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

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Outline

Motivation

Model

Data

Conclusions/Future Direction

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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

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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

Motivation behind 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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Model

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:

$$\pi_{i,j,t} = \beta_i^c F_{i,t}^c + \beta_j^g F_{j,t}^g + \beta_{i,j}^w F_t^w + \nu_{i,j,t} \tag{1}$$

Model

$$\pi_{i,j,t} = \beta_i^c F_{i,t}^c + \beta_j^g F_{j,t}^g + \beta_{i,j}^w F_t^w + \nu_{i,j,t} \tag{2}$$

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

Model

$$F_t^k = c^k + \sum_{l=1}^{P} \rho_t^k F_{t-l}^k + e_t^k \tag{3}$$

$$\nu_{i,j,t} = \sum_{l=1}^{P} \rho_{i,j} \nu_{i,t-i} + e_{i,j,t} \tag{4}$$

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

e_t^k and $e_{i,j,t}$ are uncorrelated contemporaneously and at all leads and lags so the factors are orthogonal

Identification

- Neither slope not 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 β^c, β^g and β^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

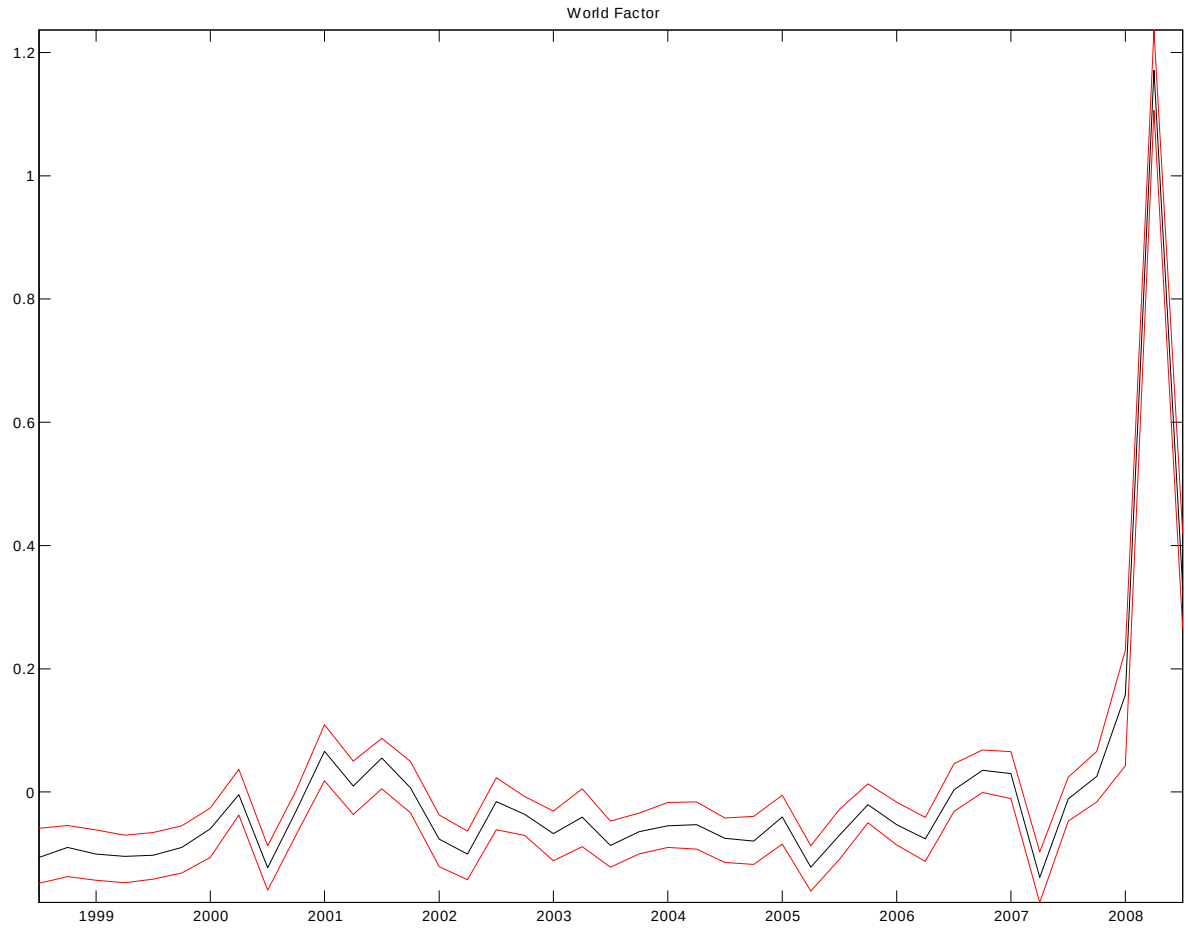
- Some categories only have discrete changes in prices once a year such as rent, electricity, gas, accommodation (Denmark)
- These kind of considerations made us to cut the sample into: 14 countries and 29 categories

