PRICE CLUSTERS IN THE EU – AN OLD STORY WITH NEW IMPLICATIONS?

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Abstract

In this paper we investigate price level convergence in comparative price levels (CPLs) in the EU-27. We test whether there is any support for the club convergence hypothesis in the EU, i.e. stratification of CPLs. Such a process would be a sign of different structural characteristics and could provide an explanation for the on-going financial crisis. Our results show the existence of different speeds in price convergence, whose implication is emergence of convergence clusters in the EU-27 (up to four convergence clubs). In a disaggregated analysis old EU member states (EU-15) and new EU member states (NMS-12) are analysed separately to explore their proximity to the EU approximated by EU-15. In both cases at least two clusters are found; in the case of NMS-12 our results confirm findings in the empirical literature (at least a "two-speed" group) and they also show a process of `synchronization' with the EU-15 and the Euro area.

Key words: cluster hypothesis, comparative price levels, economic integration, European Union

JEL Code: E31, F15, F31

Introduction

A high level of convergence of business cycles and converged price levels are essential in a monetary union such as the Euro area (EA). Even though the single European currency has enabled easier and quicker comparisons across EA/EU countries, it has also revealed huge differences between individual countries (and their markets). More than 14 years have not been enough to close existing gaps even for the EA. Similar business cycles and price levels are main building blocks pinning down potential inflation pressures and asymmetric impacts stemming from one-fits-all monetary policy of the ECB. The existence of countries with different inflation rates in a monetary union (e.g. a group of converging countries) poses a problem regarding both the effectiveness and impacts of the single monetary policy. In addition, recent experience has clearly shown implications of inflation differentials for countries using one currency (REER differentials). A loss of competitiveness seems to be at heart of the on-going crisis, together with financial (banking) sector issues.

In this paper we present one method of exploring the cluster hypothesis in the European Union. Main questions of interest are: are there any price clusters in the EU? If yes, has there been any significant impact of the on-going financial crisis on the existence of these clusters and their composition during the on-going crisis? If yes, has this effect been `common' across European countries or have they been different consequences for old and new members (NMS) of the EU? Our focus is limited to the EU only that has been affected quite significantly by both spillovers from the US sub-prime market lending crisis and the still on-going European Sovereign (Debt) Crisis in several euro area countries.

This remainder of this paper is structured as follows. Section 1 reviews theoretical background, literature and outlines the econometrical approach. Section 2 presents and discusses main results. Section 3 concludes.

1 Theoretical concepts

To begin with, changes in price levels (price convergence) is a concept established in the growth literature (neoclassical growth theory, in a stylized OLG or a Ramsey-type model)[1] and has been applied in a large number of fields in modern economics, *inter alia* for changes in prices. Most of the literature works only with two definitions of convergence (conf. Heijdra, 2009) but we will deviate and state three main hypotheses encompassing three different notions of convergence (see Galor, 1996) that exhaust the entire set of possibilities:[2]

- absolute (unconditional) convergence – countries converge towards a (common) value of an indicator (so-called *steady state*) in the long run, irrespective of their individual initial levels and at different speeds. However, empirical studies (for GDP) have not confirmed this hypothesis;

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[1] Convergence is not necessarily an outcome in new (endogenous) growth models where an important role is attributed to policies (related to R&D, knowledge, human capital, etc.) or may be spread by some economic activities such as international trade, FDI, etc., for a literature review see e.g. Martín and Sanz (2003).

[2] Some authors work with three notions as well: beta-convergence (conditional/unconditional), sigma-convergence and a common deterministic/stochastic trend of a cointegrated variable, see Lee *et al.* (1997). Since this approach seems to be rather specific (for time-series-based real convergence), we prefer our more general approach that can accommodate the previous definition. There is also an alternative definition of conditional (unconditional) convergence for stochastic processes by Canova and Marcet (1995) who focus on the link between growth and (persistence of) inequality (being the difference between the relatively rich and the relatively poor spatial units at that point in time); they also define beta-convergence both unconditional and conditional and sigma-convergence (and both concepts are consistent with persistence of inequality or without). This approach can be viewed as a generalisation of Bernard and Durlauf (1996) in the time series environment.

