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ANALYSES OF THE RELATIONSHIP BETWEEN EXCHANGE RATES AND EMPLOYMENT IN KOREA

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Previous studies about relationship between exchange rates and employment focus on only developed countries. But country characteristics in developing countries are different from those of developed countries. So this paper examines the relationship between two variables using 28 industry data in a developing country, Korea. The results show that generally, Korean employment responds positively to exchange rate shocks. All industries with high openness and low imported input ratio show a positive sign in employment to the shocks. Most industries showing a negative sign in the employment response to the shocks belong to industries with middle or low openness. As expected, Korea employment more responds to exchange rate shock than US employment.

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1. INTRODUCTION

Currency fluctuations are a substantial source of movements in relative prices. As the result, they reallocate jobs within and across industries. Gourinchas (1998), Burgess and Knetter (1998), Klein (1999), and Campa and Goldberg (2001) empirically show that real exchange rates have a significant effect on employment.

Klein and Triest (2000) show that based on panel data of the U.S labor data (annual (1973-1993)) at the 4-digit industry level, a one percent appreciation of the exchange rate gives rise to 0.48 percentage point decrease in net employment, and a one percent depreciation increases net employment by 0.048 percentage point. Meanwhile using U.S. labor market data (annual (1972-1995)) at two-digit industry levels, Campa and Goldberg (2001) show the exchange rate affects employment and hours worked. According to their study, industries with low price-over-cost markup ratios show more substantial effects in wages. Industries with low price-over-cost markup ratios and those with a less skilled workforce exhibit relatively larger employment elasticity to exchange rates.

Previous studies focus on only developed countries such as OECD countries. But country characteristics and industry characteristics in developing countries are very different from characteristics of developed countries. As a result, the effects of fluctuations in real exchange rates on employment in developing countries can be different from those in developed countries. For example, for developing countries, the market structure such as market power in the world market, and regulation of international trade through tariffs, and regulation of the labor market related to adjustment costs of labor are definitely different from those of developed countries. Such differences can generate different effects of fluctuations in real exchange rates on employment. So to broaden the understanding of the effect of real exchange rates on employment, the study for developing countries should also be performed. In this paper, I consider Korea having high openness to the world market.

I find that as shown in Campa and Goldberg (2001), trade structure is also a very important factor in the effect of exchange rates change on Korean employment. As expected in theory, each Korean industry shows a different response in both sign and magnitude to an exchange rate shock. Also, I find there are general patterns in the response of employment to the exchange rates shock and Korean employment more responds to the exchange rate shocks than US. For the objective of this study, I consider two kinds of estimation (conventional single equation estimation and panel estimation) and two different measures of exchange rates (actual and permanent exchange rates).

Most patterns found in this paper match the theory. That is, all industries with high openness and low imported input ratio show a positive sign in employment to the shocks. Most industries showing a negative sign in the employment response to the shocks belong to industries with middle or low openness. Based on panel data analysis, Korea has positive employment responses to the depreciation of exchange rates. Furthermore, it is found that, as expected, Korea tend to show a larger employment response to the shocks than a developed country, US.

In the second section, the empirical equations, along with an explanation of data used in this study is explained. In the third section, empirical results are given. In the fourth section, comparison of Korea with the US in the impact of exchange rates on employment is provided. In the final section, summary and conclusion are given.

2. EMPIRICAL EQUATIONS AND DATA

2.1. Model Specification for Non-Panel Analysis

Some authors[1] model the transmission channels of exchange rate fluctuation on employment. Klein and Triest (2000) focus on openness as the transmission channel of exchange rate fluctuation on employment. Campa and Goldberg (2001) consider imported inputs in addition to openness in analyzing the effect of exchange rates on employment.

[1] Campa and Goldberg (1998), Knetter (1998), Gourinchas (1999), and Campa and Goldberg (2001).

Campa and Goldberg (2001) drive labor demand by solving profit maximizing problem under constraints in production technology, product demand, and adjustment cost of labor. Production function is assumed to be a Cobb-Douglas function of labor, non-labor input, and imported non-labor input. It is assumed that domestic demand of product is an increasing function of aggregate demand and exchange rates. Foreign demand of domestic product is assumed to be an increasing function of foreign aggregate demand and exchange rates. Exchange rates influence demand of product by leading to shifts in the relative prices of home products versus those of foreign competitors. Cost of adjusting labor input is assumed to be quadratic. They assume that labor supply is increasing to wages and decreasing to income. Under the assumptions, they drive equilibrium employment as

$$L_t = \lambda_0 + \lambda_1 Y_t + \lambda_2 Y_t^* + \lambda_3 Z_t + \lambda_4 Z_t^* + (\lambda_{5,0} + \lambda_{5,1}\chi_t + \lambda_{5,2} M_t + \lambda_{5,3}\rho_t) E_t + \lambda_6 L_{t-1}, \tag{1}$$

where all variables other than χ_t, M_t and ρ_t are defined in logs, and χ_t M_t and ρ_t represent export orientation ratio (exports/output), import penetration ratio (imports/(output-exports+imports)) and imported input ratio (imported input/output), respectively. L_t, Y_t, Y_t^* are labor, income in the home country, and foreign country; E_t, Z_t and Z_t^* are exchange rates, the unit cost of non-labor inputs in the home and foreign country.

The sign of λ_1 depends on relative magnitude of income effect on labor demand and supply. The sign of λ_2 is expected to be positive because expansion of foreign aggregate demand increases domestic product demand. The signs of λ_3 and λ_4 depend on the relative magnitude of (negative) cost effect on labor demand and substitute (or complement) effect on labor demand to the change of non-labor inputs. If the production input is substitute (complement) of labor, labor demand is likely to increase (decrease) to the increase of price of non-labor inputs. Inclusion of lagged employment in the equation is related with the cost of adjusting labor inputs. Changes in employment will be slower in the presence of adjustment cost than otherwise. In the presence of adjustment cost, the sign of coefficient is expected to be positive.

