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Dundee Discussion Papers in Economics



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Relationship between trade openness and economic growth of India: A time series analysis

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Abstract

The paper aims to examine the empirical relationship between trade openness and economic growth of India for the time period 1970-2010. Trade openness is a multi-dimensional concept and hence measures of both trade barriers and trade volumes have been used as proxies for openness. The estimation results from Vector Autoregressive method suggest that growth in trade volumes accelerate economic growth in case of India. We do not find any evidence from our analysis that trade barriers lower growth.

Keywords: Trade openness, economic growth, India, time series analysis

JEL Classification: F14, F43, O40

1. Introduction

The relationship between trade openness and economic growth is widely debated in the growth and development literature. In general, there is optimism among most economic policy planners in favor of trade openness (See Deraniyagala et al 2001, Yanikkaya, 2003, Sarkar, 2005 and Sarkar, 2008). The primary reason for this is the failure of import-substituting industrialization (ISI) strategies adopted by many developing countries in the post Second World War period. The ISI strategy was based on the belief that poor countries will be exploited by rich countries in the

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international financial markets and trade. However, the empirical evidence suggests that the strategy only led to misallocation of resources by encouraging growth of inefficient domestic firms. Moreover, the ISI policies favored only a few powerful vested interest groups and powerful lobbies and specific political groups in many developing countries.

In the late-1970s, many countries abandoned ISI strategy and adopted trade liberalization measures. The High performance Asian economies (HPAEs) such as China, Hong Kong, Taiwan, Singapore and South Korea adopted a strategy of Export-oriented Industrialisation and experienced rapid economic growth. The success of such policies was hailed by international organisations such as the International Monetary Fund and the World Bank. The World Development Reports (World Bank 1987, 1991, 1999-2000) highlight that "outward oriented countries" performed better than "inward oriented countries" even under unfavourable market conditions.

However, the theoretical considerations and the empirical evidence whether trade openness accelerates growth is quite ambiguous.² The aim of this paper is to examine empirically, using a time series econometric approach, the relationship between trade openness and growth of India for the time period 1970-2010. The period before 1970 could not be included because of data limitations for some of the openness indices. The paper uses measures of both trade volume and trade restrictions as a proxy for trade openness. The paper is structured as follows. The next section presents an overview of the history of trade policy in India. Section 3 reviews the literature on the relationship between trade openness and economic growth of India. Section 4 describes the theoretical framework of the econometric model while Section 5 reports the results. Section 6 concludes.

2. History of trade policy in India

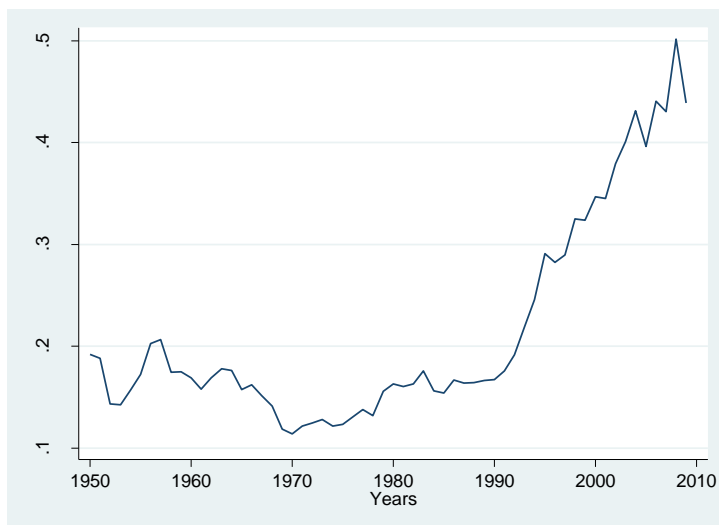
India had a relatively open trade regime until the 1950s with low tariff rates; quantitative import restrictions were not onerous and there was no evidence of foreign-exchange controls. The foreign exchange crisis in 1957 led to imposition of quantitative restrictions on imports, industrial licensing and foreign exchange controls, and these were progressively increased until

² This is discussed in detail in Section 3.

1966. The Ministry of Finance prioritized the usage of available foreign exchange.³ An array of licensing agencies was involved in the allocation process of foreign exchange. Imports of raw materials were not permitted if domestic substitutes were available.⁴The Government of India introduced export subsidization schemes in 1962 but they were not very successful in boosting exports. One of the disadvantages of the requirement that domestically produced inputs be used when available was that Indian exporters were compelled to use inferior-quality domestic inputs and therefore could not compete with their international counterparts.

India went through a phase of economic liberalization during 1966-68 which included measures such as the devaluation of the rupee by 57.5 per cent, removal of some import licensing controls and cuts in import tariffs. The measures were unpopular because of the widespread belief that they were in response to the dictates of the World Bank and the liberalization process was soon reversed and the protectionist regime continued until the 1970s (Panagariya, 2004). As seen in Figure 1, India's trade share (as percentage of GDP) went on falling continuously from late 1950s till 1970.

Figure 1: Trade openness of India, 1950-2010



Note: Data obtained from Penn World Table 7.0. Trade Openness defined as exports plus imports as % of GDP (at 2005 constant prices).

³ First the foreign exchange requirements for debt repayment, Embassy expenditures, food, fertilizer, petroleum, oil and lubricant (POL) were met and after that allocations were made for private sector imports of raw materials and machinery.

⁴ See Panagariya (2003) and Panagariya (2004) for a detailed discussion on this.

India undertook several liberalizing steps such as partial liberalization of imports during the 1980s mainly to allow a more liberal flow of essential raw materials and machinery. It also expanded domestic demand through fiscal stimuli supported by large deficits. Consequently, India achieved a growth rate of above 5 per cent during the 1980s, though it also increased its foreign and domestic debt to unsustainable levels. The result was a major macroeconomic crisis in 1991, which prompted serious economic reforms including a systematic liberalization of trade. Within a decade, import licensing was entirely abolished and the highest tariff rate was brought down from 355 per cent to about 30 per cent (Bhat, 2011; Mukherjee and Mukherjee, 2012). Consequently, India experienced a sharp rise in its trade openness (see Figure 1).

3. Trade openness and growth-Theory and Evidence

3.1 Theory

Broadly speaking, there are three sources of economic growth- factor accumulation, increase in productivity and innovation (Srinivasan, 2001). Trade openness can potentially enhance the growth prospects of a country by influencing any of these three sources of growth. For instance, an open economy can obtain factors (or their services) more easily from abroad compared to a closed economy. Trade openness also leads to better allocation of resources. When an economy opens up, forces of comparative advantage forces the economy to specialize in the sector for which it has better factor endowments. As a result, productivity of that sector goes up. The exports from that sector also increase which consequently boosts growth. Lastly, trade openness also encourages technology transfer from developed to developing economies which leads to an increase in factor productivity and finally enhances growth (Romer, 1991 and Chuang, 2000).

The traditional models of international trade discuss how trade openness improves the allocation of resources thus leading to an increase in production. The Ricardian Model says that trade liberalization makes an economy specialize in the sector where it has a comparative advantage.⁵ This, in turn, leads to an increase in production of output and makes the country better off. The Heckscher-Ohlin Model shows that if two economies have different resources (i.e. one is more labour-intensive and the other more capital-intensive) then opening up to trade can lead to higher

⁵ **Comparative Advantage:** The ability of an economy to produce a particular good or service at a lower opportunity cost than other economies.

output (thus, higher incomes) in both the economies. That is because each economy specializes in the sector which uses its abundant factor more intensively in the H-O model. In some “new” trade theories (such as Krugman, 1979) also, the total output goes up as a country liberalizes its trade.

