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* Views expressed are those of the author and do not necessarily reflect official positions of De Nederlandsche Bank.

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ABSTRACT

The purpose of this study is to examine how monetary integration affects the exchange rate pass-through, by testing whether monetary policy convergence in the euro area led to a convergence in terms of exchange rate pass-through. We conduct a comparative study between the "experiment group" (the euro area) and the "control group" (non-euro industrial countries). We find evidence for stronger convergence of exchange rate pass-through for the euro area economies as a group, especially around the 1980s. The group of non-euro industrial countries also had *conditional* convergence (convergence with permanent cross-sectional heterogeneity) in exchange rate pass-through, but its cross-sectional dispersion remains substantially larger compared to the euro area. This indicates that monetary integration affects the exchange rate pass-through. This has an important policy implication for the euro area, especially for the new member countries, as their exchange rate pass-through would not remain constant or purely exogenous; it should also converge to the euro area average as they work to achieve the Maastricht Criteria.

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I. MOTIVATION AND LITERATURE

Exchange rate pass-through (the change in local currency CPI inflation resulting from change in the exchange rate) in the last two decades declined, both for developed and developing countries.[2] What is the main cause of the decline, however, remains an open question. Existing studies identify several factors. First, trade structures of industrial countries have changed substantially in the last few decades (Gusta, Leducb and Vigfusson (2010), Campa and Goldberg (2002)).[3] Second, monetary policy has improved in many countries (Taylor (2000); Rogoff (2003); Gagnon and Ihrig (2002)). Third, basic macroeconomic conditions – such as inflation, per capita incomes, tariffs, wages, long-term inflation, and long-term exchange rate variability (Choudhri and Hakura (2001); Sekine (2006); Frankel et al (2005)) – have changed substantially in the last ten or so years. Finally, globalization and increased competition reduced producer's ability to pass cost shocks onto the prices of final goods (Sekine (2006); Rogoff (2003); IMF (2006))[4]. Other studies claim that factors such as price stickiness (Devereux and Yetman (2009)), slower price adjustment, and pricing-to-market (Goldberg and Hellerstein (2008)) explain the lower pass-through.

It is essential for central bankers to know whether the exchange rate pass-through reacts to a monetary policy change – in other words, whether it is endogenous. While some studies find that a lower inflation environment is often associated with a lower exchange rate pass-through, there is no conclusive empirical evidence that a monetary policy improvement has caused lower exchange rate pass-through (see, for example, Gagnon and Ihrig (2002)). One problem lies in the difficulty of pinning-down and quantifying monetary policy changes in a time-series context, as well as in a cross-sectional context.

To examine the impact of monetary integration on the exchange rate pass-through, we conduct a comparative study between the "experiment group" (the euro area) and the "control group" (other

[2] See for example Ihrig et al (2006), Frankel et al (2005), and Mishkin (2008).

[3] Campa and Goldberg (2002) claim that monetary policy only has a second-order impact. In their view, the most important determinant is the industry composition of a country's import bundle. However, Otani et al. (2006) find evidence to the contrary for Japan, by showing that the decline in exchange rate pass-through is attributable to its decline in *each* product category in Japan.

[4] Taylor (2000) mentions this point as well, but he stresses that globalization is less important than monetary policy improvement. The reason is that globalization has been ongoing for more than fifty years, whereas the decline in exchange rate pass-through is a much more recent phenomenon. However, the problem with his argument is that he does not consider the effect of China's and India's integration into the world economy, which should have a different impact than economic integration among industrial countries. China's and India's integration into the world economy has caused a substantial decline in manufacturing goods prices while substantially increasing competition in goods and labour markets.

industrial economies, henceforth “non-euro industrial countries”). We define the “control group” as 10 non-euro industrial countries, namely, Australia, Canada, Denmark, Japan, Korea, Norway, Switzerland, Sweden, the UK, and the US (see Table 1).[5]

Table 1: Country Groups

Group	Countries (number of countries in the group)
Euro area	Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain. (11 countries)
Non Euro industrial countries	Australia, Canada, Denmark, Japan, Korea, Norway, Switzerland, Sweden, the UK, the US. (10 countries)

Note that Iceland, New Zealand, and Luxembourg are not included due to data unavailability.

In order to check if the difference in exchange rate pass-through convergence between the euro area and non-euro industrial countries is caused by other structural differences, we compared basic economic indicators of both groups. We calculated t-statistics to test if the difference between the two groups is statistically significant. The results are summarized in Table 2. Specifically, we looked at GDP per capita (PPP-based), GDP per capita growth, import per GDP, and the inflation rate. We took the average of the annual data during period between 1975 and 1980, and the period between 2001 and 2005. We could only reject the null hypothesis of the same mean for imports per GDP in the period between 2001 and 2005. The euro area countries have higher imports per GDP (especially intra-regional area), which is not surprising given the regional integration and adoption of a single currency. Still, the difference is only marginally statistically significant (10%). Overall, the difference of macroeconomic indicators of the two groups is insignificant enough to make our experiment valid. We look at two periods where globalization had momentum, which is 1975-1980 and 2001-2005. The period after 2005, especially with a huge spike in oil prices and financial crisis, it makes the comparison difficult. Therefore we take the data up to 2005.

