DNB Working Paper
No. 497 / January 2016

Price level convergence within the euro area: How Europe caught up with the US and lost terrain again

Marco Hoeberichts and
Ad Stokman

DeNederlandscheBank
EUROSYSTEEM

Price level convergence within the euro area: How Europe caught up with the US and lost terrain again

Marco Hoeberichts and Ad Stokman *

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

Working Paper No. 497

January 2016

De Nederlandsche Bank NV
P.O. Box 98
1000 AB AMSTERDAM
The Netherlands

Price level convergence within the euro area: how Europe caught up with the US and lost terrain again*

Marco Hoeberichts[a] and Ad Stokman[a]

[a] *De Nederlandsche Bank, Economics & Research Division, PO Box 98, 1000 AB Amsterdam, the Netherlands, e-mail m.m.hoeberichts@dnb.nl and a.c.j.stokman@dnb.nl*

18 January 2016

Abstract

Persistent price differences across euro area countries are an indication of incomplete economic integration. We analyze long and short run developments of price level dispersion in the euro area and compare the results with the situation in the US. We find that monetary and economic integration in Europe has been successful in establishing a major downward trend in price level differences across countries since 1960. In 2007, price level dispersion in the euro area was at the same level as in the US. After the financial crisis, dispersion first continued its downward trend before diverging economic conditions across euro area countries contributed to a widening of price level differences again. Short-run dynamics show that price dispersion in Europe deviates more from the long-term equilibrium than in the US, although deviations have become smaller since EMU.

Keywords: economic integration, price-level convergence, law of one price, EMU, US.
JEL classifications: E31, E37, F15.

* Acknowledgements: The paper has benefited from useful comments from Peter van Els, Jakob de Haan and Johan Verbruggen. The views expressed in this paper are those of the authors and do not necessarily reflect those of De Nederlandsche Bank. Any remaining errors are the authors' own responsibility.

1. Introduction

Persistent price differences across countries are often seen as an indication of incomplete economic integration of the countries. Engel and Rogers (1996) show that both borders and sticky prices cum volatile exchange rates are key elements in explaining price differences across countries. Their approximation of the US-Canadian border effect by a distance equivalent of 75,000 miles has challenged many to investigate the sources of international price dispersion. Gorodnichenko and Tesar (2009), e.g., demonstrate that commonly used dummies to capture border effects cannot separate border frictions from economic factors that give rise to different distributions of price volatility within countries. Others investigated price differentials across regions within a single country and thereby circumvent the problems associated with measuring country border effects. See for a recent example Crucini, Shintani and Takayuki (2010). Exchange-rate volatility and shipping costs are examples of time varying segmentation effects that are found to be important determinants of price dispersion (see e.g. Parsley and Wei, 2001). Next to exchange rate variability, Faber and Stokman (2009) consider long term trade developments among European countries as a measure of diminishing border effects.

In this paper, we analyse long term developments in price *level* dispersion within Europe and within the US from 1960 up to and including 2014. This enables us to identify the time-varying component of border effects that are hard to distinguish for short episodes.

In the past 50 years, price level dispersion within the euro area more than halved. Price level convergence was particularly strong in the 1960s, early 1970s and early 1990s. There have been two episodes in which price level convergence stagnated. That was from mid 1970s up to mid 1980s and in recent years from 2010 onwards. Within the US, contrary to Europe, price level dispersion remained by and large stable until 1983, well below the European level. Halfway the 1980s, the US price dispersion rate started to rise. In the year 2007, the gap between the euro area and US price level dispersion was closed. In this paper we investigate how Europe succeeded in closing the gap and why price dispersion started rising again after 2010. We also investigate the dynamics around the long-term equilibrium and find remarkable differences between the euro area and the US.

The paper is organized as follows. In Section 2 we present our model. Section 3 discusses our dataset. Section 4 shows the results of the estimation and some robustness checks and Section 5 concludes.