However, in the growth theories, the impact of trade openness on the rate of economic growth is not very unambiguous (Lopez, 2005). For example, in the neoclassical growth models such as the Solow model, the steady-state rate of output growth is exogenous. One explanation for why a change in policies (initiating trade reforms, for example) will not bring a change in the steady-state growth rate in the neoclassical models is because of the assumption that the marginal product of capital declines to zero as the capital-labour ratio increases indefinitely.⁶ The new growth theories or the endogenous growth theories do recognize trade openness as one of the primary engines of growth (Romer, 1990 and Lucas, 1998).⁷ However, the new growth theories do not presume that trade openness will unambiguously promote economic growth (Harrison, 1991). When a closed economy opens up, the forces of comparative advantage can either promote primary sectors or technology and high-skill intensive sectors depending on the initial factor endowments of the economy. If an economy is technologically backward then trade liberalization is most likely to encourage the economy to specialize in primary or low-skilled sectors and discourage the development of its high-skilled sectors which may ultimately have an adverse effect on its long run growth rate (Grossman and Helpman, 1991).⁸ Growth after trade liberalization depends on whether the liberalization is encouraging R&D and innovation or not. However, sometimes increased competition from trade liberalization can discourage innovation by lowering expected profits.⁹ On the other hand, protectionism can facilitate long-run growth if protectionism encourages investment in research-intensive sectors (Grossman and Helpman, 1992). Furthermore, whether trade openness will accelerate growth or not depends on a large

⁶ Also, in the neoclassical growth models, technological change is exogenous and is thus unaffected by an economy’s openness to trade.

⁷ “New” growth theories say that trade policies may have an impact on the long run growth rate by its impact on technological change (Harrison, 1991b). As mentioned previously, trade openness allows an economy to import inputs from foreign countries thus giving access to new technologies. Also, openness gives domestic producers access to new markets thus increasing the return to innovation which may motivate further technological advancement.

⁸ This is because the growth of high-skilled sectors (such as high-technology manufacturing and services) generates externalities by way of promoting skills, R&D and innovation while that is not the case with the growth of primary sector.

⁹ Increased competition may reduce the market share for each firm thus lowering their profits.

number of other factors such as macroeconomic stability and investment in physical and social infrastructure (Panagariya, 2003). In short, the theoretical literature cannot provide an unambiguous answer to the question of trade and growth.

3.2 Empirical Evidence

Several studies have analyzed empirically the relationship between trade openness and growth. They can be broadly classified into two groups: cross-country studies and country-specific case studies. The cross-country literature is vast and the important papers are documented vividly in Edwards (1993), Baldwin (2003) and Winters (2003).¹⁰ Many cross-country studies such as Dollar (1992), Sachs and Warner (1995), Edwards (1998) and Frankel and Romer (1999) have found that trade openness affects growth positively. However, these studies have been criticized by Rodriguez and Rodrik (2001) on the ground of flawed trade openness measures and “weak” econometrics. Given the scope of our paper, we do not enter into a detailed discussion of the shortcomings of these cross-country studies and, instead, choose to focus more on the studies concerning India.¹¹ Overall, the cross-country evidence on the relationship between trade openness and growth (proxied by both trade share and tariff barriers) remains inconclusive. The relationship is not very robust and is sensitive to different model specifications and to use of different openness indices (see Levine and Revelt, 1992 also).

Various World Development Reports (World Bank, 1991, 1999-2000) tries to show that outward-oriented trade policies have been more successful than protectionist policies in generating growth. The transitional economies are generally always advised by the institutions such as World Bank and IMF to follow the policies of trade liberalization (See Sarkar, 2008 and Rodriguez and Rodrik, 1999). However, some authors such as Singer (1987) question the validity of the World Development Reports. Many researchers (such as Adkisson, 1998 and Went, 2000) are of the opinion that such “one-size-fit-for-all” policy prescription for developing countries ignores history, institutions and economic structures of these countries.

The empirical evidence for the connection between trade openness and economic growth for India is also quite ambiguous. Two main reasons for such ambiguity or inconsistency in findings

¹⁰ For a discussion on the more recent studies, see Lopez (2005).

¹¹ For a detailed discussion on the shortcomings of the cross-country studies, see Rodriguez and Rodrik (2001), Winters (2003) and Hallak and Levinsohn (2004).

can be attributed to methodological shortcomings and inappropriate choice of trade openness indices.

Marelli and Signorelli (2011)¹² show that trade openness facilitates economic growth in India and China under a panel model set-up. However, doing a panel data analysis with India and China is a questionable methodological choice because India and China have quite different growth experiences. As Bosworth and Collins (2008) point out, China stands out for its remarkable growth in the industrial sector which was fuelled by its fast reduction in trade barriers and active encouragement for FDI inflows. On the other hand, India's rapid growth has been primarily due to the expansion of the service sector. In other words, the sources of growth in the two countries are quite different. Thus running a panel regression with the same control variables for the two countries does not provide an accurate picture because it does not take the peculiarities of individual countries under consideration. Such "general" results cannot be used to provide a policy prescription for a particular country. In this respect time-series analysis gives a much better insight (See Sarkar, 2008). Even Marelli and Signorelli (2011) also admit that it is better to use a time-series approach if the characteristics of an individual country are to be addressed.

Sarkar (2008) employs time series analysis and finds that trade openness has negative impact on India's growth. This paper used exports and imports as percentage of GDP as the proxy for openness. This choice of just one openness index is questionable because that index focuses only on trade volumes and not on trade policies. First of all, it should be acknowledged that the greatest challenge for the researchers in this field is to give a clear definition of "trade openness" (See Yanikkaya, 2003). Different studies have used different measures for trade openness; some have focused on the absolute trade volumes whereas some have constructed openness indices based on trade barriers. However, using a proxy for only trade volume does not take into account different aspects of trade liberalization. It may be the case that one country experiences a considerable increase in its trade volume long after it has adopted free trade policies. Hence a more efficient approach will be to examine the impact of various measures of trade openness indices (including both measures of trade volumes and trade restrictions) on growth in order to get a more complete picture on the relationship between the two.

¹² This paper employs both time series and panel approach to estimate the relationship between trade openness and growth. The findings from the time series analysis are presented in Table 1.

Table 1 presents the findings of the time-series studies on the relationship between trade openness and growth for India.

Table 1: Review of Literature: India

Paper/Study	Trade Openness Indices used	Methodology	Findings
Sahoo and Mathiyazhagan (2003)	Exports/GDP	Johansen co-integration test	Evidence of long run positive relationship between exports and GDP growth during the period 1979-2000.
Khan (2003) ¹³		Bounds testing approach to cointegration	Trade openness plays a significant role in promoting economic growth in India. In the long run, two-way causality between real output and trade openness exists for India during 1970-2007.
Sarkar and Bhattacharyya (2005)	export/GDP, import/GDP and (exports+imports)/GDP	Autoregressive Distributive Lag Method (ARDL)	Evidence of “unfavourable” impact of trade liberalisation on real growth rates of India.
Sarkar (2005)	export/GDP, import/GDP and (exports+imports)/GDP	ARDL	No positive long-term relationship between opening up and growth

¹³ The book was not accessible. Hence, the results are being reported here just by reading the abstract.

			of India during 1956-1999.
Sarkar (2005a)	Export/GDP, Import/GDP and Trade/GDP	ARDL	No evidence of change in the period of liberalization from 1991 till 2002 in India's macroeconomic performance observed over the preceding period, 1970-1990/91. Real GDP did not experience an accelerated growth.
Mallick (2008)	exports+imports as % of GNP	Structural VAR	Trade openness has positive impact on growth.
Dash and Sharma (2008)		Engle and Granger two-step cointegration analysis	Trade has a positive impact on economic growth during the time period 1950-2007.
Marelli and Signorelli (2011)	exports+imports as % of GDP	2SLS	Openness has positive impact on economic growth during 1980-2007.