[5] The idea that the introduction of the euro may have changed the behavior of exchange rate pass-through has also been studied by Campa et al (2005), who find no statistical evidence that the introduction of the euro caused a structural change in the transmission of exchange rate changes into *import prices*. Our study instead looks at exchange rate pass-through to headline CPI inflation, and we focus at convergence of exchange rate instead of structural changes.

Table 2: Difference in economic indicators between the euro area and non-euro industrial countries

	GDP per capita, PPP (current international $)		GDP per capita growth		Imports of goods and services (% of GDP)		Inflation, consumer prices (annual %)	
Periods (averages)	75-80	01-05	75-80	01-05	75-80	01-05	75-80	01-05
Euro area	6737.57	27846.27	2.33	1.38	32.27	42.67	13.01	2.46
Non Euro industrial	7807.44	30478.26	2.33	1.73	25.46	28.99	10.43	1.93
Mean difference	-1069.88	-2631.99	0.00	-0.35	6.82	13,68*	2.58	0.54

Note: * denotes the mean difference is statistically significant at 10% level.
Mean difference is calculated as euro area's mean minus non-euro industrial countries' mean.
The source: World Bank, World Development Indicators

Statistical significance is based on t-statistic calculated as follows:

$$t = \frac{(\overline{X}_{euro} - \overline{X}_{non-euro})}{S_{pooled}\sqrt{\frac{1}{n}+\frac{1}{m}}} \qquad \mathrm{S}_{\mathrm{pooled}} = \frac{(n-1)S^2_{Xeuro} + (m-1)S^2_{Xnon-euro}}{m+n-2}$$

X-bar denotes the sample average, S_{pooled} denotes pooled sample variance, and m and n denote the sample size of each group (11 and 10 in this case). Under the null hypothesis, this t-statistic follows t-distribution with m+n-2 degrees of freedom.

The idea is to see if the exchange rate pass-through has converged in the euro area countries (where there has been monetary policy integration), and how the convergence compares with the one of the control group. If a group of countries with monetary policy integration (i.e., the euro area) shows a stronger convergence in exchange rate pass-through, then monetary convergence may indeed be affecting exchange rate pass-through. We proceed as follows. Following previous research, we first estimate exchange rate pass-through coefficients in an extended Phillips curve equation[6]. We use rolling-regressions for each country to obtain time-varying exchange rate pass-through coefficients. Using these estimated pass-through coefficients, we conduct panel unit-root tests to examine the convergence in exchange rate pass-through, and analyze the difference in the convergence patterns between the euro area and non euro industrial countries.

We find evidence for stronger convergence of exchange rate pass-through for the euro area economies as a group, especially around the 1980s. The group of non-euro industrial countries also had *conditional* convergence (convergence with permanent cross-sectional heterogeneity) in

[6] See, for example, Sekine (2006), Ihrig et al (2006), Campa and Goldberg (2002).

exchange rate pass-through, but its cross-sectional dispersion remains substantially larger compared to the euro area. This indicates that monetary integration affects the exchange rate pass-through, - i.e. the pass-through is endogenous – whereas it is usually treated to be exogenous and fixed in the literature.

The remainder of the paper is organized as follows. The following section explains the data and model. Section III shows our results. Section IV concludes the paper.

II. DATA AND MODEL

Empirical model and data

We run simple rolling regression using the following specification:

$$\pi_t = \beta_0 + \beta_1 \pi_{t-1} + \beta_2 \bar{y}_{t-1} + \beta_3 \sigma^2_{e,t-1} + \sum_{i=0}^{1} \gamma_{i+1} e_{t-i} + \sum_{j=1}^{2} \varphi_i oil_{t-j} + \varepsilon_t \qquad [1]$$

π is headline inflation (quarter-on-quarter % change of the seasonally adjusted[7] quarterly CPI), $\bar{y}$ is the output gap measured as % deviation from smoothed[8] seasonally adjusted real GDP, σ^2_e is the volatility of the monthly exchange rate,[9] *e* is the % change of the nominal exchange rate (local currency per US$[10], for the US we use the nominal effective exchange rate (NEER)), *oil* is % change in average crude oil prices, and ε is the disturbance term. Expected signs are positive for all coefficients.