Countries

Table: Total CPI weights by country (percent)

Country	Total CPI weight
UK	41.00
Belgium	48.54
Germany	40.24
Ireland	42.21
France	47.99
Italy	54.40
Netherlands	42.82
Spain	52.33
Austria	44.64
Finland	45.61
Greece	45.65
Norway	49.48
Canada	38.76
US	35.00

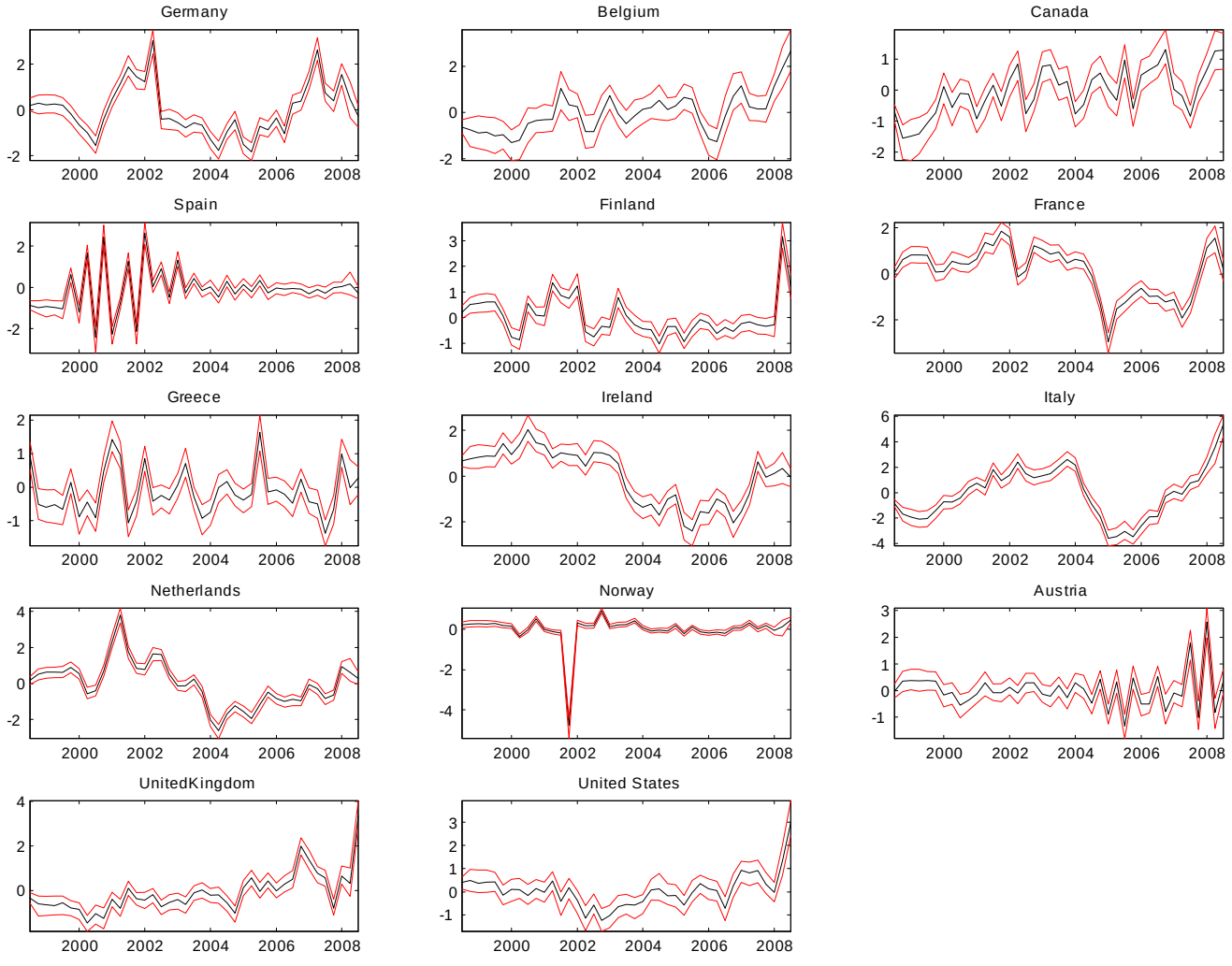
World Factor



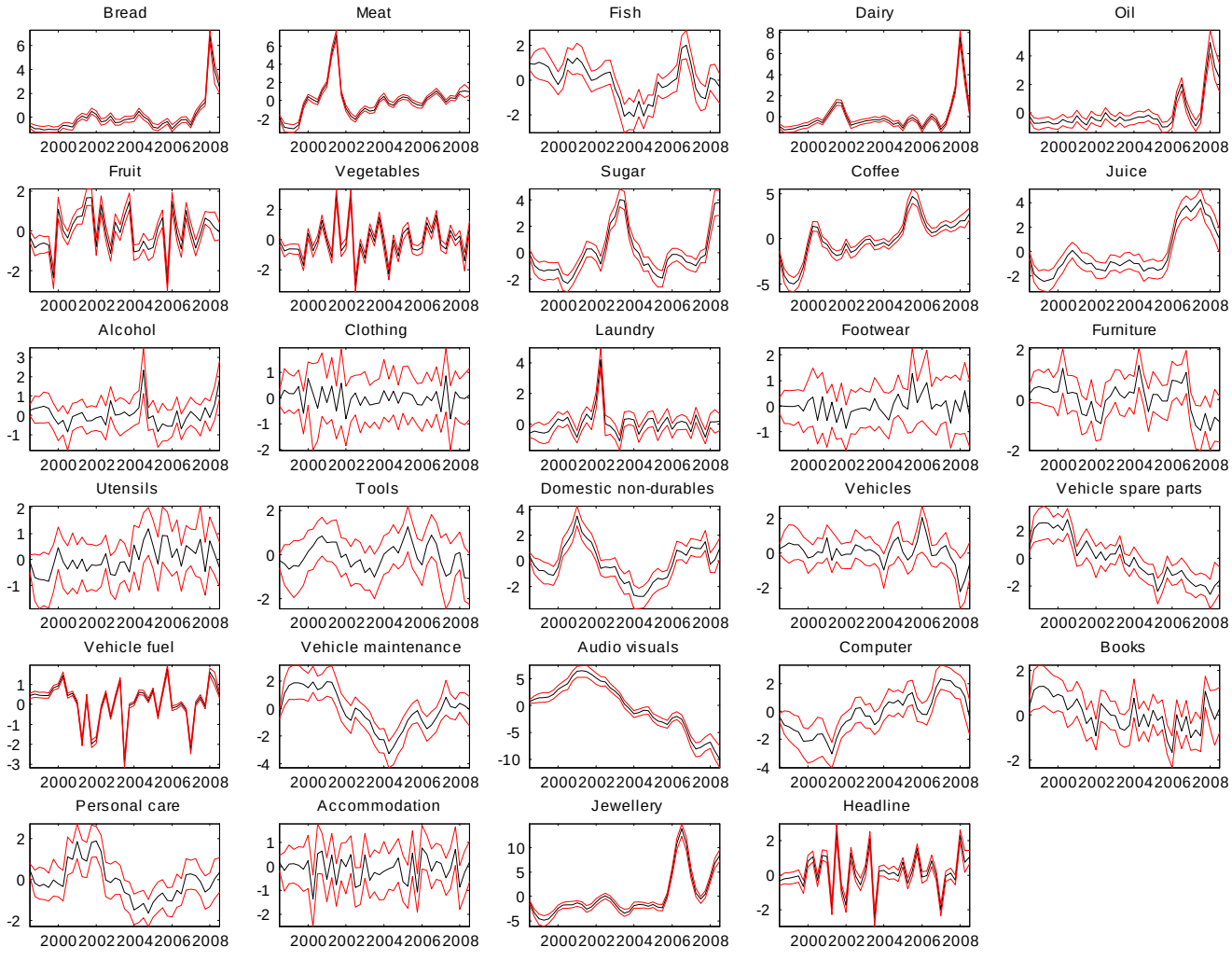
Factors

- 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



Product Factors



Variance Decomposition

With orthogonal factors:

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

- $$Country = \frac{(\beta_i^c)^2 var(F_{i,t}^c)}{var(\pi_{i,j,t})} \tag{6}$$
- $$Good = \frac{(\beta_j^g)^2 var(F_{j,t}^g)}{var(\pi_{i,j,t})} \tag{7}$$
- $$World = \frac{(\beta_{i,j}^w)^2 var(F_t^w)}{var(\pi_{i,j,t})} \tag{8}$$

Variance decomposition by product