Thus it can be seen that the empirical evidence for India is quite mixed. Some studies find positive association between trade openness and growth whereas some find a negative relationship.

However, it is quite clear from the table above that these papers on India have used trade shares (or, trade volume) as proxies for openness and have not considered any indicators of trade policies (such as tariff barriers, export duties, etc).

4. Theoretical Framework and Variable Description

Most empirical studies of economic growth begin with the neoclassical growth model which was originally proposed by Solow (1956). This model was later extended by Mankiw, Romer, and Weil (1992) to include human capital. This model appears in the general form as:

$$Y_t = A_t K_t^{\beta_1} H_t^{\beta_2} L_t^{1-\beta_1-\beta_2} e_t \dots\dots\dots(1)$$

Where Y_t = Aggregate production of the economy at time t., A_t = Total factor productivity at time t, K_t = Real physical capital stock at time t, L_t = Employed labour force at time t, H_t = Human capital stock at time t and e_t = error term.

As discussed previously, one of the channels through which trade openness affects GDP growth is via productivity growth. For example, trade openness may lead to technological diffusion thus leading to productivity growth which in turn should increase the economic growth rate. Hence, total factor productivity can be expressed as a function of trade openness and other exogenous factors C_t .

$$A_t = f(T_t, C_t, e_{2t}) \dots\dots\dots (2)$$

Where T_t = Trade openness at time t and e_{2t} = error term

Combining (2) and (1),

we get,

$$Y_t = C_t K_t^{\beta_1} H_t^{\beta_2} L_t^{\beta_3} T_t^{\beta_4} e_{3t} \dots\dots\dots(3)$$

where β_1 = Elasticity of production with respect to K_t , β_2 = Elasticity of production with respect to human capital, β_3 = Elasticity of production with respect to labour force participation, β_4 = Elasticity of production with respect to trade openness.

Taking natural logs (Ln) on both sides of equation (3) gives an estimable linear function:

$$\ln Y_t = \ln C_t + \beta_1 \ln K_t + \beta_2 \ln H_t + \beta_3 \ln L_t + \beta_4 \ln T_t + e_{3t} \dots\dots\dots(4)$$

where $\ln C_t$ is a constant parameter.

According to equation (4), an econometric model of the selected variables used in this study is given as:

$$LGDP_t = \beta_0 + \beta_1LNFCSt + \beta_2LEDEXP_t + \beta_3LLABOUR_t + \beta_4LTRADE_t + u_t \dots \dots \dots (5)$$

where, GDP is Real GDP at factor cost (Base year=99-2000, in Rs crores¹⁴) obtained from Reserve Bank of India (RBI) database, EDEXP is Public education expenditures (in Rs crores and constant prices) obtained from Directorate of Higher Education (Government of India) which acts as a proxy for human capital¹⁵, NFCS is Net fixed capital stock at 1993-94 prices (in Rs crores) obtained from National Accounts Statistics which is a proxy for physical capital stock¹⁶,

LABOUR is size of labour force in crores from World Development Indicators, 2011 (WDI) and TRADE stands for various trade openness indices described in the following sub-section.

4.1 Trade Openness Indices

There is no consensus on how to measure trade openness (Das, 2003). Openness is neither directly observable nor is there a generally accepted measure (either theoretically or empirically). As previously discussed, most empirical papers on India have used trade share as percentage of GDP as a measure of trade openness. However, the problem with this proxy is that it measures trade volume and not explicitly trade policy. It can be argued that trade share is actually the impact of trade liberalization and is not really an indicator of the rate at which the country liberalizes its trade. Furthermore, a country's trade volume is affected not only by trade policy

¹⁴ 1 crore= 10 million

¹⁵ Many studies have used Secondary school enrolment as proxy for human capital. We had re-estimated our model with enrolment in place of education expenditures as a proxy for H to check the robustness of our findings. We find that our results do not change.

¹⁶ Data on net fixed capital stock is available only till 2006. Hence to incorporate the subsequent years in our analysis, we re-estimate the model using gross fixed capital formation (% of GDP) as the proxy for physical capital. This measure has been used by many previous papers such as Marelli and Signorelli (2011) and Chaudhry, Malik and Faridi (2010) as a control variable while estimating the relation between trade and growth. We find that using gross fixed capital formation in place of NFCS as a proxy for physical capital does not change our results. Hence we do not report those results in the paper but are available upon request.

but also by other factors such as country size, distance to trade partners, transportation costs and world demand.

Hence to capture different aspects of openness we use four different indicators of openness. By doing so, we believe our study presents a more complete picture of the relationship between trade openness and growth of India as compared to some of the previous studies on India.¹⁷

a) **Import Penetration ratio (IPR):** This is a measure of trade intensity calculated as total imports as percentage of GDP. Data is obtained from World Development Indicators (WDI).

b) **Trade share (TS):** This is defined as total trade as percentage of GDP. Data is from WDI.

c) **Total Taxes on International Trade as percentage of revenue (TAX):** This is a measure of trade barriers includes import duties, export duties, profits of export or import monopolies, exchange profits and exchange taxes. Data is obtained from WDI.¹⁸

d) **KOFB:** We have chosen the fourth openness index from the KOF Economic Globalization Index. It has 2 dimensions-(i) economic flows such as trade and Foreign Direct Investment (FDI) and (ii) restrictions such as tariff barriers. Each variable has been transformed to an index on a scale of one to hundred (where hundred is the maximum value for a specific variable and one is the minimum value). Higher values denote greater globalization. Our fourth index is based on (ii) and is explained below. We call it “KOFB”. This index is based on restrictions consisting of hidden import barriers, mean tariff rate, Taxes on International Trade (% of current revenue) and capital account restrictions with assigned weights 24%, 27%, 26 % and 23% respectively. The lower the restrictions a country has, the higher the rating it gets. So, we would expect KOFB to be positively correlated with growth.

5. Results and Discussion

5.1 Econometric Analysis

Generally in time series analysis, we start by checking the order of integration of the variables.

To do that, we will use ADF test.

Let us consider the following model

¹⁷ See Appendix for graphs on individual trade openness indices and GDP.

¹⁸ Data is available from 1990 onwards only.

$$y_t = \mu + \beta t + \alpha y_{t-1} + \varepsilon_t$$

where, μ = constant, t = time trend and ε = error term.