For an industry, employment elasticity of exchange rates $(\lambda_{5,0} + \lambda_{5,1}\chi_t + \lambda_{5,2} M_t + \lambda_{5,3}\rho_t)$ depends on industry features in export orientation, import penetration, imported input ratio. In the same context, for a country, national-wide employment elasticity of exchange rates depends on country features in export orientation, import penetration, imported input ratio. From the derived elasticity of employment to exchange rates one find industry features magnify or reduce the elasticity.

From Equation (1), the sign of employment elasticity of exchange rates depends on the signs and magnitudes of $\lambda_{5,0}$, $\lambda_{5,1}$, $\lambda_{5,2}$, $\lambda_{5,3}$, and sizes of trade ratios for each industry. If the first two (positive) direct effects ($\lambda_{5,1}, \lambda_{5,2}$) dominate (negative) direct effect ($\lambda_{5,3}$), then the impact of exchange rate depreciation on employment is likely to be positive, otherwise it is likely to be negative.

The magnitude of the employment effect of an exchange rate change depends on the industry's openness (defined as export orientation ratio plus import penetration ratio), imported input ratio, and labor intensity. Industries with greater import penetration is likely to be more sensitive in labor demand to exchange rates because depreciation of domestic currency more increases domestic product demand for an industry with greater import penetration. Industries with higher export orientation is likely to be larger responsive in labor demand to exchange rates because depreciation of domestic currency much increases foreign demand of domestic product for an industry with greater export orientation. Industries with greater reliance on imported input into production are likely to be less responsive in labor demand to exchange rate depreciation. It is because for depreciation of domestic currency, increase of labor demand through export increase is likely to be partly offset by decrease of labor demand due to higher cost of imported input. If the production technology is labor intensive, labor is less responsive to exchange rates.[2]

In this paper, two kinds of estimation method are considered. One is estimation in each industry level. Through that, I want to find patterns of response of employment to exchange rate shocks across industries. The other one is estimation using panel data including all industries. Through that, I can show aggregate patterns of employment responses to exchange rate shocks. As well known, panel data estimation can provide more efficient estimates than estimates based on data of each industry because of the limit of time span for each industry. Hereafter, the former is called 'non-panel' model estimation and the latter is 'panel model' estimation.

Equation (1) is non-panel model used in this paper. OLS regression is performed for the following two different model specifications. From Equation (1), consider the following regression models.

Model 1

$$\begin{aligned} L_t &= \lambda_0 + \lambda_1 Y_t + \lambda_2 Y_t^* + \lambda_3 Z_t + \lambda_{4,1} Z_{t,1}^* + \lambda_{4,2} Z_{t,2}^* \\ &\quad + (\lambda_{5,0} + \lambda_{5,1}\chi_t + \lambda_{5,2} M_t + \lambda_{5,3}\rho_t) E_t + \lambda_6 L_{t-1} + \lambda_7 T + \lambda_8 D \end{aligned}$$

Model 2

In the model 2, trade ratios are not included in the estimation as in studies before Campa and Goldberg (2001). Model 2 is considered to show importance of trade ratios in estimating the employment elasticity of exchange rates by comparing the estimated elasticities in model 1 with those in model 2.

[2] In the process of deriving equilibrium employment, labor intensity is reflected in the parameters of labor demand function. For more details, see Campa and Goldberg(2001).

$$L_t = \lambda_0 + \lambda_1 Y_t + \lambda_2 Y_t^* + \lambda_3 Z_t + \lambda_{4,1} Z_{t,1}^* + \lambda_{4,2} Z_{t,2}^*$$
$$+ \lambda_5 E_t + \lambda_6 L_{t-1} + \lambda_7 T + \lambda_8 D$$

The dependent variable is the number of employees in each industry. Independent variables are constant, local real GDP (Y_t), world real demand (Y_t^*),[3] local interest rate (Z_t), real oil price ($Z_{t,1}^*$), world interest rate ($Z_{t,2}^*$),[4] real exchange rates (E_t), and the number of employees lagged (L_{t-1}), trend (T), and dummy variables (D). Trend is included to capture change in employment that occurs due to changes in tastes, comparative advantage, or technology (Branson and Love, NBER (1988)). Also two dummy variables are included in the estimation to capture any structural change in employment. One is based on the change in exchange rate regimes. The other one is based on empirical results.[5]

For model 1, the coefficient of exchange rates varies over time. To consider this factor, the regression equation includes trade ratios (export orientation ratio, import penetration ratio, and imported input ratio) multiplied by exchange rate. After the coefficients corresponding to the trade ratios multiplied by exchange rate and the coefficient of the exchange rate entered alone are estimated, an average employment elasticity of the exchange rates is calculated using average trade ratios for each industry.

The delta method is applied to test the null hypothesis that the average elasticity is zero.[6] The null hypothesis can be tested using Wald test as follows. Let $g(\theta)$ be an average elasticity; $g(\theta) = \hat{\lambda}_{5,0} + \hat{\lambda}_{5,1}\overline{\kappa} + \hat{\lambda}_{5,2}\overline{M} + \hat{\lambda}_{5,3}\overline{\rho}$. Using Wald statistic, I can test the hypothesis

$$H_0 : g(\theta) = 0$$

$\theta = (\hat{\lambda}_{5,0} \ \ \hat{\lambda}_{5,1} \ \ \hat{\lambda}_{5,2} \ \ \hat{\lambda}_{5,3})'$, $\overline{\kappa}$, $\overline{M}$, and $\overline{\rho}$ represent average export orientation, import penetration, and imported input ratio respectively. If the statistic is larger than the critical value, then the null hypothesis is rejected.

[3] Measured by major trading partners' GDP.

[4] Approximated by US real interest rate based on government bond yield: 3 years.

[5] Based on cumulative sum of least squares residuals (CUSUM) tests, several industries look like they have structural breaks. Based on Andrews' LM, for some industries, the null hypothesis that there is no structural break is rejected. So based on Andrews' test, one dummy variable is included to capture possible structural break in employment.

