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The Effect of Volatility of Unpredicted Exchange Rate Movement and Labor Market Regidity on Export

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Abstract

Exchange rate is one of the most volatile macroeconomic price variables. The fluctuations in the exchange rate generate volatility in the profits of firms and reduce the incentives of firms to enter the market or to expand their capacity. In response to exchange rate volatility firms may reduce labor costs to mitigate the negative impact through firing workers, reducing the work hours, eliminating severance pay, etc. However, labor market rigidity restricts a firm's ability to implement such adjustment, consequently amplifying the negative impact of exchange rate volatility on economic outcomes. This study contributes to literature by investigating the interaction effects of exchange rate volatility and labor market rigidity on industrial exports growth. We utilized a country-industry-level disaggregated panel dataset covering 17 industries for the span of 14 years (2005-2018) across 62 developed and developing countries. For our benchmark regression analysis, we employ the labor market regulation rigidity index developed by Campos et al. (2018), employing alternative indices constructed by Forteza and Rama (2006) and Botero et al. (2004) for robustness checks. Our unique measure of exchange rate volatility captures unpredictable fluctuations in the real exchange rate over the last three months. We used the fixed effects model, analogous to the triple-D estimation for the empirical analysis. We find negative and statistically significant impact of the interaction between exchange rate volatility and labor market rigidity on export growth. The findings indicate that in a country where labor market rigidity is one standard deviation higher, a one standard deviation increases in exchange rate volatility reduce export growth by 3.45 percentage points. The estimated coefficient is economically significant as well. This implies that the estimated coefficient reduces annual export growth by 3.45 percentage points relative to the annual average export growth of 3.2%. However, the estimated coefficient is smaller relative to the 40% standard deviation of annual average export growth. In subsample analysis, the results for developed and developing countries are consistent with the main findings.

1 Introduction

Exchange rate is one of the most volatile macroeconomic price variables. Table 1 shows the standard deviation of the three key macroeconomic price variables for Japan, the United Kingdom, Germany, and India. For instance, the standard deviation of the exchange rate between the Japanese yen and the United States dollar fluctuated at an average of 2.3% per month from 2005 to 2018. The exchange rate has a higher volatility compared to the consumer price index and interest rate.

Table A1: Standard Deviation of Macroeconomic Price Variables

Countries	Variables	Standard Deviation
Japan	Exchange rate Growth	0.023
	CPI Growth	0.003
	Interest Rate Growth	0.000
United Kingdom	Exchange rate Growth	0.023
	CPI Growth	0.003
	Interest Rate Growth	0.002
Germany	Exchange rate Growth	0.022
	CPI Growth	0.003
	Interest Rate Growth	0.002
India	Exchange rate Growth	0.019
	CPI Growth	0.008
	Interest Rate Growth	0.003

Note: The authors calculated the standard deviation from the data.
These are standard deviations of the difference of log of variables.

When an exporting firm faces a sudden increase of the exchange rate, one possible response is to fire workers. This adjustment can help exporting firms to cope with the negative effects of sudden change of the exchange rate.

However, firms might have difficulty to take such action when there is restriction on firing workers and in fact most countries introduce employment protection regulations and, to some extent, firing working is restricted (OECD, 2020). For example, Colombia, France Turkey, and others mandate an interview with the employee while Czech Republic, Finland, Norway, Sweden, Poland, Slovak Republic, and others necessitate consultation with a third party before firing. Thus, it is important to study the interaction effect of the exchange rate movemnt and labor market rigidity.

On the other hand, all change of the exchange rate does not impose cost to exporting firms. For example, if the change of the exchange rate can be predicted, the exporting firm can reduce the cost imposed by being engaged in the hedging in the financial market. Normally, there is premium cost

which arise from the uncertainly of the market exchange rate, but if the movement of the exchange rate is perfeclty predictable, such a premium cost should be close to zero. This indicates that among the movment of the exchange rate, what is important is the unpredictable movement of the exchange rate. To quantify the unpredicted movement of the exchange rate, using the reqression technique, we classify the preditable movement of the exchange rate and unpredictable movement of the exhcnage rate. Then we define the standard deviation of the exchange rate as the volatility of the exchnage rate.

Thus, in this paper, we examine the interactin term of the volatity of the exchange rate and the labor market rigidity on the economic outcome. More specifically, we study the interaction effects of volatility of exchange rate growth and labor market rigidity on export growth. For this purpose, we use country-industry panel data. In this panel data, we construct the trade-weighted real exchange rate for different industries using the initial trade share as the weight for the exchange rate. For example if the main export destinaiton of industry A in US is Canda and the main export destination of indusry B is EU, we put the higher weight to Canadian dollar for the real exchnage rate for industry A and to Euro for the real exchange rate for industry B. This allows us to generate the variation of the real exchnage rate for different industry in the same country and make it possible to estimate the interaction effect of the exchange rate volaity while controlling country fixed effect, industry fixed effect, country times year fixed effect and industry times fixed effect.

There are two groups of literature related to our paper. The first group includes studies examining the effect of exchange rate volatility on economic outcomes. [Small literature review] The second group examines the effect of labor market rigidity on economic outcomes. [Small literature review:]

The studies most closely related to our paper are those by Alexandre et al. (2011); **?** and (Alexandre et al., 2017) and Ishise (2019). Alexandre et al. (2011); **?** and (Alexandre et al., 2017) examine the interaction effect of real exchange rate differences and employment rigidity on employment differences in Portugal and OECD countries, respectively. Ishise (2019) investigates the interaction effect of exchange rate variability and wage rigidity, demonstrating that a country with a more volatile nominal exchange rate has a comparative advantage in industries with flexible wages, while those with less volatility benefit in industries with sticky wages.

In the first paper, authors examined the difference of the exchange rate on the ecoomic outcome and, as the result, the difference of the exchange rate include the the predictable change. In Ishise (2019) , the author is interested in the nominal wage ridigy. In our paper, we are interested in the real firing rigidity.

The remaining sections of the paper are organized as follows. This section extended to the volatility of exchange rate growth and labor market rigidity. Section 2 discusses data construction, Section 3 explains the estimation strategy, and Section 4, 5, and 6 present the empirical results, robust test, and discussion, respectively. The paper concludes with a policy recommendation.

2 Literature Review

2.1 Volatility of Exchange Rate Growth

The volatility of the real exchange rate refers to the wide range of fluctuations of the exchange rate. These fluctuations can produce uncertainty and further increase the risk of business and investment. They can also have considerable adverse effects (Oaikhenan and Aigheyisi, 2015). In the existing empirical works, three models have been presented for measuring the volatility of real exchange rates. First, the model measures the volatility of rates by the annual standard deviation of the first difference of the logarithm of the monthly effective exchange rate (Caglayan and Demir, 2014). Second, the model measures the z-score of exchange rate volatility (Morina et al., 2020). Third, the generalized autoregressive conditional heteroskedasticity (GARCH) model and it is centered on the prediction of errors, which is important for time series analysis because it accounts for the fact that the volatility of a time series can change over time (Morina et al., 2020).

2.2 Labor Market Regulations index

Labor market rigidity is often used as a synonym for ”employment protection legislation.” However, employment protection legislation is not exactly the same as labor market rigidity. The provisions of employment protection legislation can cause frictions in the labor market, and these frictions can impede the flow of labor freely from one job to another and may also hinder workers from entering the labor market. Therefore, labor market rigidity can be sourced from employment protection legislation (Bista and Sawyer, 2019). Every country has established regulations under the labor market law for the protection of the interests of workers and to ensure a minimum standard of living for its population. However, these regulations can have unintended consequences. For example, strict regulations curb employment (Autor et al., 2006; Haltiwanger et al., 2014; Gielen and Tatsiramos, 2012), trade (Bista and Sawyer, 2019), economic growth (Huang and Huang, 2013; Caparrós et al., 2013), productivity growth (Griffith and Macartney, 2014; Bassanini et al., 2009; Autor et al., 2007;

Kang, 2015), investment (Bai et al., 2020), and efficiency (Alpysbayeva and Vanormelingen, 2022; González and Miles-Touya, 2012).

3 Data Construction

3.1 Export Data

This study utilized disaggregated country-industry level panel data of 62 developed and developing countries [1]. In this empirical study, having 17 manufacturing industries indicates a sectoral heterogeneity of industries, which allows us to observe how the interaction effects of exchange rate volatility and labor market rigidity differentiate across industries and how the coefficient estimators might be different depending on the nature of the industry. Export growth is the outcome variable. The two-digit industry-level annual data of exports from 2005 to 2018 were obtained from the Trade Map. We included 17 manufacturing industries as sub-cross sections within the countries for the span of 14 years, from 2005 to 2018. Industries were added based on the availability of two-digit industry-level data for export. The list of industries used in the study, along with their International Standard Industrial Code (ISIC) and Harmonized Commodity (HS) code information, is presented in Table 1.

3.2 Exchange Rate Volatility

In this empirical analysis, the exchange rate volatility is constructed based on the following procedure. First, to exploit the fact that different industry even in the same countries face the relatively different exchange rate movement due to the fact that different industries in the same country have different export destination, we calculate the shares of the top five partners of an exporting country for each industry. To avoid the endogeniety, we use the trade share of the initial three yeas as the weight and we exclude the data of those year from the main regression. Second, we convert the nominal exchange rate to the real exchange rate and calculate the difference of the log of the trade weighted real exchange rate and its first lag, the second lag and the third lag. Finally, we regressed the difference of the log of the traded weight real exchnage rate on its first lag, second lag, the thrid lag and calculate the residual. We use the standard deviation of this residual in each year as the volatilty.