We want to test the Hypothesis of the existence of a unit root. The null and alternative hypotheses can be formulated as follows:-

$$H_0) \alpha = 1 \text{ (unit root)}$$

$$H_1) \alpha < 1 \text{ (Integrated of order zero)}$$

The equation above can be re-written as

$$\Delta y_t = \mu + (\alpha - 1)y_{t-1} + \beta t + \varepsilon_t$$

$$\text{or, } \Delta y_t = \mu + \phi y_{t-1} + \beta t + \varepsilon_t$$

For this expression the hypothesis should be re- written as

$$H_0) \phi = 0 \text{ (unit root)}$$

$$H_1) \phi < 0 \text{ (Integrated of order zero)}$$

ADF test presumes the existence of white noise errors in the regression. If that is not the case, the test will lose significant power. In order to deal with this issue, the ‘Dickey–Fuller’ test is employed as the Augmented Dickey Fuller test, in which a number of lags of the dependent variable are added to the regression to whiten the errors:

$$\Delta y_t = \mu + \phi y_{t-1} + \Omega_1 \Delta y_{t-1} + \Omega_2 \Delta y_{t-2} + \dots + \beta t + \varepsilon_t$$

All variables are in natural logs apart from import penetration ratio (IPR) and total trade share (TS). IPR and TS are in levels as their values range between 0 and 1. According to the Akaike Information Criterion (AIC), the optimal number of lags for the estimating equations with IPR, TS, LTAX and LKOFB are 1, 2, 4 and 1 respectively.

Table 3: ADF test results with trend and intercept

Variable	Level	1 st Difference	Conclusion
LGDP	-0.08	-2.75*	I(1)
LEDEXP	-2.04	-3.2**	I(1)
LNFCFS	1.39	-4.03***	I(1)
LLABOUR	-0.85	-3.41*	I(1)
IPR	-1.28	-6.45***	I(1)
TS	-1.26	-8.01***	I(1)
LTAX	-2.71*		I(0)
LKOFB	-2.00	-3.77**	I(1)

Note: *, ** and *** represent statistical significance at 10%, 5% and 1% respectively.

All the variables apart from LTax are I(1) i.e. they are stationary in 1st differences. LTax is I(0). We employ Vector Autoregression (VAR) estimation method to estimate the impact of trade openness on growth because we suspect that our variables can be endogenous.¹⁹ For example, there can be reverse causality in the sense that IPR is affected by GDP and not just vice versa. There are empirical evidence of bi-directional causality between trade openness and growth (See Tsen, 2006). Same argument applies for trade taxes also. For example, it is quite possible that as a country grows it starts to lower its trade barriers. If that is the case then we cannot treat “Tax” as an exogenous variable anymore because there will be bi-directional causality between GDP growth and trade barriers. Moreover, there can be causality running from education expenditures towards trade openness and vice versa. For example, education expenditures lead to further human capital accumulation which will increase the quality of labour. That, in turn, can lead to an increase in the productivity of the entire labour force and can encourage further exports (for example, see Chuang, 2000). There is empirical evidence that human capital accumulation affects trade and vice versa (for example, see Chaudhry, Malik and Faridi, 2010). Moreover, it can be the case that, in reality, GDP growth is leading to a growth in education expenditures as well as to opening up to international trade. In that case, all the 3 variables will be endogenous. Hence, a better way to deal with this endogeneity problem will be to use Vector Autoregression (VAR) model.

¹⁹ Vector Error Correction Model (VECM) could not be employed because, as ADF test results indicate, all the variables are not of the same order of integration. Hence we did not test for cointegration.

The term “autoregressive” is due to the appearance of the lagged value of the dependent variable on the right-hand side and the term “vector” is used because we have a vector of 2 or more variables (For example, see Gujarati, *Basic Econometrics*, 2003). A VAR is a n-equation, n-variable linear model in which each variable is explained by its own lagged values as well as current and past values of the remaining n-1 variables. The variable, size of labour force (LLABOUR) will be treated as exogenous variables in the VAR system. The reason is that size of the labour force depends on the demographics of a country. Moreover, to confirm whether LLABOUR is actually exogenous or not, we first estimated our VAR model with LLABOUR as an endogenous variable. But it came out to be statistically insignificant in equations with trade variables, education and net fixed capital stock as dependent variables. So we treat LLABOUR as an exogenous variable.

The VAR system of equations with IPR as trade openness index looks as follows.

The optimal number of lags is 2 as determined by Akaike Information Criterion (AIC).

$$\Delta LGDP_t = \beta_0 + \beta_1 \Delta IPR_{t-1} + \beta_2 \Delta IPR_{t-2} + \beta_3 \Delta LEDEXP_{t-1} + \beta_4 \Delta LEDEXP_{t-2} + \beta_5 \Delta LGDP_{t-1} + \beta_6 \Delta LGDP_{t-2} + \beta_7 \Delta LNFCST_{t-1} + \beta_8 \Delta LNFCST_{t-2} + \mu_{1t} \dots \dots \dots (6)$$

$$\Delta LEDEXP_t = \theta_0 + \theta_1 \Delta IPR_{t-1} + \theta_2 \Delta IPR_{t-2} + \theta_3 \Delta LEDEXP_{t-1} + \theta_4 \Delta LEDEXP_{t-2} + \theta_5 \Delta LGDP_{t-1} + \theta_6 \Delta LGDP_{t-2} + \theta_7 \Delta LNFCST_{t-1} + \theta_8 \Delta LNFCST_{t-2} + \mu_{2t} \dots \dots \dots (7)$$

$$\Delta IPR_t = \omega_0 + \omega_1 \Delta IPR_{t-1} + \omega_2 \Delta IPR_{t-2} + \omega_3 \Delta LEDEXP_{t-1} + \omega_4 \Delta LEDEXP_{t-2} + \omega_5 \Delta LGDP_{t-1} + \omega_6 \Delta LGDP_{t-2} + \omega_7 \Delta LNFCST_{t-1} + \omega_8 \Delta LNFCST_{t-2} + \mu_{3t} \dots \dots \dots (8)$$

$$\Delta LNFCST_t = \sigma_0 + \sigma_1 \Delta IPR_{t-1} + \sigma_2 \Delta IPR_{t-2} + \sigma_3 \Delta LEDEXP_{t-1} + \sigma_4 \Delta LEDEXP_{t-2} + \sigma_5 \Delta LGDP_{t-1} + \sigma_6 \Delta LGDP_{t-2} + \sigma_7 \Delta LNFCST_{t-1} + \sigma_8 \Delta LNFCST_{t-2} + \mu_{4t} \dots \dots \dots (9)$$

Similarly, equations with other trade openness indices were specified. Our initial results indicate that past values of trade openness (both trade share and trade restrictions) do not explain present growth in case of India.²⁰ The results are presented in the Appendix in Tables 9-12. These findings are consistent with some of the previous time series studies on India such as Sarkar

²⁰ We tried examining the relationship between trade openness and growth using other trade barrier measures such as custom and other import duties (as % of tax revenue) and Effectively Applied Tariff Rates also. We found no empirical relationship between trade restrictions and growth. Data limitations seem to be a major problem in using these variables as data is available from 1990 onwards only.

(2005) and Sarkar (2005a). However, the potential econometric problem in these empirical studies is that they estimate an “average” relationship between the two variables. If there has been a trend break in the Indian growth then the average regression function can be quite different from the true regression function at the end of the sample period. Estimating such an average regression function assumes that the parameters (coefficients of the explanatory variables) are constant for the entire sample period and if there has indeed been a break then this may lead to inaccurate findings.