[6] Since single restriction is considered here, one can also use *z* statistics to test the null hypothesis. A Wald statistic with one restriction is the same as square of *z* statistic under normality condition (Greene p. 155). However, considering the strict restriction of normality, I use Wald statistics rather than *z* statistics.

2.2. Model Specification and Some Tests for Panel Analysis

For the panel model, more discussions of model specification are needed because the model considered is panel dynamic one. From Equation (1), consider the following (random coefficient) model

$$\begin{aligned} L_{it} &= \lambda_{i0} + \lambda_{i1}Y_{it} + \lambda_{i2}Y_{it}^{*} + \lambda_{i3}Z_{it} + \lambda_{i4,1}Z_{it4,1}^{*} + \lambda_{i4,2}Z_{i4,2}^{*} \\ &\quad + (\lambda_{i5,0} + \lambda_{i5,1}\chi_{it} + \lambda_{i5,2}M_{it} + \lambda_{i5,3}\rho_{it})E_{t} + \lambda_{i6}L_{i,t-1}, \end{aligned} \tag{2}$$

where i is an industry index. In the equation, the individual (industry) effect and random coefficients are allowed through industry dependent constant term and coefficients.

2.2.1. Homogeneity Test for Coefficients

In the first step, I test for homogeneity of the coefficients in the regression equation. If an individual effect (or industry effect) really exists, conventional panel estimation such as OLS or within estimation (hereafter called FE estimation) might provide inconsistent estimates if the number of observation in the time dimension is not large, since there exists a lagged dependent variable as an explanatory variable. As a result, tests based on FE estimators for homogeneity of coefficients might be misleading. To overcome this possible problem, in addition to FE estimators, I estimate the coefficients according to Anderson and Hisao's (1981) suggestion; first difference the model and use a two-period lagged dependent variable (L_{it-2}) as an instrument variable[7](hereafter the approach is called FD-IV). Based on F statistics,[8] I accept the null hypothesis that all coefficients except the constant term (hereafter called structural parameter) are the same in all 28 industries (see Table 1).

Table 1. *F* Test for Homogeneous Structural Parameters

F statistic
1.14

Notes: 1) Estimation is based on Anderson and Hsiao (1981) to remove individual effects.
2) Critical value is 1.30 at 5% level.
3) Null hypothesis is that coefficients are the same across industries.

[7] In the estimation, I allow for heterogeneity in disturbance terms across industries.

[8] See Greene (2000) p. 608~613.

2.2.2. Tests for Individual Effects

The second step is to test whether there exists any individual effect; different constant terms for each industry. This is performed using a fixed effect model. It is known that if the number of observations in time dimension is large, the least square dummy variable (LSDV) estimator is consistent (Hsiao, Pesaran, and Tahmiscioglu (2001)). I include 27 industry dummies to test for individual effects[9] in the regression Equation (2).

The test evidently shows that there exist individual effects (see Table 2). Considering the tests for homogeneity and individual effects, from the regression equation, I consistently estimate the employment impact of exchange rate shocks based on LSDV estimators.

Table 2. Test Statistics for Individual Effects by Type of Model

Fixed effects	Random effects
F	LM
4.1	14.6

Notes: 1) The null hypothesis is rejected if statistics are larger than 1.30 at 5% level for fixed effects.
2) The null hypothesis is rejected if statistics are larger than 3.84 at 5% level for random effects.

However, if the number of observations is not large enough to get consistent estimates,[10] the conclusion made based on the LSDV estimator might mislead. To allow for this case, I also estimate the employment elasticity of the exchange rate using the FD-IV estimator that is consistent regardless of the number of observations. This is also good for checking the robustness of the results based on LSDV.

2.2.3. Tests for Exogeneity of Some Variables

To get consistent estimates of coefficients, exogeneity of explanatory variables should be satisfied. To say, contemporaneously, explanatory variables such as GDP, interest rate, and real exchange rates should not be affected by employment. Based on Spencer and Berk's (1981) Hausman test of single equation version, the null hypothesis that the variables are exogenous is accepted for most industries.[11] Based on Godfrey's (1997) Hausman test in the presence of lagged dependent variables, the null hypothesis is also accepted for most industries; exchange rates (E), GDP (Y), world GDP (Y^*),

[9] See Greene (2000) p. 560~562.

[10] The numbers of observations in time dimension are 26 in this study.

[11] To the request, author can provide the statistics.

real oil price ($Z^*_{4,1}$), real world interest rate ($Z^*_{4,2}$) are exogenous in the model.

2.2.4. Spurious Regression

Since level data are used in the estimation, possibility of spurious regression should be checked. As well known, spurious regression should be considered in the cases; first, all variables included in the regression are I(1), and second, no lags of the dependent variable are included in the regression. Even if all variables follow I(1), if lagged dependent and independent variables are included in the regression, spurious regression can be avoided (Hamilton p. 561). Considering the model with lagged dependent variables, spurious regression in the estimation might be avoided.

2.3. Data

Data for labor market variables are annual industry data (1970-1995). Employment series are total number of employees in the manufacturing sector industries (ISIC 3-digit), reported by the United Nations Industrial Development Organization (UNIDO). Labor intensity is defined as the number of employees divided by output.

The source of data for real exchange rates is *International Financial Statistics (IFS)*, IMF. The exchange rate is defined as local currency per US dollar. The (trade-weighted) real exchange rate is calculated by averaging bilateral cross-rates against major trading partners' currencies.[12] Data for interest rates are extracted from the *IFS* data set. The discount rate is used. The real interest rate is calculated based on the CPI. For the world interest rate, the US real interest rate is used based on the 3-year government bond yield. Oil price is measured by the average annual price. The source of data for real oil price is the *IFS* data set. Real world demand is defined as the (trade-weighted) average of real GDP of major trading partners. The data are extracted from the *IFS* data set.