- relative (conditional) convergence – economies with different price levels close gaps between them but a common steady state is not reached; countries have different steady states depending on their structural parameters (for example investment level, population growth, level of human capital, technology, factor markets, etc.);[3]
- club convergence hypothesis – countries converge towards a common `steady state' (an attractor) unambiguously characterised by structural characteristics in the long run if they possess `similar' structural characteristics.[4] This text primarily aims at exploring the last hypothesis.

Following these definitions, it is possible to state them in terms of price levels, i.e. for example in the case of price convergence (ad *a)*) economies with lower price levels are expected to converge faster compared to economies with higher price levels. As price system is of a dynamic nature, one could argue that conditional convergence in the long run (ad *b)*), could be preceded with club convergence (or even stratification/clustering) in the medium run because of some barriers (frictions) to price adjustments.[5] However, there is a lack of explicit theoretical concepts capturing relevant characteristics of the club convergence hypothesis not only for price, but also for real convergence. Moreover, mainly because of spatial (empirical) studies, many alternative (much broader) concepts/theories compared to ad *c)* have been used in the literature (*divergence theories*), mainly associated with the new growth theory that has been gaining ground since the mid-1980's and/or so-called new economic geography that has been spreading since the early 1990's including concepts such as theory of polarization see e.g. Armstrong (2002).

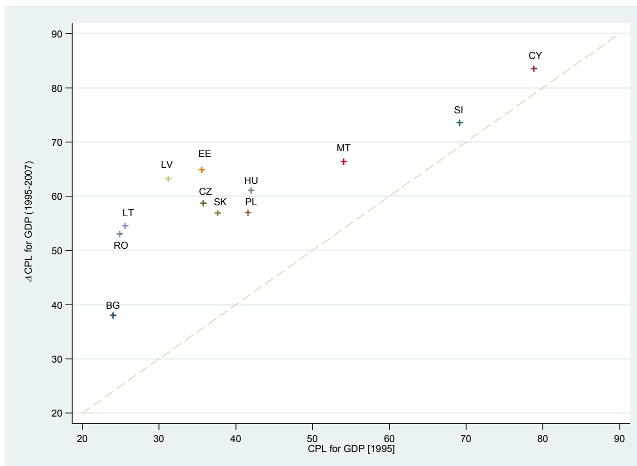
1.1 Effects of the Great Recession

There have been many effects and implications from the Great Recession (or GR). Since there is no explicit need (and also due to space considerations) we refer to e.g. Furceri and Zdzienicka (2011) for explanations of underlying reasons and mechanisms at work. Here we aim at providing some empirical evidence for its effects on price convergence process in NMS countries.

[3] Alternatively, countries with the same structural characteristics tend to converge towards a particular steady state conditional on these characteristics in the long run irrespective of their initial conditions.
[4] For a bimodal distribution some authors use the term `polarization hypothesis' see Bianchi (1997). Naturally, these steady states can `move' over time, i.e. their relative distances may shrink (increase).
[5] Similar point is made by Galor (1996) who shows this idea for real convergence graphically; his argument follows from technological progress and diffusion.

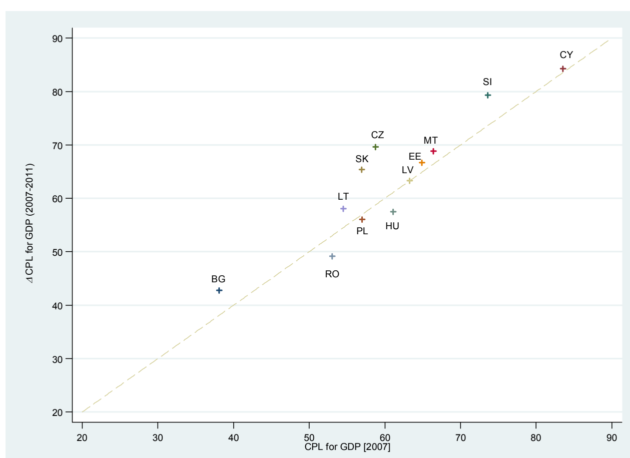
A following set of figures presents stylized facts for NMS countries.[6] To begin with, there are two figures that show changes in CPL for our group of countries (NMS-12) – for two subperiods showing the impact of the on-going GR: 1995–2006 and 2007–2011. For the former the ´desired´ patter can be seen – countries increased their price levels and therefore their CPLs lay above the 45° line (Figure 1). Conversely, the impact of the financial crisis is visible *prima facie* in Figure 2 as countries are along the 45º line or in some cases even below.

