment is a visual sign that a country has some political or cultural similarity with the US, considered to be a country very actively promoting international integration and trade. Similar voting should therefore be correlated with liberal trade policies. It could be the case that the US would “reward” countries that vote similar to them, for example by directing more aid to such countries, or trade more with them. In extreme cases, this could be true, but it is not likely the case for most of the world. The private market constitutes most of a country’s GDP, and private actors are not very likely to respond to voting in the UN. We assume that any possible effect of aid or increased trade, if at all present, would have a very limited effect on aggregate economic growth, and thus choose to disregard it. Beyond the possible linkage through increased openness, we find little ground for suspecting voting in the UN to directly affect growth in your own country, and we therefore make the claim that voting similarity with the US is both relevant and plausibly exogenous.

#### *5.4.2.4 Distance from equator*

Geographic characteristics of a country have also been used as instruments for openness to trade, and have been proven both relevant and exogenous (Frankel & Romer, 1999). We will use absolute latitude as an instrument for trade openness as it can be showed that countries with lower absolute latitude are less inclined to pursue liberal trade policies. This could possibly be due to variations in underlying cultural or political preferences between countries in different climatic regions.

It is sometimes argued that the harsh conditions close to the Equator, with high humidity and temperatures, and various insects and diseases, have hampered the economic growth in such regions. However, moving away from the equator, there are other challenges such as intensely hot deserts, or extreme cold further north. Also, previous research has found little or no direct effect of latitude on wealth, after controlling for other factors[23]. Therefore, we choose to include absolute latitude as an instrument variable, claiming it to be both relevant and plausibly exogenous.

### 5.4.3 Testing the instruments

#### *5.4.3.1 Instrument relevance and exogeneity*

Whether or not the instruments are relevant is easily tested by including them in a regression on openness, and examining their individual t-statistics and the joint F-statistic. One may also use the Stock & Yogo test for weak instruments to find out how strongly the instruments predict openness. The Kleibergen-Paap Wald F-statistic[24] (henceforth KP-statistic) is then compared with the critical values from Stock & Yogo (2002). Since we want strong instruments, we do not accept a relative bias higher than five percent. In other words, maximum five percent of the predicted bias from the OLS estimate is allowed in the 2SLS estimate. This critical value is only available for regressions with more than one exclusion restriction. To be certain that we only reject the null hypothesis at the appropriate level, size distortions are not allowed to exceed the 10 percent threshold. In other words, we only trust regressions where this test allows us to believe the reported p-value on openness. When the instruments have a KP-statistic above these critical values, we will report them as strong.

[23] See Acemoglu, Johnson, & Robinson (2000) and Hall & Jones (1999)
[24] In the regression tables, this value is reported as the “F-value excluded instruments”

It is assumed that the instruments are exogenous, and that they only affect economic growth through openness. Since there are more instruments available than the number of endogenous regressors, it is possible to test the instruments for endogeneity with an overidentification test. The question is first whether or not the individual variables are relevant, and then if the overidentification test accepts that those relevant variables produce the same coefficient on openness. Since the OLS-, RE- and FE-regressions with control variables are somewhat similar, we run the IV-regressions both in pooled 2SLS form, and with a fixed effect 2SLS form.

### 5.4.4 Pooled 2SLS-regression

We first run pooled 2SLS regressions with both single instrumental variables and different combinations, where the first and second stage regressions are presented in table 3. The main control variables are included. After the unit-root test of the residuals from the regression with the main specification, 87 countries remain. Heteroskedasticity is present, but the Wooldridge test for autocorrelation no longer rejects the null hypothesis, with a p-value at 0.33. This leads us to use heteroskedasticity-robust standard errors[25]. We find that all instrumental variables are relevant in predicting openness, except when years as member of GATT/WTO is included alone (4). This variable is significant, however, when it is included in both level and squared form (5), indicating that there is a non-linear relationship. The strength of the different instrumental variables is encouraging. The KP-statistic for the regressions with single instrumental variables (1-4) take high values except for GATT/WTO-membership. Latitude (1), voting in line with U.S. (2) and share of children immune to DPT (3) are all deemed strong. When years as GATT/WTO-member is included in both level and squared form, it is significant on a one-percent level, but it is borderline weak (5).

We have determined that the instruments are relevant, and in most cases strong, and turn to analysing their validity. Different combinations of instruments are tested, and the Hansen J-statistic from the overidentification test cannot reject that different instruments yield statistically different estimates on openness (6-8).

The estimates on openness are not equally exciting. Only one regression gets an estimate significantly different from zero, which is when voting alignment with USA and years as member of GATT/WTO (level and squared form) are the included instrumental variables for

[25] Presence of heteroskedasticity is tested with an analog of the Breusch-Pagan test, regressing the squared residual from the IV-regression on all exogenous variables, including the instruments. The joint significance-test rejects the null of homoskedasticity.

openness (7). Combined, they are strong instruments for openness. The coefficient is different from zero only on a 10 percent significance level, and states that a one-unit increase in the openness indicator corresponds with a 0.057 percentage point decrease in economic growth. Openness is also rejected as exogenous with a p-value of 0.099, an indication that it is correct to pursue an IV-model. Since this is the only result where the effect of openness on growth is statistically different from zero, we proceed to test the robustness of regression (7), presented in table 3.1[26]. We are mainly interested in inspecting whether the validity of the instrumental variables holds, and if the estimated coefficient on openness remains negative and statistically significant. The validity of the instruments holds throughout all robustness checks, while the estimate becomes statistically insignificant when either change in price level (1) or the left-oriented government-variable (5) is included. Changes in price level might function as a proxy variable for distortionary macroeconomic policy, or an unstable macroeconomic environment. The openness-coefficient otherwise remains significant on a 10 percent significance level, and also on a five percent level when the polity-index is included (4). This is an indication that, when policy variables are analysed, controlling for the institutional characteristics of a country is important. These findings are in line with the arguments of Rodriguez & Rodrik (2000), that openness indicators often capture effects of poor institutions or macroeconomic instability if they are not internalised in the model. Such variables may also be endogenous, however, meaning that including them in regressions could distort the results. Allowing poor-, middle- and high-income countries to have their own intercepts, results in a slightly more negative coefficient on openness, with a p-value of 0.058. By use of a pooled 2SLS-estimator, we find that openness is usually statistically insignificant, but one combination of instrumental variables results in a negative coefficient that is relatively robust on a ten percent significance level. The instrumental variables work well, and are both relevant and seemingly exogenous.