India’s history of growth since independence can be broadly divided into two policy regimes (for example, see Aggarwal and Kumar, 2012). During 1951-80, the focus was to achieve growth with social justice following a state-led growth model. The public sector was the key player in the economy. Since 1980-81 onwards, India began to move towards an open and liberal regime. There was a clear shift in industrial policies in favour of a market-led growth through domestic decontrols from 1980-81 onwards as the country faced stagnating industrial growth. Some reforms were initiated in the foreign trade sector also. This process of reforms further accelerated in mid-1980s and were followed by deeper and more systematic liberalization measures from 1991-92 onwards.

Many other existing studies also show that the major structural break in India’s growth occurred around 1980. Sinha and Tejani (2004) say that the long-term growth trend appears to break upward from 1980 onwards. The average growth rate of real GDP increased from 3.5 percent during 1950-1979 to around 5.5 percent for 1980-2000. Rodrik and Subramanian (2004) say that India’s GDP per capita growth more than doubled since 1980, rising from 1.7 percent during 1950-80 to 3.8 percent during 1980-2000. They do a structural break test (Bai and Perron Test) and find that the break occurs in 1979. Wallack (2003) studies GDP and its disaggregated components for structural breaks and finds the evidence of a break in 1980.²¹

So if there is a break in 1980-81 in Indian GDP, then we cannot estimate an average regression function because the parameters will not be constant over the sample period and hence the results will be inaccurate. In other words, the existence of a break may have affected our results presented in Tables 9-12 and so it will be incorrect to draw any inference from them.

²¹ Wallack (2003) finds the evidence of the break date in the early to mid-1980s. In 1980, the highest value of the F-statistic associated with the existence of a break is reached.

So we re-estimate our model given the fact that there has been a change in policy regime after 1980 onwards. We have done a parameter stability test called the Chow Test to see whether we find any evidence of break in our data on India's GDP growth in 1980. The sample period has been divided into two groups-1970-79 and 1980-2010. The Chow test examines whether the parameters (coefficients on LEDEXP, LNFCFS and the trade variables) are different for the two different time periods and we find that to be true. We create a dummy variable (dummy80) and a group of interaction terms of the regressors and the dummy variable. The dummy takes the value of 1 for years after 1980 and 0 otherwise. The idea behind creating the interaction terms is to check whether trade openness have any impact on India's growth after the policy shift in 1980-81.

We re-estimate our econometric model (see equation 5 above) by incorporating the dummy variable and the interaction terms and then conduct the Chow test.²² The null hypothesis is that the two different regimes or time period have the same parameters for the explanatory variables and the same intercept. The null is rejected because the coefficient on dummy80 and the interaction terms are significantly different from zero, as seen in Table 4.

Table 4: Chow Test Results for Regressions with IPR (Column a) and TS (Column b) as trade openness indices

(a)	(b)
H ₀ : Intercept and parameters are same for 1970-79 and 1980-2010	H ₀ : Intercept and parameters are same for 1970-79 and 1980-2010
P-value=0.009	P-value=0.013

Note: Since P-value is less than 0.1 we reject the null at 10% statistical significance.

This implies that after 1980, the nature of impact of trade openness on growth is very likely to have changed. So we re-estimate our VAR model with the interaction terms and the dummy variable. The results are presented in Tables 5-7 below.

²² We do this only for regression equations with the trade volume measures (IPR and TS) as trade openness indices. We cannot do this for TAX because data is available only from 1990 onwards. We do not do this for KOFB because trade barriers remained high throughout 1980s (see Sinha and Tejani, 2004). In fact, the average effective rate of protection for industries went up from 115.1% (during 1980-85) to 125.9% (during 1986-90). See Rodrik and Subramanian (2004) and Das (2003) for details.

Table 5: VAR results with IPR as the trade openness index

Explanatory Variables	Dummy	CON	Δ LGDP	Δ IPR80	Δ LEDEXP80	Δ LNFC80	Δ LABOUR
Dependent Variables							
Δ LGDP	0.03*	0.03	L1. Δ LGDP -0.26*	L1. Δ IPR80 1.59***	L1. Δ LEDEXP80 0.09	L1. Δ LNFC80 -0.05	0.36
Δ IPR	0.01**	0.001	L1. Δ LGDP 0.05	L1. Δ IPR80 0.42***	L1. Δ LEDEXP80 -0.06**	L1. Δ LNFC80 -0.06	-0.11
Δ LEDEXP	.10***		L1. Δ LGDP 0.08	L1. Δ IPR80 -1.25	L1. Δ LEDEXP80 0.01	L1. Δ LNFC80 0.49	-2.85**
Δ LNFC80	0.03***		L1. Δ LGDP 0.05	L1. Δ IPR80 0.07	L1. Δ LEDEXP80 -0.02	L1. Δ LNFC80 0.18	-0.58
LM test for autocorrelation	H ₀ :No autocorrelation at lag order Lag 1:P-value=0.43						

Note: *, ** and *** represent statistical significance at 10%, 5% and 1% respectively. Δ LABOUR is the exogenous variable. IPR80 is the interaction term between IPR and the period dummy for post-1980 years, EDEXP80 is the interaction term between EDEXP and the dummy variable and so on. Optimal number of lags is 1 as per the AIC. CON stands for constant.

The results indicate that import penetration ratio (IPR) has a positive impact on GDP growth. After the policy shift in 1980-81, trade openness seems to have a statistically significant impact on growth. The table below gives a similar picture even when we use total trade as percentage of GDP as the proxy for openness instead of IPR.²³

²³ The finding, that growth in trade openness accelerates economic growth rate, is being upheld if we use exports/GDP as a proxy for openness. We do not report these results in the paper.

Table 6: VAR results with TRADE as the trade openness index

Explanatory Variables	Dummy	CON	Δ LGDP	Δ TS80	Δ LEDEXP80	Δ LNFC80	Δ LLABOUR
Dependent Variables							
Δ LGDP	0.02*	0.03	L1. Δ LGDP -0.29* L2. Δ LGDP -0.04	L1. Δ TS80 0.68* L2. Δ TS80 0.32	L1. Δ LEDEXP80 0.13* L2. Δ LEDEXP80 -0.11	L1. Δ LNFC80 0.02 L2. Δ LNFC80 0.07	0.51
Δ TS	.02**	-0.01	L1. Δ LGDP 0.11 L2. Δ LGDP 0.08	L1. Δ TS80 0.04 L2. Δ TS80 0.67***	L1. Δ LEDEXP80 -0.06 L2. Δ LEDEXP80 -0.02	L1. Δ LNFC80 0.13 L2. Δ LNFC80 -0.22*	0.24
Δ LEDEXP	0.14***	0.07	L1. Δ LGDP 0.53 L2. Δ LGDP 0.33	L1. Δ TS80 -1.27* L2. Δ TS80 -1.2	L1. Δ LEDEXP80 0.06 L2. Δ LEDEXP80 -0.17	L1. Δ LNFC80 0.67 L2. Δ LNFC80 -0.20	-3.62
Δ LNFC80	0.03***	.01	L1. Δ LGDP 0.05 L2. Δ LGDP 0.01	L1. Δ TS80 0.44* L2. Δ TS80 0.47**	L1. Δ LEDEXP80 0.02 L2. Δ LEDEXP80 -0.18**	L1. Δ LNFC80 0.38** L2. Δ LNFC80 0.27*	-0.41
LM test for autocorrelation	H ₀ :No autocorrelation at lag order Lag 1:P-value=0.77 Lag 2: P-value 0.17						

Note: *, ** and *** represent statistical significance at 10%, 5% and 1% respectively. Δ LLABOUR is the exogenous variable. Optimal number of lags is 2 as per the AIC.