More specicially, we calcluate as follows. The industry-specific export weight can be expressed

[1] Table 1C presents the list of sample countries for the study in Appendix C.

Table 1: Names of ISIC Two-Digit Industries Used in the Study

#	Name of Industry	HS 2-digit Code	ISIC 2-digit Code
1	Food and Beverages	22	15
2	Tobacco Products	24	16
3	Textile	53	17
4	Wearing Apparels, fur	61	18
5	Leather, leather products and footwear	42	19
6	Wood Products (excluding furniture)	44	20
7	Paper and Paper Products	48	21
8	Printing and Publishing	49	22
9	Chemicals and Chemical Products	38	24
10	Rubber and Plastics Products	40	25
11	Non-metallic Mineral Products	27	26
12	Basic Metals	83	27
13	Fabricated Metal Products	72	28
14	Machinery and Equipment n.e.c.	84	29
15	Electronic Machinery and Apparatus	85	31
16	Motor Vehicles, Trailers, Semi-Trailers	87	34
17	Furniture; manufacturing n.e.c.	94	36

Note: The ISIC abbreviation stands for International Standard Industrial Classification for all economic activities. The HS stands for Harmonized Commodity description and coding system.

as follows:

$$\text{EXW}_{ikj} = \frac{\text{EX}_{ikj}}{\sum_{k \in \text{top 5}} \text{EX}_{ikj}} \tag{1}$$

where EXW_{ikj} is the export weight of industry i to destination country k by exporting country j is denoted by . The average export of industry i from 2001 to 2004 to destination country k by exporting country j is denoted by EX_{ikj}.

Second, we converted the nominal exchange rate of national currency per United States dollar to the nominal exchange rate of the national currency in terms of United States dollar for exporting country j and as well as for destination country k. As the export data is in United States dollars, so we need to convert it to the currency of exporting country j, so we have:

$$\text{NER}_{jkmt} = \frac{E_{kmt}}{E_{jmt}} \tag{2}$$

where NER_{jkmt} denotes the nominal exchange rate of destination country k in terms of the currency

of exporting country j at month m and year t, where E_{kmt} and E_{jmt} denote the nominal exchange rates in terms of US dollar of destination country k and exporting country j, respectively. Second, we convert the nominal exchange rates in terms of the currency of exporting country j to the real exchange rates in terms of the currency of exporting country j using country-specific Consumer Price Index (CPI)[2].

The real exchange rate of exporting country j to destination country k in month M and year t can be written as:

$$\text{RER}_{kjmt} = \text{NER}_{kjmt} \times \frac{\text{CPI}_{kmt}}{\text{CPI}_{jmt}} \tag{3}$$

The real exchange rate of destination country k in terms of exporting country j at month m and year t is denoted by RER_{kjmt}. The CPI of destination country k and exporting country j at month m and year t are denoted by CPI_{kmt} and CPI_{jmt}, respectively.

Step 3: Export weighted real exchange rate (EWRER)

Export weighted real exchange rate (EWRER) can be described as:

$$\text{EWRER}_{ikjmt} = \sum_{k \in \text{top 5}} \text{EXW}_{ikj} \times \text{RER}_{kjmt} \tag{4}$$

The export-weighted real exchange rate of industry i to destination country k from exporting country j in month m and year t is denoted by EWRER_{ikjmt}. The export weight is multiplied by the real exchange rate, which varies by industry i and destination country k. This leads to considerable heterogeneity in trade partners by the specific industry. For example, if one industry has five trade partners, then one country for 17 industries may have 85 trade partners.

Step 4: Computed export-weighted real exchange rate volatility

To compute export-weighted real exchange rate volatility, we first took the logarithm of the export-weighted real exchange rate (EWRER_{ikjmt}), and calculated the difference of the logarithm of 12 months of export-weighted real exchange rates. We then generated the first, second, and third lags of the difference of logarithmic export-weighted real exchange rates, and regressed the difference of logarithmic export-weighted real exchange rates on the first, second, and third lags of the difference of logarithmic export-weighted real exchange rate. We obtained the residual from this regression, and

[2]To use more adequate CPI data, we calculated country-specific CPI from the inflation rate (which is the percentage change in the monthly CPI from the previous year) by considering that CPI_{t+1} is a function of π_t, π_{t+1},... and CPI_t (where, π stands for inflation and t denotes time trend). We also assumed that the initial CPI is equivalent to one.

calculated the standard deviation of the residual to get the exchange rate volatility.

$$\text{EWRER Volatility}_{ikjt} = \text{SD}(\text{ Residual of difference of logarithm-EWRER}_{ikjmt}) \tag{5}$$

Finally, we standardized the volatility of exchange rate growth to address the unit of analysis problem in aggregation when interpreting the estimated coefficients.

We used the monthly nominal exchange rate of national currency per US dollar and inflation rate (percentage change in CPI from the previous period) for the period 2005-2018 from International Financial Statistics (IFS) [3]. Once we obtain the monthly real exchange rate for each industry in each country over time, we calculate difference of the log of the real exchnage rate, its first lag, the second lag and the third lag. Then, we regress the difference of the log traded real exchange rate on its first lag, the second lag and the third lag and calcualte the residual.

3.3 Labor Market Rigidty Index

According to Campos et al. (2018), most of the indices don't reflect by any means all dimensions of the labor market such as wage flexibility, team production, job rotation, social parts, different types of pension plans and workers use of courts etc., which have affect economic outcomes in various ways. However other indices capture a limited dimension of labor market regulation and used them as a measure of strictness of labor market for firms. Therefore, this study used three different effective datasets as a proxy for labor market rigidity for the empirical analysis. First, we use Labor Market Legislation Rigidity Index (LAMRIG) that was constructed by Campos et al. (2018) [4]. Second, we use Employment Law Rigidity Index developed by Botero et al. (2004). And third, we use Aggregate Labor Market Rigidity index constructed by Forteza and Rama (2006).

This study use Labor Market Legislation Rigidity Index (LAMRIG) as a benchmark for measuring as a proxy of labor market rigidity for several reasons. First, this is the most recent and comprehensive data, covering more than 140 developed and developing countries. However, other indices cover only richer countries. Second, this index is cross-sectional and time-variant, with each average period of five years from 1950-54 to 2000-2004, while other indices covering the post 1995 period. Third, this

[3]The monthly nominal exchange rate and inflation rate of Taiwan are obtained from the website of the National Statistics Republic of China (Taiwan). The inflation rate data for missing periods in the International Monetary Fund (IMF)'s database is filled from the Food and Agriculture Organization (FAO). The annual inflation rate data of Bermuda from 2005 to 2018, Uzbekistan from 2005 to 2010, and Yemen from 2015 to 2018 are obtained from the World Bank. The inflation rate data for some missing periods of Syria and Venezuela are obtained from their national statistics office websites.

[4]We thank Nauro F. Campos for providing the Labor Market Regulation Rigidity Index (LAMRIG) dataset.

index is developed with more intention on employment protection for instance, it is constructed on the basis of two pillars: (1) the employment law rigidity index constructed by Botero et al. (2004), which developed based on core indicators of employment protection and (2) National Labour, Social Security and Related Human Rights Legislation (NATLEX). National Labour, Social Security and Related Human Rights Legislation (NATLEX) is a depository of labor law of the International Labour Organization (ILO), which contains more than 20 legislation's since the 1940s for 150 countries. Therefore, this index captures various dimensions of labor market rigidity. Campos et al. (2018) focused on the categories of National Labour, Social Security and Related Human Rights Legislation in constructing the labor market regulation rigidity index. For example, they included conditions of work (such as hours of work, weekly rest and paid leave), security of job, termination of employment, conditions of employment (such as labor contract, wages and personal management), and general provisions (such as labor codes, general labor, and employment acts).

This index has considerable variation across countries since 1950, and It ranges between 0 to 3.5, with higher values indicating a more rigid employment protection law. For instance, the United States, Canada, Japan, the United Kingdom and Malaysia exhibited an average rigidity of labor market with values of 0.26, 0.32, and 0.51, 0.56 and 0.82 from 1950-54 to 2000-2004, respectively, which reflects a more flexible employment protection law. Meanwhile, Spain, Poland, Slovakia, Mexico, Brazil, Germany,the Netherlands, Estonia, Russia, China, Colombia, and Turkey experienced labor market rigidity with values around 2 in the same period. In the data of labor market rigidity, there is a decreasing trend over time in the mean and increasing changes in the standard deviation of labor market rigidity. Furthermore, there are heterogeneous changes in employment protection regulation across countries. For example, some countries exhibit significant changes in the labor market rigidity index, while other countries experience slight changes.