#### 5.4.5 Fixed effect 2SLS-regression

There is a possibility that the regression is affected by country-specific fixed effects, inducing biased estimates. We therefore move on to the fixed effect 2SLS-estimator, to see whether the results differ. When the FE 2SLS-regression is run, Stata include an F-test reporting whether or not country-specific fixed effects are statistically different from zero. This is indeed the case, as the null is rejected with a p-value of 0.00. Even though we do not know for certain

[26] Robustness tests were also performed on regression (8), but the coefficient on openness remained statistically insignificant through all tests. The instrumental variables remained valid.

the estimate is biased in the pooled 2SLS-model, this test leads us to conclude that a panel data-estimator is a better way to progress than the pooled model. The random effect 2SLS-estimator yields very similar results as the fixed effect 2SLS-estimator, except for the variable of main interest to our analysis. In the RE 2SLS-model, the estimate on openness is -0.06, while the corresponding estimate from the FE-estimator is almost five times as large in absolute terms. Consequently, we proceed with an IV-approach using a fixed effect-estimator. When the residuals from the FE 2SLS regression with the main specification is tested for unit-root, we are left with 89 countries. The errors show signs of heteroskedasticity, but the Wooldridge test for serial correlation cannot reject the null of no serial correlation, with a p-value of 0.31. We proceed while applying heteroskedasticity-robust standard errors.

In table 4, the output from the first stage regressions with the different instrumental variables is presented, latitude excluded since it is time-invariant. Both years as member of GATT/WTO (1 and 2) and voting alignment with the U.S. (4) is statistically significant in predicting openness, and the Stock & Yogo-test reject that they are weak instruments. The endogeneity tests also indicate that there is endogeneity in the FE-model, and consequently that an IV-specification is preferable. Share of children immune to DPT (3), however, has little explanatory power as country-specific fixed effects are removed, and it does not pass the Stock & Yogo-test. This indicates that the pooled 2SLS-model where this variable is included might be biased. Even though the overidentification test accepts the regressions where share of children immune to DPT is paired with the other instrumental variables (5 and 6), we leave it out of the further analyses as a precaution to avoid the possible weak instrument bias. We move forward with years of membership in GATT/WTO and voting alignment with the U.S as the preferred instrumental variables. The KP-statistic for this specification exceeds both the threshold for relative bias to OLS and the threshold for size distortion, indicating that the openness coefficient can be trusted. The reduced form, first stage regression equation is:

$$\widehat{openness}_{it} = \delta_1 yearsWTO_{it} + \delta_2 yearsWTO_{it}^2 + \delta_3 \ln(votewithUSA)_{it} + \omega C_{it} + \epsilon_{it} \quad (20)$$

Where $\epsilon_{it}$ is the random error term, $C_{it}$ is a vector of control variables the country-individual mean is removed from all variables, including omitted fixed effects. Equation (21) is the second-stage regression equation:

$$\Delta Y_{it} - \overline{\Delta Y_{it}} = \beta_1 \left(\widehat{openness}_{it} - \overline{\widehat{openness}_{it}}\right) + \theta_2 \left(C_{it} - \overline{C_i}\right) + \left(e_{it} - \overline{e_i}\right) \quad (21)$$

The coefficient on openness when share of children immune to DPT is included alone (3), gives a strong indication that our decision to leave it out of the main specification (7) was probably correct. The two other instruments yield similar estimates when they are included alone, together and in different forms, while the immunization measure gives a much larger but insignificant result. In the regression with our main specification, the coefficient indicates that a one-unit increase in the openness index corresponds with a 0.28 percentage point decrease in annual growth. This result is statistically significant within a five percent significance level. This is a large effect, and contrary to theory and most previous research.

#### 5.4.6 Robustness of the results

We want to test the robustness of this finding in several ways, and start out by looking at the relationship between the openness coefficient and other variables (table 4.1). We run one regression for each additional control variable, while the main control variables are included in all regressions. We find that the coefficient is relatively stable when the different control variables are included, and the instrumental variables remain strong and valid. Contrary to the pooled 2SLS-model, the coefficient remains statistically significant when both price level (1) and the left oriented government-variable (5) is included. It is only significant on a ten percent significance level when trade as share of GDP is included (2), but except for this, the coefficient remains significant on a five percent significance level, and with a magnitude between -0.32 and -0.26. The most encouraging regression is when human capital and labour in squared term are added to the main specification (8). This results in a coefficient on openness at -0.345, significant on a one percent significance level. Altering the regression specification result in coefficients

We would also like to see if altering the sample has any effects. The countries are divided into three groups after income level, whereby we run one regression on each sample group (table 4.2). The regression including the high-income group shows a coefficient that is more negative and significant on a one percent significance level. The coefficients on low and middle-income countries are statistically insignificant. However, we see that most of the coefficients on the control variables are also not significant, which may indicate that there is not sufficient variation within the income groups. It could also be that rich countries, that has high levels of openness on average, have little to gain by more liberalization, and that this effect drives the results. If correct, this is similar to the findings of Dreher (2006), who found that interaction terms between openness and income levels were only statistically different from zero in the case for high-income countries. In his case, however, this coefficient was positive, and the openness index was directly included in the regressions. When different control variables are included for the regression on high-income countries (table 4.3), we find that the coefficient remains statistically significant on a five percent significance level, and with a magnitude between -0.337 and -0.377. One exception is when share of trade to GDP is included (5), where openness is only significant on a ten percent significance level, and it falls to -0.22. We find that changes in price level is no longer significant (1), possibly indicating that high-income countries have less macroeconomic instability.

The FE 2SLS-regressions gives a clear indication that there exists some negative relationship between openness and economic growth, and that this effect might be large. The standard deviation of openness in a given year is roughly 0.2, corresponding with a 5.6 percentage points lower annual growth. Still, most countries would seldom increase much more than 0.02 in a given year, which would correspond with a decreased growth of 0.56 percentage points.

An additional strength of the FE 2SLS-model in our case is that it is the only specification where cross-sectional dependence is rejected (see appendix 4, table 5). This allows us to further trust the already robust findings. We conclude that the instruments show great strength. Additionally, the overidentification tests indicate that they are valid within several regression specifications.

# Part 5

## 6 Discussion

There is much debate on the topic of liberalization of trade policy and the possible connections to wealth, and even though many economists agree that free trade and openness is for the good, other researchers point out that robust relationships are hard to come by. This has definitely been the case for our research as well. We have conducted a wide array of different tests and regressions, included and excluded a variety of variables, used both pooled and FE-models, and with openness included directly and through instrument variables. Some regressions were inconclusive, with statistically insignificant coefficients on openness, but there were several results that were significantly different from zero. Contrary to expectations, most of them were negative, and especially the coefficients in the fixed effect IV-regression showed a strong negative relationship between openness and economic growth.

How can it be, that the only significant and robust result we find is contrary to economic theory, a theory with very few opponents in the world of economics? If we ignore the obvious possibility of omitted variable bias, there are a couple of potential reasons. As previously discussed, it has been argued that countries with poor institutions and corruption problems have little to gain by liberalising their trade policy, or that openness and free trade may actually be directly harmful to such countries (Rodriguez & Rodrik, 2000; Wei, 2000; Yanikkaya, 2003). Other countries, with sound institutions and well developed democracy, may experience large gains related to openness. It is possible that several countries have experienced significant negative effects from attempts of opening up, and that these effects dominate the positive effects of other countries with stronger institutions. We have run regressions where indicators of democracy are included, but the coefficient on openness has not been significantly altered.

