INFLATION DIFFERENTIALS, DETERMINANTS, AND CONVERGENCE: EVIDENCE FROM INDONESIA SUBNATIONAL DATA

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Abstract
This paper is aimed to examine co-movements and heterogeneity in inflation dynamics of different regions across Indonesian provinces to improve the understanding of the nature of inflation characteristics in the context of the Indonesian monetary union. Having employed a dynamic factor analysis, our model is able to decompose regional inflation dynamics that are explained by country wide and district (zone) specific factors as well as an idiosyncratic local factors. Regarding to the second objective of this study that is to investigate determinant factors of regional inflation differentials, our findings suggest that the differences are mainly related to their structural economic characteristics namely economic structures, degree of openness, cost of input factors (wages), market structure, and local (spatial) specific factors. The final objective of this study is to examine long run convergence of regional inflations, and in turn our model is able to find and show the existence of convergences. Overall, this paper illuminates the importance of disaggregate regional inflation information, as summarised by the local factors, in explaining aggregate national inflation rates, even after conditioning on macroeconomic variables. Accordingly, the relevant policy actions and coordinations based on subnational and local level play a vital role in enhancing the effectiveness of the monetary policy conducts in Indonesia that is primarily directed to targeting inflation.

JEL classification: E31, R10, C33

Keywords: regional inflation dynamics, dynamics panel data, common factor models

1. Introduction

Under an optimum currency area theory, inflation rates will be equalized across regions (countries) within a monetary union due to the high integration of labour, product and capital markets. However, in reality, such presumptions is questioned to hold and in fact, regional differences in inflation rates even are quite often observable and might be persistent including in developed countries namely European Monetary Union / EMU and the US states.

Theoretically inflation differentials within a monetary union can be seen as the result of an equilibrating mechanism, and if this is the case, should not be a source of worry as it might reflect an income convergence between the relatively poor and rich regions (De Grauwe, 2007). This view is popularly known as the Balassa-Samuelson effect that asserts that regional differences in inflation rates between economies within a

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monetary union are mainly induced by differences in productivity growth. More specifically, productivity should grow faster in the relatively poorer economy than in the richer one, and then, the relative price of non-traded goods would increase by more in the poorer than in the richer regions.

In contrast, inflation differentials could also be harmful if it arises from economic distortions, that may take the form as nominal price rigidities, or any other kinds of structural inefficiencies. In addition, several other factors that may also affect inflation differentials such as asynchronous business cycles, foreign shocks, and local specific shocks (see Beck et al., 2009).

Explaining heterogeneity in inflation rates across regions tend to become a trending research and discussion topic recently especially in the light of EMU era (see de Haan, 2010). For policymakers, understanding how and to what extent differences in inflation rates across regions arise is crucial particularly considering the objective of monetary policy is set up for the whole (national) economy, that in turn may lead to distributional effects across the regions. Honohan and Lane (2003) argue there are two main dimensions to possible concerns about inflation differentials (in eurozone): the fear of sustained inflation differentials and the fear of weak adjustment mechanisms that lead to boom-bust cycles.

Despite bulk of empirical studies have been conducted in this line area of research especially for developed countries, and to the best of our knowledge the similar analysis for developing countries tends to be very limited (see Annex 1). A conventional macroeconomic analysis tends to be more focused on national (aggregate) inflation issues, however it is instructive to look also at regional developments for three main reasons. First, the understanding of the behaviour of regionally disaggregated inflation rate series helps to understand aggregate inflation, since the construction of the latter is based on the regional series. Second, the use of regional data enables us to disentangle the importance of national from purely regional factors for inflation rate variability, and therefore provides policy-makers aiming at stabilizing inflation rates with useful information. Third, the larger regional than national heterogeneity in economic conditions and production structures can help the identification of the sources of inflation heterogeneity.

Focus of this study relies upon the Indonesian provincial data, that is specifically aimed to analyze to the extent that inflation rates may vary across regions and what factors may induce such differences. Indonesia could be an interesting research laboratory especially considering that Indonesia de jure is also a monetary union, and resemble to the EMU. In addition, Indonesia could be viewed as a unique country that is composed of so many islands, and also has some notable variations that are due to distinctive structure and characteristics of its regions in terms of socioeconomic conditions, natural resource endowments, institutions, geography, and ethnicity, among others (for further details, see Ridhwan, 2011).

In order to examine the characteristics and dynamics of the Indonesian inflation rates from regional perspectives, our empirical analyses are as follows. First, following Beck et al. (2009), we classify sources of the differentials by decomposing regional inflations into two major categories namely national (common) factors and regional (local) specific factors. Second, by focusing on local factors that drive regional inflation dispersion, we then investigate determinant factors of inflation differentials across Indonesia’s regions. Finally, we also aim to shed light on regional inflation convergences.

The rest of the paper is organized as follows. The next section highlights characteristics of the Indonesian regional inflations, and examine how large inflation differentials across Indonesian regions are.

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2 For further details, see Ridhwan (2011).
Section 3 provides a brief literature review of regional inflation heterogeneities. Then, we describe panel data regressions, model specification, and the data. Section 5 presents and analyses the empirical results on the sources of regional inflation differentials. A subsequent section discusses the estimation results of inflation convergence. And finally, we present our conclusions.

2. Regional characteristics of the Indonesian inflation and their variations

To highlight characteristics of the Indonesian regional inflations, and to examine how large inflation differentials across Indonesian regions are, we used data of CPI (consumer price index) from 30 provinces in Indonesia and span the period 2003 (M1) to 2013 (M12). The data are published frequently by the Indonesian Central Bureau of Statistics. The inflation data are computed as year-on-year percentage changes in the price (CPI) index as follows.

\[ \Pi_t = 100 \times (\ln P_t - \ln P_{t-12}) \], where \( P_t \) is the respective price index in month \( t \).