Fig. 1: CPLs during `tranquil times', NMS-12, 1995–2006 (EU-15 = 100)



Source: own calculations based on Eurostat (2013) database.

Fig. 2: Effects of the Great Recession on CPLs in NMS-12, 2007–2011 (EU-15=100)



Source: own calculations based on Eurostat (2013) database.

[6] Similar patterns have been observed for the EU-15 countries; figures not shown due to space limitations. Likewise, similar figures could be produced for individual components of CPL for GDP, for example for household consumption.

1.2 Convergence test approach

One way of exploring the convergence club hypothesis (i.e. the possibility of price divergence in the EU), is to apply a relatively simple test developed by Phillips and Sul (2007, 2009) (henceforth `PS test'). This test has several advantages compared to a standard time series approach.[7] This test allows for the possibility of having one steady state (an attractor for all countries) or several steady states for a group of countries.

The PS test is based upon a factor model that distinguishes between the systemic part of $Y_{i,t}$ and a common factor Γ_t for a country *i* by means of assessing its distance ϖ_i to the common factor:

$$Y_{i,t} = \varpi_i \Gamma_t + \upsilon_{i,t} \qquad (1a)$$

Phillips and Sul (2007) work directly with a logarithmic transformation of the dependent variable, i.e. $y_{i,t} = \ln(Y_{i,t})$ since they focus on real convergence. They also assumes that ϖ_i is a time-varying variable and thus, it encompasses a random component capturing the error term ($\upsilon_{i,t}$) so that Γ_t may converge towards the common factor:

$$Y_{i,t} = \varpi_{i,t} \Gamma_t \qquad (1b)$$

If a setting for a panel-data-type decomposition on permanent and transitory part is applied, then $Y_{i,t}$ is made up from the systematic (permanent) part $\iota_{i,t}$ ($\equiv \varpi_{i,t}$) and the transitory component $\Xi_{i,t}$ ($\equiv \Gamma_t$). Using these definitions in (1a) we arrive at:

$$Y_{i,t} = \frac{\iota_{i,t} \Xi_{i,t}}{\Gamma_t} \Gamma_t = \varpi_{i,t} \Gamma_t \qquad \forall_i, \forall_t \qquad (1c)$$

with $Y_{i,t}$ being a mixture of time-varying common Γ_t and idiosyncratic component $\varpi_{i,t}$; for further details see e.g. Phillips and Sul (2009).[8]

Following Phillips and Sul (2009), the transitory part can be modelled as a relative measure ($\hbar_{i,t}$ `transition trajectory') of the transition coefficients:

$$\hbar_{i,t} = \frac{Y_{i,t}}{\frac{1}{n}\sum_{i=1}^{n} Y_{i,t}} = \frac{\varpi_{i,t}}{\frac{1}{n}\sum_{i=1}^{n} \varpi_{i,t}} \qquad (2)$$

[7] Cuestas *et al.* (2012) offer these: [1] convergence is measured towards a cross-sectional average (no simple level), [2] it is more robust than unit root tests for `slowly' converging time series, [3] it is not subject to problems of mixing stationary and non-stationary time series in a panel and [4] it is assumption free (no explicit DGP has to be specified).

[8] The model (1b) can also incorporate a term for business cycles that are present in many macroeconomic time series. For an illustration see Fritsche, and Kuzin (2011).

where $\varpi_{i,t}$ is measured in relative to the cross-section average (a panel), i.e. shows *i*'s individual trajectory to the average. Given the common growth of Γ_t, $\hbar_{i,t}$ is a measure of *i*'s relative departure from it. When all spatial units (countries, etc.) have one limiting transition behaviour, ultimate (growth) convergence occurs, i.e. $\hbar_{i,t} \to 1 \quad \forall_i$ as $t \to \infty$.

