Openness and Inflation Revisited

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Abstract

This paper investigates the relationship between trade openness and inflation for panel data from 1970 to 2007. The results show a negative effect of trade openness on inflation when inflation is higher but no effect when inflation is lower. The negative relationship is stronger along with the inflation. The evidences are robust to controlling for exchange rate regime and for indebted countries in the 1980s debt crisis.

Keywords: Debt crisis; Inflation; Panel data; Quantile regression; Trade openness **JEL Classification Codes:** C23; E31; F41

1. Introduction

The relationship between trade openness and inflation is an important issue in international finance. Romer (1993) documents that less open countries have more incentive to generate surprise inflation and therefore greater openness for open countries is associated with lower inflation. He uses a crosssection study to test the relationship between trade openness and inflation. Among his results, Romer empirically finds a negative trade openness and inflation relationship in most countries, except for countries with more developed economies. Meanwhile, subsequent studies have mixed results and give rise to empirical puzzlement. Some examples include Lane (1997) and Campillo and Miron (1997). Both studies show that inflation may be lower for countries with more developed economies, after controlling for additional variables. Kim and Beladi (2005) suggest in their study, that there exists a negative trade openness and inflation relationship in developing countries and a positive trade openness and inflation relationship in developed countries. Terra (1998), in a study, further argues that during the 1980s debt crisis period, the negative trade openness and inflation relationship was attributed to the outcome of a severely indebted country and no significant trade openness and inflation relationship was found for countries with developed or non-developed economies not severely indebted.

Recently, many researchers have investigated the short-term trade openness and inflation relationship empirically by panel data technique. Sachsida et al. (2003) and Al-Nasser et al. (2009) obtain a negative relationship for 152 countries over the period 1950-1992. Gruben and McLeon (2004) also find a negative effect of trade openness on inflation for countries in 1971-2000 except the severely indebted countries in non-debt crisis period. Their result is robust to controlling for exchange rate regime. However, Alfaro (2005) obtains a positive relationship between trade openness and inflation for 130 countries over the period 1973-1998 and her empirical results show a positive relationship. She further argues that the negative relationship may come from the negative influence of fixed exchange rate regime on inflation.

Thus, this paper applies the quantile regression for panel data of Koenker (2004) to investigate the relationship between trade openness and inflation over the period 1970-2007. Different from the least square fixed effect method which provides mean behavior of the trade openness and inflation relation, the quantile regression results show that the relationship depends on different level of inflation. The relationship is significant negative for high quantiles of inflation but is insignificant negative or positive for low quantiles of inflation. The former relationship is consistent with that of Alfaro (2005) and the later relationship is consistent with that of Romer (1993), Lane (1997) and Sachside et al. (2003). Interesting, the negative effect of trade openness on inflation appears to be stronger along with quantiles. The quantile regression model provides a complete description on the trade openness and inflation relationship. Moreover, the results are robust to controlling exchange rate regime and are robust for all the indebted countries (e.g. Terra, 1998; Gruben and McLeon, 2004).

2. Data and Model 2.1 Data

2.1 Data

The panel data in this study comprise a total 106 countries for the 1970-2007 period. The data is from World Bank, *World Development Indicator*.¹ Inflation is measured by change rate in the GDP deflator. For trade openness measures, the share of imports as a percentage of GDP is used. The growth rate of GDP per capita is used to control the country size.² This paper also consider the data of 58 indebted countries which are indebted in the 1980 debt crisis. Moreover, the exchange rate regime is suspected to affect the inflation (Alfaro, 2005),³ and we consider other data that 90 countries of the full sample except those are not in Reinhart and Rogoff (2004). Countries in all three data sets are described in detail in Appendix.

	Mean	Quantiles									
		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	
Full sample	30.87	0.98	2.62	3.94	5.51	7.34	9.29	12.11	16.68	27.06	
All indebted countries	47.51	1.19	3.36	5.00	6.84	8.75	11.18	14.25	19.79	33.41	
Sample of RR	39.49	0.93	2.49	3.69	5.18	6.96	8.98	11.72	16.24	27.76	
1. The full sample covers the period 1970-2007 for 106 countries.											