Table: Variance decomposition by product

	Country			Product			World		
	S1	S2	FS	S1	S2	FS	S1	S2	FS
Bread	19	20	19	11	37	35	1	4	4
Meat	11	13	12	46	42	40	1	2	2
Fish	16	14	14	4	9	9	1	1	1
Dairy	12	13	13	29	40	37	1	5	4
Oil	13	14	13	6	25	28	1	3	3
Fruit	10	7	7	19	21	20	1	2	2
Vegetables	5	4	4	40	34	33	1	1	1
Sugar	15	21	20	23	15	15	1	3	3
Coffee	16	14	13	32	43	43	1	1	1
Juice	19	23	23	8	14	14	1	3	3
Alcohol	8	18	18	7	5	5	1	3	2
Clothing	19	16	15	8	3	3	1	1	1
Headline	12	14	14	28	31	28	1	2	2

Variance decomposition by product

Table: Variance decomposition by product

	Country			Product			World		
	S1	S2	FS	S1	S2	FS	S1	S2	FS
Laundry	10	10	10	13	10	9	1	1	1
Footwear	20	18	18	5	6	5	1	1	1
Furniture	20	15	15	5	6	6	1	1	1
Utensils	18	13	13	6	4	5	1	1	1
Tools	14	9	8	6	3	3	1	2	2
Domestic non-durables	11	16	15	12	12	11	1	2	2
Vehicles	14	6	6	5	5	5	1	3	3