The following steps include (see Phillips and Sul (2007) or Phillips and Sul (2009) for further details and derivations):

- cross-sectional mean being the square of transition differential (H_1/H_t is the distance of a unit from the common limit) is constructed:

$$H_i = \tfrac{1}{n}\sum_{i=1}^{n}\left(\bar{\hbar}_{i,t} - 1\right)^2 \qquad (3)$$

- a semi-parametric model for non-stationary transition part ($\varpi_{i,t}$) is in the form:

$$\varpi_{i,t} = \varpi_i + \sigma_i \vartheta_{i,t} L(t)^{-1} t^{-\alpha} \qquad (4)$$

where $\sigma_i = 0$, ϖ_i is fixed, $\vartheta_{i,t}$ is $iid\ (0,1)\ \forall_i$ but weakly dependent over *t*, $L(t)$ is a function (`slowly-varying') defined for example as $L(t) = \log t$, then $L(t) \to \infty$ as $t \to \infty$. Moreover, the `behaviour' of $\varpi_{i,t}$ is affected by the size of α;

- the null (convergence) $H_0 : \varpi_{i,t} = \varpi \wedge \alpha \geq 0$ and $t \to \infty$;[9]
- the alternative $H_A : \varpi_{i,t} = \varpi\ \forall_i$ and $\alpha < 0$ or alternatively $H_A : \varpi_{i,t} \neq \varpi$; [10]
- a $\log t$ model is employed for testing the hypothesis:

$$\log(H_1/H_t) - 2\log(\log(t)) = b_0 + b_1 \log(t) + \upsilon_t \qquad (5)$$

with $t = \{rT\}, \{rT+1\}, \ldots, \{T\}$ for $r > 0$. Since a part of observations is eliminated ($\{rT\} - 1$), the distribution and its power properties heavily depend on a choice of *r*. Phillips and Sul (2007) simulations-supported suggestion of its parametric value is *0.3*;

[9] Under the null $\varpi_i = \varpi_j$ for $i \neq j$ so that (4) is sufficiently flexible to allow for transition heterogeneity or divergence over *i*.

[10] For example four clusters (convergence club) hypothesis takes the form: $H_A : \varpi_{i,t} = \begin{cases} \varpi_1 \wedge \alpha \geq 0, \textit{for } i \in C_1 \\ \varpi_2 \wedge \alpha \geq 0, \textit{for } i \in C_2 \\ \varpi_3 \wedge \alpha \geq 0, \textit{for } i \in C_3 \\ \varpi_4 \wedge \alpha \geq 0, \textit{for } i \in C_4 \end{cases}$ with C_i being a specific convergence club.

- the parameter $\hat{b}_1$ is essential and it is related to α (its OLS estimate is equal to $2\hat{\alpha} = \hat{b}_1$ under the null);
- even though the null of convergence is rejected, it is still possible to test for the existence of clusters (club convergence) in the sample, likewise, club convergence can be tested for subgroups of a larger group (a panel) of countries;
- the test itself is carried out in several stages: *[1]* the (H_1/H_t) variance is calculated, *[2]* a robust *t* statistics ($t_{\hat{b}_1}$) is computed, and *[3]* one-sided t-test is performed for the null hypothesis ($\alpha \geq 0, \hat{b}_1$ and HAC standard errors) with rejection of the null (convergence) if the value of *t* statistics is smaller than *-1.65*.

1.3 Comparative price level

Our measure of price levels in the EU-27 countries is the comparative price level (CPL) that is a price level expressed as a fraction of a price level of a country or an integration group. In the case of European countries, CPL can be based on the average of EU-27; in this paper EU-15 average is utilized. Therefore, CPL in year *t* for country *i* is given as:

$$CPL_{i,t} = \frac{ER_{i,t}^{PPP}}{ER_t} \tag{5}$$

where $ER_{i,t}^{PPP}$ is the PPP exchange rate for country *i*, and ER_t is the spot exchange rate in year *t* for country *i*. Values of CPL above 100 indicate that the country is relative more expensive compared to an average and *vice versa*.

1.4 Relevant literature

There have been only few studies that investigated the Club hypothesis in EU environment; Blatná (2011) analyses price convergence of EU countries with the help of methods for cluster analysis (the Ward method, Euclidian distances). Using data for CPL (1995–2008) four clusters are identified: the Czech economy belongs to the third cluster together with seven other countries. A study by Fritsche and Kuzin (2011) who analyse inflation (CPI and GDP deflator) and GDP per capita, unit labour costs, and TFP in the EU-27 countries using the PS test; they identify several convergence clubs however, their composition depend on a particular indicator.