The relationship could not be re-tested for Total taxes on International trade (% of revenue) because of data limitations. We used another variable (KOFB) which acted as a proxy for trade restrictions to re-estimate the relationship between trade restrictions and growth. The conclusion remains unchanged in the context of the relation between trade barriers and growth. In the VAR equation with KOFB as the dependent variable we find the dummy variable to be statistically insignificant. This implies that the intercept did not change across the two policy regimes (pre-1980 and post 1980). This is actually consistent with the empirical evidence because the reforms carried out in the 1980s did not involve reduction in tariffs and other trade barriers. In fact, Das (2003) and Rodrik and Subramanian (2004) discuss how the average effective rate of protection went up at an aggregate industry level during the 1980s in India.

Table 7: VAR results with KOFB as the trade openness index

Explanatory Variables	Dummy	CON	Δ LGDP	Δ LKOFB80	Δ LEDEXP80	Δ LNFC80	Δ LLABOUR
Dependent Variables							
Δ LGDP	0.03*	0.02	L1. Δ LGDP -0.11 L2. Δ LGDP 0.10	L1. Δ LKOFB80 0.02 L2. Δ LKOFB80 0.03	L1. Δ LEDEXP80 0.10 L2. Δ LEDEXP80 -0.20	L1. Δ LNFC80 0.22 L2. Δ LNFC80 0.09	0.28
Δ LKOFB	0.05	-0.09*	L1. Δ LGDP 0.07 L2. Δ LGDP 0.43	L1. Δ LKOFB80 -0.15 L2. Δ LKOFB80 0.03	L1. Δ LEDEXP80 -0.25 L2. Δ LEDEXP80 0.08	L1. Δ LNFC80 0.42 L2. Δ LNFC80 0.03	2.76
Δ LEDEXP	0.12***	0.07	L1. Δ LGDP 0.09 L2. Δ LGDP 0.01	L1. Δ LKOFB80 -0.12 L2. Δ LKOFB80 -0.11	L1. Δ LEDEXP80 0.01 L2. Δ LEDEXP80 -0.01	L1. Δ LNFC80 0.43 L2. Δ LNFC80 -0.30	-2.81
Δ LNFC80	0.03***	0.02	L1. Δ LGDP 0.07 L2. Δ LGDP -0.05	L1. Δ LKOFB80 -0.01 L2. Δ LKOFB80 -0.01	L1. Δ LEDEXP80 -0.01 L2. Δ LEDEXP80 -0.15***	L1. Δ LNFC80 0.18 L2. Δ LNFC80 0.42***	-0.67
LM test for autocorrelation		H ₀ :No autocorrelation at lag order Lag 1:P-value=0.28 Lag 2: P-value 0.57					

Note: *, ** and *** represent statistical significance at 10%, 5% and 1% respectively. Δ LLABOUR is the exogenous variable. According to AIC, optimal number of lags is 2.

We do not find any evidence that lower trade barriers trigger higher growth in case of India. This lack of evidence may probably be attributed to data limitations to some extent. It can also be due to the indicators of trade barriers that we use to empirically test the relationship. There is no clear consensus on how to define a “perfect” indicator of trade restrictions. Most of the simple measures of trade barriers suffer from some limitation or the other.²⁴ Maybe that is why, as Rodriguez and Rodrik (2001) say,

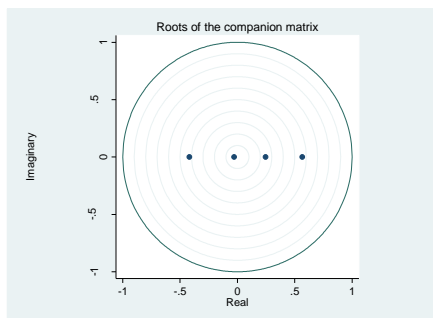
²⁴ See Rodriguez and Rodrik (2001) for a detailed discussion on the shortcomings of measures of trade restrictions.

“Simple measures of trade barriers tend not to enter significantly in well-specified growth regressions, regardless of time periods, subsamples, or the conditioning variables employed.”

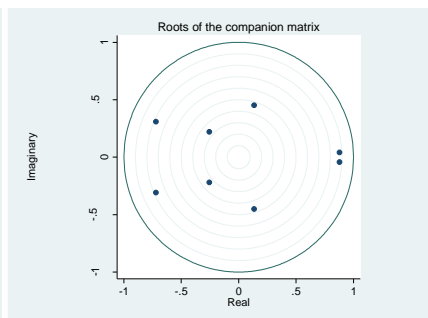
Other explanatory variables, such as public education expenditures seem to affect growth positively but the effect is inconsistent and seems sensitive to model specifications. There is also no evidence of reverse causality from GDP towards education spending. A growth in physical capital stock also does not seem to affect growth significantly.

5.1.1 Stability Test and Granger Causality Test

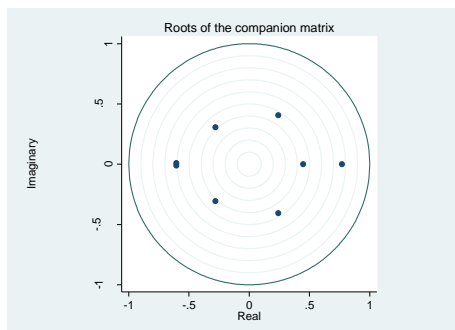
All the eigenvalues lie within the unit root circle indicating that the VAR system used in our analysis is stable. The unit root circles for the VAR systems with IPR, TS and KOFB as openness are given in Figure 2(a, b and c respectively).



2(a)



2(b)



2(c)

We further test jointly the significance of all the lags of the trade variables for each of the equation in the VAR model. As seen from Table 8, trade share (TS) seems to significantly affect growth rate in the 1st lag but not in 2nd. Hence a question can naturally arise whether the overall

impact of trade share on growth is statistically significant or not. We employ Granger Causality Wald test to check that.

Table 8: Granger Causality Test Results

Null Hypothesis	P-value
Δ LGDP does not Granger Cause Δ IPR	0.30
Δ IPR does not Granger Cause Δ LGDP	0.00
Δ LGDP does not Granger Cause Δ TS	0.31
Δ TS does not Granger Cause Δ LGDP	0.08
Δ LGDP does not Granger Cause Δ TAX	0.02
Δ TAX does not Granger Cause Δ LGDP	0.38
Δ LGDP does not Granger Cause Δ KOFB	0.54
Δ KOFB does not Granger Cause Δ LGDP	0.88

Overall, trade volume (both import penetration ratio, IPR and trade share, TS) has a positive correlation with growth. Growth in trade volumes accelerates economic growth of India. The Test for the causality between total taxes on international trade (TAX) and growth has been conducted based on the results in Table 11. We found the impact of economic growth on total taxes on trade to be positive and significant. This may imply that as the country is growing as a result of increasing trade openness, its exports and imports are increasing and consequently the total taxes collected on trade is also going up.

6. Conclusion

We have tried to examine the relationship between trade openness and growth of India during the time period 1970-2010 using import penetration ratio, total trade as percentage of GDP, total taxes on international trade and another trade restriction indicator (based on the KOF Economic Globalization Indices) as openness indices. The first two measures are indicators of trade volume and the final two measures are indicators of trade barriers or trade restrictions. We used the VAR estimation technique to examine the relationship because of potential endogeneity issues. Overall, the analysis done in this paper finds some evidence that trade openness (proxied

by trade volumes) is good for growth in India's case. We found that an increase in import penetration ratio and total trade share leads to an increase in GDP growth rate of India. The effect of trade volume on growth became significant from 1980 onwards when India gradually started to shift from a state-led growth model towards a market-oriented regime by undertaking various industrial reforms. Indian industries started importing superior intermediate and capital goods in spite of high tariffs which increased labour productivity and consequently led to faster economic growth (see Sinha and Tejani, 2004 also).