Table 1: The Sample Mean and Quantiles of Inflation

2. All indebted countries sample is the 58 indebted countries in the 1980s debt crisis.

3. Sample of RR is the 90 countries of the full sample except those are not in Reinhart and Rogoff (2004).

4. All countries are in the Appendix

Table 1 reports the mean and different quantile values of inflation for all samples. It is seen that the average inflation is very large relative to the median of inflation in all three data sets; this shows that the sample distribution of inflation is right-skewed. The extreme values of inflation rate largely affect the mean of inflation rate and analyzing the mean relationship of trade openness and inflation may mislead. Since the quantile regression enables one to study the conditional quantiles of inflation, it provides a complete description of the effect of trade openness on inflation. Therefore, we apply the quantile regression for panel data to revisit the trade openness and inflation relationship.

¹ We use the average to replace the missing values.

² The panel unit root tests are used in our study. For inflation, imports, GDP per capita, the growth rate of GDP per capita, the t statistics of Levin et al.(2001) test are -28.81, -15.56, 7.14, -43.59 and the t-bar statistics of Im et al. (2003) test are -2.76, -1.93, 0.49, -4.22. Therefore, the GDP per capital is non-stationary and the growth rate of GDP per capita is stationary.

³ This paper use the exchange-rate regime classification of Reinhart and Rogoff (2004), who classifies de facto exchange rates of a country. Five categories of their classification are: Fixed regimes, crawling pegs, managed floating, freely floating, freely failing and data are obtained from http://terpconnect.umd.edu/~creinhar/Papers.html.

2.2 Model

In this paper, we consider to a fixed effect models for panel data. Given quantile $\tau \in (0,1)$, the resulting quantile regression specification for panel data is specified as follows:

 $\log\{1 + inflation_{tr}\} = \alpha_t + x_{tr}^{\prime}\beta(r) + e_{true},$

where i = 1,...,n represents country, t = 1,...,T is time, α_i represent the fixed effect of country *i*, explanatory variables x_{it} contains the constant term, openness, the growth rate of GDP per capita, $\beta(\tau)$ is a vector of parameters, and α_{it} is error term. Note that α_i is invariant with respect to quantiles. When the dimension of *n* is large, the estimation of fixed effect α_i is not feasible. In the ordinary panel data fixed effect models, the within estimation is used to eliminate the fixed effect because the expectation is a linear operator. The quantile function is not a linear operator and we use the shrinkage method proposed by Koenker (2004) to eliminate the fixed effect.

To eliminate the fixed effect and estimate the $\{p(r_1), \dots, p(r_n)\}$ consistently, Koenker (2004) suggests the following penalized objective function:

$$\min_{\alpha_{l},\beta(\tau_{k})}\sum_{k=1}^{q}\sum_{t=1}^{T}\sum_{i=1}^{n}\omega_{k}\rho_{\tau_{k}}(y_{it}-\alpha_{l}-x_{it}^{'}\beta(\tau_{k}))+\lambda\sum_{i=1}^{n}|\alpha_{i}|$$

where $\rho_{\tau_k}(A) = A \cdot (\tau_k - \mathbf{1}_{64 < 1})$ a check function, with **1** an indicator function, $\sum_{i=1}^{|\alpha_i|}$ is the penalized term. When $\lambda \to \mathbf{0}$, the ordinary fixed effects estimator is obtained, while $\lambda \to \infty$, an estimate of the model purged the fixed effects is obtained. Further, Koenker (2004) has proved that the estimated $\{\beta(\tau_1), \dots, \beta(\tau_n)\}$ are asymptotically normal. In this paper, we use the panel bootstrap method to estimate the covariances of estimators.

3. Empirical Results

All empirical results are listed in Table 2, which reports the coefficient estimates of least square fixed effect and the quantile regression for panel data with quantiles 0.1, 0.2,...,0.9. The results of the full samples that cover 106 countries are listed in the upper panel of Table 2, those of all indebted countries are in the middle panel, and those of samples in Reinhart and Rogoff (2004) are in the lower panel.

