Bi-Annual Research Journal "BALOCHISTAN REVIEW" ISSN 1810-2174 Balochistan Study Centre, University of Balochistan, Quetta (Pakistan) VOL. 45 NO. 1, 2020

Globalisation and Inflation: Evidence from Disaggregated Inflation Data

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Abstract

The purpose of this paper is to examine whether the phenomenon of global inflation is observable at disaggregated level by measuring the co-movements in disaggregated sectoral inflation. The co-movements in disaggregate sectoral inflation are modelled as being associated with a global factor, a sector specific factor and an idiosyncratic error term. A dynamic factor model is estimated using the sectoral inflation of fifteen sectors in 15 OECD countries. The sector specific sectors are important and phenomenon of global inflation is more evident at disaggregate level. The co- movements of inflation of tradable sectors are found to be substantially greater than the co-movements in non-tradable sector which implies that the greater co-movements of inflation can be attributed to increased trade and global integration of product markets. The main contribution of the study is that it provides empirical evidence for the argument built in paper that global shocks affect the prices in different sectors with different intensity. Tradable sectors are more open to international trade, hence the variance of sectoral inflation explained by sector specific factor is observed higher in these sectors than non-tradable sectors.

Key words: Disaggregated Inflation, Globalisation and Dynamic Factor Model.
Paper type – Research Paper

Introduction

It is widely believed that globalization has been increasing since the early 1990s. World markets are much more integrated now than ever due to information technology revolution and deregulation of financial markets. The volume of international trade has been doubled in 2007 since it was in 1961. Integration of goods market has led to low cost imports from emerging economies to developed countries, increased labour supply, increased productivity and increased competitive pressures on domestic firms.

Central banks are increasingly interested in the implications of increased global integration of markets for the conduct and effectiveness of monetary policy. The operations of monetary policy might have been mainly affected by globalisation through its influence on financial, labour and goods markets and inflation process. Integration of financial, commodity and labour markets might have affected the relative importance of the channels through which monetary policy transmits by making some channels more important than the others as opposed to the case with less integrated markets. For instance, as Gali (2008) shows that though the effectiveness of transmission of monetary policy is not undermined by globalisation, it affects the relative importance of monetary policy transmission channels (exchange rate and wealth channels are strengthened and interest rate channel is weakened). However, Woodford (2010) shows that financial globalisation (even of the higher degree than has been observed) can not impair the control of central bank on monetary policy.

Nevertheless, Bernanke (2007) emphasizes, "*The integration of rapidly industrial economies into the global trading system clearly has had important effects on the prices of both manufacturers and commodities, reinforcing the need to monitor international influences on the inflation process."*

The operation of monetary policy is mainly affected by globalization through its influence on inflation process. Inflation process in turn is affected by globalization through trade openness, lower import prices and increased competitive pressures (by increased productivity growth, reduced costs and reduced mark ups). Moreover, Impact of globalization on domestic inflation is widely examined by measuring the

sensitivity of domestic inflation to foreign output gap with the argument that inflation dynamics and its formation mechanism is changed with increased integration. A vast literature on globalization and inflation has explored several channels to investigate the effect of globalisation on inflation though it remains inconclusive.

Mixed empirical evidence on the effect of globalization on inflation suggests exploring another strand of literature i.e. measuring co-movements of inflation across countries as inflation rates are observed to be moving together. Ciccarelli and Mojon (2010) highlighted that inflation has become a global phenomenon and almost 70% of the variance of national inflation of OECD countries during 1961-2007 is explained by a single common factor. Mumtaz and Surico (2006), Neely and Rapach (2009), Monacelli and Sala (2009) and Byrne et al. (2010) estimate the global common factor in inflation across different set of countries and find that a significant amount of variation in inflation across countries is explained by a common factor. Mumtaz and Surico (2006) and Byrne et al. (2010) find that a global common factor becomes more important in explaining the movements of inflation after the mid-1980s. Monacelli and Sala (2009) report a positive and significant relationship between the estimated common factor and trade intensity.