Trade ratios are calculated as follows. To match industry classification between trade data and employment data, I follow Keith E Maskus' (1989) concordance between the 3-digit ISIC, Revision 2, and the 2-digit SITC, Revision 2. The export orientation ratio is defined as exports/output. Data sources are World Trade Database (WTDB) for trade data and UNIDO for output data. The import penetration ratio is defined as imports/(output-exports *0.1+imports). Adjustment to exports is made to avoid negative values of the ratio for some years. The imported input ratio is defined as value of imported input divided by value of output. The calculation is based on Input-Output tables at the 3-digits industry level. Input-Output Tables are available for 1970, 1975, 1985, and 1990. For the missing years, the data for the ratio are interpolated and extrapolated based on growth rates between the intervals. Related data are obtained from

[12] Based on trade data in 1995, major trading partners are chosen.

International Input-Output Tables and others.[13] Because of discrepancies in industry classification in input-output tables, for some industries, more aggregated data are used[14] in calculation of the ratios.

All variables other than the interest rate and trade ratios are expressed in logs. For the real interest rate, level values are used instead of log-transformed data because of negative values in some years. To check the seriousness of misspecification, log-transformed data of real interest rate are also used after adjustment to make negative values positive by adding a constant value for all periods. There is no big difference in results between two cases. So in this paper, the results based on level values of the interest rate are reported.

3. RESULTS OF ESTIMATION

3.1. Results Based on Non-Panel Model

I find that inclusion of trade ratios in the estimation is important. According to the results of non-panel model, signs of the average elasticities are not sensitive to the type of model in most industries (see Table 3). However, magnitude of the average elasticities is sensitive to the model; ‘model 1’ (including all 3 ratios) and ‘model 2’(without 3 ratios).

Table 3 shows estimated coefficients of variables related to exchange rates and average employment elasticities of exchange rates (referred as AELS in the table). As expected, the estimated coefficients related to exchange rates ($\lambda_{5,1}\chi_t$, $\lambda_{5,2}M_t$, $\lambda_{5,3}\rho_t$) varies across industries.[15] Therefore, the average employment elasticities with respect to exchange rates also vary across industries.

From Table 3, one can find the importance of trade ratios in estimating the average employment elasticity of exchange rates by comparing elasticities in model 1 and those in model 2. In addition, I find that for model 1, the estimated average elasticities of employment with respect to exchange rates are dominated by the coefficient of the exchange rate entered alone.

Meanwhile, for some industries, there is a considerable difference in the magnitude of elasticity between ‘model 1’ with all 3 trade ratios and ‘model 2’ without trade ratios. This means that for Korea, although the exchange rate coefficient dominates average elasticity, including the interaction terms might be important for estimating the size of elasticity.

[13] *Asian Input-Output table and Input-Output tables of Korea*.

[14] ISIC 323/324, 355/356, 361/362/369 are aggregate data for imported input ratios.

[15] Appendix 1 shows the meaning of each coefficient related to exchange rates.

Table 3. Estimated Coefficients Related with Exchange Rates and Average Elasticity of Employment with Respect to Exchange Rates

	Model 1					Model 2	
ISIC	E	E*χ	E*M	E*ρ	AELS	E	AELS(=E)
311	-0.06	0.14	-0.37	0.19	-0.08	0.30	0.30
	-0.23	0.91	-1.57	1.21	2.16	1.48	1.48
313	0.50	2.29	1.23	-0.41	0.51	0.22	0.22
	1.27	1.17	0.45	-0.49	42.50	0.66	0.66
314	0.61	-0.37	-0.13	3.20	0.67	0.76	0.76
	2.66	-1.18	-0.57	4.56	218.10	2.11	2.11
321	0.61	0.11	-0.32	0.22	0.64	0.79	0.79
	3.76	1.26	-1.68	0.75	447.00	6.79	6.79
322	0.58	0.04	-0.31	-0.27	0.58	0.96	0.96
	1.89	1.83	-1.15	-1.08	84.40	3.16	3.16
323	1.92	0.16	1.62	-0.70	2.12	2.17	2.17
	2.25	0.81	0.87	-0.74	158.50	2.97	2.97
324	-0.32	0.09	-1.46	0.82	-0.12	0.23	0.23
	-0.19	2.21	-2.27	0.91	0.15	0.19	0.19
331	-0.41	0.10	-0.04	0.04	-0.37	-0.22	-0.22
	-0.97	2.57	-0.20	0.33	26.77	-0.68	-0.68
332	-0.76	-0.18	-0.23	-0.21	-0.83	-0.65	-0.65
	-2.20	-2.69	-0.64	-0.41	121.00	-1.73	-1.73
341	0.19	0.21	0.37	-0.31	0.20	0.30	0.30
	0.99	1.02	1.06	-1.48	31.89	1.44	1.44
342	-0.14	0.09	-0.17	2.23	-0.03	-0.09	-0.09
	-1.36	3.62	-0.96	2.35	2.07	-0.57	-0.57
351	-0.78	0.11	0.22	-0.03	-0.70	-0.68	-0.68
	-1.63	0.93	1.32	-0.03	80.56	-1.88	-1.88
352	0.60	1.72	-1.13	0.15	0.56	0.70	0.70
	2.37	2.12	-2.62	1.34	149.20	2.54	2.54
353	-1.09	0.52	0.21	-0.03	-1.04	-0.43	-0.43
	-1.19	0.68	1.21	-0.14	37.58	-1.15	-1.15
354	0.23	-0.24	0.05	0.38	0.31	0.23	0.23
	1.47	-3.24	1.49	5.65	110.80	1.13	1.13
355	-0.36	0.71	1.49	0.57	0.03	0.86	0.86
	-0.20	1.07	0.57	0.44	0.01	0.63	0.63
356	-0.06	-0.47	0.95	0.42	0.10	-0.03	-0.03
	-0.09	-1.09	1.96	0.58	0.92	-0.06	-0.06
361	-0.50	0.05	0.02	2.32	-0.28	0.14	0.14
	-1.34	1.28	0.17	3.21	17.66	0.33	0.33
362	0.06	0.00	0.09	0.24	0.10	0.10	0.10
	0.23	-0.04	0.75	0.44	3.92	0.53	0.53