2. Model

We define price level dispersion across a set of countries (or across regions within the US). P_{jt} is the absolute price level of a basket of products in country j (or region j) at time *t*. Price level dispersion at time *t* is measured by the cross-country (cross-region) standard deviation of ln (P_{jt}):

$$\sigma(p_t) = \sigma(\ln(P_{jt}) \mid t) = \sqrt{\frac{1}{n}\sum_{j=1}^{n}[\ln(P_{jt}) - \frac{1}{n}\sum_{i=1}^{n}\ln(P_{it})]^2} \qquad (1)$$

Next, we derive the relationship between price level dispersion and its main determinants. Following Crucini *et al.* (2005), production in a country is described by a Cobb-Douglas technology with a traded and a non-traded input factor. The distinction between traded and non-traded inputs is crucial for analyzing price differences between countries, as tradable goods open the possibility of arbitrage. In all countries under consideration, the bundle of goods is produced by the same Cobb Douglas technology with constant returns to scale. Furthermore, we assume that there is perfect competition. This gives

$$P_{jt} = W_{jt}^{\alpha} Q_{jt}^{1-\alpha} \qquad (2)$$

α is the share of non-traded inputs required for producing one unit of the basket of goods. W_{jt} is the price of the non-traded input and Q_{jt} the price of the traded input in country *j* at time *t*. From Eq. 2 we derive an approximation for the long-run relationship between the level of price dispersion and its determinants, first by taking the natural log on the right and left hand side of Eq. 2 (p=ln(P), w=ln(W)) and q=ln(Q)).

$$p_{jt} = \alpha w_{jt} + (1-\alpha) q_{jt} \tag{3}$$

At each point in time t, we calculate the variance of the price level across countries (or regions):

$$Var(p_{jt}|t) = [\sigma(p_{jt}|t)]^2 = \left[\alpha\sigma(w_{jt}) + (1-\alpha)\sigma(q_{jt})\right]^2 + 2\alpha(1-\alpha)\sigma(w_{jt})\sigma(q_{jt})\left[Cor(w_{jt}, q_{jt}) - 1\right] \tag{4}$$

For sufficiently high correlation between w_t *and* q_t the second term may be ignored (see Faber and Stokman, 2009). This gives the following expression for $\sigma(p_{jt}|t)$, shortly σp_t :

$$\sigma p_t \approx \alpha \sigma w_t + (1-\alpha)\sigma q_t \tag{5}$$

The dispersion of price levels is a weighted average of the dispersion of non-traded input costs *w* and the dispersion of traded input costs *q*. The dispersion of traded input costs is expected to be higher if arbitrage costs are higher (see e.g. Rogoff, 1996). Arbitrage costs depend on exchange rate volatility (vol_t) as a measure of cross border uncertainty stemming from the presence of national currencies. Arbitrage costs also depend on transportation costs. The crude oil price p_{oil} is taken as a proxy of the time dependent part of distance. Finally, the share of goods trade among the countries (regions) under consideration relative to GDP ($open_t$) summarizes the development over time of all other trade costs like (non-) tariffs barriers and information costs.

$$\sigma q_t = f(open_t(-), vol_t(+), p_{oil,t}(+)) = \partial_0 + \partial_1 open_t + \partial_2 vol_t + \partial_3 \ln p_{oil,t} \tag{6}$$

Substituting Eq. 6 into Eq. 5 gives the following relationship for price level dispersion

$$\sigma p_t = \alpha \sigma w_t + (1-\alpha)[\partial_0 + \partial_1 open_t + \partial_2 vol_t + \partial_3 \ln p_{oil,t}] + \varepsilon_t \tag{7}$$

Eq. 7 provides us with an analytical tool to identify the long-term factors driving price level dispersion. As the variables in Eq. 7 have a unit root we will perform an integration-cointegration analysis. Eq. 7 is also our starting point to investigate possible regularities in price dispersion dynamics.

$$\Delta \sigma p_t = \beta_0 + \beta_1 \Delta \sigma p_{t-1} + \beta_2 \Delta \sigma w_{t-1} + \beta_3 \Delta open_{t-1} + \beta_4 \Delta vol_{t-1} + \beta_5 \Delta \ln p_{oil,t-1} - \delta\, ecm_{t-1} + \xi_t \tag{8}$$

ecm_t is the residual term in the estimated Eq. 7

3. Data

Starting in 1995, EUROSTAT publishes *absolute* HICP aggregate price levels for EU member states relative to the absolute price level for the EU as a whole. The choice of the denominator does not affect the size of our price dispersion measure.