Next, Figure 1 illustrates regional inflation rates in Indonesia using the year-on-year data. Not only show a great deal of variations among regions between 2.49% and 13.05%, but the inflation figures are also highly stable around 7%. Since domestic fuel price is highly subsidized by government, then the subsidy removals in 2005 and 2008 have dramatically pushed up the figures in 2006 and 2009 respectively. Additionally, from the graphical inspection, it is quite unlikely that the inflation differentials tend to decrease over time (no \( \sigma \)-convergence). In the latter part of the sample, the inflation dispersion also tend to decrease slightly.

![Figure 1. Regional inflation dynamics (%, year-on-year /yoy)](image)

We have also computed mean of inflation rates across Indonesia’s regions for the last ten years in order to examine how persistences of regional inflation differences are. As shown in Figure 2a, the inflation differentials are considerable, and they tend to be sustained for such a long period. Consequently, this may assert high degree of persistences of the current regional inflation dispersion. In line with the former figure, standard deviation of the dispersion (Figure 2b) also tends to have a considerable size, and this again asserts that there is unlikely no \( \sigma \)-convergence across regional inflations.

\(^3\) In the next section, we will conduct a formal convergence analysis.
Since our analysis using provincial-level data, to make them comparable for a similar analysis that uses country-level data (within a monetary union), here we follow the BI’s district level data which primarily comprises some provinces in adjacency and have relatively closer social-economic links one into another. Table 1 provides some descriptive statistics of the Indonesia’s district inflations. The figures mainly confirm the graphical impression from Figure 2 that there are sizable inflation rate differentials both across regions/provinces and across districts (see Column 2), moreover they have taken for a relatively long time horizon of around ten years, for the period 2003M1-2013M12. Having compared inflation figures across districts, we can see that the lowest average inflation rate prevailed in DKI Jakarta (6.8%), Central Java (6.9%) and Eastern Java (6.9%), and while the highest inflation districts are the Southern part of Sumatra (8.0%), Kalimantan (8.0%) and Northern part of Sumatra (7.9%). As one may already know the first three districts are notably manufacturing and services-based district, while the latter one are mining and farm-estate-based economies.

Table 1. Descriptive statistics of inflation rates across the Indonesia’s districts

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<td>Northern part of Sumatra (NOS)</td>
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<td>5.06</td>
<td>10.97</td>
<td>6.01</td>
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<td>9.50</td>
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<td>2.09</td>
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<td>9.28</td>
<td>4.15</td>
<td>6.50</td>
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<td>2.72</td>
<td>7.95</td>
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<td>8.79</td>
<td>3.01</td>
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<td>6.86</td>
<td>2.69</td>
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<td>3.73</td>
<td>5.82</td>
<td>2.28</td>
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<td>8.43</td>
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<td>8.70</td>
<td>3.82</td>
<td>7.64</td>
<td>2.91</td>
</tr>
<tr>
<td>National average (unweighted)</td>
<td>7.54</td>
<td>3.15</td>
<td>8.85</td>
<td>3.47</td>
<td>6.42</td>
<td>2.63</td>
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<tr>
<td>National average (weighted)</td>
<td>7.20</td>
<td>3.65</td>
<td>8.52</td>
<td>4.05</td>
<td>5.89</td>
<td>2.63</td>
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Provinces with the lowest/highest inflation rate

<table>
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<tr>
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<th>Minimum</th>
<th>Maximum</th>
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</thead>
<tbody>
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<td>34.69</td>
</tr>
<tr>
<td>Maximum</td>
<td>-0.03</td>
<td>19.31</td>
</tr>
</tbody>
</table>

Figure 2a. Mean of regional inflation rates (% yoy, 2003-2013)

Figure 2b. Standard of deviation of regional inflation rates (in percents, 2003-2013)
As described in Figure 1, there are at least two spikes of inflation movement in 2006 and 2009 following the fuel subsidy removal by government in earlier period, and this fact underlines the influential role of fuel price in affecting the Indonesian inflation.\(^4\) Then, to assess the impacts of fuel price shocks on inflation, we split the sample into the 2005 fuel price hike (2003-2007) and the 2008 fuel price hike (2008-2013), as shown in Column 3 and Column 4 in Table 1, respectively. Another rationale of the two period split is also motivated by a hallmark macroeconomic policy changes, and they are mainly, first, the introduction of fiscal decentralization policy in 2001, and secondly, the adoption of inflation targeting framework (ITF) in 2006 by the Central Bank of Indonesia (BI). The big-bang fiscal policy has transferred central government budgets and move into regional budgets by about 40%, and consequently, the liquidity injection could also be viewed as a new source of inflationary pressures. On the contrary, the implementation of the ITF policy strategy is mainly aimed to content inflation at certain level targeted by the central bank (monetary authority). In general, there are still large differences of inflation rates across districts both in Column 3 and Column 4 period. Nevertheless, the average of inflation rates in the first period is larger than the latter period. Similarly, the volatility (as measured by SD) of inflation rates is lower in the latter period compared to the former one.

Furthermore, if we look at mean of inflation rates in Figure 4, it confirms that inflation differentials are even more pronounced across provinces than the district level. As shown, NAD, NTT, Babel and Sultra are provinces that experience the highest inflation rates for over the last ten years. They are also known as the less developed, located in Off-Java island, and with minimum infrastructure facilities. On the contrary, Java and Bali which are notably the more developed provinces, have sustained the lowest inflation rates among provinces. The two opposite regions tend to suggest a core and periphery phenomenon, in which the first term refers to Java regions, while the latter one is the off-Java regions (further details, see Ridhwan, 2011).