369	-0.16	-0.29	-0.36	0.58	-0.15	-0.14	-0.14
	-0.93	-1.81	-0.83	1.40	22.17	-0.90	-0.90
371	-0.27	0.09	0.09	0.07	-0.21	-0.01	-0.01
	-1.33	2.14	0.68	0.55	28.85	-0.05	-0.05
372	-0.32	0.32	-0.05	0.69	0.01	0.03	0.03
	-0.96	1.88	-0.38	1.80	0.01	0.10	0.10
381	-0.31	0.13	0.07	-0.30	-0.31	-0.10	-0.10
	-1.11	2.37	0.54	-0.89	37.65	-0.48	-0.48
382	-0.26	0.04	0.13	1.58	0.07	0.00	0.00
	-0.80	0.93	0.70	1.75	1.38	0.01	0.01
383	-0.19	-0.04	0.53	1.05	0.19	0.90	0.90
	-0.53	-0.34	1.46	2.82	10.71	2.73	2.73
384	-0.27	0.04	-0.15	-0.08	-0.31	-0.25	-0.25
	-0.84	0.94	-1.19	-0.20	27.19	-1.13	-1.13
385	0.89	0.45	-0.11	-0.08	0.91	1.66	1.66
	1.09	1.75	-0.47	-0.25	37.59	2.69	2.69
390	0.79	0.26	-0.67	-2.38	0.59	1.02	1.02
	1.89	2.55	-1.34	-1.55	52.66	2.79	2.79

Notes: 1) The first and second row represents coefficients and test statistics based on *t* or chi-square, respectively.

2) Critical values for AELS(average elasticity) are 3.84 and 2.71 at 5% and 10%, respectively.

3) Critical values for coefficients related to exchange rates are 1.78, 2.18 for ‘model 1’, 1.77, 2.16 for ‘model 2’ at 10% and 5%.

16 out of 28 industries show a positive employment response to a depreciation of exchange rates. There exist some general patterns in the signs of the responses.[16] As predicted by the theory, industries with high openness[17] tend to show a positive sign in the employment response to the exchange rates shocks (see Table 4 and Table 5). Industries with high openness and high imported input ratio tend to show a positive sign. Most industries showing a negative sign in the employment response to the shocks belong to industries with middle or low openness. All industries with high openness and low imported input ratio show a positive sign in employment to the shocks.

[16] In finding patterns of employment responses to exchange rate shocks, results based on ‘Model 1’ are used.

[17] In the ranking of openness, industries placing first to 9th among 28 industries (20th to 28th) are classified as industries with high (low) openness. Classification in imported input ratio or labor intensity follow the same way as in openness.

Table 4. Estimated Coefficients of Employment Elasticity with Respect to Actual Exchange Rates: by Industry Characteristics and Type of Model

					Model 1		Model 2	
	ISIC	Rank_OP	Rank_INP	Rank_L	AELS	Wald-stat	ELS	t-stat
HHH	324	1	9	5	-0.12	0.15	0.23	0.19
	385	4	5	6	0.91	37.59	1.66	2.69
HHM	323	5	8	13	2.12	158.50	2.17	2.97
	383	8	4	14	0.19	10.71	0.90	2.73
HHL	.							
HMH	322	2	17	4	0.58	84.40	0.96	3.16
HMM	384	7	14	18	-0.31	27.19	-0.25	-1.13
HML	.							
HLH	390	6	21	3	0.59	52.66	1.02	2.79
HLM	362	9	25	12	0.10	3.92	0.10	0.53
	382	3	20	10	0.07	1.38	0.00	0.01
HLL	.							
MHM								
MHM	331	11	2	16	-0.37	26.77	-0.22	-0.68
MHL	351	12	6	25	-0.70	80.56	-0.68	-1.88
	372	14	3	22	0.01	0.01	0.03	0.10
MMH	381	18	19	7	-0.31	37.65	-0.10	-0.48
MMM	321	13	18	11	0.64	447.00	0.79	6.79
	356	19	11	15	0.10	0.92	-0.03	-0.06
MML	354	16	16	24	0.31	110.80	0.23	1.13
	371	15	13	26	-0.21	28.85	-0.01	-0.05
MLH	342	17	26	9	-0.03	2.07	-0.09	-0.57
	361	10	23	1	-0.28	17.66	0.14	0.33
MLM	.							
MLL	.							
LHH	.							
LHM	341	23	7	19	0.20	31.89	0.30	1.44
LHL	353	22	1	28	-1.04	37.58	-0.43	-1.15
LMH	355	20	12	8	0.03	0.01	0.86	0.63
LMM	.							
LML	311	21	15	21	-0.08	2.16	0.30	1.48
	352	25	10	20	0.56	149.20	0.70	2.54
LLH	332	24	22	2	-0.83	121.00	-0.65	-1.73
LLM	369	26	24	17	-0.15	22.17	-0.14	-0.90
LLL	313	28	27	23	0.51	42.50	0.22	0.66
	314	27	28	27	0.67	218.10	0.76	2.11

Notes: 1) To test null hypothesis, delta method is used.
2) Critical values for AELS (average elasticity) are 2.71 and 3.84 at 10% and 5%, respectively.
3) Critical values for coefficients are 1.75 and 2.13 at 10% and 5% level for 'model 2'.
4) HML indicates industry category with high openness, middle import penetration, and low imported input ratio.
5) Rank_OP, Rank_INP, and Rank_L indicate ranking of each industry in all industries for openness, imported input ratio, and labor intensity, respectively.