HICP *indices* are available back to 1960.[1] To construct absolute levels of HICP for years preceding 1995, we apply a similar methodology as used by Chen and Devereux (2003) for US city CPIs. Firstly, all country HICP indices are converted into a common currency using yearly averages of market exchange rates. Next, the HICP indices up to and including 1995 are

[1] Source: OECD Economic Outlook (Number 75, June 2004).

converted into absolute price levels through synchronization with the country HICP absolute price level for the year 1995.[2]

Aggregate price levels for 20 US cities from 1960 onwards are constructed similarly.[3] By doing so, we obtain a consistent dataset covering the 1960 – 2014 period. Chen and Devereux (2003) and Faber and Stokman (2009) show that this approximation of the underlying absolute values of HICP is reliable. The set of partly constructed and partly collected absolute price levels allows us to calculate price level dispersion for the euro area and for the US (see Fig. 1A below).

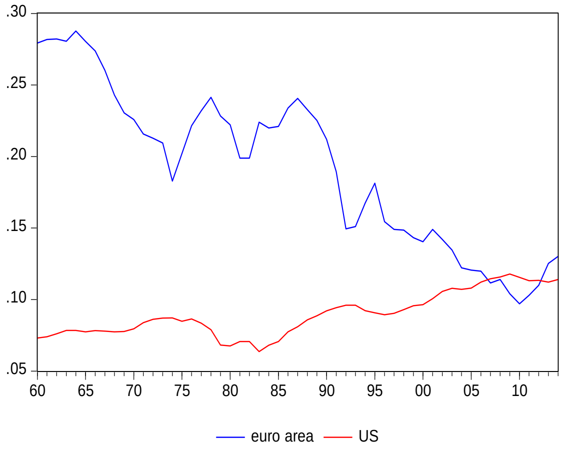
Following the model specification in Eq. 7 and Eq. 8, additional data are required for non-traded input costs, openness, exchange rate volatility and transportation costs. The level of income dispersion within the euro area, which we use as a proxy for dispersion in the cost of the non-traded input in Eq. 7, is calculated on the basis of the per capita gross domestic product at factor costs in each of the 11 euro area countries converted to common units using PPP measures.[4] For the US the construction of income dispersion is based on annual data of GDP per head in US states. Figure 1B depicts the development of GDP per head dispersion in the euro area and the US.

For openness within the euro area we take the average share in GDP of goods exports from all 11 euro area countries to other EU countries (members 2003). For the US no time series on trade among US states or regions are available. From the Commodity Flow Survey, which offers the most comprehensive nationwide source of freight data, the value of goods traded between US regions was calculated for 1977, 1993, 1997, 2002 and 2007.[5] See Fig 1C.

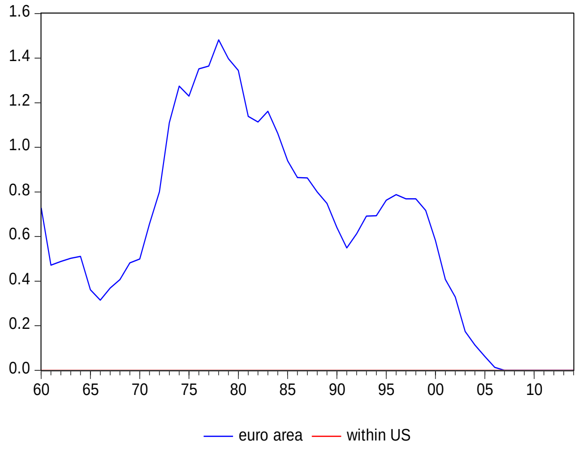
[2] Source: Eurostat Chronos.
[3] Source: Bureau of Labor Statistics and Cecchetti, Mark, and Sonora (2002) for city CPIs.
[4] Source: OECD Economic Outlook and additional data from the World Development Indicators database. (Europe) / Bureau of Economic Analysis (US). A correction is made for the German reunification.
[5] Source: Bureau of Transportation Statistics, Commodity Flow Surveys, US Dept. of Transportation.