2 Tests of the club hypothesis

In this section results of the PS test are presented for the entire period 1995–2011 and three groups of countries: the whole EU (EU-27), and its subgroups (EU-15 and NMS-12).[11]

Tab. 1: Cluster analysis – the PS (*log t*) test, EU-27, 1995–2011

	1st club analysis	
	b coefficient	t-statistics
constant	-1.824	-5.082
log t	0.143	0.963
	Test whether there is another cluster	
constant	0.609	4.236
log t	-1.713	-28.792
	2nd club analysis	
	b coefficient	t-statistics
constant	-3.239	-5.265
log t	-0.876	-3.439
	Test whether there is another cluster	
constant	0.609	-5.265
log t	-1.260	-15.055
	3rd club analysis	
	b coefficient	t-statistics
constant	-2.649	-4.687
log t	-0.268	1.145
	Test whether there is another cluster	
constant	0.079	0.404

[11] All our results have been obtained using D. Sul's Gauss code. Our of parametric value was *5* based on a selection procedure included in the test; the whole time span is used; however, our results do not change if we choose for example the last 2/3, i.e. leaving out the 1990's completely. Luxembourg is not excluded since its price level is not an outlier (rather an average) in our sample and our results are not changed if excluded.
Results for a shorter period (until 2007) are very similar and are available from the author upon request.

log t	-1.365	-16.796
	4th club analysis	
	b coefficient	t-statistics
constant	-1.899	-4.720
log t	-0.059	-0.355

Notes: 1st cluster consists of the Czech Republic, Latvia, Lithuania, and Romania; 2nd cluster consists of Bulgaria, Estonia, and Slovak Republic; 3rd cluster consists of Greece, Ireland, Italy, Malta and Slovenia; 4th cluster consists of Austria, Belgium, Cyprus, Denmark, Finland, Luxembourg, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. Countries not included in any cluster: France, Germany, Hungary, and Poland. [a] if $t < -1.65$ repeat the steps; clustering stops when the rest of the group less than 3; for details see the main text. Source: own using D. Sul's Gauss code and Eurostat (2013) data.

The PS test algorithm goes in four steps (see e.g. Phillips and Sul (2007): *(i)* ordering countries according to the last third period price levels; *(ii)* choosing countries with the ω highest individuals to form a group ($2 \le \omega \le N$) running the $\log t$ regression and choosing the group size ω^* according to t-test value ($t_\omega > -1.65$); *(iii)* all remaining countries are individually test for its inclusion in the club based on $\log t$ again; *(iv)* search for a new cluster (not included countries in step *3* via $\log t$). If no ω is found in step *(ii)*, the remaining members have diverging behaviour; for a full description of the testing procedure (algorithm) we refer to e.g. Phillips and Sul (2009) or Fritsche and Kuzin (2011).

Our results for the entire period, CPL for GDP and EU-27 countries are in table 1. The PS test indicates presence of four convergence clubs in our sample whose members cannot be simply distinguish as `core', `periphery' or `old' and `new'. Another surprising finding is the non-inclusion of some `core' EU-15 countries to any cluster (club) such as Germany. The first cluster contains only NMS countries (the Czech Republic, Latvia, Lithuania and Romania), similarly the second (Bulgaria, Estonia, and Slovakia). Third is a mixture of catching-up old EU-15 countries (Greece, Ireland, and Italy) and two NMS (Malta and Slovenia) and the last cluster consists of Cyprus and 10 old EU-15 countries. It seems to be surprising that Portugal does not belong to a middle cluster or that two core EU-15 countries are not included in any cluster either. Price levels of both countries do not seem to have followed very similar patterns to other countries (German price level `swimming' somewhat `against the stream' or sharing patterns with various countries during this period).

In a disaggregate view two and three clusters were identified in the case of EU-15 and NMS-12 countries respectively (see tables nos. 2 and 3). There is a certain distinction between core and periphery for EU-15 countries, and surprisingly the inclusion of British price level to catching-up countries. However, that may be due to the similarity of price structures in Ireland and the UK. These results are broadly consistent with those found by Fritsche and Kuzin (2011) who analyse *inter alia* price two indices (inflation and GDP deflator).