Dependent v	ariable: Inflat	tion								
Full Sample						Quantiles				
	LSFE	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Openness	$-3.12 e^{-4*}$	5.69 e^{-5}	$-5.43 e^{-5}$	$-1.06 e^{-4}$	-1.27 e^{-4*}	- 1.63 $e^{-4^{**}}$	-2.13 $e^{-4^{***}}$	-2.64 $e^{-4^{***}}$	-3.47 $e^{-4^{***}}$	-5.33 $e^{-4^{***}}$
Openness	$(1.66 e^{-4})$	$(1.03 e^{-4})$	$(8.31 e^{-5})$	$(7.59 e^{-5})$	$(7.03 e^{-5})$	$(6.81 e^{-5})$	$(7.03 e^{-5})$	$(7.55 e^{-5})$	$\begin{array}{r} 0.8 \\ \hline 0.8 \\ \hline 3.47 \ e^{-4^{***}} \\ \hline (1.00 \ e^{-4} \) \\ \hline 0.48 \ e^{-2^{***}} \\ \hline (3.41 \ e^{-2} \) \\ \hline 0.8 \\ \hline 4.03 \ e^{-4^{**}} \\ \hline (2 \ e^{-4} \) \\ \hline 7.87 \ e^{-4} \\ \hline (3.93 \ e^{-2} \) \\ \hline \hline 0.8 \\ \hline 2.96 \ e^{-4^{***}} \\ \hline (9.43 \ e^{-5} \) \\ \hline 2.08 \ e^{-3} \\ \hline (5.79 \ e^{-2} \) \\ \hline 1.46 \ e^{-2^{***}} \\ \hline (5.12 \ e^{-3} \) \end{array}$	$(1.63 e^{-4})$
GDP per capita	$3.27 e^{-2}$	1.75 $e^{-1^{***}}$	$1.35 e^{-1^{***}}$	1.17 $e^{-1^{***}}$	1.11 $e^{-1^{***}}$	1.14 $e^{-1^{***}}$	$1.12 e^{-1^{***}}$	1.1 $e^{-1^{***}}$	9.48 $e^{-2^{***}}$	7.42 e^{-2}
	$(2.82 e^{-2})$	$(3.57 e^{-2})$	$(3.17 e^{-2})$	$(2.02 e^{-2})$	$(2.07 e^{-2})$	$(1.96 e^{-2})$	$(2.13 e^{-2})$	$(2.75 e^{-2})$	$(3.41 e^{-2})$	$(5.21 e^{-2})$
All Indebted	countries					Quantiles				
	LSFE	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Openness	-5.7 e^{-4*}	2.7 e^{-4*}	$1.06 e^{-4}$	$-5.44 e^{-6}$	$-6.51 e^{-5}$	$-1.24 e^{-4}$	$-2.08 e^{-4}$	-3.01 $e^{-4^{**}}$	-4.03 $e^{-4^{**}}$	-7.97 e^{-4*}
Openness	$(2.98 e^{-4})$	$(1.54 e^{-4})$	$(1.02 e^{-4})$	$(1.03 e^{-4})$	$(1.05 e^{-4})$	$(1.13 e^{-4})$	$(1.26 e^{-4})$	$(1.45 e^{-4})$	$(2e^{-4})$	$(4.13 e^{-4})$
GDP per	$1.35 e^{-2}$	$4.82 e^{-3}$	$1.92 e^{-3}$	$1.89 e^{-3}$	$1.08 e^{-3}$	$3.6 e^{-4}$	7.95 e^{-4}	$1.89 e^{-3}$	7.87 e^{-4}	$1.53 e^{-3}$