Fig. 1 The data

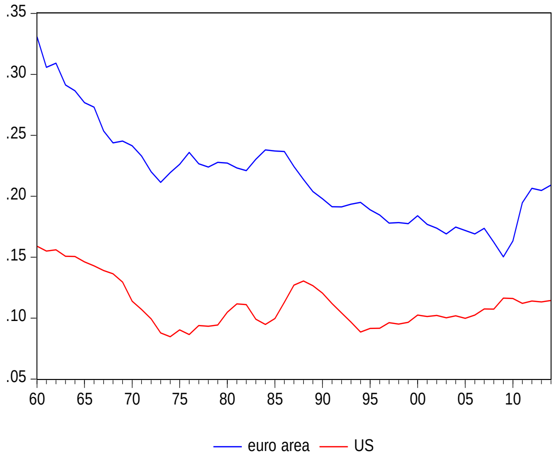
1A Price level dispersion within Europe and the US



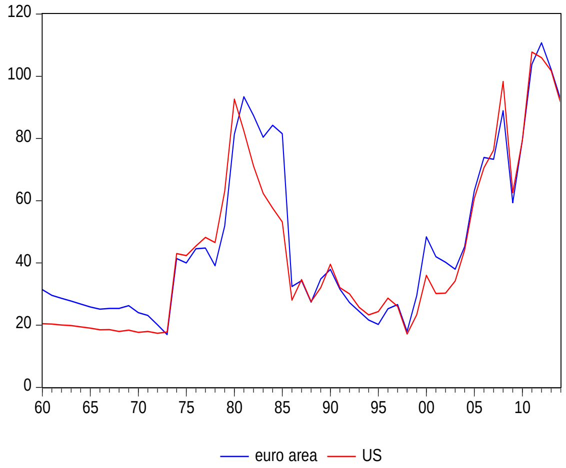
1D Nominal exchange rate volatility



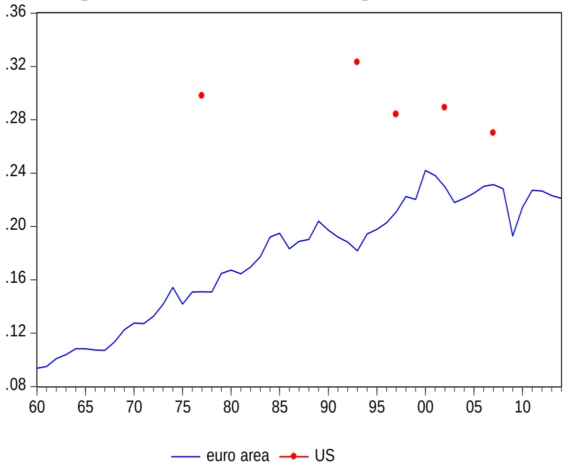
1B Income dispersion within Europe and the US



1E Price crude oil per barrel (deflated by CPI 2010=1)



1C Openness internal market Europe and the US



Long-term European exchange rate volatility vol_t is measured by the standard deviation of all monthly changes in the exchange rate of a country against the German DM in a given year, averaged over all countries in the group and over eight years.[6] We use the nominal bilateral exchange rate with Germany because Germany was de facto the anchor country in the European exchange rate system. Since we analyze unweighted price dispersion across countries, we do not use an effective exchange rate based on trade weights. Eight years is about the average length of the European business cycle during the past 50 years. See Fig. 1D.

Finally, transportation costs are represented by the crude oil price per barrel deflated by the CPI (in $ for the US, DM/euro for Europe). See Fig 1E.

4. Empirical findings

In this section, we present our empirical results. As price level dispersion in the euro area and the US are non-stationary variables, we apply a co-integration analysis. This puts us in a position to disentangle the long-term equilibrium behaviour from the short-term dynamics. The long-term equilibrium is specified in Eq. 7 and the dynamic part in Eq. 8.