The data covers the period between 1975 and 2005 with quarterly frequency. We did not include the data after 2005 as a sharp oil price increase, the rise of BRICs, and the financial crisis makes the data very volatile and makes it difficult to come up with robust results. For Denmark, Ireland, the

[7] We use the X-12 methods to seasonally adjust the inflation rate, real GDP and industrial production when the original data is not seasonally adjusted.
[8] The quarterly series is smoothed using Hodrick-Prescott (HP) filter with smoothing parameter of 1600.
[9] Volatility (change in natural log of exchange rate) of monthly exchange rate (local currency per US$) over the previous 12 months. Volatility is included based on a finding by Campa and Goldberg (2002) that exchange rate volatility is associated with higher pass-through of exchange rates into import prices.
[10] We believe that the exchange rate vis-à-vis the US$ is a better measure for external cost shocks than nominal effective exchange rate (NEER), given the role of the US dollar as the world's vehicle currency. Especially, primary commodities are almost exclusively denominated in the US dollar (Source: Rehman (1998), Goldberg and Tille (2005)). As an illustrative example, the difference between the NEER and per dollar exchange rate becomes very substantial around 2000 for many European economies, because of the Russian financial crisis in the year. However, most imports of European countries from Russia are commodity products, which are almost exclusively denominated in the US dollar. Therefore, the per US dollar exchange rate is a more relevant indicator for external shocks.

Netherlands, and Portugal, we use industrial production data instead of real GDP due to unavailability of quarterly real GDP in the 70s. All the data are taken from IMF-IFS, except German CPI, Italian real GDP, Korean nominal effective exchange rate, which come from the Bundesbunk, Datastream, and the BIS, respectively. The rolling regressions are estimated with Newey-West standard errors, to control for possible serial correlations from using over-lapping data. The window length is 40 quarters (10 years). Regarding lag structures, Marrazzi et al (2006) find that exchange rate pass-through tends to occur fairly rapidly, mostly with a quarter lag. Based on this observation, we include the contemporaneous and 1-quarter lag of exchange rate percentage change. For the oil price, we include two lags following Hooker (2002)[11]

In order for the extended Phillips curve as represented by equation [1] to be estimated consistently, all variables in the equation need to be stationary. To test the stationarity of variables, we used the Phillips-Perron test, which rejects the unit root hypothesis at the 10% or less level of significance for all variables of all countries, except for the two cases (Greece's inflation rate and UK's output gap).[12]

Panel unit root tests

Estimating [1] with a rolling regression method gives us the panel dataset of exchange rate pass-through coefficients, for which we apply panel unit root test. Panel unit root tests are widely used to measure convergence of economic variables across economies (Quah (1998), Evans and Karras (1996), and Cecchetti, Mark and Sonota (2002), Weber and Beck (2005)). The idea is to apply a unit-root test in a panel setting to see if variables diverge from each other (the null hypothesis) or converge to a steady state value (the alternative hypothesis). In our study, following Cecchetti et al. (2002), we use the Levin, Lin and Chu (henceforth LLC) test (2002) and the Im, Pesaran and Shin (henceforth IPS) (2003) test.

[11] Ideally, we should pick the optimal lag using the AIC or BIC test, but due to the constraint that we have to have the same lag structure across the countries, we picked the number of lags derived from the recent literature.

[12] The augmented Dicky-Fuller tests rejected the unit-root hypothesis for all variables of all countries except for the inflation rate. For the period between 1985 and 2005, we could reject the unit root hypothesis for all of our sample countries except for Germany, Greece, Sweden and Switzerland. This implies that structural breaks or a change in the mean of inflation may be causing under-rejection of the unit root hypothesis. It may also be the case that serial correlation is leading to the rejection of the unit-root hypothesis, as Phillips-Perron tests reject the unit root hypothesis in most cases even when we take the entire period as our sample. Since we run rolling regressions for different sub-periods and Phillips-Perron tests reject the unit root hypothesis, we do not take the first difference of inflation.

Specifically, we apply the following specification to the pass-through coefficient.

$$\Delta q_{i,t} = \alpha_i + \theta_t + \varphi_i q_{i,t-1} + \sum_{j=1}^{k_i} \lambda_{ij} \Delta q_{i,t-j} + \varepsilon_{i,t} \qquad [2]$$

Where $q_{i,t}$ represents the pass-through coefficients ($\gamma_1 + \gamma_2$ of equation [1]) of country i at time t, α_i is a country-specific constant (to control for possible structural heterogeneity across countries), θ_t is a common time effect, k_i is lag-length chosen for each country[13] using the Schwarz criterium, and. λ_{ij} is a lag coefficient in the process characterizing q_{it},

$$\varphi_i \equiv \rho_i - 1,\ \rho_i \equiv \sum_{j=1}^{k_i} \lambda_{ij} \qquad [3]$$

ρ is a persistent parameter.