\(^4\) However, to identify the pure effects of fuel price on inflation, one needs to disentangle other factors namely expectation. The latter point is beyond the scope of this paper.
3. Comovement and heterogeneity of the Indonesian regional inflation

Following Beck et al. (2009), our empirical analysis is starting here by decomposing what factors could explain the Indonesian regional inflation variations. Specifically, they are in further could be classified into three groups in a nation wide context, namely into district, province, and local specific factors. To implement such decomposition, our approach relies upon a factor analysis method, specifically, we employ principal component based estimators for the factors, along the lines of Stock and Watson (2002b), and Beck et al. (2009). The main advantages of this technique are first, the method is relatively simple, and second, interpretation of the result is also tractable.\(^5\)

Next, we could write inflation in province (region) \(i\) of district \(j\) at period \(t\), denoted by \(\pi_{ijt}\) as follows:

\[
\pi_{ijt} = \mu_{ij} + q_{ijt} \quad \text{................................................. (1)}
\]

where:

\[
\mu_{ij} = \text{mean of regional inflation rate (a fixed effect)}
\]

\[
q_{ijt} = \text{deviation of inflation from its mean, yaitu: } q_{ijt} = \pi_{ijt} - \mu_{ij}
\]

\(\mu_{ij}\) is assumed as \(i.i.d\) \((0, \tau_{ij}^2)\); and \(i = 1, \ldots, N, j = 1, \ldots; t = 1, \ldots, T\).

Then, deviation of inflation from its mean \(q_{ijt}\) can be further decomposed into:

\[
q_{ijt} = \lambda_{ij} f_t + \eta_{ij} g_{jt} + e_{ijt} \quad \text{................................................. (2)}
\]

where:

\[
\lambda_{ij} f_t = \text{This term represents a common/national factor component, that is specifically reflects a homogeneity in terms of macroeconomic environment, namely the common monetary policy (interest rate) and the common external effects namely exchange rate and (oil) commodity prices.}
\]

\[
\eta_{ij} g_{jt} = \text{This term represents district specific factor component that can be related to some common factors namely economic structures, labor markets, regional fiscal policy, adjacent location (common border) among others.}
\]

\[
e_{ijt} = \text{This idiosyncratic component (local specific factors) could be related a “unique” factor in a region, for example: a region is located in remote area (with minimum infrastructures), a communal-conflict region, and a prone natural disaster region.}
\]

As asserted by Beck et al. (2009), in order to identify the model for \(q_{ijt}\), we assume that the common and national factors are orthonormal (namely, orthogonal, with zero mean and unit variance), and orthogonal to the idiosyncratic component \(e_{ijt}\). Under these assumptions, it is possible to estimate each region specific mean \(\mu_{ij}\) as the sample average (over time) of \(x_{ij}\); the common factors \(f_t\) as the principal components of the standardized \(x_{ij}\); the district factors \(g_{jt}\) as the principal components of the residuals of a regression of the standardized \(x_{ij}\) on the estimated common factors; the loadings \(\lambda_{ij}\) and \(\eta_{ij}\) as the coefficients in a regression of each standardized \(x_{ij}\)

\(^5\) While more sophisticated estimation techniques are available, see e.g. Forni, Hallin, Lippi and Reichlin (2000, 2005), the differences are usually minor both in simulation experiments and in empirical applications, see e.g. Kapetanios and Marcellino (2004), Favero, Marcellino & Neglia (2005), although this will depend on the unknown data generating process.
on the estimated common and national factors; the residuals of these regressions represent the estimated regional components \(e_{ijt}\) (for further details, see Stock and Watson, 2002). Next, following Beck et al. (2006), here we also assume there is one area wide (common) factor, which then to be estimated by the principal components from the pooled regional dataset. In addition, the use of the one factor assumption is referred to Bai and Ng (2002) whom suggest its sufficiency due to the statistical information criteria for the selection of the number of factors. Given the random administered prices shocks particularly due to fuel price jumps that may affect the regional data, in turn here we also exclude fuel prices from the data.

Having estimated using the method for the monthly period of 2003-2013, we could then obtain the estimation results of the common factors \((f_t)\) and district factors \((g_{jt})\) as shown in Table 1. In its upper panel, the proportion of the variance in all inflation rates is predominantly explained by the national factor by about 53.57% on average, and while the rest (47.13%) is explained by regional factors (a sum of district factor and local factor). Given the fact that the proportion of national inflation variance is almost equally contributed by national and regional factors, it essentially asserts that regional developments tend to have more profound roles in affecting inflation movement especially in this era of fiscal decentralization. In addition, geographical factors of the Indonesia’s regions which spread across numerous islands may have contributions to regional economic variations. However, macroeconomic policies notably monetary policy and fiscal policy are still conducted at national level, may still indicate the relative importances of national factors.

Further looking into the country wide factor, the common (national) factor shows different size of inflation variance across regions ranges from 8% for Maluku to almost 84% for Jakarta (Figure 4 - upper panel). In general, the most developed provinces located in Java island namely DKI Jakarta, East Java, Central Java, West Java and DI Yogyakarta, are the ones which show the highest common factors among others, by about 70% on average.

Meanwhile, the lower panel of Figure 4 describes proportion of inflation variance explained by regional (district and local) factors. Some “special” namely NAD (Aceh), Riau, East Kalimantan, Bali, North Sulawesi, Maluku and Papua have the largest regional components by about 49% on average. Those special regions are notably known as rich (mining) resources, yet are less developed, located in remote areas (with minimum infrastructures) and had experienced with communal conflicts (Aceh, Maluku and Papua). While Bali is popularly recognized as a major international tourism destination.
As shown by Figure 4, there are large differences across provinces in the proportion of overall variance in provincial inflation rates explained either by the country wide or regional factors. As suggested by the mainstream theories, the observed regional variations in inflation rates are determined by country wide and regional (district and local) factors are very likely due to asymmetries in the regional input factor prices, the economic structure and the business cycle position and the convergence of the respective regions (further discussions, for instance, see Beck et al., 2006).