Long run

First, we take a closer look at the outcomes for the long-run relationship of price level dispersion. In the euro area, price level dispersion, income dispersion, exchange rate volatility, the natural logarithm of the oil price and openness all have a unit root of order one for the full sample (Table 1). Price level dispersion within the US is non-stationary; income dispersion within the US is stationary (Table 2). Time series data for trade within the US are lacking. The

[6] Source: IMF IFS and Reinhart and Rogoff (2004).

Table 1 Adf unit root test statistics euro area

	1962-2014	
	Level	Δ
σp_t	-3.00 (0.14)	- 5.45 (0.00)
σw_t	-2.32 (0.17)	-4.13 (0.00)
$open_t$	-2.15 (0.51)	-7.87 (0.00)
vol_t^l	-2.13 (0.52)	-3.09 (0.03)
$\ln p_{oil,t}^{dm}$	-1.49 (0.53)	-7.31 (0.00)

Note p-values between parentheses

Table 2 Adf unit root test statistics US

	1962-2014		1984-2014	
	Level	Δ	Level	Δ
σp_t	-2.11 (0.53)	- 4.65 (0.00)	-3.11 (0.12)	- 4.83 (0.00)
σw_t	-3.10 (0.03)	-4.20 (0.00)	-2.96 (0.05)	-3.49 (0.02)
$\ln p_{oil,t}$	-1.22 (0.66)	-7.29 (0.00)	-2.36 (0.39)	-5.80 (0.00)

Note p-values between parentheses

available years reveal no clear upward or downward trend. We treat this series in the following as a stationary variable. The log oil price in US dollars is a non-stationary variable.

Concerning price level dispersion in the euro area, we adopt the Johansen co-integration procedure to determine the underlying long-term relationship. The model is estimated for the full sample 1960-2014. The co-integration rank tests for the euro area indicate the presence of one co-integrating relation at the 1% significance level (Table 3). The oil price is not significant and is therefore left out in the long-term equilibrium equation (Table 3, column 1 and 2). This does not mean that transportation costs are not relevant, but that these likely affect price dispersion through other channels like openness. The remaining three estimated parameters are all significant and have the expected sign: openness lowers price-level dispersion, exchange rate volatility increases price-level dispersion and income dispersion is positively related to price-level dispersion. Oil prices are significant in explaining the long-term equilibrium for

Table 3 Estimates euro area long-term equilibrium parameters σp_t

coefficient of	1962-2014 (1)	(2)	(3)
constant	0.35 (0.07)	0.38 (0.02)	0.21 (0.07)
σw_t	0.01 (0.17)	-	0.37 (0.19)
$open_t$	-1.07 (0.16)	-1.17 (0.07)	-0.73 (0.17)
vol_t^l	0.027 (0.006)	0.027 (0.007)	0.029 (0.006)
$\ln p_{oil,t}^{dm}$	0.006 (0.006)	-0.005 (0.007)	-
Johansen test			
-trace test	1 co-int relation *	1 co-int relation *	1 co-int relation *
-eigenvalue test	1 co-int relation *	1 co-int relation *	1 co-int relation *

Intercept (no trend) in CE
Standard errors between parentheses
* = 1% significance level

price dispersion between cities in the US (Table 4). The augmented Dickey-Fuller test, however, indicates that co-integration must be rejected for the full sample. One explanation for this is that the energy intensity of the US economy has come down substantially, especially in the period from the first oil crisis in the early 1970s to the second oil crisis in the early 1980s. Starting from 1984 onwards, the presence of a co-integrating relationship between the US price level dispersion and the oil price cannot be rejected. As expected, higher oil prices are associated with more price dispersion. The coefficient for income dispersion is not significant. Bergin and Glick (2007), for example, also find a strong relationship between international price dispersion and oil price movements. Their period of investigation runs from 1990 to 2005.