The potential candidates for explaining the phenomenon of high co-movements of inflation across countries are co-movements in real activities (such as output gap, investment and consumption), common shocks to demand and supply forces, similarities in conduct of monetary policy across countries and increased globalization. It is shown by Henriksen et al. (2011), Bagliano and Morana (2009), Eickmmeier and Moll (2009) and Wang and Wen (2007) that the co-movements in inflation are substantially higher than the co-movements in real output. Moreover, it is documented by Wang and Wen (2007) that common monetary policy responses do not fully explain the synchronization of inflation. Therefore, phenomenon of global inflation may be attributed to increased globalization.

A number of studies which address the theme of inflation and globalisation (as mentioned above) by estimating the co-movements of inflation across countries examine aggregate inflation. Monacelli and Sala

(2009) is an exception who investigates disaggregated inflation of four countries (i-e United States, United Kingdom, France and Germany) over a period 1991-2004. They estimate a single common factor and relate the estimated commonality ratio to trade intensity. Altansukh et al. (2017) estimate synchronization of aggregate inflation by analysing the core, food and energy components of inflation. They report higher synchronisation of aggregate inflation than core inflation and foreign energy inflation significantly contributes to globalization of inflation. On the other hand, similar study by Forster and Tillmann (2014) report less globalization of inflation and conclude that inflation process in mainly driven by local factors.

We argue that globalization being a potential candidate in explaining the co-movements of inflation, inflation in sectors that are more open to international trade should observe higher co-movements than inflation in sectors which are less open to international trade. Hence, estimating a single global common factor from aggregate or disaggregated inflation data may not capture true nature and size of global factor because a global shock may not affect all sectors of an economy with same intensity. For example a global shock affecting the prices in agriculture sector may not affect the prices in health and social work sector in a similar fashion. The sectors which are more globalized should observe more convergence (and less variability) than less globalized sectors of an economy.

This paper provides analysis of international co-movements of inflation at disaggregate level. We contribute to the literature, first, by analysing sectoral inflation and consider a larger sample of countries over an extended period of 1971-2007. Secondly, we decompose the sectoral inflation into a common factor (henceforth the global factor), sector specific factors and idiosyncratic component using a dynamic factor model. The global factor captures the effect of a global shock on all sectors of all countries and the sector specific factors capture the effects of shocks that affect particular sectors in all countries. This allows us to examine the co-movements in tradable and non-tradable sectors across countries (We follow the classification of tradable and non–tradable sectors suggested by Gregorio et al. (1994) because their classification is based on sectoral

inflation data of 14 OECD countries which is similar to sample of countries in this study). We expect that the inflation in tradable sectors across countries should display higher co-movements than non-tradable sectors if increased integration of world factor and product markets is one of the responsible factors in globalisation of inflation. Once we find that sector specific factors are important, we estimate a single dynamic factor model for individual panel of sectors across all countries (separately) for robustness check and expect that the common factor in tradable sectors should be higher than the common factor in non-tradable sectors.

This study has important policy implication because understanding the source and nature of international fluctuations in inflation leads to effective domestic policy making and reducing the risk of over reacting to domestic factors and ignoring the global ones or over reacting to global factors when they are not important. Moreover, examination of sectoral inflation data may also help us understand the effect of trade integration on co-movements of inflation by estimating the sector specific factor.

The rest of the paper is set out as follows. Section 2 reviews the related literature. Section 3 explains our data set and preliminary analysis. Section 4 outlines the econometric methodology, while the empirical results are presented and discussed in section 5. Section 6 concludes and summarises our findings.

2. A Brief Review of Literature

There is a strong nexus between inflation across countries and global integration. The link of globalisation to inflation works through the channel of low import prices and increased competitive pressures. The impact of increased global integration on inflation is mainly investigated by using two different approaches. First, a Philips curve framework with different specifications of the process driving inflation is used. However, this does not provide conclusive evidence on the effect of globalisation on inflation dynamics (the pronounced evidence favouring the positive impact of globalisation on inflation is provided by Borio and Filardo (2007) among others which is however challenged by Ihrig et al. (2010) who show that Borio and Filardo's results are not robust to alternate measures of foreign output gap. Coibion and Gorodnichenko (2015) provide evidence of

globalized inflation by estimating global Philips curve). A recent study by Zhang and Zhou (2016) provides evidence in favour of importance of global slack for inflation in china.