We do not find evidence of any empirical relationship between trade barriers and growth. The problem can probably be attributed to data limitations and lack of accurate measures of trade barriers. We see that there is actually some reverse causality from growth towards trade barriers. This may imply that as India is growing as a result of increasing its trade openness, its exports and imports are increasing and as a result the total taxes collected on trade are also rising.

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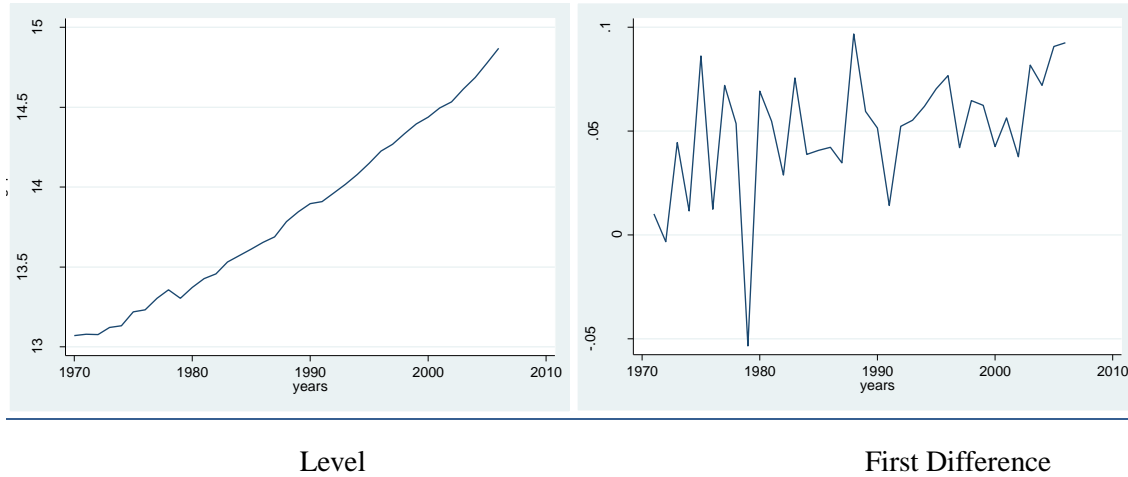
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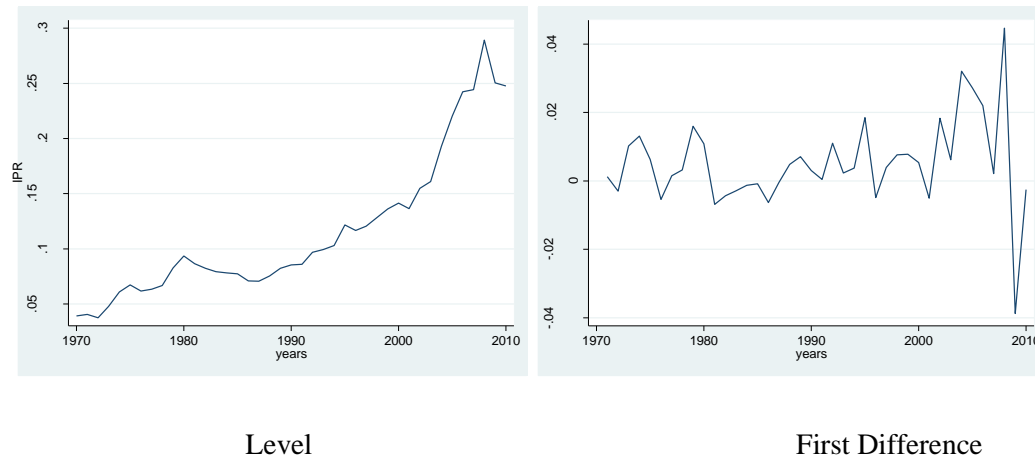
Appendix

Figure 3: Log of GDP (LGDP) in levels and in first difference



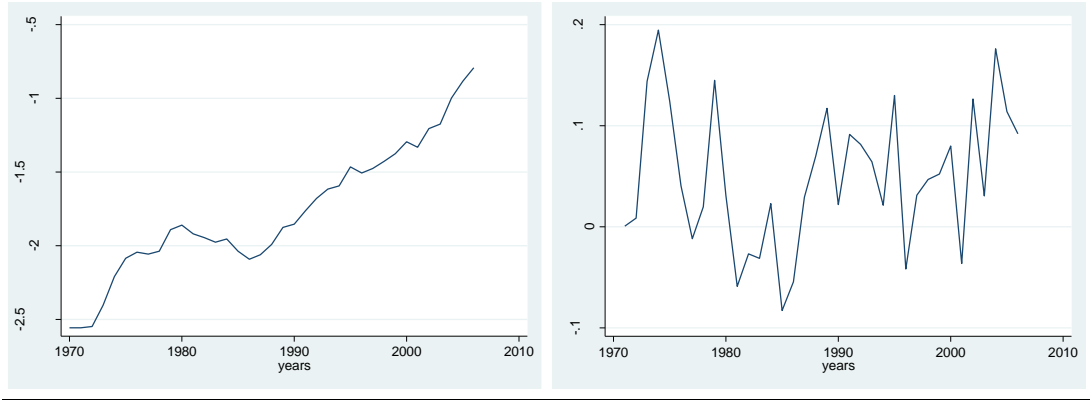
Source: Authors' own calculations based on data obtained from RBI database.

Figure 4: Import Penetration ratio (IPR) in levels and in first difference



Source: Authors' own calculations based on data obtained from WDI.

Figure 5: Log of Trade share as percentage of GDP (TS) in levels and in first difference



Level

First Difference

Source: Authors' own calculations based on data obtained from WDI.

Figure 6: Log of Total Taxes on International Trade (% of revenue) in level

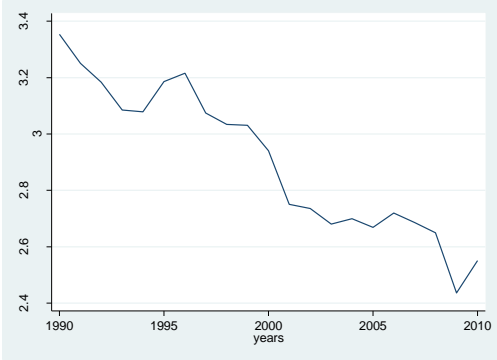


Table 9: VAR results with IPR as the trade openness index (ignoring the break in 1980)