Table 5. Directions of Employment Responses to Exchange Rate Shock by Type of Model: Based on Actual Exchange Rates

		OPENESS							
		H		M		L			
		+	-	+	-	+	-	+	-
INPUT	H	3(3)	1(0)	1(0)	2(2)	1(1)	1(1)	5(4)	4(3)
	M	1(1)	1(1)	3(2)	2(2)	2(1)	1(0)	6(4)	4(3)
	L	3(2)	0(0)	0(0)	2(1)	2(2)	2(2)	5(4)	4(3)
		7(6)	2(1)	4(2)	6(5)	5(4)	4(3)		

Notes: 1) H, M, L in column represent industry category with high, middle, and low openness, respectively.
2) H, M, L in row represent industry category with high, middle, and low imported input ratio, respectively.
3) The number of each cell indicates the number of '+' or '-' for each industry category.
4) The number in parenthesis indicates the number of industries with statistically significant employment impact to exchange rate shocks.
5) Tables above are constructed using Table 4.

Most of these results match the theory. According to the theory, industries with high (low) openness are likely to show positive (negative) response in employment to a depreciation of exchange rates. Industries with low (high) imported input ratio are likely to respond positively (negatively) in employment to exchange rate shocks relative to industries with high (low) imported input ratio. If only statistically significant elasticities are considered, the patterns mentioned above are more evident. Especially, industries with high openness and low imported input ratio show a positive sign. In addition, most industries with middle imported input ratio show a positive sign.

Table 6. Estimated Coefficients of Employment Elasticity with Respect to Permanent Exchange Rates: by Industry Characteristics and Type of Model

					Model 1		Model 2	
	ISIC	Rank_OP	Rank_INP	Rank_L	AELS	Wald-stat	ELS	t-stat
HHH	324	1	9	5	-5.73	29.00	-2.06	-0.54
	385	4	5	6	4.40	111.80	5.93	4.28
HHM	323	5	8	13	5.71	164.30	7.21	3.61
	383	8	4	14	1.70	79.46	3.34	4.07
HHL	.							
HMH	322	2	17	4	2.31	226.90	3.28	4.81
HMM	384	7	14	18	-0.09	0.24	-0.31	-0.42
HML	.							
HLH	390	6	21	3	2.74	124.20	3.20	3.22
HLM	362	9	25	12	0.41	10.69	0.31	0.55
	382	3	20	10	0.11	0.41	0.29	0.32
HLL	.							
MHM	.							
MHM	331	11	2	16	-0.57	7.29	0.13	0.13
MHL	351	12	6	25	-0.95	11.41	-0.43	-0.36
	372	14	3	22	0.01	0.00	-0.03	-0.03
MMH	381	18	19	7	-0.01	0.00	0.30	0.47
MMM	321	13	18	11	1.85	545.30	2.16	6.00
	356	19	11	15	0.73	5.62	0.27	0.19
MML	354	16	16	24	1.31	239.10	0.83	1.27
	371	15	13	26	-0.50	14.42	0.19	0.31
MLH	342	17	26	9	0.04	0.42	0.20	0.40
	361	10	23	1	0.24	1.15	1.25	1.05
MLM	.							
MLL	.							
LHH	.							
LHM	341	23	7	19	0.83	50.88	1.17	2.22
LHL	353	22	1	28	0.04	0.00	-0.81	-0.72
LMH	355	20	12	8	4.66	23.60	6.64	1.84
LMM	.							
LML	311	21	15	21	-0.08	0.24	1.08	1.83
	352	25	10	20	1.93	188.10	2.27	3.30
LLH	332	24	22	2	-2.60	94.42	-2.40	-1.84
LLM	369	26	24	17	-0.62	48.42	-0.81	-1.79
LLL	313	28	27	23	2.35	136.30	1.18	1.35
	314	27	28	27	2.77	280.40	3.27	2.89

Notes: 1) To test null hypothesis of zero value of AELS, delta method is used.
2) Critical values of Wald statistics for AELS are 2.71 and 3.84 at 10% and 5%, respectively.
3) Critical values of t statistics are 1.75 and 2.13 at 10% and 5% level for model 2.
4) HML indicates industry category with high openness, middle import penetration, and low imported input ratio.
5) Rank_OP, Rank_INP, and Rank_L indicate ranking of each industry in all industries for openness, imported input ratio, and labor intensity, respectively.

However, results based on permanent exchange rates[18] show more distinctive patterns in the sign (see Table 6 and Table 7). That is, all industries with high openness and low imported input ratio show a positive sign. And industries showing a negative sign tend to have middle or low openness.

Table 7. Directions of Employment Responses to Permanent Exchange Rate Shock by Type of Model - Korea

		OPENNESS							
		H		M		L			
		+	-	+	-	+	-	+	-
INPUT	H	3(3)	1(1)	1(0)	2(2)	2(1)	0(0)	6(4)	3(3)
	M	1(1)	1(0)	3(3)	2(1)	2(2)	1(0)	6(6)	4(1)
	L	3(2)	0(0)	2(0)	0(0)	2(2)	2(2)	7(4)	2(2)
		7(6)	2(1)	6(3)	4(3)	6(5)	3(2)		

Notes: 1) H, M, L in column represent industry category with high, middle, and low openness, respectively.
2) H, M, L in row represent industry category with high, middle, and low imported input ratio.
3) The number of each cell indicates the number of '+' or '-' for each industry category respectively.
4) The number in parenthesis indicates the number of industries with statistically significant employment impact to exchange rate shocks.
5) Tables above are constructed using Table 6.

[18] Permanent real exchange rates can be calculated following John Huizinga (1987). John Huizinga (1987) shows the way to decompose real exchange rates into permanent and transitory components based on the decomposition suggested by Beveridge and Nelson (1981) and considers permanent component of exchange rate as permanent exchange rate. In this way, permanent exchange rates can be thought of as long run behavior of exchange rates. Firms may be inclined to use overtime hours in response to transitory shocks instead of hiring or firing permanent workers. Meanwhile they are more likely to adjust the number of employees in response to the permanent exchange rates. In this respect, permanent exchange rates might better explain change of the number of employees than actual exchange rates.

There exist some patterns in the magnitude of the employment response to the shocks. Most industries showing a small response have middle or low openness (see Table 8). Industry showing the largest response has high openness. Industries showing the largest responsiveness have high openness and middle labor intensity,[19] as expected. If only statistically significant elasticities are considered, the patterns do not change. Also, results based on permanent exchange rates show almost same patterns in magnitude of the elasticity as in the results based on actual exchange rates (see Table 9).