The empirical evidence on the effect of globalization on inflation is relatively more convincing at sectoral level. For instance, see Gamber and Hung (2001), IMF (2006), Chen et al. (2004), Koske et al. (2010) and Binici et al. (2012). They argue that the sectors that are more exposed to foreign trade face more competitive pressures. Increased competition increases the price elasticity of demand which in turn leads to increased productivity, lower prices and lower mark ups.

Second, relatively recently developed alternative approach focuses on the international dimensions of inflation by using factor modelling. The Factor models are used to study the synchronization of macroeconomic variables by decomposing them into common and idiosyncratic components (for instance, this approach is applied to estimate the synchronization of business cycles by Kose at al. (2003), IMF (2006) and Aiolfi et al. (2010) among many others).

A static factor model is used by Ciccarelli and Mojon (2007). They point out that aggregate inflation in 22 OECD countries is a global phenomenon as 70% of the inflation variability in these countries can be explained by a single common factor. This interesting finding is followed by the research of Mumtaz and Surico (2008) who examine the role of common and idiosyncratic factors in the evolution of aggregate inflation dynamics in 11 OECD countries. They apply a dynamic factor model with stochastic volatility and conclude that international factor has been important in reducing the persistence and volatility of inflation, however, the high volatility of inflation in the seventies was due to country specific factors. Neely and Rapach (2009) decompose the aggregate inflation rates of 65 countries into an international, regional and idiosyncratic components. They find that on average 34% of the inflation variability is explained by the international factor while the regional and idiosyncratic factors account for 16% and 50% of inflation variability respectively. Byrne et al. (2010) also apply a dynamic factor model with stochastic volatility to decompose the inflation of 22 OECD countries into a global, regional and an idiosyncratic component. They find that though the country

specific factors are important drivers of inflation dynamics, the importance of the global factor is increasing over time at the expense of idiosyncratic component.

All the above cited studies look at aggregate inflation data to investigate the role of international factor in inflation dynamics. Monacelli and Sala (2009) contribute to the literature by looking at highly disaggregated monthly product-category (Product category means that the data is less aggregated than individual scanner data and higher than sector price data) inflation data of four industrialized countries to address the issue. They apply a factor model to a cross section of 948 consumer prices and conclude that one international common factor explains, on average, 15% to 30 % of variance of consumer product inflation rates. The increased importance of global common factor in explaining the variations of inflation across countries may be attributed to increased integration of factor and product markets. Monacelli and Sala (2009) test this hypothesis by examining relationship between sectoral trade intensity and sectoral commonality ratio. They find a positive and significant relationship between trade intensity and commonality ratio. Altansukh et al. (2017) estimate synchronization of aggregate inflation by analysing the core, food and energy components of inflation. They report that foreign energy inflation significantly contributes to globalization of inflation. To summarise, the empirical literature, addressing the general theme of globalisation and inflation by identifying the co-movements in international inflation is at embryonic stage and is still limited.

3. Data and Preliminary Analysis

We computed inflation rate from the annual data on the Gross Value Added price index from the EUKLEMS database for 15 sectors of 15 OECD countries: Austria, Belgium, Finland, France, Germany, Greece, Italy, Korea, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom and the United States. The EUKLEMS is a database which is built with the objective of developing a system of analysis at industry level. It provides internationally harmonized and national accounts based high quality data on prices, output and labour compensations. The sample period

under investigation is 1971-2007. Thus in total, we have 225 annual series of sectoral inflation.