As the second measre of the labor market rigidity, we use Employment Law Rigidity Index: The employment law rigidity index is an aggregate cross-section time-invariant index constructed by Botero et al. (2004). It covers 85 countries and the index values vary between 0 and 1, with higher values reflecting stricter regulation of employment protection. The index is an average of four subindices:, such as 1) firing costs of workers, 2) firing procedures, 3) cost of increasing hours worked, and 4) alternative employment contracts. These subindices are themselves averages of several factors[5]

[5] 1) Cost of Firing Workers: This measure quantifies the expenses associated with terminating employees. It considers factors such as the notice period, severance pay, and any mandatory penalties imposed by law or collective agreements. For workers with three years of tenure, the index calculates the cost of firing. In cases where a worker's firing is unlawful, the index equates the cost of firing to the annual wage. The new wage bill encompasses both the regular wages of the remaining

As the third index, we use Aggregate Labor Market Rigidity index. This index is developed by Forteza and Rama (2006) from the ratified labor laws of a country under the International Labor Organization's (ILO) conventions. The measure of this labor market rigidity is based on four pairs of more narrowly specified indicators such as minimum wages, mandated benefits, trade unions, and government employment.

3.4 Computation of Export-Weighted Real Exchange Rate Volatility

We computed the export-weighted real exchange rate volatility in the following steps:

3.5 Descriptive Statistics

Table 2 presents the mean and standard deviation of the key variables used in this study. The large number of countries and industries over a span of 14 years enabled us to have sufficient variation in the data and cover a massive proportional share of exports of manufacturing commodities in the globe. The outcome variable is two-digit industry-level export growth. The mean of annual export growth is 0.032, which indicates positive annual export growth with a standard deviation of 0.40. The main explanatory variable is the interaction of exchange rate volatility and labor market rigidity. In Panel A, the statistics of the interaction term and standardized labor market rigidity belong to the labor market rigidity regulation index developed by Campos et al. (2018). Using this index, the number of observations is 12,567, covering 62 countries.

Control variables include the volatility of exchange rate growth, the growth of export-weighted real exchange rate, and the first lag of the growth of real exchange rate. Panel B and Panel C report the statistics of the interaction of exchange rate volatility and labor market rigidity, and standardized labor market rigidity index constructed by Botero et al. (2004) and Forteza and Rama (2006), respectively. The number of observations for these two indices are 10,787 and 9,764, and the number of countries are 53 and 48, respectively. This indicates a lower number of observations and countries under these two rigidity indices relative to the benchmark index. This is unbalanced panel data due to missing data for specific industries (such as tobacco, etc.) or periods for some countries.

workforce and the cost of firing employees. Additionally, this index assesses the cost of firing workers by comparing the new wage bill to the previous one.

Table 2: The Summary Statistics

Variable	Mean	Std. Dev.	Min	Max
Panel A: LAMRIG index of Campos & Nugent (2018):				
Dependent Variable				
Export (in thousands USD)	7437.697	29561.764	0.001	664425.06
Differece of logarithm of Export	0.032	0.40	-5.71	7.17
Independent Variable				
Interaction of Volatility and Rigidity	0.07	0.90	-4.70	28.58
Controls & other Variables				
Volatility of Exchange Rate Growth	0.022	1.08	-0.32	35.73
Standardized Labor Market Rigidity	0.014	0.991	-2.12	1.78
Difference of log-EWRER	0.007	0.14	-1.32	2.20
First lag of differece of logarithmic EWRER	0.001	0.11	-1.32	1.66
Export-Weighted GDP Growth Rate	0.44	0.53	-4.07	6.90
Industry	56.11	23.19	22	94
Year	2012.499	3.45	2007	2018
Countries/Observations		62/12567		
Panel B: Employment Law Index of Botero et al. (2004):				
Interaction of Volatility and Rigidity	-0.08	0.94	-23.54	5.76
Standardized Labor Market Rigidity	-0.001	1.00	-1.90	1.71
Countries/Observations		53/10, 585		
Panel C: Aggregate Regulation Index of Forteza & Rama et al. (2006):				
Interaction of Volatility and Rigidity	-0.026	0.40	-8.16	4.14
Standardized Labor Market Rigidity	-0.002	1.00	-1.64	2.32
Countries/Observations		48/9, 764		

4 Estimation Strategy

To quantify the interaction effect of exchange rate volatility and labor market rigidity on export growth, the following econometric model is employed:

$$\Delta y_{ijt} = \beta_0 + \beta_1 \sigma_{ijt} + \beta_2 LMR_j \times \sigma_{ijt} + \beta_3 Z_{ijt} + \eta_j + \eta_i + \eta_t + \eta_{jt} + \eta_{it} + \eta_{ji} + \epsilon_{ijt} \quad (6)$$

$$\text{j=1, 2,...,62, i=1, 2,...,17, t=2005, 2006,...,2018}$$

where j, i, and t are the indices of country, industry, and year, respectively. Δy_{ijt} is the logarithmic export growth at industry level. σ_{ijt} is industry-specific volatility of residualized logarithmic growth of 12 months averaged export-weighted real exchange rates. LMR_j is standardized time-invariant labor market rigidity of country j. Z_{ijt} is a set of control variables, including exchange rate volatility

growth, real exchange rate growth, and first lag of real exchange rate growth. η_j is country fixed effect, η_i is industry fixed effect, η_t is time fixed effect, η_{jt} is country-time fixed effect, η_{it} is industry-time fixed effect and η_{ji} is country-industry fixed effect. The higher correlation among right-hand side variables, such as volatility of exchange rate growth, interaction term, growth of real exchange rate, and first lag of real exchange rate growth, may cause the multicollinearity problem. However, by exploiting fixed effects regression, this issue is treated appropriately.

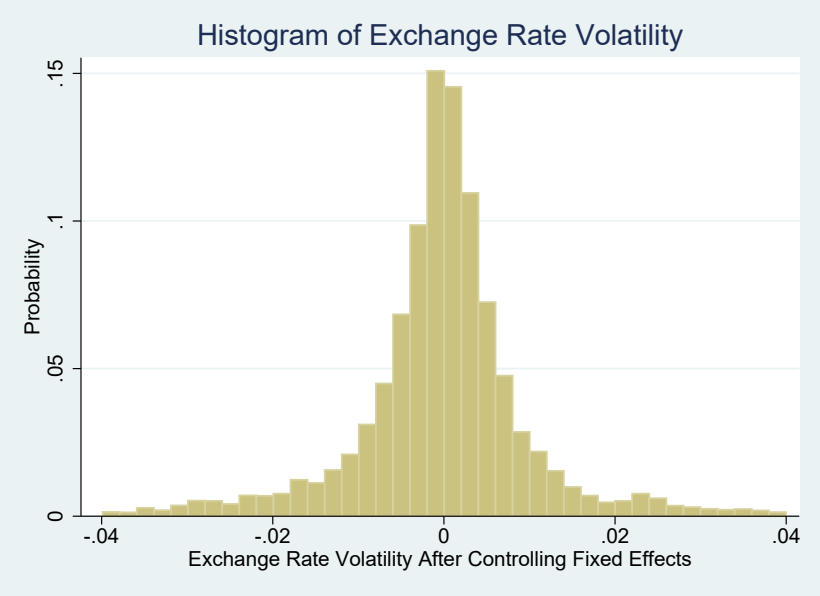
Fixed effects models can measure an observation repeatedly over time for a specific industry and a specific country. This identification strategy is analogous to the difference-in-difference-in-differences (DDD) estimation. In this model, country fixed effects are used to control for country-level factors that affect the export growth, independent of changes in industry and time trend. For example, different countries have different GDP, population, legislative, and institutional policies, all of which can affect export growth. Country fixed effects control for all of these observed and unobserved country-level factors affecting export growth. Industry fixed effect account for industry level various factors that influence the exports of industries irrespective to the changes in country and time. We have several industries and the availability of many industries may explore the different industry-level characteristics in terms of size, use of technology, access to loan, policy changes etc. The inclusion of such specifications control industry-level factors that affect the export growth of industries heterogeneously. Time fixed effects are included to control for time trend shocks, such as business cycle fluctuations, over time, regardless of country or industry. For example, a global economic recession would affect export growth in all countries and industries. Time fixed effects control for these time-specific shocks. We also include country-time fixed effects and industry-time fixed effects. Country-time fixed effects control for country-level factors that affect the growth of exports over time trend, regardless of industry. For example, a change in government policy in a country could affect export growth over time, regardless of the industry. Industry-time fixed effects control for industry-level factors that affect the growth of exports in time-specific shocks, such as trade costs and boom or bust specific to an industry. For example, a change in trade policy could affect the export growth of a specific industry over time. Finally, we included country-industry fixed effects with the intention of absorbing the factors that affect the growth of exports relative to variation in country and industry, regardless of variation over time period. For example, a country with a more rigid labor market may be more sensitive to exchange rate volatility than a country with a more flexible labor market. The country-industry fixed effects will control for this country-industry specific

effect.

5 Empirical Results

Figure 1 shows the probability distribution of volatility of exchange rate growth after controlling for various fixed effects. To obtain the volatility of real exchange rate, we regressed the growth of exchange rate volatility on control variables and used all fixed effect specifications of equation (6), and obtained the residual. Figure 1 depicts the identification of variation in exchange rate volatility, after partialling out the effects of fixed effect specifications and control variables on exchange rate volatility. The histogram of exchange rate volatility has a normal distribution and depicts the variation in exchange rate volatility that is unexplained by fixed effects and control variables. This eliminates concerns about the inclusion of so many fixed effect specifications in the model, which might identify the whole variation in export growth and leave no room for the volatility effects of real exchange rate growth on export.

Figure 1 : Histogram of exchange rate volatility after controlling of fixed effects specifications.



The above histogram is obtained after regressing the real exchange rate volatility on country-specific effects, industry-specific effects, time-specific effects, country-time-specific effects, industry-time-specific effects, country-industry-specific effects, and controls. The controls include growth of real exchange rate and first lag of growth of real exchange rate. The volatility residuals are derived from a panel regression using data of 62 countries from 2005 to 2018.