Tab. 2: Cluster analysis – the PS (*log t*) test, EU-15, 1995–2011

	1st club analysis	
	b coefficient	t-statistics
constant	-2.112	-5.569
log t	0.114	0.727
	Test whether there is another cluster	
constant	0.369	2.556
log t	-1.239	-20.826
	2nd club analysis	
	b coefficient	t-statistics
constant	-1.245	-5.570
log t	-0.022	-0.236

Notes: 1st cluster consists of Greece, Ireland, Italy, Spain, and the UK; 2nd cluster consists of Austria, Belgium, Denmark, Finland, Luxembourg, the Netherlands, and Sweden. Countries not included in any cluster: France, Germany, and Portugal. [a] if $t < -1.65$ repeat the steps; clustering stops when the rest of the group less than 3; for details see the main text. Source: own using D. Sul's Gauss code and Eurostat (2013) data.

In the case of NMS-12 countries (table 3), the clusters have more or less the same structure 1st and 2nd cluster for EU-27, and third cluster is perhaps not surprisingly formed of Cyprus and Malta confirming their somewhat different position within this group of countries. A rather interesting is the composition of the first and second cluster does not match results of previous exercise (e.g. the Czech Republic and Slovak Republic are no in one cluster, Baltic States or `latecomers'). There are many possible explanations both associated with the method (its limits e.g. the minimal size of a group) and the data (the length of our time span).

Tab. 3: Cluster analysis – the PS (*log t*) test, NMS-12, 1995–2011

	1st club analysis	
	b coefficient	t-statistics
constant	-1.824	-5.082
log t	0.143	0.963
	Test whether there is another cluster	
constant	1.178	-5.265
log t	-1.817	-43.935
	2nd club analysis	
	b coefficient	t-statistics
constant	-3.239	-5.265
log t	-0.876	3.439
	Test whether there is another cluster	
constant	0.548	2.964
log t	-1.507	-19.688
	3rd club analysis	
	b coefficient	t-statistics
constant	-2.007	-4.692
log t	0.036	0.202

Notes: 1st cluster consists of the Czech Republic, Latvia, Lithuania, and Romania; 2nd cluster consists of Bulgaria, Estonia, and Slovak Republic; 3rd cluster consists of Malta and Slovenia. Not included in any cluster: Cyprus, Hungary, and Poland. [a] if $t < -1.65$ repeat the steps; clustering stops when the rest of the group less than 3; for details see the main text. Source: own using D. Sul's Gauss code and Eurostat (2013) data.

2.1 Some implications

The existence of convergence clubs seems to be one of stylized facts. However, there is a great deal of uncertainty as regards the `composition' of individual clubs. One explanation for this phenomenon is that only price levels are used, another explanation could add a rather short time span of available time series. In addition, the financial crisis has `added' another layer of complexity to this problem since there have been and are different responses of individual European economies to positive and negative (demand vs. supply, internal vs. external, idiosyncratic vs. common) shocks.

That only illustrates potential problems for a national (common) monetary authority. While a national authority can tailor its policy accordingly, hands of its common counterpart are tied. That may be viewed as rather undesirable. This has profound implications for monetary policy since inflation rates have been and will be affected by both adjustments and price convergence for a longer period of time. Moreover, the very existence of convergence clubs opens a door to differentiated impacts of the single monetary policy.

Conclusion

This paper focuses on investigating the cluster hypothesis for price levels in the EU-27. Our results show the existence of several clusters both in the EU and EU-15 (NMS-12). These clusters (three) consist of member states that are not uniquely linked to the `standard' classification of EU countries (old and new) but rather to `core' and `periphery' and/or catching-up countries and vaguely to the Euro area members. The Czech economy belongs to the NMS group (together with Baltic States and Romania), some NMS for a cluster with both catching-up and old EU countries (Cyprus, Malta, and Slovenia); there is also a Euro link given the level of GDP per capita in NMS (Estonia, and Slovakia).

However, there have been changes in the wake of the financial crisis that may further change the picture. Future development will be dependent on both the resolution of the crisis in the EU and the on-going Global Recession. Our dataset does not contain observations for 2012 that could show whether some changes we have illustrated may have changed by the SDC. It is also possible that the current reshuffling in the EU affecting almost all fields will have positive consequences for competition, removal of barrier and distortions in primary and final-good markets (mainly services and other non-traded goods), again with favourable effects on price levels.

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