Table 4 Estimates US long-term equilibrium parameters σp_t

coefficient of	1962-2014		1984-2014	
	(1)	(2)	(3)	(4)
constant	0.10 (0.01)	0.10 (0.04)	0.12 (0.02)	0.11 (0.003)
σw_t	-0.05 (0.12)	-	-0.10 (0.20)	-
$\ln p_{oil,t}$	0.009 (0.004)	0.010 (0.003)	0.015 (0.004)	0.015 (0.004)
Aug DF test stat	-2.07 *	-2.04 *	-4.18 *	-3.95 *

Note: Standard errors between parentheses

*Asymptotical critical t-value at 1% level is -3.91 (Davidson, Mc Kinnon, 1993)

Short run

The dynamic part is estimated by means of an error-correction specification. The error-correction term for the euro area is the residual from the long-run equation presented in Table 3 (parameter estimates in column 3), and for the US the residual from the equation in Table 4 (column 4).

First we take a closer look at the estimation results for Europe (Table 5). Column 1 shows the specification with the lagged changes in price level dispersion and changes in the dispersion of income, openness, exchange rate volatility and the oil price. The estimated error-correction parameter is highly significant. With a value of 0.33, the half life of returning to the underlying equilibrium level of price dispersion in Europe is about two years. Furthermore, a significant part of lagged changes in price dispersion are passed through to the current year. In other words, price dispersion movements tend to persist in the short run. From the factors that may affect short-term dynamics, only the lagged change in exchange rate volatility is significant. Changes in openness do not significantly affect price dispersion movements in the

Table 5 Estimates euro area error-correction equation $\Delta \sigma p_t$

		1962-2014	1962-2014	1962-2007
		(1)	*excl. 2007-09* (2)	(3)
ecm_{t-1}		0.334 (0.087)	0.337 (0.089)	0.345 (0.096)
constant		0.000 (0.002)	0.001 (0.002)	0.001 (0.002)
$\Delta \sigma p_{t-1}$		0.293 (0.125)	0.313 (0.131)	0.272 (0.139)
$\Delta \sigma w_{t-1}$		0.175 (0.193)	0.141 (0.202)	0.160 (0.255)
$\Delta open_{t-1}$		0.279 (0.204)	0.271 (0.210)	0.297 (0.265)
Δvol^{l}_{t-1}		-0.040 (0.017)	-0.041 (0.018)	-0.041 (0.018)
$\Delta \ln p^{dm}_{oil,t-1}$		-0.004 (-0.007)	-0.002 (0.008)	-0.004 (0.008)
$\bar{R}^2$		0.33	0.33	0.29
SR		0.010	0.011	0.011
pLM(1)	*	0.84	0.78	0.50
pLM(2)	*	0.36	0.34	0.37
pLM(4)	*	0.68	0.68	0.67
pNormality	*	0.57	0.59	0.36
pHeteroskedasticity	*	0.59	0.52	0.59

Note: standard errors between parentheses * p-values short run, but are important drivers of price dispersion in the longer run. We also estimate the model for the full sample excluding the years 2007, 2008 and 2009, thereby eliminating the potentially distortionary influence of the financial crisis. We obtain very similar results (see column 2). Neither does cutting off the estimation period in 2007 (column 3) alter these findings.

The estimated parameters for the short-run equation for price dispersion across US cities are shown in Table 6**.** The sample period for the US is 1984-2014. The error-correction parameter is highly significant (column 1). With a half life of 5 to 6 years, a return to the long-term equilibrium takes substantially longer in the US than in the euro area. What may explain this? First of all, measured in squared kilometres, the US area is four times bigger than the euro area. Larger distances are accompanied with trade costs. These trade costs are an important reason for the presence of price differences between locations. Secondly, since the establishment of the European Economic Union, price dispersion developments in the euro area have to a substantial degree been determined by a process of monetary and economic