Vehicle spareparts	11	10	10	11	18	17	2	2	2
Vehicle fuel	3	1	1	63	78	67	1	1	1
Vehicle maintanance	12	11	10	7	9	10	1	2	2
Audio visuals	10	4	4	17	41	33	1	2	2
Computer	9	3	3	6	8	8	1	1	1
Books	10	6	6	4	3	4	1	10	9
Personal Care	22	28	26	5	3	4	1	1	1
Accommodation	9	7	7	8	4	4	1	1	1
Jewellery	12	4	4	9	44	43	1	2	2
Headline	12	14	14	28	31	28	1	2	2

Variance decomposition by country

Table:

	Country			Product			World		
	S1	S2	FS	S1	S2	FS	S1	S2	FS
Germany	22	13	14	21	27	26	1	3	3
Belgium	14	3	3	13	26	25	1	1	1
Canada	13	9	8	10	10	10	1	3	2
Spain	12	10	10	16	28	26	1	2	2
Finland	8	9	9	17	14	13	1	3	3
France	9	12	10	25	27	26	1	3	3
Greece	5	6	5	10	14	12	1	1	1
Ireland	10	17	17	12	17	16	1	2	1
Italy	13	17	18	13	19	18	1	1	1
Netherlands	23	26	24	15	25	24	1	3	2
Norway	29	23	21	11	11	10	1	4	4
Austria	9	7	6	21	25	25	1	2	2
UK	7	9	9	16	18	17	1	3	3
US	10	8	8	9	10	10	1	1	1

