All together now: do international factors explain relative price co-movements?

Özer Karagedikli, Haroon Mumtaz and Misa Tanaka

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Outline

Motivation

Model

Data

Conclusions/Future Direction
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Conclusions/Future Direction
Motivation

“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”

Ben Bernanke, 2007
Motivation

“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”

Ben Bernanke, 2007
Motivation

- Inflation rates in developed world has become more of an international phenomenon

- Influences of international factors are more important than before

- These are the findings of some recent literature:
  - Ciccarelli and Mojon (2007)
  - Mumtaz and Surico (2009, JMCB)
  - Monacelli and Sala (2009, JMCB)
  - Neely and Rapach (2009)
What is behind the ‘internalisation’ of inflation?

- Three explanations
  - Central banks conducting similar policies
  - Common shocks
  - Product market integration, globalisation
Motivation

- These papers have shown the existence and the importance of international factors
- Do we also see this at product/good level?
- Do relative prices also co-move?
This paper

- Tests for the co-movements of relative prices across countries
- Do this by means of a Bayesian dynamic factor model
  - By using 29 matched products from 14 countries and
  - By estimating product specific factors
Bernanke (2006) divides this link between trade integration and inflation into two complementary channels:

- **Direct channel (terms of trade),** due to lower import prices

- **Indirect channel (pro-competitive),** due to competitive pressures, lower markups and reduced pricing power of domestic firms
Motivation behind product specific factors (common drivers of relative prices)

- As long as the entry to a particular market is not restricted

- Prices in that sector = Production cost + margin

- The costs would fall if productivity increases

- The costs would fall if imported input prices fall
Motivation behind product specific factors

- This has implications for our set up
- Since most technical advances can be copied
- Since cheap imports are readily available
- The relative size of cost pressures in that sector should be similar in developed economies
- Therefore the relative price changes in that sector should exhibit common elements, factors
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Consider a panel of international price changes $\pi_{i,j,t}$ where $\pi_{i,j,t}$ is the inflation rate of

- product category $j$
- in country $i$
- at time $t$

Write this as a dynamic latent factor model:

$$\pi_{i,j,t} = \beta^c_i F^c_{i,t} + \beta^g_j F^g_{j,t} + \beta^w_{i,j} F^w_t + \nu_{i,j,t}$$ (1)
Model

\[ \pi_{i,j,t} = \beta^c_i F^c_{i,t} + \beta^g_j F^g_{j,t} + \beta^w_{i,j} F^w_t + \nu_{i,j,t} \tag{2} \]

- \( F^c \) is the country factor
- \( F^g \) is the product/good factor
- \( F^w \) is the world factor
- \( \beta^k \) are the associated loadings \((k = g, c, w)\)
Model

\[ F_t^k = c^k + \sum_{l=1}^{P} \rho_t^k F_{t-l}^k + e_t^k \]  

(3)

\[ \nu_{i,j,t} = \sum_{l=1}^{P} \rho_{i,j} \nu_{i,t-l} + e_{i,j,t} \]  

(4)

where \( \text{var}(e_t^k) = Q_k \) and \( \text{var}(e_{i,j,t}) = R \)

\( e_t^k \) and \( e_{i,j,t} \) are uncorrelated contemporaneously and at all leads and lags so the factors are orthogonal
Neither slope nor the scale of factors/loadings are identified separately.

For example: multiply world factor by $-2$ and associated loadings by $-\frac{1}{2}$, we get identical results.

We need identification restrictions.
Identification

- We follow Köse, Otrok and Whiteman (2003, AER) to identify

- We fix the magnitude of $Q_k$ to unity. This fixes the scale problem

- We restrict the signs of some factor loadings to identify
  - World factor is (+)ly loaded to the US headline CPI
  - Good factors are (+)ly loaded to the US products
  - Country factors are (+)ly loaded to the headline CPI of the each country
Identification

- The sign and scale normalisations have no economic meaning and do not affect any economic inference.

- For example the variance decomposition is invariant to those normalisations.

- Because of the latent nature of factors, we cannot use regression methods to estimate loadings. Instead we follow Otrok and Whiteman (1998) and Köse et al (2003, 2008).