This paper conducts a country-industry level analysis of the interaction effects of exchange rate volatility and labor market rigidity on export growth. We begin our empirical analysis by employing the aforementioned benchmark index of labor market regulation rigidity, expanded by Campos et al. (2018), as a proxy for labor market rigidity in Table 3, 4, and 5.

Table 3: The Effects of Interaction of Labor Market Rigidity and Real Exchange Rate Volatility on Export Growth : Using Campus & Nugent (2018)'s LMR Index

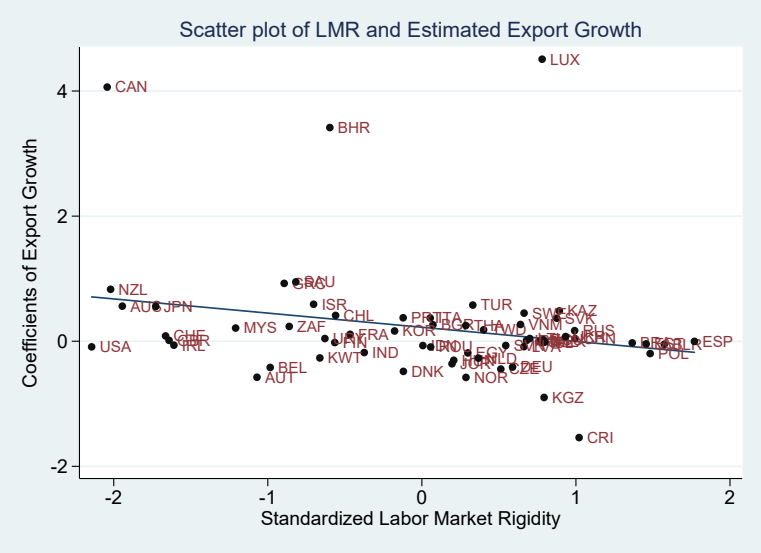
Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0193	-0.0335**	-0.0129	-0.0341**
	(0.0118)	(0.0142)	(0.0132)	(0.0139)
Volatility of Exchange Rate Growth	0.0173*	0.0309**	0.0132	0.0327**
	(0.00983)	(0.0142)	(0.0111)	(0.0141)
Difference of Log-EWRER	-0.0104	0.146	-0.0120	0.123
	(0.0338)	(0.0968)	(0.0361)	(0.0959)
First Lag Differece of Log-EWRER	0.0674**	-0.0619	0.0715**	-0.0245
	(0.0326)	(0.135)	(0.0334)	(0.132)
Constant	0.0332***	0.107***	0.0559	0.105**
	(0.00230)	(0.0314)	(0.0401)	(0.0476)
Countries/Observations	62/12,567	62/12,567	62/12,567	62/12,567
R-squared	0.099	0.257	0.170	0.290
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

Note: All columns included country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country ×industry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

To quantify the impact of the interaction of exchange rate volatility and labor market rigidity on industry's export growth, we controlled for the covariates e.g. volatility of real exchange rate growth, difference of logarithmic real exchange rate, first lag of the difference of logarithmic real exchange rate, country fixed effect, industry fixed effect, and time fixed effect in all regression estimations in Tables 3, 4, and 5. We also included the Country-industry fixed effect in columns 2, 3, and 4, country-time fixed effect in columns 2 and 4, industry-time fixed effect in columns 3 and 4 in specific regression estimations. The reported standard errors are robust clustered errors in all regression estimations.

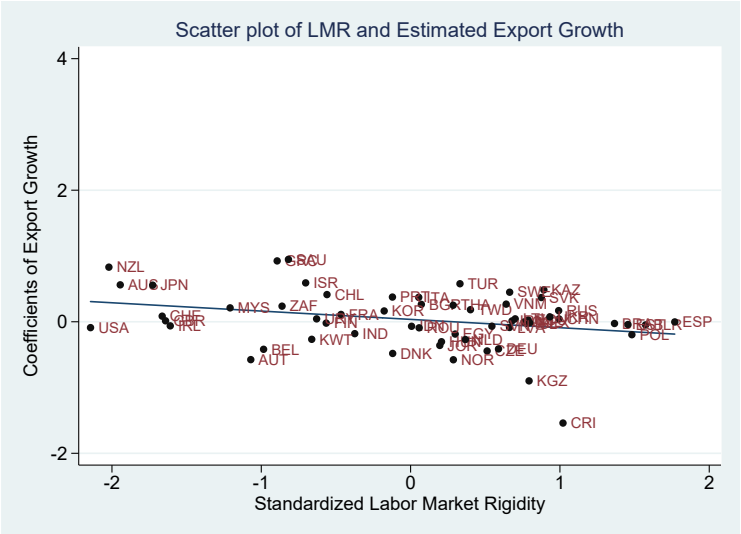
Table 3 presents the regression estimations for all 62 countries in the sample. The dependent

Figure 2: The Association between Labor Market Rigidity and the Estimated Effect of the Exchange Rate Volatility on Export Growth



Note: The labor market rigidity regulation index developed by Campos et al. (2018) is used as a proxy for labor market rigidity. The slope, standard error, and R-squared of the fitted line are -0.226, 0.119, and 0.056, respectively.

Figure 3: The Association between Labor Market Rigidity and the Estimated Effect of the Exchange Rate Volatility on Export Growth



Notes: The labor market regulations rigidity index developed by Campos et al. (2018) is used as a proxy for labor market rigidity. In this figure, Bahrain, Canada, and Luxembourg are dropped from the sample. The slope, standard error, and R-squared of the fitted line are -0.126, 0.054, and 0.086, respectively.

variable is export growth, and the main independent variable is the interaction of real exchange rate volatility and labor market rigidity. The regression estimation in column 4 shows that the estimated coefficient of the interaction of volatility of exchange rate growth and labor market rigidity is negative and statistically significant at the 5% level. This indicates that for a country where the rigidity of the labor market is one standard deviation higher, one standard deviation increase in real exchange rate volatility reduces export growth by 3.41 percentage points. The estimated coefficients are economically significant. The result implies that the interaction of exchange rate volatility and labor market rigidity reduces annual export growth by 3.41 percentage points. The annual average export growth is 3.2 percentage points, so the economic effect of the interaction term is much larger. However, the estimated coefficient is smaller relative to the 40% standard deviation of annual average export growth.

Table 4: The Effects of Interaction of Labor Market Rigidity and Real Exchange Rate Volatility on Export Growth : Using Campus & Nugent (2018)'s LMR Index

Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0211*	-0.0330**	-0.0153	-0.0345**
	(0.0121)	(0.0144)	(0.0135)	(0.0141)
Volatility of Exchange Rate Growth	0.0192*	0.0296**	0.0156	0.0318**
	(0.00990)	(0.0143)	(0.0112)	(0.0141)
Difference of Log-EWRER	-0.00930	0.137	-0.0117	0.110
	(0.0338)	(0.0971)	(0.0360)	(0.0960)
First Lag Differece of Log-EWRER	0.0569*	-0.0406	0.0615*	0.00286
	(0.0325)	(0.136)	(0.0333)	(0.132)
Constant	0.0323***	0.102***	0.0549	0.0975*
	(0.00235)	(0.0315)	(0.0417)	(0.0502)
Countries/Observations	59/11,959	59/11,959	59/11,959	59/11,959
R-squared	0.105	0.262	0.178	0.298
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

Note: In this regression model we dropped Bahrain, Canada and Luxembourg. All columns included country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country Íindustry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

Figure 2 presents a scatter plot of the coefficient effects of exchange rate volatility on export

growth [6] and labor market rigidity. The vertical axis shows the coefficient effects of exchange rate volatility on export growth, and the horizontal axis shows standardized labor market rigidity. The fitted line depicts a negative slope, indicating that the coefficient effects of exchange rate volatility on export growth are negatively correlated with labor market rigidity.

Table 4 evidences the negative and statistically significant effect of the interaction of exchange rate volatility and labor market rigidity on export growth, even after removing outliers (see Figure 2). The number of countries in this sample decreased to 59 after dropping Bahrain, Canada, and Luxembourg. The estimated coefficient remained consistent with the main results of Table 3. Empirical results show that for a country with one standard deviation higher labor market rigidity, an increase in the volatility of real exchange rate growth by one standard deviation decreases export growth by 3.45 percentage points. The magnitude of the interaction effect of exchange rate volatility and labor market rigidity is economically significant as well. This implies that the annual decrease in export growth due to the interaction term is larger relative to the annual average export growth of 3.2%. However, the estimated coefficient is smaller relative to the 40% standard deviation of annual average export growth.

Figure 3 depicts the graphical association between the coefficient effects of exchange rate volatility on export growth [7] and labor market rigidity. The vertical axis denotes the coefficient effects of exchange rate volatility on export growth, and the horizontal axis is the standardized labor market rigidity. There is a negative relationship between the coefficient effects of exchange rate volatility on export growth and labor market rigidity, even after dropping Bahrain, Canada, and Luxembourg, which appear to be outliers in Figure 2.