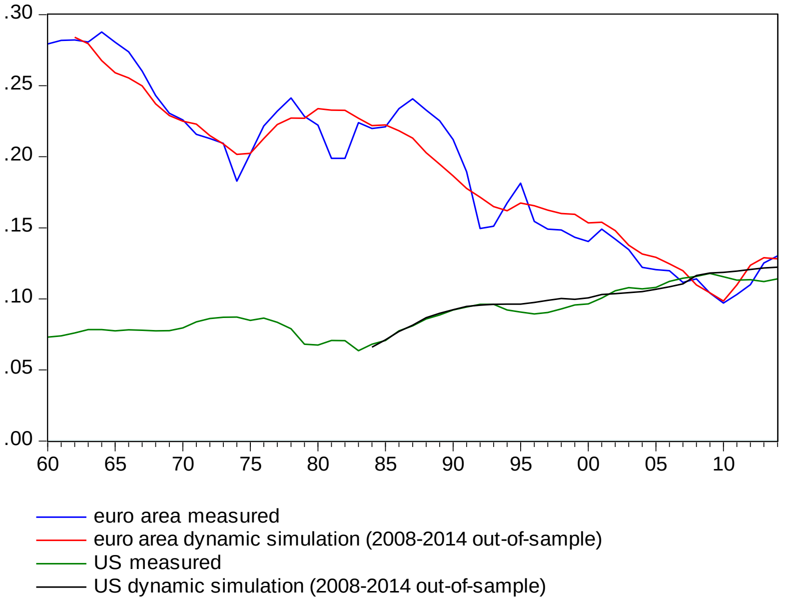
Table 6 Estimates US error-correction equation $\Delta\sigma p_t$

	1984-2014 (1)	1984-2014 excl. 2007-09 (2)	1984-2007 (3)
ecm_{t-1}	0.114 (0.027)	0.115 (0.029)	0.094 (0.032)
constant	0.001 (0.0004)	0.001 (0.0004)	0.001 (0.0005)
$\Delta\sigma p_{t-1}$	0.344 (0.140)	0.339 (0.152)	0.227 (0.163)
$\Delta\sigma w_{t-1}$	0.037 (0.066)	0.038 (0.070)	0.089 (0.074)
$\Delta \ln p_{oil,t-1}$	0.002 (0.001)	0.002 (0.002)	0.001 (0.002)
$\bar{R}^2$	0.40	0.39	0.34
SR	0.002	0.002	0.002
pLM(1) *	0.89	0.99	0.95
pLM(2) *	0.98	0.95	0.997
pLM(4) *	0.90	0.84	0.97
pNormality *	0.99	0.92	0.99
pHeteroskedasticity *	0.84	0.78	0.85

Note: standard errors between parentheses * p-values integration. Borders have become much less significant in Europe. This contributed to shrinking price level differences between countries. Again as with the euro area, leaving out the financial crisis years or cutting of the sample in the year does not affects the findings for the US (see Table 6, column 2 and 3).

Figure 2 shows the combined long and short term performance of the model by means of a dynamic simulation. In the dynamic simulation, we start with realisations for the dependent variable in the first year and calibrate the level of price dispersion in year 2. In year 3, price level dispersion is determined by the simulated level of price level dispersion in year 2 and the values of the exogenous variables in that year, and so on. We take the equations for the period up to 2007 as a starting point. The dynamic simulation up to and including 2007 is an in-sample exercise. From 2008 up to 2014, the outcomes are out-of-sample estimates. Overall the description given by the model simulation is satisfactory. In the euro area, the largest departure from realised price level dispersion occurs in the second half of the 1980s and early 1990s. Rogers (2007) noted that the unprecedented drop in price level dispersion during this period coincided with the completion of the European Single Market in 1992.

Fig. 2 Dynamic simulation price level dispersion



Price dispersion across US regions displays a gently upward sloping trend, with a slightly lower dispersion in the first half of the 1980s. This is tracked by the dynamic simulation with the overall model for the US.

5. Conclusion

We have analysed the long-term trend and short-term dynamics of price level dispersion in Europe and in the US. Our results for the long-run trend show that the price levels across the euro area countries converged between 1960 and 2010. The long-run level of price dispersion came down to the level of the US in 2007, fell further until 2010 and started rising again in the years after 2010. Important drivers behind the converging trend are lower exchange rate volatility, smaller income dispersion and more openness of European economies. These drivers can at least partly be attributed to the success of economic and monetary integration in Europe. The more recent rising trend in the years 2010-2014 is mostly due to rising income dispersion as a result of the European debt crisis. The long-run development of price dispersion across US regions is much more stable and until 2007 at a lower level than in Europe. The oil price is the only important driver behind the long-run trend in price dispersion in the US.