Next, we continue to examine the proportion of the variance in regional inflation rates based on their expenditure categories. There are 9 (nine) categories attributed to the inflation figures (following the Consumer Price Index categories), for the sake of simplicity, here we only discuss two of them which are more relevant to regional (local) characteristics.\(^6\) The first one is housing sector, and from Figure 5, it can be easily observed that

\(^6\) Discussions for the rest of categories can be found in Ridhwan et al. (2013).
the darkest-colored provinces are West Nustra (73.8%), Gorontalo (80.7%), dan North Maluku (70.3%), respectively. Those three regions with the highest local components in housing sector may correlate to their geographical (remote) locations, while their economies are growing rapidly in recent years. Given the fact that housing is non-traded goods, consequently local monopoly may play significant role in affecting its prices.

Figure 5. Provincial inflation variances (%) from housing expenditure category

Another regional factors which are likely dominant in affecting inflation variances from expenditure category is transportation. As shown in Figure 6, West Sumatra, West Kalimantan, Southeast Sulawesi, Maluku and Papua are provinces with the largest local factors. Several relevant factors may be able to explain, the first one is related to their remote locations while infrastructures are pretty much limited. Another factor is related to their limited trade (economic) developments, which also affects their limited economic of scales, and in turn, leads to high transportation costs.

Figure 6. Provincial inflation variances (%) from transportation expenditure category
4. Sources of Inflation Differentials across Indonesian Regions

4.1. Empirical Model

From a theoretical point of view, the inflation differentials could bring desirable effects, if it is a product of equilibrating adjustment mechanism that leads to long-run convergence in per-capita incomes between relatively poor and rich regions. Nonetheless, the differences in inflation rates may also lead to undesirable outcomes if related to market rigidities or other distortions. As an illustration, regions within a monetary union generally have a common interest rate, however, given differences in their inflation rates, lead to variations of their real interest rates. Regions with relatively high inflation regime will have lower real interest rates, and so, pushing up aggregate demand (particularly through consumption-driven side), and cumulatively it boosts higher inflation movements.

As suggested by the mainstream literature, there are several potential factors could explain the differences in regional inflation rates, namely (i) convergence process – the Balassa-Samuelson effect, (ii) differences in business cycles, asymmetric shocks (of demand and supply) and asymmetric effects to common impulses, (iii) differences in regional economic characteristics particularly factor markets, and (iv) nominal wage and price rigidities. In explaining the factors, certainly they are not mutually exclusive (for further discussion, see Haan (2010); Beck et al. (2009)).

Next, we will briefly discuss and elaborate the four sources of regional inflation differentials. First, inflation differentials across regions within monetary union are related to the process of economic convergence in per-capita income levels. This hypothesis is popularly known as the Balassa–Samuelson effect. This effect hinges on differences in labour productivity growth between the tradable and nontradable sector. If this growth is higher in the tradable sector, wages will tend to increase in that sector, while unit labour costs are relatively unchanged. However, in case of high labour mobility between sectors wages will also tend to increase in the non-tradable sector, where—given the lower average labour productivity growth—prices will exhibit higher average increases. Therefore, regions with a large difference between labour productivity growth rates in the tradable and non-tradable sectors will also experience a higher inflation rate.

Second, asynchronous business cycles across regions, or the existence of asymmetric shocks in general, could be a key answer of why regional inflation variations exist. As discussed by Beck et al. (2009), a region that experiences a high aggregate excess demand is also likely to experience (due to capacity constraints and the price-setting power of the firms) an increase in goods prices (or, high inflation rates), and contrastly a region which has low aggregate excess demand might experience price decreases (or, low inflation). Thereby, the lack of synchronization regional business cycles may lead to inflation differentials.

In line with this discussion, regional asymmetries in the transmission mechanisms to common shocks could be a result of differences in production structure. A study by Amiti (2008) found that higher integration of European markets has led to sectoral specialization in member countries. Accordingly differences in the economic structure could lead to inflation differentials.

As suggested by De Haan et al. (2010), pass-through effect of exchange rate shocks on consumer prices could also vary across regions depending on their demand (import) structure. Likewise degree of openness towards international trading partners will affect the external transmission channel.

As aforementioned, theoretically speaking, the two sources of inflation differentials discussed so far are probably not worrisome from policymaker’s viewpoint, since they reflect the result of convergence or
equilibrating dynamics, and hence, they tend to have transitory effect. In contrast, as suggested by Beck et al. (2009), the following sources may lead to undesirable effects that are more related to regional (local) economic characteristics namely labour and other input markets; and nominal wage and price rigidities.

From the input factor prices, differences in labour market institutions can give rise to different inflation rate outcomes. Regions with with relatively higher wages vis-à-vis higher labour costs, in turn the prices of goods produced will increase relatively higher than competing regions, and consequently external demand for their goods will decrease.

Geographically speaking, labour and other input markets tend to be both higher and regionally dispersed than in smaller and homogeneous ones (Bertola, 2006). From spatial economics theory, such phenomenon of the segmentation may reflect agglomeration effects of economic integration (see, Krugman, 1991; Overman and Puga, 2002). Also related to the spatial aspect is the cost of other non-traded input factors particularly housing-related expenses such as: renting, water, electricity, fuel, and gas; which are likely to vary across regions.

Another local specific factor that has strong influences to inflation differentials is nominal wage and price rigidities. As argued by Beck et al. (2009), nominal rigidities are commonly associated with imperfect competition in the goods and labour markets. Higher market concentration tends to lead to high degree of persistence in prices, that could decrease economic efficiency.