Table 5 presents the sub-sample regression estimation for developed and developing countries. The results suggest that the interaction effect of exchange rate volatility and labor market rigidity on export growth is not significantly different between developed and developing countries. However, the size of the interaction effect is larger for developing countries (5.8 percentage points) than for developed countries (3.88 percentage points). This suggests that exchange rate volatility and labor market rigidity have a more pronounced negative impact on export growth in developing countries

[6] First, we conducted a regression of the difference of the logarithm of exports on export-weighted real exchange rate volatility, the difference of the logarithm of export-weighted real exchange rate, and the first lag of the difference of the logarithm of export-weighted real exchange rate. We included industry-specific effects and time-specific effects for each individual country, and obtained the coefficients of the effects of exchange rate volatility on export growth.

[7] First, we conducted a regression of the difference of the logarithm of exports on export-weighted real exchange rate volatility, the difference of the logarithm of export-weighted real exchange rate, and the first lag of the difference of the logarithm of export-weighted real exchange rate. We included industry-specific effects and time-specific effects for each individual country, and obtained the coefficients of the effects of exchange rate volatility on export growth.

Table 5: The Effects of Interaction of Labor Market Rigidity and Volatility on Export Growth: Using Campus & Nugent (2018)'s LMR Index for Developed and Developing Countries

Panel A: Developed Countries Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0201***	-0.0545**	-0.0181***	-0.0388**
	(0.00521)	(0.0214)	(0.00529)	(0.0197)
Constant	0.0218***	0.0475*	0.0567***	0.0920***
	(0.00246)	(0.0247)	(0.0149)	(0.0313)
Countries/Observations	32/6,504	32/6,504	32/6,504	32/6,504
R-squared	0.198	0.303	0.312	0.379
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes
Panel B: Developing Countries				
Interaction of LMR & Exchange Rate Volatility	-0.0245	-0.0401**	-0.0281	-0.0580***
	(0.0199)	(0.0204)	(0.0236)	(0.0223)
Constant	0.0428***	0.0425	0.0184	0.000502
	(0.00394)	(0.0366)	(0.0816)	(0.0801)
Countries/Observations	30/6,063	30/6,063	30/6,063	30/6,063
R-squared	0.072	0.240	0.152	0.285
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

Note: All columns controls the volatility of exchange rate growth, the difference of logarithmic real exchange rate, the first lag of difference of logarithmic real exchage rate, country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country Íindustry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

than in developed countries and the estimated coefficients are economically significant for both developed and developing countries.

6 Robustness Checks

In the robustness checks, we extended our empirical analysis by employing labor market rigidity regulation indices constructed by Botero et al. (2004) and Forteza and Rama (2006) as a proxy for labor market rigidity. We included various fixed effects specifications, such as country fixed effects,

industry fixed effects, and time fixed effects in regression estimations of Table 6, 7, 8 and 9. Specifically, we included country-industry fixed effects in columns 2, 3, and 4; country-time fixed effects in columns 2 and 4; and industry-time fixed effects in columns 3 and 4. The control variables were volatility of real exchange rate growth, difference of logarithmic real exchange rate, and first lag of the difference of logarithmic real exchange rate. The reported standard errors were robust clustered errors in all regression estimations.

Table 6: The Effects of Interaction of Labor Market Rigidity and Real Exchange Rate Volatility on Export Growth : Using Botero et al. (2004)'s LMR Index

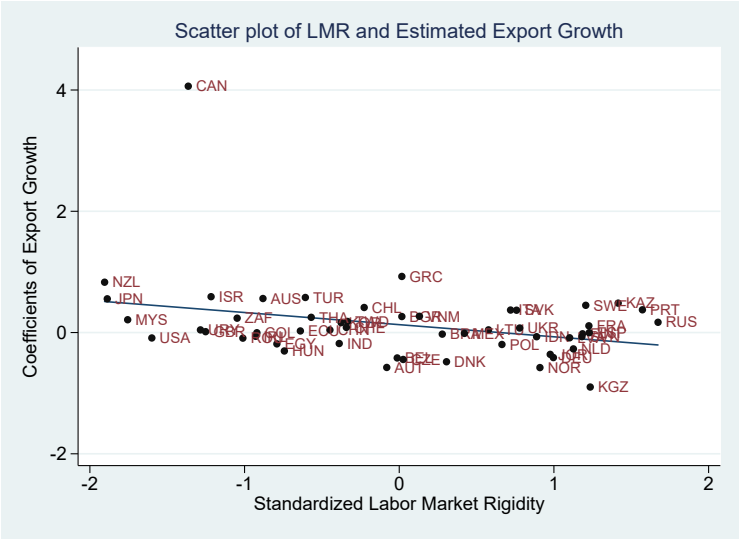
Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0276***	-0.00660	-0.0308***	-0.0121
	(0.00733)	(0.0126)	(0.00738)	(0.0116)
Volatility of Exchange Rate Growth	-0.0116**	-0.000739	-0.0130**	-0.00294
	(0.00571)	(0.0102)	(0.00595)	(0.00971)
Difference of Log-EWRER	-0.0499*	0.0609	-0.0588**	0.0393
	(0.0284)	(0.0712)	(0.0292)	(0.0689)
First Lag Differece of Log-EWRER	0.0210	0.0282	0.0241	0.0495
	(0.0291)	(0.123)	(0.0292)	(0.122)
Constant	0.0316***	0.101***	0.0675	0.107**
	(0.00228)	(0.0312)	(0.0450)	(0.0457)
Countries/Observations	52/10,585	52/10,585	52/10,585	52/10,585
R-squared	0.145	0.299	0.226	0.342
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

Note: All columns included country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country ×industry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

Table 6 shows the regression estimation by employing Botero et al. (2004)'s labor market rigidity index and with 53 countries in the sample. The interaction term is negative and statistically significant in columns 1, 2, and 3. However, the coefficient is statistically insignificant in column 4. This suggests that for a country with one standard deviation higher labor market rigidity, a one standard deviation increase in real exchange rate volatility reduces export growth by 1.21 percentage points. Although the estimated coefficient is statistically insignificant, Figure 4 shows a negative association

between the coefficient effect of exchange rate volatility on export growth and labor market rigidity. The estimated coefficient size is 1.21 percentage point, very close to the 3.2% annual average export growth, which implies that the interaction effect reduces export growth by 1.21 percentage points in each single year. This is economically significant. However, the estimated coefficient is smaller than the 40% standard deviation of export growth.

Figure 4: The Association between Labor Market Rigidity and the Estimated Effect of the Exchange Rate Volatility on Export Growth



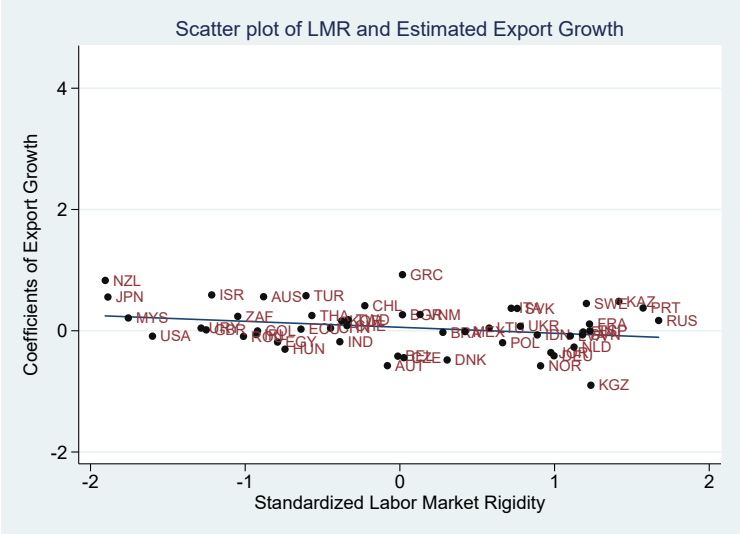
Notes: The employment law index developed by Botero et al. (2004) is used as a proxy for labor market rigidity. The slope, standard error, and R-squared of the fitted line are -0.20, 0.087, and 0.092, respectively.

In Figure 4, the vertical axis shows the estimated coefficient of the effect of exchange rate volatility on export growth[8], and the horizontal axis shows the standardized labor market rigidity. The slope of the fitted line indicates a negative association between labor market rigidity and the coefficient effects of exchange rate volatility on export growth.

Table 7 presents the regression estimation by using Botero et al. (2004)'s index for labor market rigidity after removing outliers observed in Figure 4. The estimated results are consistent with those in Table 6, and the estimated coefficient sizes are approximately the same. The regression estimates show negative but statistically insignificant effects of the interaction of exchange rate volatility and labor market rigidity on export growth. However, Figure 5 depicts a negative relationship between the

[8]First, we conducted a regression of the difference of the logarithm of exports on export-weighted real exchange rate volatility, the difference of the logarithm of export-weighted real exchange rate, and the first lag of the difference of the logarithm of export-weighted real exchange rate. We included industry-specific effects and time-specific effects for each individual country, and obtained the coefficients of the effects of exchange rate volatility on export growth.

Figure 5: The Association between Labor Market Rigidity and the Estimated Effect of the Exchange Rate Volatility on Export Growth



Note: The employment law index developed by Botero et al. (2004) is used as a proxy for labor market rigidity. Canada is dropped from this figure. The slope, standard error, and R-squared of the fitted line are -0.098, 0.05, and 0.071, respectively.

coefficient effects of exchange rate volatility on export growth and labor market rigidity. Compared to the annual average export growth of 3.2%, the estimated coefficient size is economically significant, which shows a 1.21 percentage point annual decrease in export growth. However, the estimated coefficient is smaller relative to the 40% standard deviation of export growth.