Also, we find that richer countries, which presumably on average have the best institutions, have the largest negative coefficient. Krugman, Melitz, & Obstfeld (2012, p. 283) proved that the optimum tariff is larger than zero, and it may be that the optimum level of general openness to trade is not complete free trade. Adding to the direct "supply and demand"-effects that they calculate, there could be other, more complex effects. Many countries' tax systems are progressive, and most of the benefits are distributed to the less wealthy parts of the population. Possibly, poorer individuals have a larger propensity to consume, and if the distortions from the barriers to trade are sufficiently small, the extra consumption could induce a net positive effect. It is also possible that the result is driven mainly by the fact that high-income countries already find themselves on high levels of openness.

Frankel & Romer (1999) finds a link between trade and economic growth, where trade is predicted via a gravity model. As previously noted, trade policy is part of the residual in their paper. It we assume that the positive impact of trade on growth, our finding is somewhat puzzling. If the findings in both the article of Frankel & Romer and our thesis are true, one must conclude that trade policy does not significantly affect the level of trade. Otherwise, it could be that the variables included in the gravity model simply are not exogenous, and that they themselves are beneficial to economic growth. If so, the positive effect of trade on economic growth, found by Frankel & Romer, is simply a spurious result.

In the research of Dollar (1992) and Sachs & Warner (1995), they employed different proxies for trade policy, and found significant positive effect of policies open to international trade. If our result is correct, it is a clear support of Rodriguez & Rodrik (2000) and their claim that the indices of Dollar and SW actually capture the effect of macroeconomic instability and poor institutions. Contrary to those indicators, this thesis employs an index that is a rather direct measure of trade policy, and this might be the best way to capture policy's effect on economic growth.

### 6.1.1 If openness is harmful, why would it persist?

There are many reasons why a country would keep open after it has liberalised its trade policy, even if one assumes the costs to outweigh the gains. An obvious reason is that laws and policies takes time to reverse within a country, and multilateral agreements could also ban a country from reversing such policies. When a policy is made active it will most likely continue at least through the current governments reign, and politicians may be aware that frequent policy changes create instability and uncertainty that is usually considered bad for business. This is associated with the fact that shifts in trade policy forces structural changes in the economy that are costly to reverse, acting as an incentive for new governments to continue on the same path as governments before them. International credibility also plays a role in a country´s sustainability of its current level of openness. Even if current trade policies are not optimal for a specific country, the costs of increased protectionism might be much larger if other countries decides to impose some sort of "punishment".

### 6.1.2 Important caveats

There could be important, time-variant effects that correlate with both GDP-growth and level of openness, and that are omitted from the model. If so, they will lead to bias in the estimated beta-coefficients. The 2SLS-estimator accounts for this bias if the instruments are truly exogenous, but the overidentification test and our reasoning might be incorrect or in some way incomplete. It possibly exists a direct connection between the instrument variables and economic growth, that is not time-invariant, rendering them endogenous. Most of our results either indicate a negative relationship or no relationship at all. If most omitted variables correlate in the same direction with both openness and growth, something we assume that is the case, including them in the model would actually lead to a more negative coefficient.

Related to the problem of omitted variable bias is the fact that it might not exist a single, direct relationship between openness and growth, but that certain preconditions are required. This is properly discussed in the section for earlier research, and is important to keep in mind. It might also be the case that international trade openness has network effects. If every individual had its own, private Facebook not connected to everyone else's, it is doubtful if so many people would enjoy it very much. Similarly, countries that liberalize their trade policy might see little benefits if other countries remained at a constant level. However, as the world has become a more open market, it should be possible to find increasing growth-effects of liberalization in the later years if this was indeed correct, effects that we could not identify.

Finally, and perhaps most importantly, our aim was to find whether or not openness to trade had an effect on the welfare in a country. We define GDP per capita as an adequate proxy variable for welfare, and it is the dependent variable in our structural model. Several problematic issues were mentioned, and we would like to single out two of them here. Firstly, the distribution of income is not captured in the GDP-figures, making an empirical analysis less covering. Also, people's wellbeing is not perfectly captured by GDP, even though there is a correlation between the two. If trade barriers make foreign goods very expensive, or even unobtainable, people may buy the domestic counterparts of those products. The price might be the same or higher, but the consumer is possibly less happy than he could have been with the foreign option. The use of GDP per capita as a welfare measure thus affect the conclusions ambiguously.

# 7 Conclusion

The objective of this thesis is to answer the following research question:

*"To which degree, if any, does openness to international trade lead to increased economic growth within a country?"*

To find an answer, we employ data from several sources in different regressions, testing for various statistical issues that may distort the answers, and thus prevent any conclusions on the existence of a causal relationship. We conclude that endogeneity is a problem, and that omitted, country-specific fixed effects are present and potentially causing spurious results. Consequently, we employ instrumental variables, where the main focus of the analysis is a fixed effect-regression where two instrumental variables are used to predict the level of openness within each country at any point in time.

The theoretical foundation for the relationship between trade and growth build on the classical work of David Ricardo, and is later augmented by other researchers, but this thesis is strictly empirical, and does not directly apply any of the theory other than as a baseline for discussion and understanding. We initially had no strong beliefs regarding the results, but some sort of positive relationship was expected, as indicated by most of the literature. However, the results surprised us, and we are not able to locate any robust, positive relationship. The world has seen high growth in periods of openness, and low growth in periods of protectionism, but the econometric results still leave us with a negative estimated effect of openness on growth. Applying different estimators yield different results, but common for all of them is that neither result in robust coefficients that are significantly larger than zero.

Our main specification is a fixed effect 2SLS-regression with years as GATT/WTO-member and voting-similarity with the U.S. as instrumental variables for openness. Tests indicate that they are both strong and exogenous. The negative coefficient on openness in this regression holds when controlling for autocorrelation and heteroskedasticity, and also when performing several robustness tests. These tests include adding and removing different control variables, an overidentification test of the instruments and modification of the sample, and we find that the result is not sensitive to any of these variations.

We draw two main conclusions from the results in this thesis. Firstly, we have found that performing econometric analyses to macroeconomic data in general, and policy variables in particular, implies large uncertainties, no matter which methods are applied. There are important variables that are either omitted or can be assumed endogenous if included, cultural and institutional differences relevant examples. Many such effects are likely removed by a fixed effect estimator, but not all. That is also the reason why we choose to apply instrumental variables, to account for endogeneity. However, any conclusion is weakened by the fact that testing for endogeneity is only possible to a limited extent.