capita	$(2.35 e^{-3})$	$(8.12 e^{-2})$	$(7.11 e^{-2})$	$(6.36 e^{-2})$	$(5.99e^{-2})$	$(5.79 e^{-2})$	$(5.27 e^{-2})$	$(4.8 e^{-2})$	$(3.93e^{-2})$	$(4.42 e^{-2})$
Sample of R	R					Quantiles				
	LSFE	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Openness	-1.36 e^{-4}	$-3.49 e^{-6}$	-7.97 e^{-5}	$-1.16 e^{-4}$	-1.47 e^{-4*}	-1.76 $e^{-4^{**}}$	-2.24 $e^{-4^{***}}$	-2.63 $e^{-4^{***}}$	$2.96 e^{-4^{***}}$	-4.05 $e^{-4^{***}}$
opennes	$(2.03 e^{-4})$	$(1.13 e^{-4})$	$(8.33 e^{-5})$	$(7.68 e^{-5})$	$(7.58 e^{-5})$	$(7.34 e^{-5})$	$(7.65 e^{-5})$	$(8.26 e^{-5})$	$\begin{array}{r} \textbf{0.8} \\ \hline \textbf{0.8} \\ \hline (1.00 \ e^{-4} \) \\ 9.48 \ e^{-2^{***}} \\ (3.41 \ e^{-2} \) \\ \hline \textbf{0.8} \\ \hline \textbf{-4.03 \ e^{-4^{**}} \\ (2 \ e^{-4} \) \\ 7.87 \ e^{-4} \\ (3.93 \ e^{-2} \) \\ \hline \textbf{0.8} \\ 2.96 \ e^{-4^{***}} \\ (9.43 \ e^{-5} \) \\ 2.08 \ e^{-3} \\ (5.79 \ e^{-2} \) \\ \hline \textbf{-1.46 \ e^{-2^{***}} \\ (5.12 \ e^{-3} \) \\ \end{array}$	$(1.33 e^{-4})$
GDP per	$1.5 e^{-3}$	$3.82 e^{-3}$	$2.01 e^{-3}$	2.48 e^{-3}	$1.88 e^{-3}$	8.21 e^{-4}	6.07 e^{-4}	$1.19 e^{-3}$	$2.08 e^{-3}$	$8.62 e^{-4}$
capita	$(2.06 e^{-3})$	$(8.1 e^{-2})$	$(6.42 e^{-2})$	$(5.74 e^{-2})$	$(5.69e^{-2})$	$(5.88 e^{-2})$	$(5.96 e^{-2})$	$(5.82 e^{-2})$	$(5.79 e^{-2})$	$(7.24 e^{-2})$
Exchange-	-2.78 $e^{-2^{***}}$	8.27 e^{-4}	$-2.54 e^{-3}$	$-3.26 e^{-3}$	$-4.06 e^{-3*}$	-4.94 $e^{-3^{**}}$	-6.11 $e^{-3^{**}}$	-9.23 $e^{-3^{**}}$	-1.46 $e^{-2^{***}}$	$-3.1 e^{-2^{**}}$
rate	$(3.74 e^{-3})$	$(3.65 e^{-3})$	$(2.31 e^{-3})$	$(2.30 e^{-3})$	$(2.42 e^{-3})$	$(2.51 e^{-3})$	$(3.01 e^{-3})$	$(3.73 e^{-3})$	$(5.12 e^{-3})$	$(1.32 e^{-2})$
1.The column	1 of LSFE repo	rts the least so	quare fixed effe	ect estimation	results.					
2.Standard er	rors are in pare	ntheses.								
3.*.**.*** ar	e significant at	the 10%. 5%	. 1% level.							