Having briefly discussed several key factors that may drive regional differences in inflation rate across Indonesia’s regions, next we continue to write model specification (see Honohan and Lane, 2007) as follows.

\[
\pi_{it} - \pi_t^E = \beta(z_{it} - z_t^E) - \delta([P_{it-1} - P_t^{*E}] - [P_{t-1}^E - P_t^{*E}]) + \varepsilon_{it}
\]  

(1)

where \( \pi_{it} \) and \( \pi_t^E \) are the annual provincial and national inflation rates respectively; \( z_{it} \) and \( z_t^E \) are provincial and national (control) variables that exert short-term influence on the inflation rate; \( P_{it} \) and \( P_t^E \) are the provincial and national price levels and \( P_t^{*E} \) are the provincial and national long-run equilibrium price levels. The prominent advantage of Equation (1) does not only relate inflation differentials (between region and country-wide) with the key explanatory variables, but it can also relate to its long-run dynamic behavior.

Next, it can further be assumed that the Indonesian regions share a common long-run price level, the above equation can be simplified to:

\[
\pi_{it} - \pi_t^E = \beta(z_{it} - z_t^E) - \delta(P_{it-1} - P_t^{*E}) + \varepsilon_{it}
\]  

(2)

As already known that the assumption of a common long-run price level refers to the convergence theory, and is quite likely to hold for a country like Indonesia, which has no limitations for labor and capital mobility, or simply has free flows of goods, people and capitals. As consequences, we focus on the restricted specification in our further analysis. Equation (2) can be further written as:

\[
\pi_{it} = \theta_t + \beta z_{it} - \delta P_{it-1} + \varepsilon_{it}
\]  

(3)

\(^7\) See, for instance, Calmfors and Driffl (1988).
Equation (3) now is only left with one-vector variable $z$ and price level $P$ variable. Following the above literature, vector $z$ consists of several key variables, namely labor wages and unemployment rate (representing labor market institutions), economic sectors (production structure), degree of openness (share of average of export-import to regional output), exchange rate (external effect), change of price index in housing-related expenses (cost of other non-traded input factors), proxy variable for market structures. Another prominent variable is the lagged of price level (convergence conditioning variable). Theoretically, if there is convergence in inflation rates, the estimated values for $\delta$ will be negative. This would imply that inflation of a region with an initially relatively high inflation rate would increase more slowly (or decrease faster) in the subsequent period than those of a region with an initially relatively low inflation rate. Thus, the existing inflation rate gap would diminish. Then this model specification can be written as:

$$\pi_{it} = \theta + \beta_1 w_{age_{it-1}} + \beta_2 unemp_{it-1} + \beta_3 struct_{it} + \beta_4 ER \times open_{it} + \beta_5 dp\_house_{it-1} + \beta_6 dens_{it-1} - \delta price_{it-1} + \varepsilon_{it}$$

(4.1)

In addition, provided that long-run price levels may diverge due to for instance, productivity or income differences, therefore we have also experimented with the alternative hypotheses, and thus Equation (4.1) will be added with a productivity variable becomes:

$$\pi_{it} = \theta + \beta_1 w_{age_{it-1}} + \beta_2 unemp_{it-1} + \beta_3 prodv_{it-1} + \beta_4 struct_{it} + \beta_5 ER \times open_{it} + \beta_6 dp\_house_{it-1} + \beta_7 dens_{it-1} - \delta price_{it-1} + \varepsilon_{it}$$

(4.2)
### Table 2. Producible statistics for regional inflation regressions

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<th>density</th>
<th>ihkL1</th>
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<tbody>
<tr>
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<td>.152888</td>
<td>.21709</td>
<td>.173057</td>
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<td>5.9844</td>
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<td>sd</td>
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<td>.033044</td>
<td>.01115</td>
<td>.03423</td>
<td>.03981</td>
<td>.20911</td>
<td>10.6589</td>
<td>21.0404</td>
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<td>.1053</td>
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<td>.03981</td>
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<td>.12112</td>
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<td>3</td>
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<td>1.0990</td>
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<td>.78029</td>
<td>2.41938</td>
<td>11.7788</td>
<td></td>
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**Note:** Table 2 reports means and standard deviations of the respective regional variables. **dtlh:** dlog CPI, **gupahsk:** growth of nominal wages based on Sakernas data, **unemp:** unemployment rate, **prodv:** productivity (ratio of number output to number of productive labs), **managty:** manafy of sharing of manufacturing sector to regional output, **agriy:** agricultural sector to output, **servy:** service sector, **er_open:** a proxy for externa development, and using interaction variable of exchange rate and share of exports to regional output (er_open), **inf_ho~e:** the change of price index in housing sector, and **density:** ratio of number of manufacturing firms to total size of province i, and **IHK_L1:** lagged of CPI. All of the variables are in lagged form, except price P in level.

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4.2. Estimation Results and Discussions

We begin by presenting the results of the regional inflation differential model based on the pooled annual data of 30 provinces for the period 2007–2012. The key explanatory variables consist of the share of manufacturing sector to real GRP (gross regional products), the share of agriculture, the share of service sector, the change in labour wages, the unemployment rate, interaction term between exchange rate and share of export-import to GRP, the change in housing costs, the ratio of number of producers to population, and a proxy variable for convergence (lagged of price). In our estimation, we employ a panel data approach. The main attraction of the approach is the possibility of consistent estimation of the fixed effects model, which controls for unobserved regional heterogeneity that might otherwise bias results. The fixed effects are contained in the error term in equation (4.1-4.2), which consists of the unobserved region-specific effects, $v_i$, and the observation-specific errors, $e_{it}$. Accordingly by adding the dummy variables, basically we estimate the 'pure effect' of an explanatory variable, while the specific effects of regions, or years, or both are absorbed (for further discussions, see also Wooldridge, 2002; Cameron and Trivedi, 2005).

Based on the derived model in equation (4.1), Columns (1)–(2) in Table 3 present the results of the inflation differential regression with fixed effects, and Column (1) shows the basic model. As aforementioned, we also aim to test the alternative hypothesis of equation (4.2) by allowing productivity to enter the model, and the result is presented in Column (3)–(4). Additionally, the tables also report robust standard errors. This is primarily motivated by the characteristics of panel data in which the error terms are unlikely have the same variance over time for a given individual region (heteroscedasticity), and thus, as suggested by the literature, we employ the White-corrected standard errors.