Related to policy, the negative connection between growth and openness to trade indicates that forcing countries into liberalisation is not generally a good solution. Convincing theories have evolved over time, and most research find that free trade is economically beneficial, findings that this thesis cannot falsify. In fact, we believe that a world where countries trade and barriers are limited, can contribute positively to increased wealth. However, opening up to trade can be directly harmful if not properly conducted, with very real consequences to the people involved. The fact that we identified several robust, negative coefficients, and no robust positive coefficients, might mean that barriers to trade can be positive for an individual country, all else equal. The conclusion of this thesis is consequently that openness to international trade does not automatically lead to increased economic growth.

## 7.1 Further research

The scenario that openness to trade is beneficial for all, conditional on everyone following the same policy, is a plausible one. If there indeed exists a negative ceteris paribus relationship between openness and growth, the situation takes form of a classical prisoners' dilemma, where each individual has an incentive to deviate from the common best solution, that is free trade. Hypothetically this is meaningful, but future research could try to prove that it is the case, by analysing whether for example negotiation rounds in GATT or WTO caused large, immediate shifts in mean tariff rates. Such shocks could potentially cause increased trade, and if Frankel and Romer are correct, increased growth.

Several policy variables are available, and one possibility is finding a variable that has a cointegrating relationship with GDP in level form. If such a relationship exists, one could build a vector error correction model, separating the long-run relationship between trade openness and economic growth from the short-run relationship. Such a framework could possibly better explain which way the causality goes. Alternatively, instead of finding a different measure of policy, one could try to find other measures of welfare that cointegrated with the openness indicator applied in this thesis. This has an additional advantage, since there may exist better measures of welfare than GDP. Indices measuring happiness and quality of life will surely improve in the coming years, and as data becomes more abundant, more robust econometric analyses are made possible. This may be the best way to go forward in order to find the policy that works best for as many people as possible.

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# 9 Attachments

## 9.1 Appendix 1 – Data information

Table 1

***Country list***

| | | | | | |
|---|---|---|---|---|---|
| 1 | Angola | 50 | United Kingdom | 99 | Nigeria |
| 2 | Albania | 51 | Georgia | 100 | Netherlands |
| 3 | Argentina | 52 | Ghana | 101 | Norway |
| 4 | Armenia | 53 | Guinea | 102 | Nepal |
| 5 | Australia | 54 | Gambia | 103 | New Zealand |
| 6 | Austria | 55 | Guinea-Bissau | 104 | Oman |
| 7 | Azerbaijan | 56 | Greece | 105 | Pakistan |
| 8 | Burundi | 57 | Guatemala | 106 | Panama |
| 9 | Belgium | 58 | Honduras | 107 | Peru |
| 10 | Benin | 59 | Croatia | 108 | Philippines |
| 11 | Burkina Faso | 60 | Hungary | 109 | Poland |
| 12 | Bangladesh | 61 | Indonesia | 110 | Portugal |
| 13 | Bulgaria | 62 | India | 111 | Paraguay |
| 14 | Bahrain | 63 | Ireland | 112 | Qatar |
| 15 | Bahamas | 64 | Iran (Islamic Republic of) | 113 | Romania |
| 16 | Bosnia and Herzegovina | 65 | Iceland | 114 | Russian Federation |
| 17 | Belarus | 66 | Israel | 115 | Rwanda |
| 18 | Belize | 67 | Italy | 116 | Saudi Arabia |
| 19 | Bolivia | 68 | Jamaica | 117 | Senegal |
| 20 | Brazil | 69 | Jordan | 118 | Singapore |
| 21 | Barbados | 70 | Japan | 119 | Sierra Leone |
| 22 | Brunei Darussalam | 71 | Kazakhstan | 120 | El Salvador |
| 23 | Botswana | 72 | Kenya | 121 | Serbia |
| 24 | Central African Republic | 73 | Kyrgyzstan | 122 | Sao Tome and Principe |
| 25 | Canada | 74 | Cambodia | 123 | Suriname |
| 26 | Switzerland | 75 | Saint Kitts and Nevis | 124 | Slovakia |
| 27 | Chile | 76 | Republic of Korea | 125 | Slovenia |
| 28 | China, People's Republic of | 77 | Kuwait | 126 | Sweden |
| 29 | Côte d'Ivoire | 78 | Lao People's Democratic Republic | 127 | Swaziland |
| 30 | Cameroon | 79 | Lebanon | 128 | Syrian Arab Republic |
| 31 | Democratic Republic of the Congo | 80 | Liberia | 129 | Chad |
| 32 | Congo | 81 | Lesotho | 130 | Togo |
| 33 | Colombia | 82 | Luxembourg | 131 | Thailand |
| 34 | Cape Verde | 83 | Morocco | 132 | Turkmenistan |
| 35 | Costa Rica | 84 | Republic of Moldova | 133 | Trinidad and Tobago |
| 36 | Cyprus | 85 | Madagascar | 134 | Tunisia |
| 37 | Czech Republic | 86 | Maldives | 135 | Turkey |
| 38 | Germany | 87 | Mexico | 136 | Taiwan |
| 39 | Denmark | 88 | The Former Yugoslav Republic of Macedonia | 137 | United Republic of Tanzania: Mainland |
| 40 | Dominican Republic | 89 | Mali | 138 | Ukraine |
| 41 | Ecuador | 90 | Montenegro | 139 | Uruguay |
| 42 | Egypt | 91 | Mongolia | 140 | United States |
| 43 | Spain | 92 | Mozambique | 141 | Venezuela |
| 44 | Estonia | 93 | Mauritania | 142 | Viet Nam |
| 45 | Ethiopia | 94 | Mauritius | 143 | Yemen |
| 46 | Finland | 95 | Malawi | 144 | South Africa |
| 47 | Fiji | 96 | Malaysia | 145 | Zambia |
| 48 | France | 97 | Namibia | 146 | Zimbabwe |
| 49 | Gabon | 98 | Niger | | |