[Figure 1 here]

The plots of sectoral inflation in figure 1 depict that the sectoral inflation across countries is highly volatile and less persistent. These are the features especially associated with disaggregated data. The noteworthy point in the plots is that the sectoral inflation across countries appears to co-move throughout the sample period. These co-movements are strikingly high in some sectors (For example Agriculture, Hunting, Forestry and Fishing, Mining and Quarrying, Education, and Total Manufacturing sectors) whilst less apparent in others (For example Financial Intermediation, Other Community, Personal and Social Services and Private Households with Employed Persons sectors).

Table 1: Summary Statistics

	Sector	**Average**	**Standard**	**Average**
Tradable Sectors	Agriculture, hunting, forestry and fishing	3.70	8.73	0.35
	Mining and Quarrying	5.89	13.3	0.34
	Total Manufacturing	4.60	5.04	0..55
	Transport, Storage and Communication	4.50	5.47	0.54
	Average	**4.67**	**8.13**	**0.45**
Non-Tradable Sectors	Construction	6.97	5.53	0.38
	Education	7.28	5.28	0.38
	Electricity, Gas and Water supply	5.11	9.12	0.36
	Financial intermediation	5.63	9.11	0.20
	Hotels and Restaurants	7.65	5.2	0.40

	Health and Social work	7.17	5.02	0.48
	Other community, Personal and social	7.23	4.9	0.49
	Public Admin and Defence	7.00	5.13	0.49
	Private households with employed persons	7.28	5.31	0.42
	Real Estate, Renting and Business Activities	6.68	4.6	0.42
	Whole Sale and Retail	5.61	5.22	0.53
	Average	**6.69**	**5.86**	**0.41**
Total Indust	**Average**	**5.85**	**2.62**	**0.67**

We present summary statistics in Table 1. First and second columns of the Table 1 present mean and standard deviation of disaggregated and total industry inflation. In third column, average correlation is reported. Table 1 suggests a number of observations. First, sectoral inflation is substantially heterogeneous and more volatile than aggregate inflation (It is also shown in Clark (2003) and Altissimo et al. (2007) and Monacelli and Sala (2009). Second, the average inflation of tradable sectors (4.67) is lower than the inflation of non-tradable sector (6.69). The phenomenon of higher inflation in non- tradable sectors than tradable sectors may be explained by Balassa-Samuelson effect. The Balassa- Samuelson effect explains that prices in tradable goods converge internationally while this convergence does not take place in non-tradable sectors (Balassa (1964) and Samuelson (1964). The mean standard deviation of tradable sectors is higher than the mean standard deviation of non-tradable sectors as the tradable sectors are more exposed to global shocks. Third, for sectoral inflation the average cross- country correlation in tradable sectors across countries is higher than non-tradable sectors. The highest cross country average correlation is reported for Total Manufacturing sector (i.e. 55%) while lowest is for Financial Intermediation (i.e. 20%). To have an insight on the time series properties

of aggregate and disaggregate inflation rates we test for the presence of unit root by DF-GLS unit root test statistics proposed by Elliot, Rothenberg and Stock (1996). DF-GLS test statistics indicate that null hypothesis of a unit root is rejected in all cases except for few. Therefore, we model the disaggregate inflation as a stationary process (the evidence for less persistence disaggregated inflation is provided in literature by Altissimo et al. (2009), Monacelli and Sala (2009) and Byrne et al. (2010) for UK among others).

4. Econometric Methodology

In this section we present the dynamic factor model of Stock and Watson (2008). The aim of model is to capture a global component, a sector specific component, and an idiosyncratic component from the inflation rate series of 15 sectors of 15 OECD countries. The global component captures the common component in all sectors across all countries and the sector specific components capture the common component in a particular sector across all countries while idiosyncratic component is unique for each sectoral inflation series. Specifically inflation is modelled as the following dynamic factor model.

$$\pi_{it} = \lambda_i F_t + \sum_{j=1}^{N_S} \gamma_{ij} S_{jt} + e_{it} \quad (1)$$

Where, π_{it} is demeaned inflation rates and the global factor F_t, the sector specific factors S_{jt} and the idiosyncratic disturbance e_{it} follows AR(1) process.

$$F_t = \alpha_i F_{t-1} + \eta_t \quad (2)$$

$$S_{jt} = \beta_j S_{jt-1} + \upsilon_{jt} \quad (3)$$

$$e_{it} = \rho_i e_{it-1} + \varepsilon_{it} \quad (4)$$

The disturbances η_t, υ_{jt} and ε_{it} are independently distributed, where ε_{it} is i.i.d, N(0,σ^2_{ε}).