Product Factors

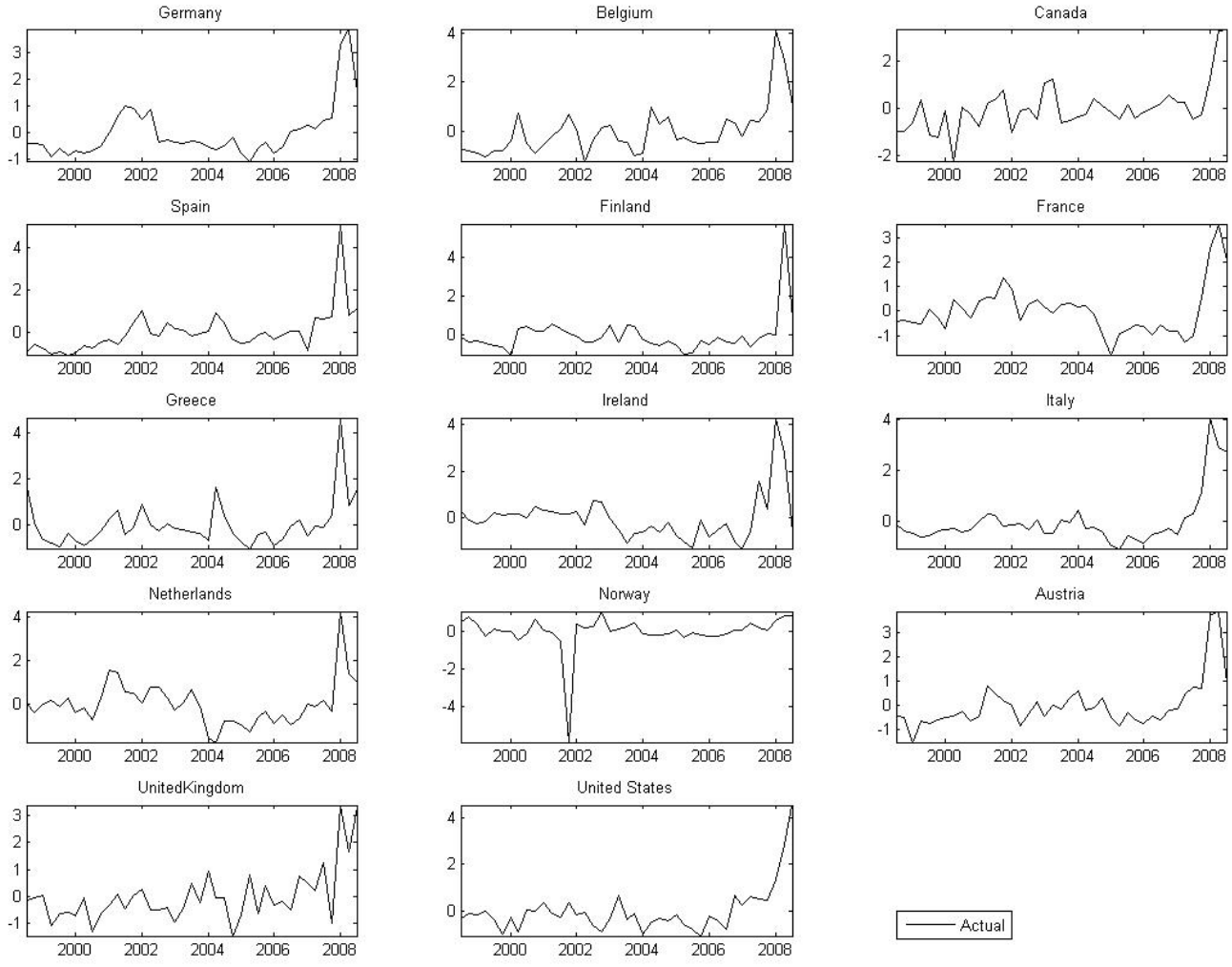
- Goods that have inputs from primary commodities, bread, vehicle fuel for example
- Product factors are important on average