By taking de-meaned (deviation from the group mean) exchange rate pass-through coefficients, [2] can be expressed as:

$$\Delta \tilde{q}_{it} = \tilde{\alpha}_i + \varphi_i \tilde{q}_{i,t-1} + \sum_{j=1}^{k_i} \lambda_{ij} \Delta \tilde{q}_{i,t-j} + \varepsilon_{it} \qquad [4]$$

where the tilde operator denotes deviation from the cross-sectional mean.

The null hypothesis is that there is a unit root for all i (each series contains a unit root), H_1: $\varphi_i = \varphi < 0$ (under LLC), or H_1: $\varphi_i < 0$ for *at least* one i (under IPS)). The difference between LLC and IPS tests is their treatment of φ under the alternative hypothesis. Whereas the LLC test assumes a common unit root process, the IPS test allows φ_i to differ across countries under the alternative hypothesis (H_1: $\varphi_i < 0$ for <u>some</u> i). Each test has its advantages and disadvantages relative to each other. The LLC test has the advantage of providing us with a panel estimator for persistence, whereas IPS does not (Cecchetti, et al. (2002)). However, the IPS test has more power than the LLC test (Bowman (1998), Maddala and Wu (1997)). Therefore, we conduct both tests. In doing the tests, we include individual fixed effects. To analyze the speed of convergence, we also calculate the half-life of a shock to pass-through, which is computed as $-\ln(2)/\ln(\rho)$. Regarding the persistence parameter (ρ), it is shown by Nickell (1981) that this parameter is biased downwards in small samples. Since a half-life is a non-linear function of serial correlation estimates, a small bias can lead to a large difference in a half-life convergence. We therefore use Nickell's bias correction formula.

[13] Lag length are allowed to differ across countries.

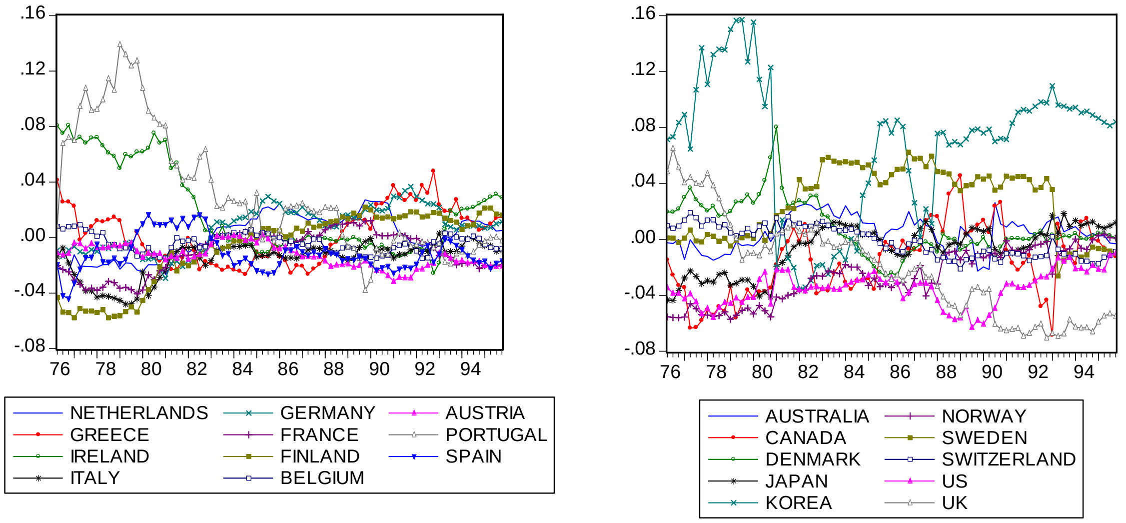
III. RESULTS

Graphical inspection

We estimate equation [1] with a rolling regression with a window length of 40 quarters. The rolling regression estimates of ($\gamma_1 + \gamma_2$) in equation [1] (pass-through coefficients) are reported in Figure 1. For each country's pass-through coefficients, please refer to the Appendix I.