The factors are identified by restrictions on the factor loadings. The global factor enters all equations so λ_i is unrestricted. The sector specific factors are restricted to load on only those variables in a specific sector, so γ_{ij} is nonzero if an inflation series i of a country is in sector j and is zero otherwise. The scale of the factors is normalized setting $\lambda'\lambda/N = 1$ and $\gamma j \gamma j/N_{Sj} = 1$ where $\lambda = (\lambda_1 \ldots\ldots \lambda_N)'$ and $\gamma_j = (\gamma_{1j} \ldots\ldots\ldots \gamma_{Nj})'$, and N_S is the number of countries in sector j. The parameters $(\alpha_i, \lambda_i, \gamma_{ij}, \rho_i)$, $i = 1, \ldots.., 225$ are estimated by Gaussian Maximum Likelihood. The likelihood is maximized using the EM (Expectation-Maximization) algorithm (see Dempster, Laird and Rubin, 1977).

Furthermore, we estimate a single factor model for each sector separately.

$$\pi_{it} = \lambda_i F_t + u_{it} \tag{5}$$

$$F_t = \alpha_i F_{t-1} + \eta_t \tag{6}$$

$$u_{it} = \rho_i u_{it-1} + \varepsilon_{it}, \tag{7}$$

Where (η_t and ε_{it}) are independently distributed normal variables with zero mean and constant variances.

To account for sectoral and national heterogeneity, we take average of the individual time-series coefficients' estimates to obtain the MG (Mean Group) panel estimator (Pesaran and Smith, 1995), $\widehat{\Psi}_{MG}$:

$$\widehat{\Psi}_{MG} = \frac{1}{N}\sum_{i=1}^{N}\widehat{\Psi}_i \tag{8}$$

Where, $\widehat{\Psi}_i$ denotes the individual estimates. The standard error of the MG estimator is computed as:

$$se(\widehat{\Psi}_{MG}) = \sqrt{\frac{1}{N(N-1)}\sum_{i=1}^{N}(\widehat{\Psi}_i - \widehat{\Psi}_{MG})^2} \tag{9}$$

MG estimates are computed for sectors across countries (average of estimates for a sector in each country, e.g. Austrian construction, Belgium construction….).

5. Empirical Results

This section aims to present and discuss the results of our empirical analysis of disaggregate and aggregate inflation. We present the results obtained by estimation of the Dynamic Factor Model (Equations 1- 4) and the variance decomposition of disaggregated inflation into a global, sector specific and idiosyncratic component and the variance decomposition of inflation of each sector into a common factor and idiosyncratic component (obtained from separate estimations of Eqs 5-7 for each sector) is reported.

The Mean Group Maximum Likelihood estimates of the model (1) - (4) for disaggregate data are presented in Table 2. The first and second column show the mean group factor loadings on global and sector specific factors and the last two columns present average autoregressive coefficient and idiosyncratic standard deviation respectively. The factor loadings are normalized so that $\lambda'\lambda / N = 1$ and $\gamma_j'\gamma_j / N_{sj} = 1$. The loadings on the global and sector specific factors show the correlation of inflation process to the global and sector specific factors.