Table 2:	Quantile F	Regression a	and Least Sq	uares Fixed	Effect l	Estimates	for P	Panel E	Data
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4.Openness is the imports share of GDP, GDP per capita is the growth rate of GDP per capita.

From the upper panel of Table 2, we see that the least square fixed effect estimate of trade openness on inflation is significant negative while the quantile regression estimates vary across quantiles. The trade openness and inflation relationships are positive at the 0.1 quantile; this is consistent with that in Alfaro (2005). In addition, the relationships are negative in the 0.2-0.9 quantiles and are significant for the 0.4-0.9 quantiles. This result shows that for higher level of inflation, the relationship of trade openness to inflation becomes significant negative; which is consistent with that in Romer (1993), Lane (1997), Sachside et al. (2003). It is noted that the negative effect of trade openness on inflation is stronger along with quantiles.

Following Terra (1998) and Gruben and McLeod (2004), we study the trade openness and inflation relationship by using the countries which are indebted in the 1980s debt crisis. In the middle panel of Table 2, the least square fixed effect estimate indicates a negative effect of trade openness on inflation while the quantile regression panel data estimates show a positive effect for lower quantile of inflation and a negative effect of middle and upper quantiles of inflation. When inflation is lower, the trade openness and inflation is insignificant which is different from the least square fixed effect result. Moreover, different from the result of the full sample, only very high inflation is affected by the openness.

Lane (1997) and Alfaro (2005) stress the effects of exchange rate to inflation on studying the trade openness and inflation relationship. From the lower panel of Table 2, we can see that all regression results conclude negative effect from openness to inflation when controlling the effect of exchange rate regime. This result supports the view that the negative relationship between trade openness and inflation is robust to controlling exchange rate regime. Interesting, the least square fixed effect estimates is insignificant which shows that there is no relationship between openness and inflation and such result is contradict with several existing theory such as Lane (1997) and Gruben and McLeod (2004). On the other hand, the quantile regression results indicate no relationship for very low quantiles of inflation but significant relationship for middle to high quantiles of inflation. The relationship becomes stronger along with quantiles of inflation.

In addition, the least square fixed effect regression obtains a positive effect of exchange rate on inflation; which is opposite to that in Alfaro (2005). Our quantile regression results show that the fixed exchange rate has significantly negative effect on inflation for high quantiles of inflation but has insignificantly negative effect on inflation for low quantiles of inflation.

4. Conclusions

Using the quantile regression for panel data, we find a negative relationship between trade openness and inflation. The trade openness and inflation relationship appears to have strengthener in high inflation stages and is extremely robust to consider the 1980s debt crisis and control the exchange-rate regime.

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Appendix I. Full sample:

Algeria, Argentina, Australia, Austria, Bangladesh, Barbados, Belgium, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African, Chad, Chile, Colombia, Congo, Rep., Cote d'Ivoire, Costa Rica, Denmark, Dominican, Ecuador, Egypt, El Salvador, Fiji, Finland, France, Gabon, Germany, Ghana, Greece, Guatemala, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Islamic Rep., Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Lesotho, Luxembourg, Madagascar, Malaysia, Mali, Malawi, Malta, Mauritania, Mauritius, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Oman, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Portugal, Puerto Rico, Rwanda, Saudi Arabia, Senegal, Seychelles, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Suriname, St. Vincent and the Grenadines, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Trinidad and Tobago, Tunisia, United Arab Emirates, United Kingdom, United States, Uruguay, Venezuela RB, Zambia, Zimbabwe.

II. All Indebted Countries:

Algeria, Argentina, Barbados, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Central African, Chile, Colombia, Congo, Rep., Cote d'Ivoire, Costa Rica, Dominican, Ecuador, Egypt, El Salvador, Gabon, Ghana, Greece, Guatemala, Haiti, Honduras, Hungary, India, Indonesia, Jamaica, Kenya, Korea, Lesotho, Madagascar, Malaysia, Malawi, Mexico, Morocco, Nepal, Nicaragua, Niger, Nigeria, Panama, Paraguay, Peru, Philippines, Portugal, Saudi Arabia, Senegal, Sri Lanka, Suriname, Swaziland, Syrian Arab Republic, Thailand, Togo, Tunisia, Uganda, Uruguay.

III. Sample Covered by Reinhart and Rogoff (2004):

Algeria, Angola, Argentina, Australia, Austria, Barbados, Belgium, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Burundi, Cameroon, Canada, Central African, Chad, Chile, Colombia, Congo, Rep., Cote d'Ivoire, Costa Rica, Denmark, Dominican, Ecuador, Egypt, El Salvador, Finland, France, Gabon, Germany, Ghana, Greece, Grenada, Guatemala, Guinea-Bissau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Lesotho, Luxembourg, Madagascar, Malaysia, Mali, Malawi, Malta, Mexico, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Panama, Paraguay, Peru, Philippines, Portugal, Puerto Rico, Saudi Arabia, Senegal, Spain, Sri Lanka, Suriname, St. Lucia, St. Vincent and the Grenadines, Swaziland, Sweden, Switzerland, Syrian Arab Republic, Thailand, Togo, Tunisia, Uganda, United Kingdom, United States, Uruguay.