Figure 1: Estimated exchange rate pass-through coefficients from rolling regression

Euro area Non-Euro industrial countries

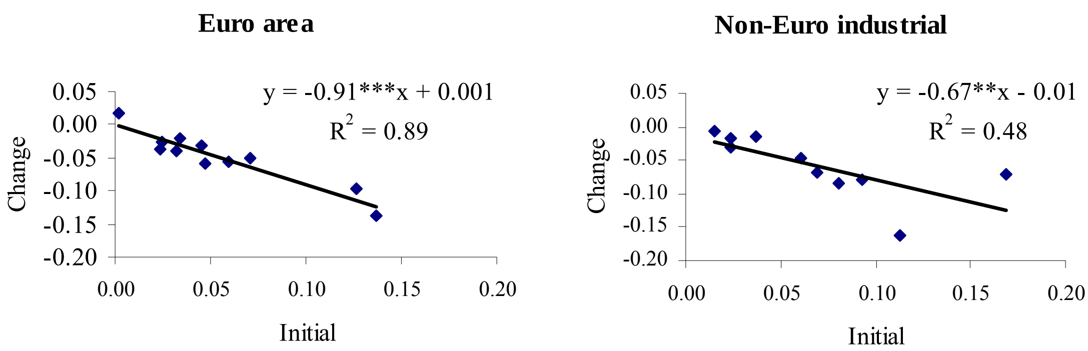


Note: Difference from the cross-sectional mean. Each data point denotes the first quarter/year of the 10-years rolling regression windows.

We begin with a graphical inspection of the pass-through coefficients. We begin with a graphical inspection of the pass-through coefficients. Figure 1 shows declines in exchange rate pass-through in most of our sample countries, which is consistent with previous findings in the literature. More importantly, the figure shows that the initially dispersed exchange rate pass-through coefficients for the euro area countries converged in the 1980s (note that the dates represent the *beginning* of the 10-years rolling window, so a coefficient in 1980Q1, for example, is estimated using the period from 1980Q1 up to 1989Q4). During the period, the exchange rate pass-through has declined substantially for countries which had high inflation in the 1970s, such as Portugal, Greece, and Ireland. For the group of non-euro industrial countries, the dispersion is substantially wider, and there is no strong (graphical) indication for convergence. Cross-sectional dispersion for the non-euro industrial countries remains large even with recent data, ranging from negative -0.08 to + 0.08, which is much larger than the euro area's dispersion (from -0.02 to 0.03).

Figure 2 plots changes in pass-through over the sample period versus the initial pass-through. Negative and statistically significant slopes indicate convergence of exchange rate pass-through for both groups. The convergence seems to be more pronounced for the euro area, as indicated by larger (absolute) coefficient and higher R^2.

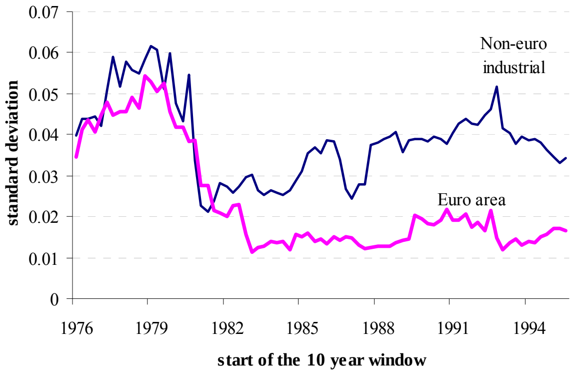
Figure 2: Initial exchange rate pass-through and change in pass-through



:
X-axis = Initial pass-through (the average of first 10 quarters)
Y-axis = Change in pass-through (the average of last 10 quarters minus the average of first 10 quarters)

Furthermore, Figure 3 plots the standard deviation of the exchange rate pass-through of each group, which illustrates the overall low dispersion of exchange rate pass-through for the euro area, especially after the early 1980s. This should give us a good idea of the absolute convergence of exchange rate pass-through of both groups. It is interesting to notice that the dispersion of exchange rate pass-through declined in the beginning of the 1980s.

Figure 3: Cross-country dispersion of exchange rate pass-through



Note: standard deviation of estimated exchange rate pass-through coefficients of each group.

Formal test for convergence – panel unit root tests

To formally test for convergence, we conduct panel unit root tests described in the previous section. To avoid under-rejection of unit root hypothesis due to structural breaks, we split the sample into the following three sub-periods (See Appendix II):[14]

Period I: 1976Q2 – 1984Q4 (Estimated coefficients apply to the data between 1976Q2 and 1994Q4)

Period II: 1980Q1 – 1989Q4 (Estimated coefficients apply to the data between 1980Q1 and 1999Q4)

Period III: 1985Q1 – 1995Q4 (Estimated coefficients apply to the data between 1985Q1 and 2005Q4)

We conduct the Levin, Lin and Chu (2002) and the Im, Pesaran and Shin (2003) tests. The LLC test tests for absolute convergence as well as conditional convergence (the latter allows for cross-sectional heterogeneity in exchange rate pass-through), whereas the IPS test can only test for conditional convergence by its construction. If we are willing to assume that exchange rate pass-through should not be affected by structural factors (such as trade structure), then absolute convergence makes more sense, but it is a rather strong assumption. Hence, we focus our discussion on the conditional convergence test. For those instances in which we could reject the unit-root hypothesis (i.e., there is a statistical convergence) at the 10% significance level or less, we also calculate the half-life convergence periods (reported in quarters), corrected for the Nickell bias. Since IPS assumes a different persistence parameter across the sample, it does not provide the panel

[14] In splitting up the sample, we roughly followed structural breaks estimated in the previous section.

persistent parameter. Therefore we report estimated panel persistent parameter and half-life only for the LLC test.