Figure 5 shows a scatter plot of the negative relationship between the coefficients of export growth and labor market rigidity in different countries. The vertical axis is the estimated coefficient of the effects of exchange rate volatility on export growth [9], and the horizontal axis is the standardized rigidity of the labor market. The slope of the fitted line shows a negative association between the coefficient effects of exchange rate volatility on export growth and labor market rigidity.

Table 8 implies the regression estimation by employing Forteza and Rama (2006)'s labor market rigidity index with the 48 countries in the sample. The regression estimates in column 4 show that, after controlling for all fixed effects specifications, the coefficient is negative but statistically insignificant. This suggests that for a country with one standard deviation higher labor market rigidity, a one standard deviation increase in the volatility growth of the real exchange rate reduces export growth by

[9] First, we conducted a regression of the difference of the logarithm of exports on export-weighted real exchange rate volatility, the difference of the logarithm of export-weighted real exchange rate, and the first lag of the difference of the logarithm of export-weighted real exchange rate. We included industry-specific effects and time-specific effects for each individual country, and obtained the coefficients of the effects of exchange rate volatility on export growth.

Table 7: The Effects of Interaction of Labor Market Rigidity and Real Exchange Rate Volatility on Export Growth : Using Botero et al. (2004)'s LMR Index

Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0277***	-0.00656	-0.0310***	-0.0121
	(0.00736)	(0.0126)	(0.00740)	(0.0116)
Volatility of Exchange Rate Growth	-0.0121**	-0.000943	-0.0136**	-0.00335
	(0.00592)	(0.0106)	(0.00616)	(0.0100)
Difference of Log-EWRER	-0.0514*	0.0610	-0.0606**	0.0385
	(0.0285)	(0.0712)	(0.0294)	(0.0691)
First Lag Differece of Log-EWRER	0.0166	0.0289	0.0200	0.0526
	(0.0292)	(0.123)	(0.0293)	(0.123)
Constant	0.0324***	0.101***	0.0682	0.107**
	(0.00232)	(0.0313)	(0.0459)	(0.0463)
Countries/Observations	51/10,583	51/10,583	51/10,583	51/10,583
R-squared	0.145	0.299	0.226	0.341
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

Note: In this regression model, we dropped Canada. All columns included country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country Íindustry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

5.69 percentage points. The results are economically significant as well, as the estimated coefficient is much larger than the 3.2% annual export growth. However, the estimated coefficient is smaller than the 40% standard deviation of export growth. Although the results are statistically insignificant, Figure 6 depicts a negative relationship between the coefficient effects of exchange rate volatility on export growth and labor market rigidity.

Figure 6 shows a scatter plot of the estimated coefficients of the effects of exchange rate volatility on export growth against labor market rigidity. The vertical axis is the estimated coefficient of the effects of exchange rate volatility on export growth[10], and the horizontal axis is the standardized labor market rigidity. The fitted line has a negative slope, which indicates a negative relationship between

[10]First, we conducted a regression of the difference of the logarithm of exports on export-weighted real exchange rate volatility, the difference of the logarithm of export-weighted real exchange rate, and the first lag of the difference of the logarithm of export-weighted real exchange rate. We included industry-specific effects and time-specific effects for each individual country, and obtained the coefficients of the effects of exchange rate volatility on export growth.

the estimated coefficients of export growth and labor market rigidity.

Table 8: The Effects of Interaction of Labor Market Rigidity and Real Exchange Rate Volatility on Export Growth : Using Forteza & Rama (2000)'s LMR Index

Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0199	-0.0553	-0.0173	-0.0569
	(0.0233)	(0.0376)	(0.0251)	(0.0376)
Volatility of Exchange Rate Growth	0.00334	-0.0106	0.00548	-0.00924
	(0.00703)	(0.0141)	(0.00764)	(0.0143)
Difference of Log-EWRER	-0.0738*	0.120	-0.0822**	0.104
	(0.0394)	(0.0774)	(0.0403)	(0.0749)
First Lag Differece of Log-EWRER	0.0824*	-0.0715	0.0826*	-0.0679
	(0.0495)	(0.174)	(0.0498)	(0.173)
Constant	0.0284***	0.0841***	0.0442	0.0766
	(0.00252)	(0.0319)	(0.0494)	(0.0511)
Countries/Observations	48/9,764	48/9,764	48/9,764	48/9,764
R-squared	0.104	0.276	0.181	0.311
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

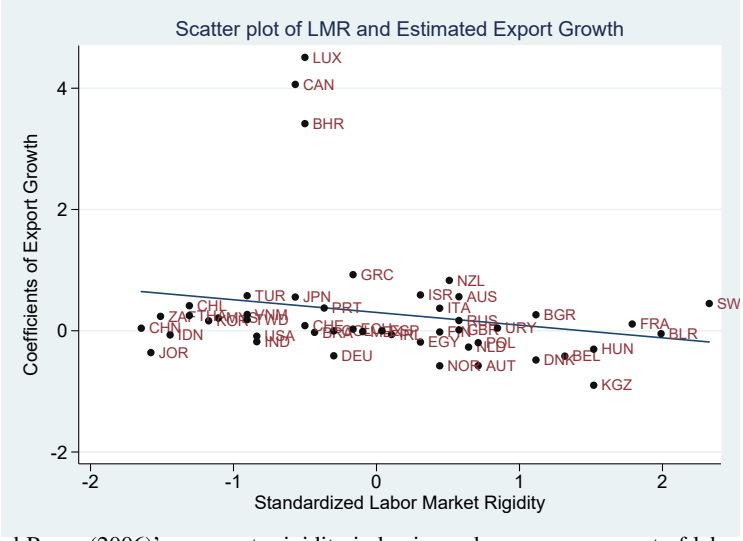
Note: All columns included country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country ×industry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

Table 9 presents the empirical results by using Forteza and Rama (2006)'s labor market rigidity index after dropping Bahrain, Canada, and Luxembourg from the sample, which appear to be outliers in Figure 6. The number of countries in the sample declined to 45. The results suggest that the coefficient estimate of the interaction term has a negative relationship with export growth, with a value of 6.07 percentage points. Although the estimated coefficient is statistically insignificant, Figure 7 shows a negative association between the coefficient effect of exchange rate volatility on export growth and labor market rigidity.

Figure 7 explores the relationship between the coefficient effects of exchange rate volatility on export growth and labor market rigidity. The vertical axis shows the estimated coefficient of the effects of exchange rate volatility on export growth[11], and the horizontal axis shows the standardized labor

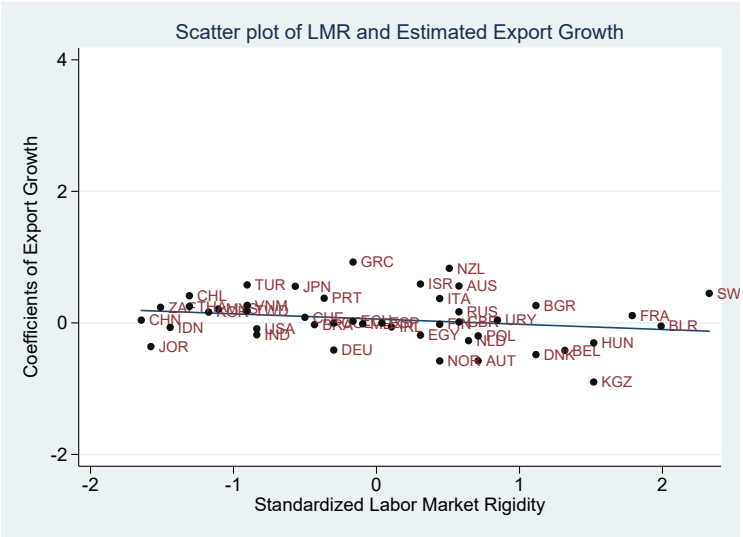
[11]First, we conducted a regression of the difference of the logarithm of exports on export-weighted real exchange rate volatility, the difference of the logarithm of export-weighted real exchange rate, and the first lag of the difference of the

Figure 6: The Association between Labor Market Rigidity and the Estimated Effect of the Exchange Rate Volatility on Export Growth



Note: Forteza and Rama (2006)'s aggregate rigidity index is used as a measurement of labor market rigidity. The slope, standard error, and R-squared of the fitted line are -0.21, 0.15, and 0.041, respectively.

Figure 7: The Association between Labor Market Rigidity and the Estimated Effect of the Exchange Rate Volatility on Export Growth



Note: Forteza and Rama (2006)'s aggregate rigidity index is used as a measurement of labor market rigidity. Bahrain, Canada and Luxembourg have been dropped from this figure. The slope, standard error, and R-squared of the fitted line are -0.079, 0.054, and 0.046, respectively.

logarithm of export-weighted real exchange rate. We included industry-specific effects and time-specific effects for each individual country, and obtained the coefficients of the effects of exchange rate volatility on export growth.

market rigidity. The fitted line has a negative trend, which reflects a negative association between the estimated coefficients of export growth and standardized cross-sectional labor market rigidity.