Table 8. Mangnitudes of Employment Responses to Actual Exchange Rate Shock by Type of Industry

	H				M					L				
H	9	21	3	8		26	16	15		4	27			
M	1	23	25	19	13	7	12	22		18	20			
L						5	14	17	28	24	11	6	10	2

Table 8. Based on Only Statistically Significant Coefficients

	H					M			L				
H	9		3	8			19	15	4				
M	1	23		19	13	7	12		18	20			
L						5	14	17		11	6	10	2

Notes: 1) H, M, L in column represent industry category with high, middle, and low openness, respectively.
2) H, M, L in row represent industry category with high, middle, and low labor intensity, respectively.
3) The number of each cell indicates the ranking of each industry in 28 industries.
4) Tables are constructed using Table 4.

Table 9. Mangnitudes of Employment Responses to Permanent Exchange Rate Shock by Type of Industry

	H					M				L				
H	9	1	4	6		25	21	28		7	3			
M	2	20	22	12	23	11	18	16		15	17			
L						14	13	19	27	24	8	5	10	26

[19] According to Campa and Goldberg (2001), industries with low labor intensity are likely to show large employment response to exchange rate shocks.

Table 9. Based on Only Statistically Significant Coefficients

	H					M			L			
H	9	1	4		6				7	3		
M	2	20		12		11	18	16	15	17		
L						14	13	19		8	5	10

Note 1) H, M, L in column represent industry category with high, middle, and low openness, respectively.
2) H, M, L in row represent industry category with high, middle, and low labor intensity, respectively.
3) The number of each cell indicates the ranking of each industry in 28 industries.
4) Tables are constructed using Table 6.

3.2. Results Based on Panel Model

Based on panel analysis, Korean employment responds positively to actual exchange rate shocks regardless of type of model; FE and FD-IV model (see Table 10). Although the signs of the employment effect of exchange rates are not sensitive to the type of model, the magnitudes of the effects are. Based on the FE estimator, employment increases by 0.60 percentage to a 1 percentage depreciation of exchange rates. Based on the FD-IV estimator, employment increases only by 0.52 percentage to the same depreciation of exchange rates.

Table 10. Estimated Employment Elasticity with Respect to Actual Exchange Rates

	E	E*χ	E*M	E*ρ	AELS
FE	0.60	0.04	-0.04	0.00	0.60
	7.40	3.46	-1.22	0.13	55.60
AH	0.42	0.07	0.30	0.09	0.52
	1.63	2.43	1.34	0.63	3.28

Notes: 1) E and E*χ, E*M, E*ρ represents estimated employment elasticities of exchange rates and interaction effects. AELS means average employment elasticity of exchange rates.
2) The first and second row represent coefficients and test statistics based on t or chi-square test, respectively.
3) Critical values for AELS (average elasticity) are 2.71, 3.84 and at 10% and 5%, respectively
4) Critical values for coefficients related to exchange rate are 1.65, 1.96 at 10% and 5% level for all models.
5) FE represents estimates based on fixed effect model.
6) AH represents IV estimates using instrument variables of lagged dependent variable.

Meanwhile, as expected, Korean employment more responds to the permanent exchange rate shock than to the actual exchange rate shock. According to the results based on FE estimator, employment increases by 1.34 percentage to a 1 percentage depreciation of permanent exchange rates (see Table 11). Based on FD-IV estimator, employment increases by 1.03 percentage to a 1 percentage depreciation of permanent exchange rates.

Table 11. Estimated Employment Elasticity with Respect to Permanent Exchange Rates

	E	E*χ	E*M	E*ρ	AELS
FE	1.34	0.04	-0.05	0.01	1.34
	7.55	3.41	-1.57	0.19	57.50
AH	0.93	0.06	0.28	0.12	1.03
	1.95	2.34	1.25	0.82	4.38

Notes: 1) E and E*χ, E*M, E*ρ represents estimated employment elasticities of exchange rates and interaction effects. AELS means average employment elasticity of exchange rates.

2) The first and second row represent coefficients and test statistics based on t or chi-square test, respectively.

3) Critical values for AELS (average elasticity) are 2.71, 3.84 at 10% and 5%, respectively.

4) Critical values for coefficients related to exchange rate are 1.65, 1.96 at 10% and 5% level for all models.

5) FE represents estimates based on fixed effect model.

6) AH represents IV estimates using instrument variables of lagged dependent variable.

4. COMPARISON WITH PREVIOUS RESEARCH ON DEVELOPED COUNTRIES

This research is motivated by a comparison of the effect of exchange rates on employment between developed countries and developing countries. The only published study including trade ratios in estimating employment elasticity with respect to exchange rates is Campa and Goldberg (2001).

Goldberg and Campa (2001) analyze 2-digit US SIC manufacturing industries using annual data. Although their preferred methodology is panel analysis, they also provide the results from 20 separate regressions at the 2-digit industry level. Since my research is based on 3-digit ISIC industries, the results are not directly comparable. Therefore, I compare results based on the average employment elasticity across industries with respect to exchange rates.

Goldberg and Campa (2001) consider only the export orientation and imported input ratios in their estimation. According to their results, over 24 years (1972-95) the average elasticity of employment with respect to exchange rates is 0.009, with a standard deviation of 0.059 (see Table 12). But based on a t-test, this estimated average elasticity is not statistically significant.