$$\hat{Y}^{C}_{i,j,t} = \hat{\Phi}_i F^{C}_{t} \tag{9}$$

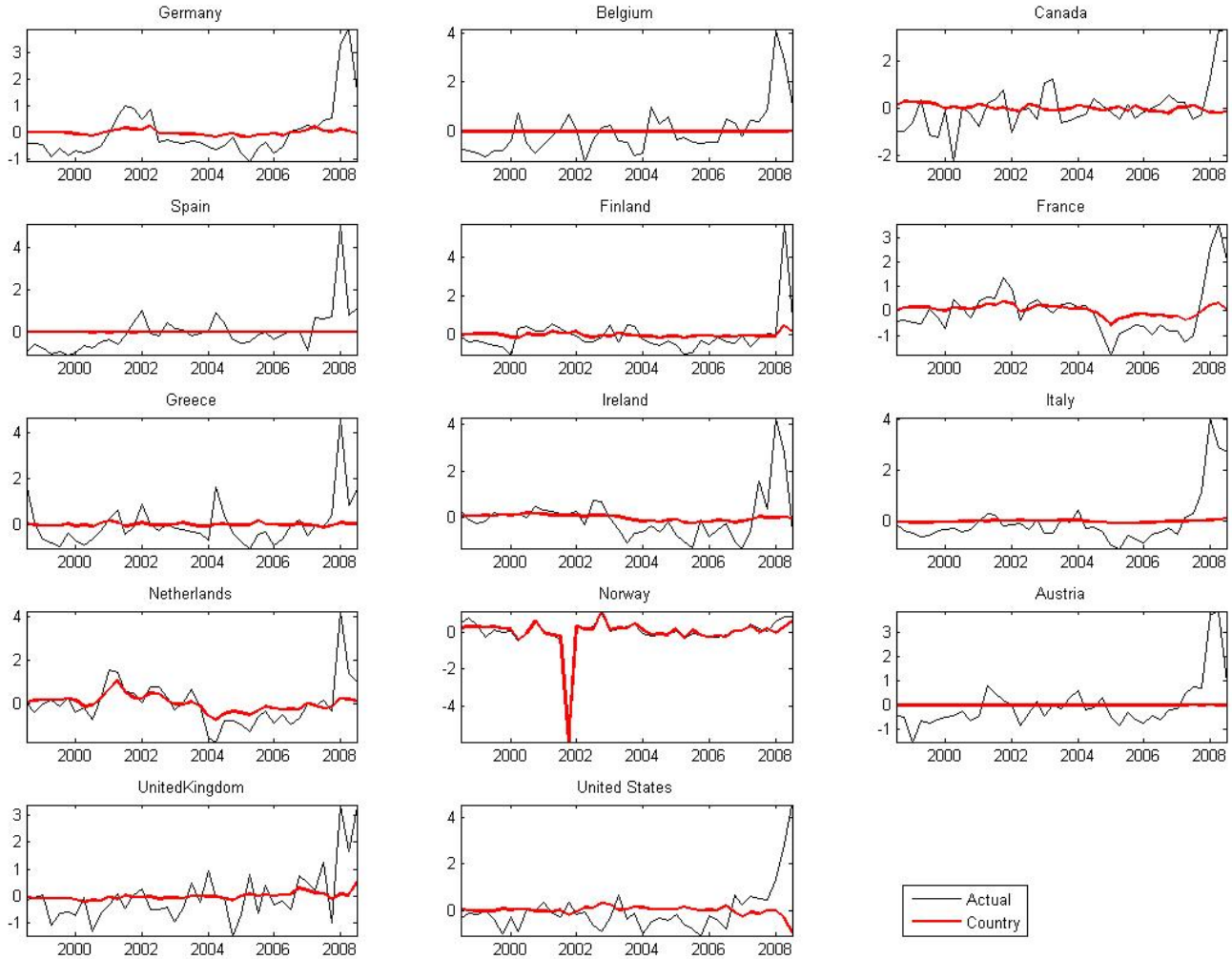
$$\hat{Y}^{GC}_{i,j,t} = \hat{\Phi}_i F^{C}_{t} + \hat{\Upsilon}_j F^{G}_{j,t} \tag{10}$$

$$\hat{Y}^{GCW}_{i,j,t} = \hat{\Phi}_i F^{C}_{t} + \hat{\Upsilon}_j F^{G}_{j,t} + \hat{\lambda}_k F^{W}_{k,t} \tag{11}$$