There is a caveat. Since we are using estimated coefficients as dependent variables, our sample is vulnerable to measurement errors. This means that, while coefficients are correctly estimated, critical values of coefficients might not be correct. We have to take this into account when interpreting the results.

The results are presented in Table 3. We can reject the null hypothesis of no (conditional) convergence for the euro area for sub-period II and sub-period III. For non-euro industrial countries, we can reject the null hypothesis for sub-period III. The cross-sectional heterogeneity, however, is much smaller for the euro area, especially after 1982. Given that the European Exchange Rate Mechanism (ERM) was introduced in 1979, convergence in exchange rate pass-through during the early 1980s indicates that monetary integration may have played a role. Regarding the speed of (conditional) convergence, the estimated half-life to convergence is around 4 years for the euro area for sub-period II, and around 3 and 2 years for the euro area and non-euro industrial countries, respectively, for sub-period III.

Table 3: Panel unit root test for exchange rate pass-through convergence

	IPS Test	LLC Test		
1976Q2 to 1984Q4 (subperiod I)	Statistic	Statistic	Adjusted $\hat{\rho}$	Adj. half life
The Euro area	2.09	0.92	--	--
Non euro industrial countries	0.70	-0.01	--	--
	IPS Test	**LLC Test**		
1980Q1 to 1989Q4 (subperiod II)	Statistic	Statistic	Adjusted $\hat{\rho}$	Adj. half life
The Euro area	-2.04 **	-3.70 ***	0.96	17.30
Non euro industrial countries	-0.29	-1.10	--	--
	IPS Test	**LLC Test**		
1985Q1 to 1995Q4 (subperiod III)	Statistic	Statistic	Adjusted $\hat{\rho}$	Adj. half life
The Euro area	-1.28 *	-0.84	0.94	11.64
Non euro industrial countries	-2.35 ***	-2.47 **	0.91	7.00

Note: The period denotes the first period of rolling regression windows.
IPS Test = In, Pesearan and Shin Test, LLC Test = Levin, Lin and Chu Test
Reported half life is in number of quarters.

IV. CONCLUSION

The purpose of this study is to assess how monetary integration affects the exchange rate pass-through. In order to do so, we test how the exchange rate pass-through converged in the euro area, which gradually achieved monetary integration since the start of exchange rate mechanism (ERM) in 1979. To get a better perspective, we compare the convergence of the euro area's exchange rate pass-through with that in the other group non-euro industrial countries.

Overall, we find evidence for stronger convergence in terms of exchange rate pass-through for the euro area. When we allow for structural individual heterogeneity (conditional convergence), then our panel unit root tests reject the null hypothesis of no convergence for the non-euro economies as well as euro economies. However, in terms of absolute convergence, the euro area's exchange rate pass-through shows clear convergence in the 1980s, as shown by a sharply declining cross-sectional dispersion of the pass-through during the period. The non-euro area industrial countries' pass-through dispersion remains substantially larger than the one of the euro area. In terms of timing, the convergence occurred around the 1980s, implying that the monetary integration process which started in 1979 under ERM may indeed have played a role.

Our results indicate that monetary integration affects the exchange rate pass-through. This has an important policy implication for the euro area, especially for the new member countries, as their exchange rate pass-through would not remain constant or purely exogenous; it should also converge to the euro area average as they work to achieve the Maastricht Criteria.