As shown in the first (restricted) specification, the FE results (Column 2) indicate that labour market institutions play an important role in explaining long-lasting regional inflation differentials. Both labour wages (Wages) and unemployment rate (Unemp) are statistically significant, in which wages have the positive sign, while unemployment has the negative one. This result suggests that differences in labour market institutions seem to have caused long-lasting differences in inflation rates due to their impact on marginal costs.

In the meantime, we also found statistical evidence for the importance of the cost of non-wage input factors, specifically is the price changes in housing-related expenses (phouse) are found highly significant with positive sign. This result confirms that prices of some input factors such as: renting, water, electricity, fuel, and gas are significantly different across regions.

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8 A standard procedure before selecting an appropriate panel data model is that one first conducts the Hausman test, and the result indicates that the fixed effects model would be the model of choice rather than the random effects model. For simplicity, the result is not shown, and it is available upon request.
### Table 3. Regression Results of Regional Differences in Inflation Rate

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>P-OLS (1)</th>
<th>FE-OLS (1)</th>
<th>P-OLS (2)</th>
<th>FE-OLS (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wages (L)</td>
<td>0.00457*</td>
<td>0.00289*</td>
<td>0.00487*</td>
<td>0.00289*</td>
</tr>
<tr>
<td></td>
<td>1.79</td>
<td>1.77</td>
<td>(1.91)</td>
<td>(1.76)</td>
</tr>
<tr>
<td>Unemp (L)</td>
<td>0.00008</td>
<td>-0.00644***</td>
<td>-0.00014</td>
<td>-0.00645***</td>
</tr>
<tr>
<td></td>
<td>(0.12)</td>
<td>(5.71)</td>
<td>(0.19)</td>
<td>(5.68)</td>
</tr>
<tr>
<td>Prodv (L)</td>
<td></td>
<td></td>
<td>0.00016</td>
<td>-0.00002</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1.54)</td>
<td>(0.04)</td>
</tr>
<tr>
<td>Manufy</td>
<td>-0.01376</td>
<td>-0.24989***</td>
<td>0.00204</td>
<td>-0.24961***</td>
</tr>
<tr>
<td></td>
<td>(0.71)</td>
<td>(7.00)</td>
<td>(0.09)</td>
<td>(6.92)</td>
</tr>
<tr>
<td>Agry</td>
<td>0.01969</td>
<td>-0.41695***</td>
<td>0.03573</td>
<td>-0.41795***</td>
</tr>
<tr>
<td></td>
<td>(1.02)</td>
<td>(4.51)</td>
<td>(1.63)</td>
<td>(3.92)</td>
</tr>
<tr>
<td>Servy</td>
<td>-0.03009</td>
<td>1.16913***</td>
<td>-0.00615</td>
<td>1.16866***</td>
</tr>
<tr>
<td></td>
<td>(0.83)</td>
<td>(5.86)</td>
<td>(0.15)</td>
<td>(5.84)</td>
</tr>
<tr>
<td>ER*Open</td>
<td>-0.00269*</td>
<td>-0.00298***</td>
<td>-0.00260*</td>
<td>-0.00298***</td>
</tr>
<tr>
<td></td>
<td>(1.97)</td>
<td>(2.76)</td>
<td>(1.97)</td>
<td>(2.70)</td>
</tr>
<tr>
<td>phouse (L)</td>
<td>0.00433***</td>
<td>0.00381***</td>
<td>0.00429***</td>
<td>0.00381***</td>
</tr>
<tr>
<td></td>
<td>(8.79)</td>
<td>(5.91)</td>
<td>(8.83)</td>
<td>(5.86)</td>
</tr>
<tr>
<td>Dens</td>
<td>0.00003</td>
<td>0.00228***</td>
<td>0.00009</td>
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<td>(0.33)</td>
<td>(4.89)</td>
<td>(1.08)</td>
<td>(3.7)</td>
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<tr>
<td>Price (L)</td>
<td>-0.00100***</td>
<td>-0.00210***</td>
<td>-0.00102***</td>
<td>-0.00210***</td>
</tr>
<tr>
<td></td>
<td>(7.52)</td>
<td>(11.48)</td>
<td>(7.88)</td>
<td>(11.27)</td>
</tr>
<tr>
<td>Constant</td>
<td>0.15426***</td>
<td>0.31756***</td>
<td>0.14704***</td>
<td>0.31820***</td>
</tr>
<tr>
<td></td>
<td>(7.69)</td>
<td>(7.97)</td>
<td>(7.03)</td>
<td>(6.67)</td>
</tr>
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<td>Observations</td>
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<tr>
<td>R-squared</td>
<td>0.671</td>
<td>0.76</td>
<td>0.676</td>
<td>0.76</td>
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</table>

_t-statistics in parentheses. *** p<0.01, ** p<0.05, * p<0.1. L=lagged variables._

As predicted by theory, the results in Table 3 also highlight the importance of economic structure of a region in driving inflation differentials. Our proxy variable for sectoral specialization namely the share of manufacturing (Manufy), agriculture (Agry) and service sector (Servy) to regional output, all of them are found statistically significant. Interestingly the size of manufacturing sector and agriculture sector have positive relationship with inflation differentials, while that of services sector shows negative. This finding suggests that differences in inflation rates are mainly due to differences in productive capacity (manufacturing and industry) across regions, and in the same time, issue of regional connectivity (logistics and distribution) for the archipelago country like Indonesia is still very problematic. Overall this result indicates that asymmetric shocks caused by sectoral specialization might be one of the sources of inflation differentials across Indonesia’s regions. Theoretically speaking, this type of inflation differentials should not be a case of concern from policymakers’ point of view, as it could be considered to be transitory process and a part of the adjustment process in response to the asymmetric shock.