Table 2

***Variable descriptions***

| Variable | Name in regressions | Observations | Mean | Std. Dev. | Min | Max | Description | Source |
|---|---|---|---|---|---|---|---|---|
| Economic Growth | Δ(GDP/cap) | 5,587 | 0.0193314 | 0.088442 | -0.9218097 | 1.012582 | Expenditure-side real GDP per capita at chained PPPs (in mil. 2005US$) | Penn World Table |
| Openness to trade | Openness | 5,509 | 0.4977908 | 0.2305108 | 0.0426301 | 0.9826156 | Measure of countries' level of trade-openness (see detailed decription in table 3) | KOF globalisation index |
| Social Globalization | Social Globalization | 5,650 | 40.99243 | 21.88831 | 5.222476 | 93.53602 | Measuring countries level of social globalization | KOF globalisation index |
| Political Globalization | Political Globalization | 5,650 | 56.75712 | 22.50375 | 3.991329 | 98.15632 | Measuring a countries level of political globalization | KOF globalisation index |
| Change in Capital | Δln(Capital) | 5,587 | 0.0522499 | 0.0605513 | -0.487587 | 0.9719934 | Capital stock at current PPPs (in mil. 2005US$) | Penn World Table |
| Change in persons engaged | Δln(Labor) | 5,264 | 0.0212295 | 0.0291351 | -0.2396488 | 0.291219 | Number of persons engaged (in millions) | Penn World Table |
| Change in population | Δln(Population) | 5,587 | 0.0174327 | 0.0150065 | -0.199246 | 0.1858832 | Population (in millions) | Penn World Table |
| Life Expectancy | Life expectancy | 6,025 | 64.59694 | 11.00081 | 19.50493 | 82.93146 | Measured as life expectancy at birth | World Bank |
| Human Capital | Human Capital | 4,949 | 2.209653 | 0.6076951 | 1.039863 | 3.618748 | Index of human capital per worker based on the average years of schooling | Penn World Table |
| Initial Wealth | ln(Initial wealth) | 5,292 | 8.129418 | 1.087524 | 6.113977 | 11.29507 | Initial wealth in 1970 using expenditure-side Real GDP per capita at chained PPPs (in mil. 2005US$) | Penn World Table |
| Change in price level | Δ(Price level) | 5,587 | 0.0159909 | 0.0611676 | -0.7559226 | 0.7022061 | Price level of Real consumption of households and government PPP-adjusted, divided by the nominal exchange rate measured in price level of USA GDP in 2005=1 | Penn World Table |
| Change in exchange rate | Δ(Exchange rate) | 5,587 | 19.97845 | 186.7822 | -2158.472 | 7104.243 | Exchange rate, national currency/USD (market+estimated) | Penn World Table |
| Government Expenditure | Government Exp. | 3,999 | 6.528984 | 20.68545 | -83.568 | 649.151 | General government total expenditure | Quality of Government (Variable name: imf_exp) |
| Tradeshare | Trade share | 5,113 | 76.63037 | 47.53917 | 5.314175 | 562.0604 | (Export+Import)/Real GDP | Penn World Table |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Freedom House Index | Democracy | 4,938 | 5.747983 | 3.376763 | 0 | 10 | Freedom House Index ranging from 0 (Least democratized) to 10 (Fully democratized) | Freedom House |
| Polity Index | Polity-index | 5,173 | 1.699981 | 7.409526 | -10 | 10 | Polity scale ranges from +10 (strongly democratic) to -10 (strongly autocratic) | Quality of Government (Variable name: p_polity2) |
| Change in Oil Price | Δ(Oil price) | 5,986 | 1.821596 | 11.18125 | -28.28465 | 37.47994 | World Oil price measured in Constant price of oil in 2000 (dollar/brl) | Quality of Government (Variable name: ross_oil_price) |
| Left-Oriented Government | Left government | 6,132 | 0.2429876 | 0.4289226 | 0 | 1 | Dummy variable taking the number 1 if Chief executiv party orientation orientation is left and 0 if otherwise | Quality of Government (Variable name: dpi_erlc) |
| Fertility | Fertility | 5,436 | 3.829807 | 2.019125 | 1.076 | 8.667 | Fertility rate, total (births per woman) | Quality of Government (Variable name: wdi_fertility |
| Dummy for years after 1990 | After 1990 | 6,132 | 0.5 | 0.5000408 | 0 | 1 | Dummy variable taking the value 1 after 1990 and zero otherwise | |
| Voting in line with United States | Voting in line with United States | 5,467 | .2488545 | .1624598 | 0 | 1 | Share of votes in line with U.S. in UN General Assembly (% pr. Year) | Erik Voeten |
| Distance from equator | Latitude | 6,088 | .2952706 | .189995 | 0 | .7222222 | Absolute latitude | Quality of Government (Variable name: lp_lat_abst) |
| Percentage of Children Immune to DPT | Immunization DPT | 4,306 | 75.23154 | 26.55726 | 0 | 99 | Percentage of children immune to DPT | Quality of Government (Variable name: wdi_immdpt) |
| Years with GATT/WTO membership | Years in Gatt/WTO | 6,132 | 17.26486 | 18.48107 | 0 | 63 | Years since joining WTO/GATT | WTO Homepage |
| High income country | Highincome | 6,132 | 0.3424658 | 0.4745732 | 0 | 1 | Dummy variable taking the value 1 if defined as high income country by The World Bank and zero if otherwise | World Bank |
| Middle income country | Middleincome | 6,132 | 0.5 | 0.5000408 | 0 | 1 | Dummy variable taking the value 1 if defined as middle income country by The World Bank and zero if otherwise | World Bank |
| Low income country | Lowincome | 6,132 | 0.1575342 | 0.3643334 | 0 | 1 | Dummy variable taking the value 1 if defined as low income country by The World Bank and zero if otherwise | World Bank |

Table 3 - Description of the components of openness indicator

| | | |
|---|---|---|
| Data on restrictions | | |
| Hidden Import Barriers | Gwartney et al. (2014) | The index is based on the Global Competitiveness Report's survey question: "In your country, tariff and non-tariff barriers significantly reduce the ability of imported goods to compete in the domestic market." The question's wording has varied slightly over the years. |
| Mean Tariff Rate | Gwartney et al. (2014) | As the mean tariff rate increases, countries are assigned lower ratings. The rating declines toward zero as the mean tariff rate approaches 50%. |
| Taxes on International Trade (percent of current revenue) | World Bank (2014) | Taxes on international trade include import duties, export duties, profits of export or import monopolies, exchange profits, and exchange taxes. Current revenue includes all revenue from taxes and nonrepayable receipts (other than grants) from the sale of land, intangible assets, government stocks, or fixed capital assets, or from capital transfers from nongovernmental sources. It also includes fines, fees, recoveries, inheritance taxes, and nonrecurrent levies on capital. Data are for central government and in percent of all current revenue. |
| Capital Account Restrictions | Gwartney et al. (2014) | Index based on two components: (i) Beginning with the year 2002, this sub-component is based on the question: "Foreign ownership of companies in your country is (1) rare, limited to minority stakes, and often prohibited in key sectors or (2) prevalent and encouraged". For earlier years, this sub-component was based on two questions about "Access of citizens to foreign capital markets and foreign access to domestic capital markets". (ii) Index based on the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions, including 13 different types of capital controls. It is constructed by subtracting the number of restrictions from 13 and multiplying the result by 10. |

*Source: Dreher (2006)*

### 9.1.1 Sources for data

- Penn World Table: (Feenstra, Inklaar, & Timmer, 2015)
- Quality of Government: (Teorell, et al., 2015)
    - Ross_Oil_Price: (Ross, 2013)
    - Wdi_fertility and Wdi_immdpt: (United Nations Statistics, 2014)
    - Dpi_erlc: (Beck, Clarke, Groff, Keefer, & Walsh, 2001)
    - P_polity2: (Freedom House, 2014)
- The KOF Globalisation index: (Dreher, 2006),
    - Available at: http://globalization.kof.ethz.ch/
- Erik Voeten: (Voeten, Strezhnev, & Bailey, 2009)
- Freedom House: (Freedom House, 2015)
- The World Bank: (The World Bank, 2015)