Table 2: Sectoral Disaggregate MG-Maximum Likelihood Estimates

	Sector	λ	γ	ρ	σ_ε
Tradable Sectors	Agriculture, hunting, forestry and fishing	0.74*	3.40*	0.01	6.23
	Mining and Quarrying	1.29*	3.13*	0.02	9.24
	Total Manufacturing	0.84*	2.58*	0.22*	2.59
	Transport, Storage and Communication	0.95*	1.84*	0.28*	2.89
	Average	**0.96**	**2.73**	**0.13**	**5.23**

Non-Tradable Sectors	Construction	0.80*	-0.98	0.25*	3.43
	Education	0.71*	0.2	0.18*	3.01
	Electricity, Gas and Water supply	1.09*	3.46*	0.01	6.93
	Financial intermediation	0.93*	0.99	0.00	6.54
	Hotels and Restaurants	0.80*	1.08	0.21*	3.03
	Health and Social work	0.82*	0.87	0.40*	2.78
	Other community, Personal and Social services	0.83*	0.28	0.34*	2.56
	Public Admin and Defence	0.87*	0.44	0.19*	2.49
	Private households with employed persons	0.84*	1.10	0.23*	2.89
	Real Estate, Renting and Business Activities	0.67*	0.36	0.28*	2.68
	Whole Sale and Retail	0.94*	1.73	0.23*	2.65
	Average	**0.85**	**0.86**	**0.21**	**3.54**

Notes: This table shows Mean Group (MG)-Maximum Likelihood Estimates of the dynamic factor model (1) – (4) using disaggregated inflation. The Mean Group is computed by taking the average of Maximum Likelihood estimates for each sector across 15 sample countries. λ, γ are factor loading on global factor and sector specific factors respectively, ρ is autoregressive coefficient of the disturbance term and σ_ε denotes disturbance variance. * indicate statistical significance at 5% level.

A number of observations in Table 2 are important. First, the loadings on the global factor (λ) are all positive and significant ranging

from 0.67 for Real Estate renting and Business activities sector to 1.29 for Mining and Quarrying. This implies that inflation process in all sectors is positively correlated with global factor. Second, on average mean group factor loadings on the global factor of tradable sectors is not substantially greater than the non-tradable sector which is not surprising as we argue that estimating a global factor from disaggregated data underestimates the co-movements because global factor estimation from disaggregated sectoral inflation captures the common factor across all sectors and all countries but not the ones that are specific to particular sectors. The factors that are specific to particular sectors should display high co-movements. Third, the sector specific factor loadings (γ) are also positive for all sectors except for Construction sector indicating that inflation process in all sectors (except Construction) have a positive correlation with sector specific factors. Fourth, the sector specific factor loadings for tradable sectors are significant and substantially higher than the sectors that are non-tradable while they are all insignificant for non-tradable sectors apart from Electricity, Gas and water supply. Insignificant mean group estimates of sector specific loading on non-tradable sectors are due to heterogeneity of inflation rates in non- tradable sectors which may be explained by Balassa-Samuelson effect. However, the significant sector specific factor loading on Electricity, Gas and water supply which is a non-tradable sector (less traded directly) may be justified as this sector is closest to energy sector and shocks to energy prices spill over across countries relatively easily because the inputs to this sector are highly traded commodities (oil for example). Altansukh et al. (2017) provide evidence that foreign energy inflation plays an important role in the globalization effect. This is consistent with our argument and expectation that estimation of a single common factor from disaggregated data may not capture the effects of the international factors that are sector specific. Hence, the loadings on global factor for tradable and non tradable sector are not significantly different because they capture the pattern that is common across all sectors across countries. The higher loadings on sector specific factors for tradable sectors clearly indicate that prices of the goods that are actively traded across countries observe higher co-movements than those that are less traded. The low persistence of idiosyncratic disturbance is shown by the

autoregressive coefficient (ρ) in third column. Fourth column reports the standard deviations which indicate that inflation in tradable sectors is highly volatile as they are more exposed to international shocks than the non tradable sectors.

Table 3 reports the average proportion of variance of sectoral inflation that is explained by a global factor, sector specific factor and the idiosyncratic term. We find that on average 9% of variance in disaggregated inflation is explained by the global factor and 15% of it is attributed to the sector specific factors. It is interesting to note that the average share of the global sector in explaining the variance of inflation for tradable sectors is not considerably different from non-tradable sectors. This is consistent with the fact that international factors do not affect all the sectors similarly and justifies our approach of estimating the Dynamic factor model with a global factor and sector specific factors.