Table 9: The Effects of Interaction of Labor Market Rigidity and Real Exchange Rate Volatility on Export Growth : Using Forteza & Rama (2000)'s LMR Index

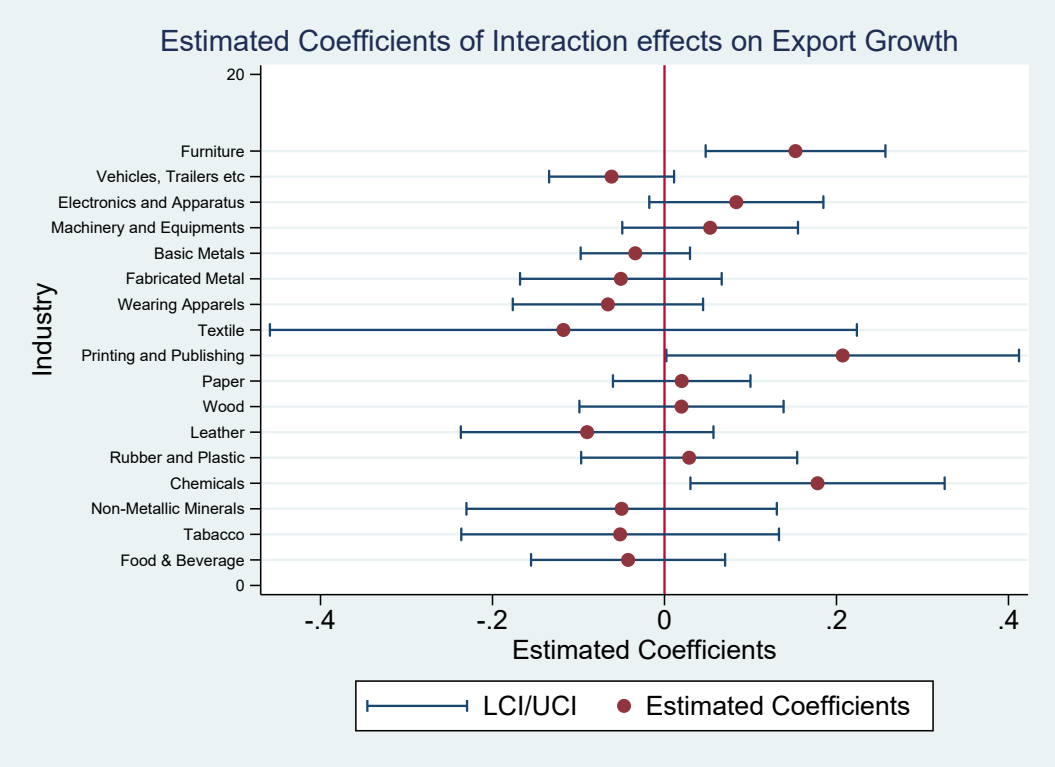
Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0229	-0.0587	-0.0194	-0.0607
	(0.0246)	(0.0400)	(0.0263)	(0.0399)
Volatility of Exchange Rate Growth	0.00349	-0.0138	0.00597	-0.0132
	(0.00794)	(0.0157)	(0.00860)	(0.0157)
Difference of Log-EWRER	-0.0674*	0.105	-0.0777*	0.0815
	(0.0395)	(0.0776)	(0.0403)	(0.0753)
First Lag Differece of Log-EWRER	0.0542	-0.0367	0.0551	-0.0205
	(0.0495)	(0.175)	(0.0499)	(0.173)
Constant	0.0265***	0.0760**	0.0419	0.0653
	(0.00257)	(0.0319)	(0.0522)	(0.0543)
Countries/Observations	45/9,156	45/9,156	45/9,156	45/9,156
R-squared	0.112	0.286	0.193	0.324
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

Note: In this regression estimation, we dropped Bahrain, Canada and Luxembourg. All columns included country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country Íindustry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

In the robustness check estimations, we also controlled the export-weighted GDP growth of the top five partners of an exporting country. The estimated coefficient is negative and statistically significant. After including export-weighted GDP growth, the estimated results are approximately the same as the main findings. Table B1 and B2 present the regression estimations in the appendix.

Figure 8 presents the estimated coefficient plot of the interaction term of exchange rate volatility and labor market rigidity on export growth for 17 industries. The labor market regulation rigidity index developed by Campos et al. (2018) is used in this graph, and the sample contains 62 countries for the period 2005-2018. More than half of the industries have negative estimated coefficients, and the confidence intervals are narrower for most industries except for textiles and printing and publish-

Figure 8: The Estimated Coefficient effects of interaction term on export growth across industries



Notes: In the above coefficient plot, we first regressed export growth on the interaction term of exchange rate volatility and labor market rigidity, volatility of exchange rate growth, difference of logarithmic real exchange rate, and first lag of difference of logarithmic real exchange rate for each industry separately. Additionally, country fixed effects and time fixed effects specifications were included. Then, we calculated estimated coefficients and confidence intervals for each industry. The labor market regulation rigidity index developed by Campos et al. (2018) was utilized and the sample contained 62 countries for the period 2005-2018.

ing. The narrower confidence intervals for most industries indicate that we have higher confidence in the estimated coefficients. The result of the graph is consistent with our main empirical findings. The magnitude of the estimated coefficients vary across industries. In the presence of labor market rigidity industries such as vehicle, basic metals, fabricated metal, leather, non-metallic, tobacco, and food & beverage are more sensitive to the exchange rate volatility. However, furniture, electronics and apparatus, machinery and equipment, printing and publishing, paper, rubber and plastic, chemical and wood industries are less sensitive to exchange rate volatility in presence of labor market rigidity.

7 Discussion

Previous literature focused on exchange rate shocks and interacted them with labor market rigidity to examine its effects on employment for a single country (Bação and Cerejeira, 2010) or specific group of countries (such as OECD countries) (Alexandre et al., 2017). Ishise (2019) interacted exchange rate variability with wages rigidity and examined its effects on exports. Whereas, this study empirically investigated how the impact of exchange rate volatility on export growth depends on the firing rigidity in the labor market.

This study builds on various indices of labor market regulation rigidity developed by Campos et al. (2018), Botero et al. (2004), and Forteza and Rama (2006). The benchmark result is based on the labor market regulation rigidity index developed by Campos et al. (2018). Table 10 summarizes the estimated coefficients of interaction term, standard errors, and R-squared for different labor market rigidity indices with all countries in the sample and after dropping countries seems to be outliers. The regression estimation in Panel A, which is based on Campos et al. (2018) labor market rigidity index indicates that for a country where labor market rigidity is one standard deviation higher, one standard deviation increase in exchange rate volatility growth depress export growth by 3.41 percentage points and after dropping the outlier, the estimated coefficient size become slightly larger to 3.45 percentage point. The effects of exchange rate volatility on export growth in presence of labor market rigidity is economically significant as well. The estimated coefficient of interaction terms is economically significant as well. The economic magnitude of interaction terms implies that exchange rate volatility reduce export growth annually by 3.41 percentage points of countries with higher labor market rigidity, which is larger than 3.2% annual average export growth, whereas, relative to the 40% standard deviation of export growth, the estimated coefficient is much smaller. Panel B and Panel C evidence the negative interaction effect of exchange rate volatility and labor market rigidity on export growth. The estimated coefficients are negative and statistically insignificant, however, the coefficients are consistent with main results and the scatter plots of the coefficient effects of exchange rate volatility on export growth and labor market rigidity in Figure 4, 5, 6 and 7 also describe negative association. In sub-sample analysis, the interaction effect is statistically significant and negative for both developed countries and developing countries, but the effect is more pronounced for developing countries.

Table 10: Summarized Empirical Results of Interaction Term

LMR Dataset	Outlier(s) Removed	Countries/ Observations	Estimated Coefficient	SE	R-squared
Panel A: Labor Market Regulation Index, Expanded by Campos & Nugent (2018)		62/12,567	-0.0341**	-0.014	0.290
	Yes	59/11,959	-0.0345**	-0.014	0.298
Panel B: Employment Law Index, Constructed by Botero et al. (2004)		52/10,585	-0.0121	(0.0116)	0.342
	Yes	51/10,583	-0.0121	(0.0116)	0.341
Panel C: Aggregate Rigidity Index, Developed by Forteza & Rama (2006)		48/9,764	-0.0569	-0.038	0.311
	Yes	45/9,156	-0.0607	-0.04	0.324

Note: This table summarizes the estimated coefficients of interaction term of exchange rate volatility growth and labor market rigidity over different indices of rigidity. The estimated coefficients, clustered robus errors and r-squared obtained from the regression model, after using control variables and all fixed effects specifications of equation (6).

8 Conclusion

In the theoretical and empirical research, the volatility impact of exchange rate on trade (Arize et al., 2000; Caporale and Doroodian, 1994), productivity (Aghion et al., 2009; Baggs et al., 2009; Caglayan and Demir, 2014), investment (Kandilov and Leblebicioğlu, 2011; Atella et al., 2003; Kiyota and Urata, 2004) and economic growth (Morina et al., 2020) has been explored intensively. However, there is little about how the fluctuations in real exchange rate affect the export growth in response to the rigidity in labor market. We implement our analysis by using comprehensive country-industry panel data of 17 industries for the span of 14 years from 2005 to 2018 in 62 developed and developing countries. The labor market rigidity index developed by Campos et al. (2018) is used as the benchmark index. This index builds not only on the four components introduced by Botero et al. (2004)'s employment law rigidity index, but also considers the conventions of the International Labor Organization approved by countries. This is the most recent index, covers more than 140 countries with having variation over periods. The labor market rigidity indices developed by Forteza and Rama (2006) and Botero et al. (2004) are used for the robustness checks estimation. We exploited the volatility of real exchange rate growth uniquely by imposing specific assumption. The assumption is that firms' decisions are negatively affected by the unpredictable fluctuations in exchange rate during the past three months. We calculated exchange rate by regressing difference of logarithmic export-

weighted real exchange rate on the first, second and third lags of the difference of logarithmic export-weighted real exchange rate, and obtained the residual. In order to get volatility of real exchange rate growth, we calculated the standard deviation of monthly residualized difference of logarithmic export-weighted real exchange rate. Thus, exchange rate volatility is calculated by fluctuations in real exchange rate of the past three months.