Table 12. US Employment Elasticities with Respect to Exchange Rates

US SIC	Description	Weight	Elasticity
20	Food and kindred products	0.095	0.033
21	Tobacco products	0.002	-0.096
22	Textile mill products	0.035	0.039
23	Apparel and other textile products	0.049	0.027
24	Lumber and wood products	0.041	0.052
25	Furniture and fixtures	0.027	0.021
26	Paper and allied products	0.037	0.045
27	Printing and publishing	0.084	0.039
28	Chemicals and allied products	0.057	-0.061
29	Petroleum and coal products	0.008	0.023
30	Rubber and misc. plastics products	0.052	0.012
31	Leather and leather products	0.006	0.064
32	Stone, clay, and glass products	0.030	0.016
33	Primary metal industries	0.039	0.049
34	Fabricated metal products	0.078	0.046
35	Industrial machinery and equipment	0.110	-0.123
36	Electronic and other electrical equipment	0.088	-0.026
37	Transportation equipment	0.094	0.115
38	Instruments and related products	0.046	-0.103
39	Miscellaneous manufacturing	0.021	0.016
	Non-weighted average elasticity		0.009
	standard deviation		0.059
	t-stat		0.707
	Employment-weighted average elasticity		0.008

Notes: 1) Elasticity shown above comes from Goldberg and Campa (2001).
2) Weight means the ratio of number of industry employment to manufacturing employment in 1995.
3) Weight is calculated using Bureau of Labor Stasistics data.

To compare US employment elasticity with respect to exchange rates with Korea's, I perform the regressions using the same regression equation as in Campa and Goldberg (2001). Korea shows larger employment elasticity to the exchange rate shocks than the US. This is expected and can be understood by the fact that Korea has higher openness and imported input ratios than the US. For Korea, based on actual exchange rates, the average elasticity of employment to the depreciation of exchange rates is 0.09, with a standard deviation of 0.55. This is not statistically significant. But in the results based on permanent exchange rates, the average elasticity is 0.61, with a standard deviation of 2.68. This is statistically significant.

Although the value of average elasticity is a simple average elasticity across industries, it can be thought of as a consistent estimate of mean employment elasticity with respect to exchange rates. The model considered in the study is a heterogeous dynamic panel model because the model is a dynamic model and the coefficients of employment elasticity are heterogeneous across industry. It is shown by Pesaran and Smith (1995) that in the heterogeneous dynamic model, conventional panel analysis based on fixed or random effects gives inconsistent estimates. Pesaran and Smith (1995) show that group mean estimates are consistent. In this context, the mean of estimated employment elasticity across industries can be thought of as group mean estimates of employment elasticity with respect to exchange rates.

Summing up, as expected, Korea show larger employment responses to a change of exchange rates than the US, a developed country.[20]

5. SUMMARY AND CONCLUSION

From this study, I find some interesting patterns in employment responses to exchange rate shocks. First, it appears that for Korea, it is important to consider trade ratios in analyzing the effect of exchange rates on employment. The magnitude of response obtained from 'model 1' with 3 trade ratios and 'model 2' without trade ratios is considerably different for some industries.

Second, I find some general patterns in the signs of the employment responses to the exchange rate shocks for Korea. And most patterns found in this paper match the theory. That is, industries with high openness tend to show a positive sign in the employment response to the exchange rates shocks. All industries with high openness and low imported input ratio show a positive sign in employment to the shocks. Most industries showing a negative sign in the employment response to the shocks belong to industries with middle or low openness.

Third, in this paper, I find that exchange rates have much impact on employment for Korea. According to the panel data analysis, Korean employment responds positively to exchange rate shocks. And the results are statistically significant. In addition, as expected, Korean employment more responds to the permanent exchange rate shock than to actual exchange rate shock. The findings mean that for Korea, exchange rate is a key variable to determine level of employment. Fourth, Korea employment more responds to exchange rate shock than US employment. It is consistent to a theory because Korea has higher openness than the US.

Future research about the relationship between volatility of exchange rates and

[20] Employment-weighted average elasticity can be considered for the comparison between the US and Korea. When weighted average is used, Korea has still larger employment response to an exchange rate shock than US: for US, 0.008 and for Korea, 0.11.

employment change can provide more policy implication to the policymakers. Also, since there is a close relation between employment and output in an economy, relation between output and exchange rates can be considered as further research for Korea and other developing countries.

APPENDIX

Meaning of coefficients related to exchange rates:

$$\begin{aligned}\ln L_t &= \lambda_0 + \lambda_1 \ln Y_t + \lambda_2 \ln Y_t^* + \lambda_3 Z_t + \lambda_4 Z_t^* \\ &\quad + (\lambda_{5,0} + \lambda_{5,1}\chi_t + \lambda_{5,2} M_t + \lambda_{5,3}\rho_t)\ln E_t + \lambda_6 \ln L_{t-1}.\end{aligned} \tag{1}$$

$$\begin{aligned}d\ln L_t &= \cdots + \lambda_{5,0} d\ln E_t + \lambda_{5,1}(d\chi_t \ln E_t + \chi_t d\ln E_t) \\ &\quad + \lambda_{5,2}(dM_t \ln E_t + M_t d\ln E_t) + \lambda_{5,3}(d\rho_t \ln E_t + \rho_t d\ln E_t) + \cdots.\end{aligned} \tag{2}$$

$$\partial \ln L_t / \partial \chi_t = \lambda_{5,1} \ln E_t \quad \Rightarrow \quad \lambda_{5,1} = (\partial \ln L_t / \partial \chi_t) * (1/\ln E_t)\,. \tag{3}$$

$$\partial \ln L_t / \partial M_t = \lambda_{5,2} \ln E_t \quad \Rightarrow \quad \lambda_{5,2} = (\partial \ln L_t / \partial M_t) * (1/\ln E_t)\,. \tag{4}$$

$$\partial \ln L_t / \partial \rho_t = \lambda_{5,3} \ln E_t \quad \Rightarrow \quad \lambda_{5,3} = (\partial \ln L_t / \partial \rho_t) * (1/\ln E_t)\,. \tag{5}$$

$$\partial \ln L_t / \partial \ln E_t = \lambda_{5,0} + \lambda_{5,1}\chi_t + \lambda_{5,2} M_t + \lambda_{5,3}\rho_t \quad \Rightarrow \quad \lambda_{5,0} = (\partial \ln L_t / \partial \ln E_t) - \lambda_{5,1}\chi_t - \lambda_{5,2} M_t - \lambda_{5,3}\rho_t. \tag{6}$$

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