## 9.2 Appendix 2 – Unit-root test

Below, results from the unit-root tests are presented. The reported p-values in the table is from testing the null hypothesis that all panels are non-stationary. The test is a Fisher-type Phillips-Perron unit-root test for panel data, based on Phillips & Perron (1988). For the variables on level form, a linear trend is included, while the tests on the differenced variables is run without a linear trend. All tests are run with one lag.

| | LEVEL FORM | FIRST DIFFERENCED |
|---|---|---|
| **GDP PER CAPITA** | 1.00 | 0.00 |
| **OPENNESS** | 1.00 | 0.00 |
| **CAPITAL** | 1.00 | 0.00 |
| **LABOUR** | 1.00 | 0.00 |
| **POPULATION** | 0.00 | 0.00 |
| **LIFE EXPECTANCY** | 0.00 | - |
| **HUMAN CAPITAL** | 0.00 | - |
| **PRICE LEVEL** | 1.00 | 0.00 |
| **DEMOCRACY** | 0.00 | - |
| **POLITY INDEX** | 0.00 | - |
| **TRADE SHARE** | 0.00 | - |
| **EXCHANGE RATE** | 0.02 | 0.00 |
| **FERTILITY** | 0.00 | - |
| **SOCIAL GLOBALISATION** | 1.00 | 0.00 |
| **POLITICAL GLOBALISATION** | 0.00 | - |
| **OIL PRICE** | 1.00 | 0.00 |

## 9.3 Appendix 3 – Regression results

Table 1

***Ordinary Least Squares - OLS***

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | 0.0204*** | 0.00843 | 0.0108* | 0.00871 | 0.000244 | -0.00619 | -0.00529 | -0.00131 |
| | (0.00703) | (0.00701) | (0.00642) | (0.00622) | (0.00560) | (0.00496) | (0.00490) | (0.00548) |
| Δln(Capital) | | | 0.345*** | 0.351*** | 0.365*** | 0.358*** | 0.356*** | 0.343*** |
| | | | (0.0695) | (0.0718) | (0.0762) | (0.0751) | (0.0759) | (0.0790) |
| Δln(Labour) | | | | -0.109 | 0.109* | 0.0892 | 0.0898 | 0.0921 |
| | | | | (0.0864) | (0.0604) | (0.0604) | (0.0602) | (0.0623) |
| Δln(Population) | | | | | -0.693*** | -0.599*** | -0.619*** | -0.532** |
| | | | | | (0.166) | (0.184) | (0.189) | (0.215) |
| Life expectancy | | | | | | 0.000502*** | 0.000587*** | 0.000834*** |
| | | | | | | (0.000160) | (0.000198) | (0.000260) |
| Human capital | | | | | | | -0.00266 | 0.00122 |
| | | | | | | | (0.00334) | (0.00423) |
| ln(Initial wealth) | | | | | | | | -0.00523* |
| | | | | | | | | (0.00272) |
| Constant | 0.00946** | 0.0362** | 0.0113 | 0.0150 | 0.0261 | -0.0112 | -0.0113 | 0.00757 |
| | (0.00401) | (0.0145) | (0.0156) | (0.0162) | (0.0170) | (0.0142) | (0.0141) | (0.0114) |
| Observations | 3416 | 3416 | 3416 | 3416 | 3416 | 3416 | 3416 | 3416 |
| R-squared | 0.003 | 0.071 | 0.124 | 0.125 | 0.134 | 0.138 | 0.138 | 0.140 |
| Adjusted R-squared | 0.003 | 0.060 | 0.113 | 0.114 | 0.123 | 0.126 | 0.126 | 0.128 |
| F-value | 8.379 | 7.721 | 9.729 | 9.225 | 9.183 | 15.42 | 15.91 | 19.01 |

Cluster robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

Regression 2-7 are controlled for year-specific effects

Table 1.1

***Ordinary Least Squares - Additional Controls***

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | 0.00235 | 0.00122 | 0.0155* | -0.00192 | -0.000589 | -0.00253 | -0.00131 |
| | (0.00575) | (0.00601) | (0.00930) | (0.00567) | (0.00664) | (0.00620) | (0.00548) |
| *Additional controls* | | | | | | | |
| Δ(Price level) | -0.278** | | | | | | |
| | (0.108) | | | | | | |
| Government Exp. | | 0.000824* | | | | | |
| | | (0.000480) | | | | | |
| Social Globalization | | | -0.000235** | | | | |
| | | | (0.0000894) | | | | |
| Political Globalization | | | | 0.0000356 | | | |
| | | | | (0.0000484) | | | |
| Trade share | | | | | -0.00000216 | | |
| | | | | | (0.0000235) | | |
| Democracy | | | | | | 0.000109 | |
| | | | | | | (0.000408) | |
| Δ(Oil price) | | | | | | | 0.000713*** |
| | | | | | | | (0.000214) |
| **Main controls included** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| Observations | 3416 | 2576 | 3416 | 3416 | 3178 | 3106 | 3416 |
| R-Squared | 0.179 | 0.198 | 0.141 | 0.140 | 0.134 | 0.142 | 0.140 |
| Adj. R-Squared | 0.168 | 0.185 | 0.129 | 0.128 | 0.121 | 0.128 | 0.128 |
| F-Value | 19.88 | 13.31 | 17.90 | 19.29 | 15.00 | 21.68 | 19.01 |

Cluster robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific effects

Table 2

***Fixed effect regression***

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | 0.0796*** | 0.0298 | 0.0252 | 0.0253 | 0.0243 | 0.0203 | 0.0240 |
| | (0.0177) | (0.0281) | (0.0216) | (0.0216) | (0.0216) | (0.0208) | (0.0201) |
| Δln(Capital) | | | 0.343*** | 0.344*** | 0.350*** | 0.335*** | 0.335*** |
| | | | (0.0815) | (0.0824) | (0.0865) | (0.0878) | (0.0876) |
| Δln(Labour) | | | | -0.0166 | 0.0898 | 0.0954 | 0.101 |
| | | | | (0.102) | (0.0663) | (0.0640) | (0.0639) |
| Δln(Population) | | | | | -0.534 | -0.647** | -0.686** |
| | | | | | (0.348) | (0.301) | (0.307) |
| Life expectancy | | | | | | 0.00162** | 0.00163** |
| | | | | | | (0.000636) | (0.000624) |
| Human capital | | | | | | | -0.0274** |
| | | | | | | | (0.0124) |
| Observations | 3334 | 3334 | 3334 | 3334 | 3334 | 3334 | 3334 |
| R-Squared | 0.010 | 0.074 | 0.118 | 0.118 | 0.121 | 0.125 | 0.126 |
| Adj. R-Squared | 0.009 | 0.062 | 0.107 | 0.107 | 0.109 | 0.113 | 0.114 |
| F-Value | 20.19 | 7.672 | 9.230 | 9.203 | 9.649 | 10.74 | 10.23 |