Given the fact that Indonesia’s regions are open economies that are freely to trade within the country as well as across countries, and thus more likely to expose external developments. Our proxy variable that is exchange rate*open turns out to be statistically significant with negative sign. This finding suggests the
importance of international trade in reducing regional price variations, especially remote regions like in Papua and other regions where interregional connectivity still remains problematic. Meanwhile, since positive exchange rate changes or depreciation could boost the inflation rate, therefore direction of this variable to inflation dispersion can be both, positive or negative.

Likewise a proxy variable for market density that is number of industry is also found to be statistically significant with positive direction in affecting regional inflation dispersion. This result tends to confirm with previous studies’ results (for instance, see, Ridhwan, 2012) that indicate high market concentration in Indonesia – where number of producers/suppliers tend to collocate in a core region (namely Java) – despite poor infrastructure condition, this situation in turn may induce price rigidities, and thus regional dispersion in inflation rates. Unsurprisingly, low-inflation regions tend to have sizable competitiveness gains, while high inflation regions may experience considerable competitiveness losses.

Having added productivity variable in the previous model, the results in column (3)-(4) that using both FE and pooled model indicate that productivity turns out not significant, and with negative sign in the FE model. This result tends to be similar with previous studies which can not find a significant role of productivity in affecting inflation (see, for instance, Ridhwan et al., 2012).

Furthermore, the most interesting part from our estimation result is particularly from the lagged price variable which turns out to be stastically significant and with the negative sign for the four different model specifications and methods. This result then suggests the existence of price convergence, although the speed is quite slow process. And the -0.002 point estimate of CPI inflation implies that a region with a price level two basis point below the national average, would experience an additional one percentage point of inflation. This finding is somewhat different from the former study by Wimanda (2011) whom was unable to find price convergence across regions.

5. Conclusions

In this paper we study regional inflation variability in a large emerging and archipelago country, Indonesia. We use a novel disaggregate dataset, which contains CPI data at a provincial level and on a monthly frequency. Having employed a factor analysis method, we are able to decompose sources of inflation differentials that is classified by common (national) factors, district factors and a remaining idiosyncratic local component.

There are several interesting points regarding the findings of the regional inflation heterogeneity across country emerge. First, there is a substantial common area wide component in regional inflation rates, likely related to the common monetary policy in the euro area, to external developments, in particular to exchange rate movements and changes in commodity prices. While the importance of regional (district and local) factors in explaining the variability suggests that differences in regional inflation developments are mainly due to local specific factor phenomena.

Having had isolated the national factors from local factors, our further step is to examine factors that potentially drive inflation differentials, and find significant roles in particular due to differences in sectoral specialization, asynchronous business cycles, degree of openness, nominal wage rigidities, and local (spatial) specific factors. This finding is robust for different model specifications and estimators. Theoretically the three main causes of inflation should not be source of concerns, since it is considered as a transitory phenomenon. Yet the latter ones – local factors – indeed have to be monitored closely especially in the autonomy era, in particular due to weak local institutions and governance in Indonesia that may hurdle such convergence process.
Consequently the two causes of inflation differentials have different policy implications. However, despite the variability phenomenon, this study finally reveals that there is also a tendency of long run convergence of inflation across Indonesia’s regions.

References


<table>
<thead>
<tr>
<th>No.</th>
<th>Title</th>
<th>Objectives</th>
<th>Methodology</th>
<th>Conclusion</th>
</tr>
</thead>
</table>
| 1.  | Monetary union, price level convergence, and inflation: How close is Europe to the USA? (Rogers, 2005) | Evidence of price level convergence in Europe | a) Price Dispersion (demeaned price)  
 b) Price Convergence (Standard deviation across cities for the prices indexed) | 1. There has been a striking decline in the dispersion of traded goods prices in Europe over the period preceding the launch of the euro.  
 2. Traded goods price dispersion is now quite close to that of the USA, any differences in dispersion measures are |
<p>| | | | |</p>
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<thead>
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<tbody>
<tr>
<td>2.</td>
<td>Price Index Convergence Among United States Cities (Cecchetti, 2002)</td>
<td>- To gain better understanding of the source of persistence in the deviations from PPP found in studies national price indices and exchange rate data.</td>
<td>a) To compute half-life the paper estimate log price level as a function lagged log price level. b) Determinants of half-life as a function of distance, nontrade goods in price index, differentials adjustment following small and large deviations.</td>
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<tr>
<td></td>
<td></td>
<td>- To study the behavior of prices across US cities.</td>
<td></td>
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<tr>
<td>3.</td>
<td>International Price Dispersion and the Direction of Trade (Inanc and Zachariadis, 2007)</td>
<td>To examine an empirical model where international price dispersion is determined by transport costs and local trade (distribution) costs, as well as by taxes, good-specific characteristics and differences in</td>
<td>Microeconomic price levels along with cross-sectional productivity indices and bilateral trade flows between countries to identify the likely source of each product.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1. The data are consistent with a model where transport costs and distribution costs are important determinants of international price differences. 2. Utilizing relative productivity and bilateral trade flows along with relative prices from survey data, can help identify trade costs and</td>
</tr>
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</table>
| 4. | Inflation differentials among the Euro area countries: Potential causes and consequences (Hofmann and Remsperger, 2005) | • The development, potential causes and macroeconomic implications of inflation differentials in the euro area.  
• Some evidences based on an estimated New Keynesian style model of the euro area economies | Hybrid Phillips and IS Curve for the euro area economies where inflation is a function of structure inflation, output gap, and exchange rate. | 1. The observed inflation differentials since the start of EMU were mainly driven by temporary shocks combined with a rather high level of inflation persistence.  
2. The scope for an amplification of inflation differentials via corresponding real interest rate differentials appears to be limited by the presence of significant real exchange rate and direct output spill-over effects in the euro area IS Curves.  
3. Inflation persistence is significantly lower, virtually zero, in the group of euro area countries which have already experienced comparably low and stable inflation rates in the past. |
| 5. | Regional inflation dynamics within and across euro area countries and a comparison with the United States (Beck et al, 2009). | 1. A systematic analysis of inflation rates at the regional level  
2. To identify the sources of regional inflation differentials  
3. Quantify the extent to which observed inflation variations are caused by area-wide, national and regional factors  
4. Examine is how our results for the | a) Descriptive analysis  
b) Regression analysis on long-lasting inflation differentials equation  
c) a factor model to decompose regional inflation rates into a common area-wide, a country-specific and an idiosyncratic regional component. | 1. There exist large and long-lasting differences in inflation rates across European regions, implying changes in the real exchange rate across individual regions of up to 25% over our sample period from 1996 to 2004.  
2. These differences are not related to business cycle or income growth dynamics, neither our labour market related variables nor our proxy variables for the Balassa–Samuelson effect turn out to be significant in our |
1. Regional inflation is determined by common monetary policy in the euro area.