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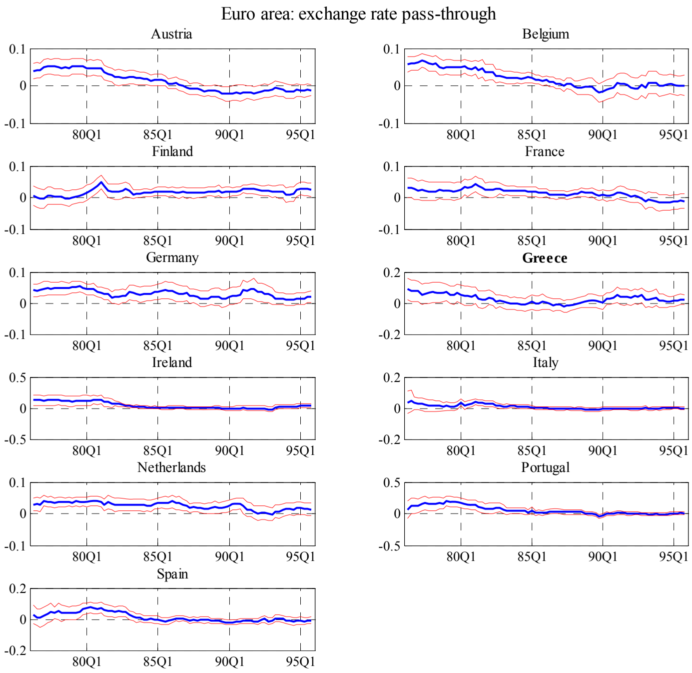
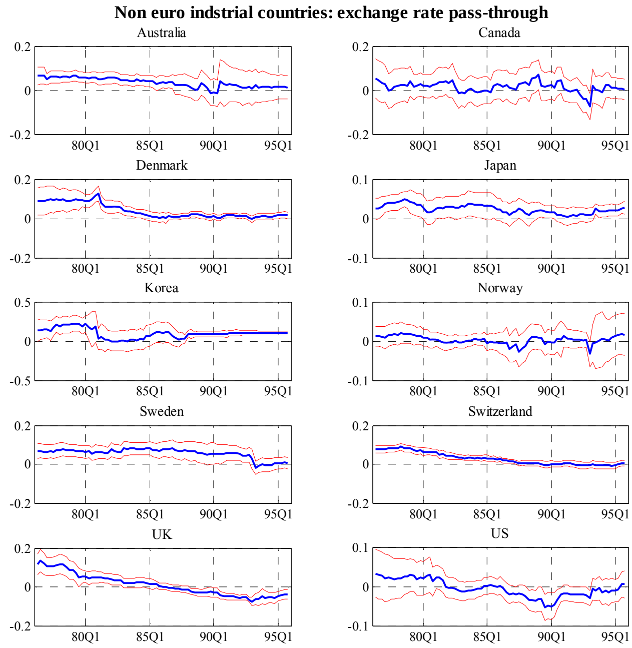
Appendix I: Exchange rate pass-through coefficient and 95% confidence intervals





Note: Estimated coefficient ± 2 standard deviations. Year and quarter reported in X-axis denotes the beginning of the rolling windows. The coefficient is the sum of γ_1 and $\gamma 2$, and the standard deviation reported is the average of σ (γ_1) and σ (γ_2) in equation [1].

Appendix II: Structural stability of exchange pass-through equation (equation [1])

Before testing exchange rate convergence, we check for the structural stability of estimated coefficients. Levin and Piger (1994) and Perron (1999) show that when there is a structural break, persistence parameters will be biased upwards. To test the parameter stability of equation [1], we conducted a structural break analysis proposed by Andrews (1993), and Andrews and Ploberger (1994).[15] Testing for endogenous structural breaks in a macroeconomic series is a subject of rich literature. A pioneering study by Andrews (1993) provides statistics for parameter instability when the structural break point is unknown. Andrews and Ploberger (1994) examine the optimal test for problems in which a nuisance parameter exists under the alternative but not under the null. These methods can be used to test for a one-time structural change with an unknown change point. Hansen (1997) conducts a numerical approximation to the asymptotic distribution proposed by Andrews (1993) and Andrews and Ploberger (1994) and presents an approximation of p-values.[16]

The results are presented in table A1 (next page). Note that these statistics relate to a structural break of the entire equation [1] (not of the individual coefficient).[17] The evidence for a structural break is compelling, with the null hypothesis of no structural break rejected at 5% in almost all cases.[18] Most structural breaks occur in the late 80s and the early 90s, which is consistent with observations in the literature that inflation behavior has changed in the last 10-20 years.[19] There is no apparent difference between the structural breaks found for the euro area economies and the non-euro industrial countries.

[15] It is not feasible to conduct endogenous structural break test directly for LLC or IPS tests (equation [2]), if the break period differs across countries (Breitung and Candelon (2003)).
[16] Available on his web-site: www.ssc.wisc.edu/~bhansen
[17] It is possible to conduct structural break tests for exchange rate pass-through coefficient alone, but this causes a problem when there is a structural break in other parameters as they are not allowed to change if we place that restriction.
[18] Based on Sup, Ave, Exp tests proposed by Andrews (1993) and Andrews and Ploberger (1994). For a few countries in our sample, the null hypothesis is rejected at 10% level. Detailed results are available upon request.
[19] Please see Appendix III for statistical properties of inflation rate of our sample countries in different sub-periods.