Cluster robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific effects

Table 2.1

***Fixed effect regression - Additional Controls***

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | 0.0284 | 0.0167 | 0.0349* | 0.0238 | 0.0344 | 0.0339 | 0.0240 |
| | (0.0199) | (0.0220) | (0.0208) | (0.0200) | (0.0222) | (0.0220) | (0.0201) |
| *Additional Controls* | | | | | | | |
| Δ(Price level) | -0.280** | | | | | | |
| | (0.112) | | | | | | |
| Government Exp. | | 0.000807 | | | | | |
| | | (0.000500) | | | | | |
| Social Globalization | | | -0.000549* | | | | |
| | | | (0.000289) | | | | |
| Political Globalization | | | | 0.000228 | | | |
| | | | | (0.000201) | | | |
| Trade share | | | | | -0.000186* | | |
| | | | | | (0.000109) | | |
| Democracy | | | | | | -0.0000914 | |
| | | | | | | (0.000937) | |
| Δ(Oil price) | | | | | | | -0.00519*** |
| | | | | | | | (0.00105) |
| **Main controls included** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| Observations | 3334 | 2512 | 3334 | 3334 | 3111 | 3031 | 3334 |
| R-Squared | 0.166 | 0.182 | 0.127 | 0.127 | 0.120 | 0.128 | 0.126 |
| Adj. R-Squared | 0.154 | 0.170 | 0.115 | 0.114 | 0.107 | 0.114 | 0.114 |
| F-Value | 10.12 | 9.192 | 10.61 | 10.03 | 9.222 | 8.186 | 10.23 |

Cluster robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific effects

Table 3

**Two-Stage Least Squares - Pooled 2SLS**

*Second stage*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | 0.00939 | -0.0481 | -0.00762 | -3.942 | -0.0561 | -0.00362 | -0.0566* | -0.0117 |
| | (0.0264) | (0.0367) | (0.0181) | (43.51) | (0.0711) | (0.0248) | (0.0327) | (0.0173) |
| *First stage* | | | | | | | | |
| | | | *First-stage for Openness:* | | | | | |
| Latitude | 0.415*** | | | | | 0.376*** | | 0.256*** |
| | (0.0240) | | | | | (0.0246) | | (0.0265) |
| Ln(Voting in line with United States) | | 0.0948*** | | | | 0.0639*** | 0.100*** | 0.074*** |
| | | (0.00814) | | | | (0.00818) | (0.00847) | (0.009) |
| Ln(Immunization DPT) | | | 0.177*** | | | | | 0.158*** |
| | | | (0.0142) | | | | | (0.0123) |
| Years as GATT/WTO-member | | | | -0.0000204 | -0.00283*** | | -0.00315*** | -0.0016** |
| | | | | (0.000227) | (0.000597) | | (0.000589) | (0.0006) |
| (Years as GATT/WTO-member)^2 | | | | | 0.0000585*** | | 0.0000495*** | 0.00003** |
| | | | | | (0.0000109) | | (0.0000107) | (0.000011) |
| ***Main controls*** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| Observations | 3182 | 3182 | 2526 | 3182 | 3182 | 3182 | 3182 | 2526 |
| Overidentification Test | - | - | - | - | - | 0.113 | 0.761 | 0.218 |
| F-value excluded instruments | 300.8 | 135.6 | 154.6 | 0.00814 | 14.67 | 176.3 | 60.26 | 113.8 |
| Test for endogeneity | 0.547 | 0.224 | 0.893 | 0.455 | 0.502 | 0.988 | 0.0975 | 0.765 |
| F-value second stage | 9.038 | 8.975 | 8.676 | 0.102 | 8.767 | 8.987 | 8.831 | 8.552 |

Robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific effects

Table 3.1

**2SLS - Additional controls**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | -0.0347 | -0.0613* | -0.0574* | -0.0664** | -0.0498 | -0.0704* | -0.0566* |
| | (0.0329) | (0.0346) | (0.0328) | (0.0333) | (0.0313) | (0.0392) | (0.0327) |
| *Additional controls* | | | | | | | |
| Δ(Price level) | -0.234*** | | | | | | |
| | (0.0698) | | | | | | |
| Trade share | | -0.00000619 | | | | | |
| | | (0.0000421) | | | | | |
| Δ(Exchange rate) | | | 0.0000203 | | | | |
| | | | (0.0000146) | | | | |
| Polity-index | | | | 0.0000777 | | | |
| | | | | (0.000342) | | | |
| Left government | | | | | 0.00594* | | |
| | | | | | (0.00323) | | |
| Fertility | | | | | | -0.00466 | |
| | | | | | | (0.00287) | |
| After 1990 | | | | | | | 0.0183 |
| | | | | | | | (0.0112) |
| **Main controls included** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| **Overidentification Test** | 0.665 | 0.871 | 0.701 | 0.807 | 0.731 | 0.915 | 0.761 |
| Observations | 3182 | 2977 | 3182 | 3020 | 3182 | 3116 | 3182 |
| F-value excluded instruments | 58.46 | 59.05 | 60.21 | 51.27 | 67.08 | 50.41 | 60.26 |
| Test for endogeneity | 0.291 | 0.0783 | 0.0933 | 0.0768 | 0.138 | 0.108 | 0.0975 |
| F-value second stage | 9.079 | 8.051 | 8.586 | 8.807 | 8.738 | 8.479 | 8.785 |

Robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific effects

Table 4

***Fixed Effects Two-Stage Least Squares - FE 2SLS***

*Second stage*

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | -0.293* | -0.251** | 0.245 | -0.384 | -0.377** | -0.412 | -0.283** |
| | (0.150) | (0.128) | (0.853) | (0.239) | (0.179) | (0.274) | (0.118) |
| *First stage* | | | | | | | |
| | | | *First stage on Openness:* | | | | |
| Years in Gatt/WTO | 0.002977*** | 0.0015831*** | | | 0.00362*** | | 0.00167*** |
| | (0.0003564) | (0.0005492) | | | (0.0008) | | (0.000548) |
| (Years in Gatt/WTO)^2 | | 0.0000193*** | | | 0.0000068 | | 0.000018*** |
| | | (0.000006) | | | (0.000007) | | (0.000006) |
| ln(Immunization DPT) | | | -0.0055* | | -0.008935*** | -0.00313 | |
| | | | ( 0.0032539) | | (0.00327) | (0.003246) | |
| ln(Voting in line with United States) | | | | 0.022431*** | | 0.022593*** | 0.022063*** |
| | | | | (0.004797) | | (0.00542) | (0.004816) |
| ***Main controls*** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| Observations | 3117 | 3117 | 2531 | 3117 | 2531 | 2531 | 3117 |
| Overidentification Test | | | | | 0.749 | 0.447 | 0.591 |
| F-value excluded instruments | 69.79 | 38.68 | 2.857 | 21.86 | 19.43 | 9.671 | 36.48 |
| Test for endogeneity | 0.0326 | 0.0457 | 0.777 | 0.0821 | 0.0189 | 0.126 | 0.0130 |
| F-value second stage | 7.162 | 7.254 | 7.975 | 6.697 | 7.287 | 7.056 | 7.096 |

Robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific effects

Table 4.1

**TSLS - Additional controls**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | -0.0347 | -0.0613* | -0.0574* | -0.0664** | -0.0498 | -0.0704* | -0.0566* | -0.345*** |
| | (0.0329) | (0.0346) | (0.0328) | (0.0333) | (0.0313) | (0.0392) | (0.0327) | (0.131) |
| *Additional controls* | | | | | | | | |
| Δ(Price level) | -0.234*** | | | | | | | |
| | (0.0698) | | | | | | | |
| Trade share | | -0.00000619 | | | | | | |
| | | (0.0000421) | | | | | | |
| Δ(Exchange rate) | | | 0.0000203 | | | | | |
| | | | (0.0000146) | | | | | |
| Polity-index | | | | 0.0000777 | | | | |
| | | | | (0.000342) | | | | |
| Left government | | | | | 0.00594* | | | |
| | | | | | (0.00323) | | | |
| Fertility | | | | | | -0.00466 | | |
| | | | | | | (0.00287) | | |
| After 1990 | | | | | | | 0.0183 | |
| | | | | | | | (0.0112) | |
| Δln(Labour)^2 | | | | | | | | -1.448* |
| | | | | | | | | (0.852) |
| (Human capital)^2 | | | | | | | | 0.0177** |
| | | | | | | | | (0.00822) |
| **Main controls included** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| **Overidentification Test** | 0.665 | 0.871 | 0.701 | 0.807 | 0.731 | 0.915 | 0.761 | 0.391 |
| Observations | 3182 | 2977 | 3182 | 3020 | 3182 | 3116 | 3182 | 3117 |
| F-value excluded instruments | 58.46 | 59.05 | 60.21 | 51.27 | 67.08 | 50.41 | 60.26 | 32.27 |
| Test for endogeneity | 0.291 | 0.0783 | 0.0933 | 0.0768 | 0.138 | 0.108 | 0.0975 | 0.0083 |
| F-value second stage | 9.079 | 8.051 | 8.586 | 8.807 | 8.738 | 8.479 | 8.785 | 6.633 |

Robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific effects

## Tabell 4.2

### *Fixed Effects Two-Stage Least Squares - Income groups*

| | **High income** | **Middle income** | **Low income** |
|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | -0.356*** | -0.0371 | -0.273 |
| | (0.128) | (0.141) | (0.208) |
| Δln(Capital) | 0.554*** | 0.394*** | 0.122 |
| | (0.0740) | (0.0358) | (0.128) |
| Δln(Labor) | 0.241 | 0.0656 | -0.00915 |
| | (0.205) | (0.0840) | (0.144) |
| Δln(Population) | -1.552* | 0.353 | 0.808 |
| | (0.827) | (0.751) | (0.765) |
| Life expectancy | -0.00358 | 0.000908 | 0.00111 |
| | (0.00329) | (0.000822) | (0.00104) |
| Human Capital | 0.0629* | -0.0338 | -0.0249 |
| | (0.0341) | (0.0240) | (0.0691) |
| Observations | 930 | 1713 | 474 |
| Overidentification Test | 0.878 | 0.0507 | 0.633 |
| F-value excluded instruments | 39.53 | 12.60 | 17.38 |
| Test for endogeneity | 0.00341 | 0.969 | 0.0676 |
| F-value second stage | 5.620 | 7.360 | 2.155 |

Robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific-effects

Table 4.3

***Fixed Effects Two-Stage Least Squares - High income group***

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Dependent variable | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) | Δ(GDP/cap) |
| Openness | -0.337*** | -0.356*** | -0.377** | -0.361** | -0.220* | -0.356*** |
| | (0.129) | (0.129) | (0.163) | (0.155) | (0.131) | (0.128) |
| *Additional controls* | | | | | | |
| Δ(Price level) | -0.137 | | | | | |
| | (0.0962) | | | | | |
| Δ(Exchange rate) | | -0.0000366 | | | | |
| | | (0.0000758) | | | | |
| Democracy | | | 0.00525** | | | |
| | | | (0.00266) | | | |
| Polity-index | | | | 0.00139 | | |
| | | | | (0.000910) | | |
| Trade share | | | | | -0.000145 | |
| | | | | | (0.000109) | |
| After 1990 | | | | | | 0.0671** |
| | | | | | | (0.0276) |
| **Main controls included** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** | **Yes** |
| Observations | 930 | 930 | 801 | 817 | 890 | 930 |
| Overidentification Test | 0.930 | 0.874 | 0.900 | 0.991 | 0.741 | 0.878 |
| F-value excluded instruments | 38.61 | 39.39 | 36.88 | 33.94 | 38.03 | 39.53 |
| Test for endogeneity | 0.00684 | 0.00343 | 0.0127 | 0.00988 | 0.0704 | 0.00341 |
| F-value second stage | 5.595 | 5.533 | 5.710 | 5.495 | 5.588 | 5.620 |

Robust standard errors in parentheses

* p<0.10 ** p<0.05 *** p<0.01

All regressions are controlled for year-specific effects

Table 5

**Testing various statistical problems**

| Estimator | Ordinary Least Squares | Fixed Effects | 2SLS | Fixed effects - 2SLS |
|---|---|---|---|---|
| Tests | | | | |
| **Test for heteroskedasticity*** | Breuch-Pagan: p-val (0.0068) | Modified Wald test: p-val ( 0.000) | Analog of Breusch-Pagan: p-val (0.000) | Analog of Breusch-Pagan: p-val (0.000) |
| **Test for Serial correlation**** | Wolldridge test: p-val (0.0630) | Wolldridge test: p-val (0.0646) | Wooldridge test: p-val (0.3342) | Wooldridge test: p-val (0.3077) |
| **Test for Cross-Sectional dependency***** | Pesaran: p-val (0.0000) | Pesaran: p-val (0.0000) | Pesaran: p-val (0.0004) | Pesaran: p-val (0.1568) |
| **Test for unit root in residuals****** | Augmented DF: p-val (0.000)<br>Phillips-Perron: p-val (0.000) | Augmented DF: p-val (0.000)<br>Phillips-Perron: p-val (0.000) | Augmented DF: p-val (0.000)<br>Phillips-Perron: p-val (0.000) | Augmented DF: p-val (0.000)<br>Phillips-Perron: p-val (0.000) |

***Null hypothesis for all tests of heteroskedasticity is that errors are homoskedatic**

****Null hypothesis Wooldridge test of serial correlation is that errors exhibits no autocorrelation**

*****Null hypothesis for Pesaran test of cross-sectional dependency is that the pairwise errors do not exhibit cross-section dependency**

******Null hypothesis for both tests of unit root in panels is that at least 1 panel is stationary (Each individual country`s residual is also tested)**