Table 3: Variance Decomposition of Sectoral Disaggregated Inflation into Global, Sector -Specific and Idiosyncratic Component

	Sector	R^2-***F***	R^2-***S***	R^2-***e***
Tradable Sectors	Agriculture, Hunting, Forestry and Fishing	0.03	0.28	0.69
	Mining and Quarrying	0.02	0.23	0.75
	Total Manufacturing	0.12	0.23	0.65
	Transport, storage and communication	0.11	0.21	0.68
	Average	**0.07**	**0.24**	**0.69**
Non-Tradable Sectors	Construction	0.07	0.02	0.91
	Education	0.09	0.06	0.85
	Electricity, water supply and Gas	0.03	0.14	0.83
	Financial intermediation	0.04	0.15	0.81
	Hotels and Restaurants	0.08	0.18	0.73

	Health and social work	0.13	0.13	0.74
	Other Community Personal and social services	0.14	0.13	0.73
	Public Admin and Defence	0.17	0.05	0.78
	Private households with employed persons	0.10	0.11	0.79
	Real Estate renting and business Activities	0.12	0.10	0.77
	Whole sale and retail trade	0.13	0.17	0.70
	Average	**0.10**	**0.11**	**0.78**
Total Average		**0.09**	**0.15**	**0.76**

Notes: This table shows the average variance decomposition of sectoral disaggregated inflation rate. First, second and third columns show the fraction of variance attributed to global factor *F*, sector specific factor *S* and the idiosyncratic disturbance term *e* respectively.

Another important feature to note in Table 3 is that the variance of disaggregated inflation that is explained by the sector specific factors is higher for tradable sectors than the non-tradable sectors. For instance, for tradable sectors, on average 24% of the variance of inflation is attributed to sector specific factors while for non-tradable sectors it is 11%. Hence, estimating the sector specific factor helps identify the effect of real integration on co-movements of inflation. Similarly, the average variance of inflation attributed to idiosyncratic component for tradable sectors is lower (69%) than non-tradable sectors (76%). Thus, it provides evidence that inflation in tradable sectors that are more integrated globally observe higher co-movements across countries.

The estimation of the dynamic factor model with sector specific factors (Equations 1 - 4) provides evidence that the international component of inflation is global as well as sector specific and sector specific factors are important. Therefore, we estimate the single factor model for each sector across countries separately. Table 4 presents the variance decomposition of sectoral inflation rates into a global factor and an idiosyncratic component. It is exhibited in the table that a significant

amount of variance of sectoral inflation is explained by a common factor for most of the sectors. It is interesting to note that the sectors which are intensively involved in international trade have significantly high global R^2 (the average global R^2 for tradable sectors is 74% whereas for non-tradable sectors it is 44%). The 89% of the variance of inflation of Agriculture, Hunting, Forestry and Fishing sector is explained by a global factor. Similar is the case for Mining and Quarrying sector.

Table 4: Variance Decomposition of Disaggregated Inflation Estimated for Each Sector across Countries (estimated individually) into Global and idiosyncratic Component:

	Sectors	R^2-*F*	R^2-*e*
Tradable Sectors	Agriculture, Hunting, Forestry and Fishing	0.89	0.11
	Mining and Quarrying	0.88	0.12
	Total Manufacturing	0.63	0.37
	Transport Storage and Communication	0.58	0.42
	Average	**0.74**	**0.26**
Non-Tradable Sectors	Construction	0.40	0.60
	Education	0.42	0.58
	Electricity, Gas and Water supply	0.84	0.15
	Financial Intermediation	0.28	0.72
	Hotels and Restaurants	0.44	0.56
	Health and Social Work	0.46	0.54
	Other Community Personal and social services	0.42	0.58

	Public Admin and Defence	0.43	0.57
	Private households with employed persons	0.31	0.69
	Real Estate Renting and Business Activities	0.27	0.73
	Whole sale and retail trade	0.55	0.45
	Average	**0.44**	**0.56**

Notes: This table shows average variance decomposition of sectoral disaggregated inflation rate estimated for each sectors across countries separately. First and second columns show the fraction of variance attributed to global factor *F* and the idiosyncratic disturbance *e* respectively.