Appendix A(I). Structural break test

	Estimated structural breakdate	SUP	EXPP	AVE
Australia	1991 Q2	**	**	***
Austria	1985 Q2		*	**
Belgium	1985 Q2	**	**	***
Canada	1991 Q2		*	**
Denmark	1989 Q1	*	**	***
Finland	1989 Q2	**	**	***
France	1984 Q3	*	**	**
Germany	1991 Q4		*	**
Greece	1996 Q1	*	**	**
Ireland	1986 Q2		*	**
Italy	1995 Q1			
Japan	1981 Q2	**	**	**
Korea	1980 Q2	***	***	**
Netherlands	1984 Q1	*		
Norway	1986 Q3		*	**
Portugal	1992 Q3			
Spain	1989 Q3		*	**
Sweden	1994 Q3	**	**	***
Switzerland	1993 Q3	***	***	***
United Kingdom	1991 Q1	*	**	**
United States	1986 Q3	**	**	***

Note: Structural break test applied for equation [1]. ***, **, * denotes statistical significance of structural break from Sup, Expp and Ave test proposed by Andrews (1993) and Andrews and Plogerber (1994)

Appendix III: Statistical properties of inflation process of our sample countries

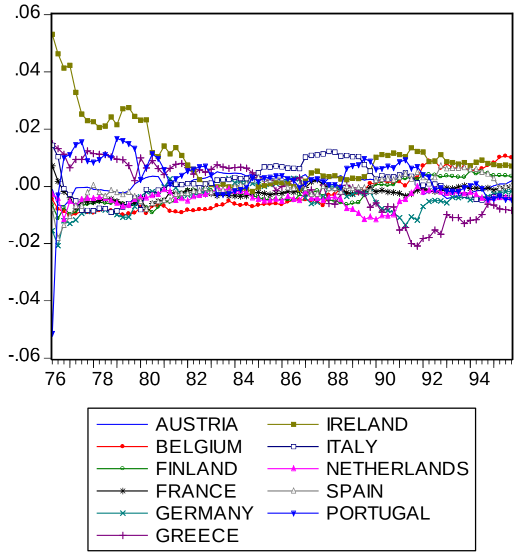
	Inflation average of the period (in percent)											Average across countries	Standard deviation (across countries, average of the period)
	Austria	Belgium	Finland	France	Germany	Greece	Ireland	Italy	Netherlands	Portugal	Spain		
All period (1976Q2 to 2006 Q1)	3.15	3.63	4.83	4.65	2.64	12.17	6.24	7.35	3.12	10.93	7.82	6.05	0.98
1976Q2 to 1984Q4	5.41	7.08	10.39	10.50	4.31	17.70	14.12	15.78	5.69	21.64	15.98	11.69	1.61
1985Q1 to 1992Q4	2.67	2.52	4.44	3.11	2.32	17.26	3.33	5.68	1.63	11.20	6.35	5.50	1.18
1993Q1 to 2006Q1	1.90	1.93	1.32	1.62	1.74	5.30	2.85	2.79	2.33	3.30	3.31	2.58	0.40

	Australia	Canada	Denmark	Japan	Korea	Norway	Sweden	Switzerland	UK	US	Average across countries	Standard deviation (across countries, average of the period)
All period (1976Q2 to 2006 Q1)	5.64	4.45	4.62	1.96	7.20	4.94	5.18	2.30	6.06	4.37	4.67	0.70
1976Q2 to 1984Q4	10.01	8.75	9.54	5.04	14.09	9.12	10.02	3.34	12.06	7.64	8.96	1.11
1985Q1 to 1992Q4	6.08	4.08	3.38	1.62	5.66	5.12	5.99	3.23	5.47	3.79	4.44	0.64
1993Q1 to 2006Q1	2.60	1.89	2.06	0.06	3.89	2.01	1.37	1.01	2.53	2.59	2.00	0.43

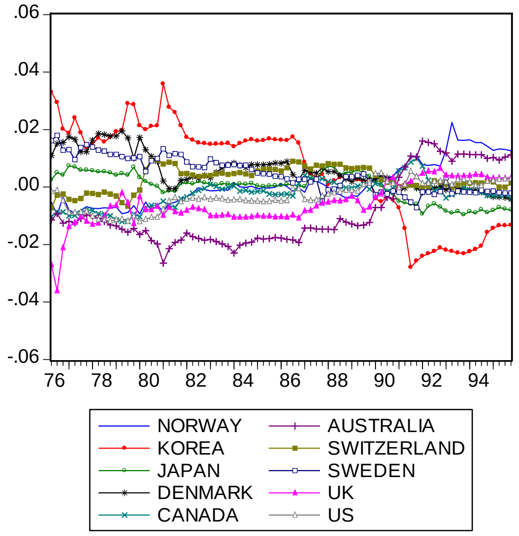
Note: inflation rate is defined as annualized quarter-on-quarter % change of CPI (seasonally adjusted, headline inflation).

Appendix IV: Oil price pass-through coefficients from rolling regression (demeaned)

Euro area



Non-euro industrial countries



Note: Difference from the cross-sectional mean. The period denotes the first quarter/year of the 10-years rolling regression windows.

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