2. Regional inflation is explained by common area-wide factor, which can be related to the common monetary policy in the euro area and to external developments, such as changes in oil prices, and the euro exchange rate.

3. The observed differences in regional inflation rates are primarily caused by increases in non-wage input factor prices, which do not reflect market-driven forces, and by limited competition in goods markets.

4. We also find that sectoral specialization plays a significant role for the existence of regional inflation differentials.

5. The main sources of long-lasting inflation differentials within the euro area are factor market distortions and other structural characteristics, which implies that inflation differentials within the euro area are welfare affecting and should be addressed by policy-makers.

6. About 50% of regional inflation variation is explained by the common area-wide factor, which can be related to the common monetary policy in the euro area and to external developments, such as changes in oil prices, and the euro exchange rate.

7. The national factor explains on average 32% of regional inflation rate variance due to nationally determined fiscal policies and labour market institutions.

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<table>
<thead>
<tr>
<th>6.</th>
<th>Regional Inflation Dynamics within</th>
<th>To investigate co-movements and differences in inflation</th>
<th>Regional inflation is explained by common area-wide factor</th>
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<tr>
<td>and across Euro Area Countries and a Comparison with the US (Beck and Hubrich, 2006)</td>
<td>dynamics of different regions within and across euro area countries using a novel disaggregate dataset</td>
<td>euro area and country specific factors and a remaining idiosyncratic regional component.</td>
<td>euro area, to external developments, in particular to changes in oil prices and exchange rate movements.</td>
</tr>
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</tr>
<tr>
<td>2. While the area wide factors are strongly significant. Their loadings are different across different regions, which suggests that differences in regional inflation developments are partly due to area wide phenomena.</td>
<td>3. the national components are relevant for explaining regional inflation, with idiosyncratic regional variability playing a minor role convergence.</td>
<td>7. On The Relevance and Nature of Regional Inflation Differentials: The Case of Spain (Alberola,...)</td>
<td>two aspects of the behaviour of provincial relative prices in Spain: the relevance and the nature of provincial inflation divergences and relative price shifts.</td>
</tr>
<tr>
<td>a) Testing for mean reversion province by province</td>
<td>b) Testing for overall mean reversion sectoral prices and the Balassa-Samuelson hypothesis</td>
<td>1. Inflation differentials are found to be small (the range is less than half point per year in the long-run), but deviations of relative prices from equilibrium can be very persistent.</td>
<td>2. Relative price shifts turn out to be determined by characteristics which are intrinsic to very deep economic integration, in particular, price and wage mechanisms which operate at the national level.</td>
</tr>
<tr>
<td>3. The Balassa-Samuelson hypothesis results clearly rejected.</td>
<td>4. Therefore, while admitting that inflation differentials among EMU participants are possible, their nature will be different from those...</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Title</td>
<td>Objective</td>
<td>Methodology</td>
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<td>----------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
</tbody>
</table>
| 8 | Euro Area Inflation Differentials (Angeloni and Ehrmann, 2007)       | To analyse how differences in national inflation and growth rates arise within the European Economic and Monetary Union (EMU) | a) a stylised 12-country model of the euro area. The paper model each national economy by means of an aggregate supply and an aggregate demand equation. | 1. The main source of differentials in the early years of the EMU have been aggregate demand shocks, followed by cost-push shocks; euro exchange rate shocks come third.  
2. Among the propagation mechanisms a key role is played by inflation persistence; for plausible parameter values even small changes in persistence can produce a dramatic increase in the differentials.  
3. A tight control of average area-wide inflation around a target tends to reduce the differentials as well. |
| 9 | The Origins of Spatial Interaction (Keller and Shiue, 2004)           | To detect and analyze trade patterns in a historical data set on Chinese rice prices | spatial empirical methods                                                   | 1. Spatial features were important for the expansion of interregional trade. Geography dictates, first, over what distances trade was possible in different regions, because the costs of ship transport were considerably below those for land transport. Spatial features also influence the direction in which a trading network is expanding.  
2. Paper analysis captures the impact of new trade routes both within and outside the trading areas. |
| 10| Inflation persistence in Hungary: A spatial analysis (Zsibok and      | To describe the spatial patterns of Hungarian inflation persistence on the NUTS-3 level | inflation persistence in Hungary by focusing on regional                    | 1. The overall level of inflation persistence decreased during the sample period, however, there are notable... |
| Varga, 2009) | by using various exploratory spatial data analysis (ESDA) techniques to investigate the spatial differences at the sectoral level | cross-sectional variation time-varying-coefficient autoregressive models as described in Darvas and Varga (2007) | differences between the local patterns
2. Inflation is less anchored in the past at the end of the sample period than before.
3. Inflation is determined by the actual innovations rather than past values.
4. The spatial aspects of these phenomena were described by measures of global and local spatial autocorrelation which allowed us to investigate the neighbourhood effects. |