We show that the phenomenon of global inflation is more evident at disaggregate level and provide support to the argument that increased trade integration and globalisation has contributed to higher co-movements of sectoral inflation across countries. The decomposition of sectoral inflation into global factor, sector specific factor and idiosyncratic component discern the effect of trade integration from other forms of integrations such as common responses of monetary policy to shocks. The sector specific factor estimates the co-movements of inflation due to trade integration which is found to be important in explaining the variance of sectoral inflation.

6. Conclusion

Aggregate inflation rates are observed to be highly synchronized across countries since last two decades. The common macroeconomic shocks and similar responses to these shocks by central banks are often attributed to produce the co-movements in inflation rates. However, Wang and Wen (2007) show that common monetary policy and common oil price shock may not be the whole story behind international synchronization on inflation rates. Several studies such as Ciccarelli and Mojon (2010), Mumtaz and Surico (2012), Neely and Rapach (2011) estimate the co-movements of aggregate inflation and document mixed results. Ciccarelli

and Mojon (2010) report a highly dominant global factor (70%) whereas, others find though important global factor in explaining the variance of inflation yet dominant country specific factor.

In this paper, we estimated the contribution of the international factors that drive the co-movements in sectoral inflation rates across 15 OECD countries. To investigate the globalization of inflation from sectoral perspective is important as it can deepen our understanding about the nature and source of co-movements of inflation rates. We take into account the fact that exposure to global shocks varies across sectors. Hence, international factors do not affect all the sectors with similar intensity and there may be a component of international shocks that are specific to some sectoral inflation rates which may not be captured by a single global factor. We use dynamic factor modelling to decompose the disaggregated inflation rates into a common global factor, sector specific factors and the idiosyncratic disturbances. Once we find that the sector specific factors are important, we estimate a single dynamic factor model for each sector separately and decompose the sectoral inflation into a global and idiosyncratic component.

Main contribution of the paper is that we examined the disaggregated sectoral inflation data and document the importance of sector specific factors in explaining the volatility of disaggregate inflation. We provide the empirical evidence for the argument that international shocks affect prices in different sectors with different intensity. Therefore, a global factor estimation from disaggregate sectoral inflation captures the common patterns across all sectors but not the ones that are specific to particular sectors. The sectors where products are actively traded should display higher co-movements. We show that on average the loadings on the global factor and variance of disaggregate inflation explained by the global factor is not different for tradable and non tradable sectors. However, the importance of sector specific factors in explaining the volatility of disaggregate inflation is substantially greater for tradable sectors than non tradable sectors. This implies that strikingly high co-movements of sectoral inflation rates are function of globalisation and increased integration of world factor and product markets.

However, the degree of co-movements of inflation might have been changed during the sample period under investigation. An analysis by splitting the sample period may help better understand the phenomenon of globalization of inflation over time. For instance, introduction of Euro might have caused further synchronization of sectoral inflation due to increased regional integration. The limitation of the study is that sample period under investigation is from 1971-2007 and Euro was introduced in 1999 so splitting the sample at 1999 leaves us with annual data of 8 years only after introduction of Euro. This research may be updated with extended sample period and with time varying volatility in future.

The findings of paper have important policy implications. It is very important for policy makers to understand how international shocks spill over different sectors depending on the exposure of sectors to global shocks. It is found that trade integration has an important role in globalization of inflation. For an effective monetary policy central banks should consider developments in foreign sectoral inflation rates and how relative price shocks translate into aggregate inflation. The task of central banks has become challenging as they need to maintain a good balance in responding to international and domestic shocks. Overreacting to one and ignoring the other may lead to less effective or poor monetary control. Future research may be extended to investigate that to what extent international shocks which affect sectoral inflation with different intensity may translate into aggregate inflation.

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