The fixed effects panel model is employed for regression estimation, which is analogous to difference-in-difference-in-differences and is considered as a potential empirical model for such detailed panel data. The identification of variation in the model is coming from the country, industry and time trend. We controlled the volatility of real exchange rate growth, the difference of the logarithm of export-weighted real exchange rate and the first lag of the difference of logarithm of export-weighted real exchange rate. Furthermore, by inclusion of various fixed effects specifications, for example fixed effects, industry fixed effects, time fixed effects, country-time fixed effects, industry-time fixed effects and country-industry fixed effects, we controlled all country level, industry level and time trend factors that affects the export growth of industries.

The most striking finding of this paper is that the interaction of exchange rate volatility and labor market rigidity has an economically and statistically negative impact on industrial export growth. Empirical result implies that for a country where labor market rigidity is one standard deviation higher, one standard deviation increase in volatility of exchange rate growth reduces industrial exports growth by 3.41 percentage points. This indicates that 3.41 percentage points decrease in annual exports is much considerable, because the annual average export growth for the sample countries is 3.2 percent and the estimated coefficient size is larger than annual average export growth. However, standard deviation of export growth is 40 percent and the estimated coefficient is smaller in relative to the standard deviation of export growth. Furthermore, in sub-sample empirical results for developed and developing countries results are also negative and statistically significant alike main findings. The robustness check results also support the main findings. Moreover, we find that there is heterogeneous effects of the interaction of exchange rate volatility and labor market rigidity on export growth of industries. The estimated coefficients are vary across industries and the export growth of the most industries are more sensitive to the effects of exchange rate volatility in the presence of labor market rigidity.

Policy recommendations have also evolved towards a more flexible and balanced labor market. A flexible labor market regulation is needed that not only protects employees from labor market risk,

but also allows firms to respond to macroeconomic shocks effectively and efficiently. Accordingly, as suggested by the Oecd (2004), the flexibility expressed by firms should not be opposed to the importance of protecting workers against labor market risk.

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9 Appendix

9.1 Appendix A

Table A1: Standard Deviation of Macroeconomic Price Variables

Countries	Variables	Standard Deviation
Japan	Exchange rate Growth	0.023
	CPI Growth	0.003
	Interest Rate Growth	0.000
United Kingdom	Exchange rate Growth	0.023
	CPI Growth	0.003
	Interest Rate Growth	0.002
Germany	Exchange rate Growth	0.022
	CPI Growth	0.003
	Interest Rate Growth	0.002
India	Exchange rate Growth	0.019
	CPI Growth	0.008
	Interest Rate Growth	0.003

Note: The authors calculated the standard deviation from the data. These are standard deviations of the difference of log of variables.

9.2 Appendix B

Table B1: The Effects of Interaction of Labor Market Rigidity and Real Exchange Rate Volatility on Export Growth : Using Campus & Nugent (2018)'s LMR Index

Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0192*	-0.0336**	-0.0131	-0.0341**
	(0.0116)	(0.0143)	(0.0130)	(0.0140)
Volatility of Exchange Rate Growth	0.0184*	0.0307**	0.0147	0.0326**
	(0.00968)	(0.0143)	(0.0109)	(0.0141)
Difference of Log-EWRER	-0.00329	0.147	-0.00299	0.123
	(0.0340)	(0.0967)	(0.0364)	(0.0957)
First Lag Differece of Log-EWRER	0.0678**	-0.0622	0.0736**	-0.0248
	(0.0326)	(0.135)	(0.0334)	(0.132)
Export-Weighted GDP Growth Rate	0.0320***	-0.00547	0.0387***	-0.00408
	(0.0114)	(0.0151)	(0.0148)	(0.0158)
Constant	0.0192***	0.112***	0.0245	0.109**
	(0.00557)	(0.0341)	(0.0419)	(0.0499)
Countries/Observations	62/12,567	62/12,567	62/12,567	62/12,567
R-squared	0.100	0.257	0.17	0.290
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

Note: All columns included country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country ×industry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

9.3 Appendix C

Table B2: The Effects of Interaction of Labor Market Rigidity and Real Exchange Rate Volatility on Export Growth : Using Campus & Nugent (2018)'s LMR Index

Dependent Variable	Export Growth			
	(1)	(2)	(3)	(4)
Interaction of LMR & Exchange Rate Volatility	-0.0210*	-0.0331**	-0.0152	-0.0345**
	(0.0119)	(0.0145)	(0.0133)	(0.0142)
Volatility of Exchange Rate Growth	0.0200**	0.0295**	0.0166	0.0318**
	(0.00977)	(0.0144)	(0.0110)	(0.0141)
Difference of Log-EWRER	-0.00293	0.137	-0.00405	0.110
	(0.0340)	(0.0970)	(0.0364)	(0.0958)
First Lag Differece of Log-EWRER	0.0577*	-0.0407	0.0636*	0.00286
	(0.0324)	(0.136)	(0.0333)	(0.132)
Export-Weighted GDP Growth Rate	0.0273**	-0.00175	0.0312**	-5.75e-05
	(0.0114)	(0.0148)	(0.0148)	(0.0155)
Constant	0.0203***	0.104***	0.0297	0.0976*
	(0.00564)	(0.0339)	(0.0433)	(0.0522)
Countries/Observations	59/11,959	59/11,959	59/11,959	59/11,959
R-squared	0.105	0.262	0.179	0.298
Country-Industry FE		Yes	Yes	Yes
Country-Time FE		Yes		Yes
Industry-Time FE			Yes	Yes

Note: In this regression model we dropped Bahrain, Canada and Luxembourg. All columns included country fixed effects, industry fixed effects and time fixed effects. Clustered robust standard errors are reported in parentheses, assuming that error terms are correlated within each country Íindustry. * indicates significant at 1% level, ** indicates significant at 5% level and *** indicates significant at 10% level.

Table C1: List of Countries used in this Paper

Panel A: Developed Countries				Panel B: Developing Countries			
1	$Australia^{a,b,c}$	17	$Japan^{a,b,c}$	1	$Bahrain^{a,c}$	17	$Kuwait^{a}$
2	$Austria^{a,b,c}$	18	$Latvia^{a,b}$	2	$Belarus^{a,c}$	18	$Kyrgyzstan^{a,b,c}$
3	$Belgium^{a,b,c}$	19	$Lithuania^{a,b}$	3	$Brazil^{a,b,c}$	19	$Malaysia^{a,b,c}$
4	$Canada^{a,b,c}$	20	$Luxembourg^{a,c}$	4	$Bulgaria^{a,b,c}$	20	$Mexico^{a,b,c}$
5	$Czech\ Republic^{a,b}$	21	$Netherlands^{a,b,c}$	5	$Chile^{a,b,c}$	21	$Romania^{a,b}$
6	$Denmark^{a,b,c}$	22	$New\ Zealand^{a,b,c}$	6	$China^{a,b,c}$	22	$Russian\ Federation^{a,b,c}$
7	$Estonia^{a}$	23	$Norway^{a,b,c}$	7	$Colombia^{a,b,c}$	23	$Saudi\ Arabia^{a}$
8	$Finland^{a,b,c}$	24	$Poland^{a,b,c}$	8	$Costa\ Rica^{a}$	24	$South\ Africa^{a,b,c}$
9	$France^{a,b,c}$	25	$Portugal^{a,b,c}$	9	$Ecuador^{a,b,c}$	25	$Taiwan^{a,b,c}$
10	$Germany^{a,b,c}$	26	$Slovakia^{a,b}$	10	$Egypt^{a,b,c}$	26	$Thailand^{a,b,c}$
11	$Greece^{a,b,c}$	27	$Slovenia^{a,b}$	11	$India^{a,b,c}$	27	$Türkey^{a,b,c}$
12	$Hungary^{a,b,c}$	28	$Spain^{a,b,c}$	12	$Indonesia^{a,b,c}$	28	$Ukraine^{a,b}$
13	$Iceland^{a}$	29	$Sweden^{a,b,c}$	13	$Iran^{a}$	29	$Uruguay^{a,b,c}$
14	$Ireland^{a,b,c}$	30	$Switzerland^{a,b,c}$	14	$Jordon^{a,c}$	30	$Viet\ Nam^{a,b,c}$
15	$Israel^{a,b,c}$	31	$United\ Kingdom^{a,b,c}$	15	$Kazakhstan^{a,b}$		
16	$Italy^{a,b,c}$	32	$United\ States\ of\ America^{a,b,c}$	16	$Korea, Republic\ of^{a,b,c}$		

Note: The countries are selected based on the availability of data.

[a] denotes list of countries in the sample of labor market rigidity index developed by Campus & Negunt (2018).

[b] denotes list of countries in the sample of labor market rigidity index constructed by Botero et al. (2004).

[c] denotes list of countries in the sample of of labor market rigidity index expanded by Forteza and Rama (2006).