The dynamic simulations reveal some important differences between the euro area and the US. Deviations from the simulated path have become smaller since EMU, but are still considerably larger than in the US. Although monetary and economic integration in Europe has been successful in establishing a downward trend in differences between price levels across countries, large deviations are an indication that idiosyncratic shocks in Europe are transmitted into price dispersion, more so than in the US. This may be due to more limited risk sharing arrangements across European countries.

Consistent with this possible explanation of incomplete European economic integration is a final observation about price dispersion during the years after the financial crisis. In Europe, the dynamic simulation shows an upward trend since 2010 (see Fig. 2). This development is driven by larger income dispersion across European countries (see Fig. 1b), which was a result of the recession and the debt crisis following the financial crisis. In the US, however, income dispersion did not increase after the crisis.

References

Bergin, P.R. and R. Glick, (2007), Global price dispersion: Are prices converging or diverging?, *Journal of International Money and Finance,* 26, 703-729.

Cecchetti, S.G., Nelson, C. M. and R.J. Sonora, (2002), Price index convergence among United States cities, *International Economic Review, 43,* 1081-1110.

Chen, L and J. Devereux, (2003), What can US city price data tell us about purchasing power parity?, *Journal of International Money and Finance*, 22, 213-22.

Crucini, M.J., Telmer, C.I. and M. Zachariadir, (2005), Understanding European real exchange rates, *American Economic Review*, 95(3), 724-738.

Crucini, M.J., Shintani M. and T. Takayuki, (2010), The law of one price without the border: the role of distance versus sticky prices, *The Economic Journal*, 120, 462-480.

Engel, C. and J.H. Rogers, (1996), How wide is the border?, *American Economic Review*, 86(5), 1112-25

Engel, C., and J.H. Rogers, (2001), Deviations from purchasing power parity: causes and welfare costs, *Journal of International Economics*, 55(1), 29-57

Faber, R.P., and A.C.J. Stokman, (2009), A short history of price level convergence in Europe, *Journal of Money Credit and Banking,* 41, 2-3, 461-477

Gorodnichenko, Y. and L.L. Tesar, (2009), Border effect or country effect? Seattle may not be so far from Vancouver after all, *American Economic Journal*; Macroeconomics, 1, 219-241.

OECD Economic Outlook (Number 75, June 2004).

Parsley, C. and S. Wei, (2001), Explaining the border effect: the role of exchange rate variability, shipping costs, and geography, *Journal of International Economics, 55,* 87-105.

Reinhart, C.M. and K.S. Rogoff, (2004), The modern history of exchange rate arrangements: a reinterpretation, *Quarterly Journal of Economics*, 119, 1-48.

Rogers, J.H., (2007), Monetary union, price level convergence, and inflation: How close is Europe to the USA?, *Journal of Monetary Economics, 54,* 3, 785-796

Rogoff, K.S., (1996), The purchasing power parity puzzle, *Journal of Economic Literature, 34,* 647-68.

Previous DNB Working Papers in 2016

No. 493 **Jacob Bikker, Dirk Gerritsen and Steffie Schwillens,** Competing for savings: how important is creditworthiness during the crisis?
No. 494 **Jon Danielsson and Chen Zhou**, Why risk is so hard to measure
No. 495 **Gabriele Galati, Irma Hindrayanto, Siem Jan Koopman and Marente Vlekke**, Measuring financial cycles with a model-based filter: Empirical evidence for the United States and the euro area
No. 496 **Dimitris Christelis, Dimitris Georgarakos, Tullio Jappelli and Maarten van Rooij**, Consumption uncertainty and precautionary saving

DeNederlandscheBank

EUROSYSTEEM

De Nederlandsche Bank N.V.
Postbus 98, 1000 AB Amsterdam
020 524 91 11
dnb.nl