Explanatory Variables	CONSTANT	Δ LGDP	Δ IPR	Δ LEDEXP	Δ LNFCFS	Δ LLABOUR
Dependent Variables						
Δ LGDP	0.07***	L1. Δ LGDP -0.07 L2. Δ LGDP 0.17	L1. Δ IPR 0.26 L2. Δ IPR 0.32	L1. Δ LEDEXP 0.10** L2. Δ LEDEXP -0.31***	L1. Δ LNFCFS 0.19 L2. Δ LNFCFS 0.09	-0.01
Δ IPR	0.01	L1. Δ LGDP 0.03 L2. Δ LGDP 0.06	L1. Δ IPR 0.26 L2. Δ IPR 0.10	L1. Δ LEDEXP -0.05* L2. Δ LEDEXP -0.04	L1. Δ LNFCFS -0.01 L2. Δ LNFCFS -0.01	0.04
Δ LEDEXP		L1. Δ LGDP -0.08 L2. Δ LGDP 0.03	L1. Δ IPR -1.6 L2. Δ IPR -0.07	L1. Δ LEDEXP 0.10 L2. Δ LEDEXP -0.03	L1. Δ LNFCFS 0.83 L2. Δ LNFCFS -0.60	-2.6
Δ LNFCFS		L1. Δ LGDP 0.08 L2. Δ LGDP -0.01	L1. Δ IPR -0.48 L2. Δ IPR 0.65*	L1. Δ LEDEXP 0.02 L2. Δ LEDEXP -0.13**	L1. Δ LNFCFS 0.36** L2. Δ LNFCFS 0.26	-0.27
LM test for autocorrelation	H ₀ :No autocorrelation at lag order Lag 1:P-value=0.67 Lag 2: P-value 0.19					

Note: Coefficients in parentheses. *, ** and *** represent statistical significance at 10%, 5% and 1% respectively. Δ LLABOUR is the exogenous variable.

Table 10: VAR results with TS as the trade openness index (ignoring the break in 1980)

Explanatory Variables	CONSTANT	Δ LGDP	Δ TS	Δ LEDEXP	Δ LNFCFS	Δ LLABOUR
Dependent Variables						
Δ LGDP	0.07***	L1. Δ LGDP -0.10 L2. Δ LGDP 0.14	L1. Δ TS 0.23 L2. Δ TS 0.32	L1. Δ LEDEXP 0.11* L2. Δ LEDEXP -0.29***	L1. Δ LNFCFS 0.16 L2. Δ LNFCFS 0.03	-0.04
Δ TS	0.02	L1. Δ LGDP 0.09 L2. Δ LGDP 0.02	L1. Δ TS 0.07 L2. Δ TS 0.47**	L1. Δ LEDEXP -0.07* L2. Δ LEDEXP -0.04	L1. Δ LNFCFS 0.1 L2. Δ LNFCFS -0.24*	.07

ΔLEDEXP	0.18***	L1.ΔLGDP -0.03 L2.ΔLGDP 0.15	L1.ΔTS -1.01 L2.ΔTS -0.31	L1.ΔLEDEXP 0.08 L2.ΔLEDEXP -0.06	L1.ΔLNFCFS 0.86 L2.ΔLNFCFS -0.46	-2.5
ΔLNFCFS	.03*	L1.ΔLGDP 0.05 L2.ΔLGDP 0.03	L1.ΔTS 0.01 L2.ΔTS -0.13**	L1.ΔLEDEXP -0.35 L2.ΔLEDEXP 0.43*	L1.ΔLNFCFS 0.39** L2.ΔLNFCFS 0.26	-0.3
LM test for autocorrelation	H ₀ :No autocorrelation at lag order Lag 1:P-value=0.67 Lag 2: P-value 0.13					

Note: Coefficients in parentheses. *, ** and *** represent statistical significance at 10%, 5% and 1% respectively. ΔLLABOUR is the exogenous variable.

Table 11: VAR results with TAX as the trade openness index

Explanatory Variables	CONSTANT	ΔLGDP	ΔTAX	ΔLEDEXP	ΔLNFCFS	ΔLLABOUR
Dependent Variables						
ΔLGDP	0.08***	L1.ΔLGDP -0.15 L2.ΔLGDP 0.11	L1.ΔTAX 0.01 L2.ΔTAX 0.06	L1.ΔLEDEXP 0.07 L2.ΔLEDEXP -0.24***	L1.ΔLNFCFS 0.34*** L2.ΔLNFCFS 0.10	-0.14
ΔTAX	0.01	L1.ΔLGDP 2.7* L2.ΔLGDP 0.24	L1.ΔTAX -0.02 L2.ΔTAX -0.58	L1.ΔLEDEXP -0.33 L2.ΔLEDEXP -0.03	L1.ΔLNFCFS 0.08 L2.ΔLNFCFS -0.57	-5.95
ΔLEDEXP	0.18	L1.ΔLGDP 0.88 L2.ΔLGDP -0.51	L1.ΔTAX -0.38 L2.ΔTAX 0.31	L1.ΔLEDEXP 0.63** L2.ΔLEDEXP -0.49	L1.ΔLNFCFS 0.31 L2.ΔLNFCFS -1.1**	-3.53
ΔLNFCFS	-0.12**	L1.ΔLGDP 1.7*** L2.ΔLGDP 0.22	L1.ΔTAX -0.25*** L2.ΔTAX -0.16*	L1.ΔLEDEXP 0.19* L2.ΔLEDEXP -0.18**	L1.ΔLNFCFS 0.17 L2.ΔLNFCFS 0.22	0.82
LM test for autocorrelation	H ₀ :No autocorrelation at lag order Lag 1:P-value=0.36 Lag 2: P-value 0.53					

Note: Coefficients in parentheses. *, ** and *** represent statistical significance at 10%, 5% and 1% respectively. ΔLLABOUR is the exogenous variable. The issue of a trend break in 1980 does not matter because data on TAX is available from 1990 onwards only.

Table 12: VAR results with KOFB as the trade openness index (ignoring the break in 1980)

Explanatory Variables	CONSTANT	Δ LGDP	Δ LKOFB	Δ LEDEXP	Δ LNFCFS	Δ LLABOUR
Dependent Variables						
Δ LGDP	0.07***	L1. Δ LGDP -0.03 L2. Δ LGDP 0.17	L1. Δ LKOFB 0.01 L2. Δ LKOFB 0.02	L1. Δ LEDEXP 0.09 L2. Δ LEDEXP -0.33***	L1. Δ LNFCFS 0.22 L2. Δ LNFCFS 0.11	-0.08
Δ LKOFB	-0.02	L1. Δ LGDP 0.22 L2. Δ LGDP 0.54	L1. Δ LKOFB -0.15 L2. Δ LKOFB 0.03	L1. Δ LEDEXP -0.30 L2. Δ LEDEXP -0.06	L1. Δ LNFCFS 0.23 L2. Δ LNFCFS 0.03	2.29
Δ LEDEXP	0.20***	L1. Δ LGDP -0.12 L2. Δ LGDP 0.04	L1. Δ LKOFB -0.17 L2. Δ LKOFB -0.13	L1. Δ LEDEXP 0.04 L2. Δ LEDEXP -0.01	L1. Δ LNFCFS 0.63 L2. Δ LNFCFS -0.40	-2.53
Δ LNFCFS	0.04*	L1. Δ LGDP 0.10 L2. Δ LGDP -0.01	L1. Δ LKOFB 0.005 L2. Δ LKOFB 0.004	L1. Δ LEDEXP -0.02 L2. Δ LEDEXP -0.11	L1. Δ LNFCFS 0.23 L2. Δ LNFCFS 0.40***	-0.41
LM test for autocorrelation	H ₀ :No autocorrelation at lag order Lag 1:P-value=0.14 Lag 2: P-value 0.89					

Note: Coefficients in parentheses. *, ** and *** represent statistical significance at 10%, 5% and 1% respectively. Δ LLABOUR is the exogenous variable.