- Use Bayesian techniques with data augmentation to estimate the model.
Algorithm

Our algorithm contains the following steps:

1. Conditional on a draw for $F^c$, $F^g$ and $F^w$, we simulate the AR parameters and the hyper-parameters

2. Conditional on a draw of $F^c$, $F^g$ and $F^w$, we draw the factor loadings $\beta^c$, $\beta^g$ and $\beta^w$ and the covariance matrix $R$

3. Given data on $F^c$, $F^g$ and $F^w$ and $\pi_{i,j,t}$, standard results for regression models are used and the coefficients and the variances are simulated from normal and inverse gamma distributions

4. Simulate $F^c$, $F^g$ and $F^w$ conditional on all other parameters above

5. Go to step 1

6. 35000 iterations and the first 31000 is burnt in item Results report the median values of the remaining 4000 draws
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We started with 30 countries and 40 categories

However, for some countries we only have data starting from 2000

- Some categories only have discrete changes in prices once a year such as rent, electricity, gas, accommodation (Denmark)

- These kind of considerations made us to cut the sample into: 14 countries and 29 categories
### Countries

**Table: Total CPI weights by country (percent)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Total CPI weight</th>
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<tbody>
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<td>UK</td>
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World Factor
Factors

- World factor shows very little variation except in 2008
- May be due to the food and fuel having high weight in our sample, world factor jumps in 2008
- Country factors
- Product factors are important
Country Factors

German

Belgium

Canada

Spain

Finland

France

Greece

Ireland

Netherlands

Norway

Austria

United Kingdom

United States
Product Factors
Variance Decomposition

With orthogonal factors:

\[
\text{var}(\pi) = (\beta_i^c)^2 \text{var}(F_{i,t}^c) + (\beta_j^g)^2 \text{var}(F_{j,t}^g) + (\beta_{i,j}^w)^2 \text{var}(F_{t}^w) + \text{var}(\nu_{i,j,t})
\] (5)

\[\text{Country} = \frac{(\beta_i^c)^2 \text{var}(F_{i,t}^c)}{\text{var}(\pi_{i,j,t})} \] (6)

\[\text{Good} = \frac{(\beta_j^g)^2 \text{var}(F_{j,t}^g)}{\text{var}(\pi_{i,j,t})} \] (7)

\[\text{World} = \frac{(\beta_{i,j}^w)^2 \text{var}(F_{t}^w)}{\text{var}(\pi_{i,j,t})} \] (8)
Variance decomposition by product

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## Variance decomposition by product

### Table: Variance decomposition by product

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### Variance decomposition by country

**Table:**

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Product Factors

- Goods that have inputs from primary commodities, bread, vehicle fuel for example
- Product factors are important on average
\( \hat{Y}^C_{i,j,t} = \Phi_i F^C_t \)  

(9)

\( \hat{Y}^{GC}_{i,j,t} = \Phi_i F^C_t + \hat{\gamma}_j F^G_{j,t} \)  

(10)

\( \hat{Y}^{GCW}_{i,j,t} = \Phi_i F^C_t + \hat{\gamma}_j F^G_{j,t} + \hat{\lambda}_k F^W_{k,t} \)  

(11)
Bread - Actual and Country
Bread - Actual, Country and Product
Bread - Actual, Country, Product and World
Fuel - Actual

Graphs showing fuel data for various countries from 2000 to 2008.
Fuel - Actual and Country

[Graphs showing data trends for different countries such as Germany, Belgium, Canada, Spain, Finland, France, Greece, Ireland, Italy, Netherlands, Norway, Austria, United Kingdom, and United States. Each graph includes a line for 'Actual' and 'Country'.]
Fuel - Actual, Country and Product
Fuel - Actual, Country, Product and World
Sugar - Actual
Sugar - Actual and Country
Sugar - Actual, Country and Product
Meat - Actual
Meat - Actual and Country
Meat - Actual, Country and Product
Meat - Actual, Country, Product and World

Graphs showing meat production trends in various countries from 2000 to 2008.
Dairy - Actual
Dairy - Actual and Country
Dairy - Actual, Country and Product
Dairy - Actual, Country, Product and World
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Conclusions

- We show that international product specific factors explain relative price changes across 14 countries.

- Remember this is in quarterly space. At longer horizons this co-movement may/should be even more striking.

- In quarterly terms around 20-25 per cent of variation on average.

- Country factors still explain a significant degree of variation in relative price changes.
Future Directions

- Increase the size of the data

- Look at the variations in variance decompositions
  - An empirical assessment of product factors variation across products and countries

- Time variation in loadings and stochastic volatility