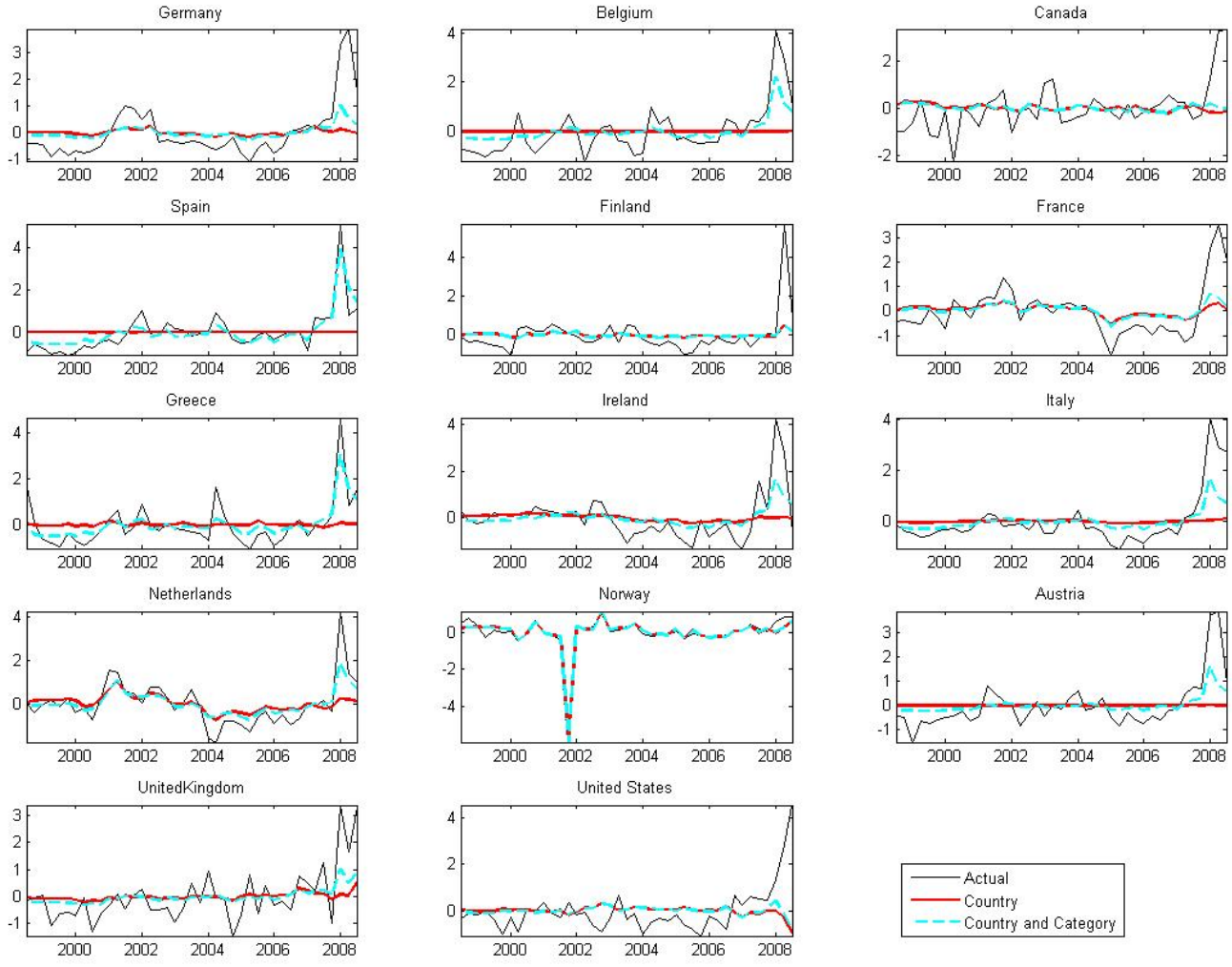
Bread - Actual



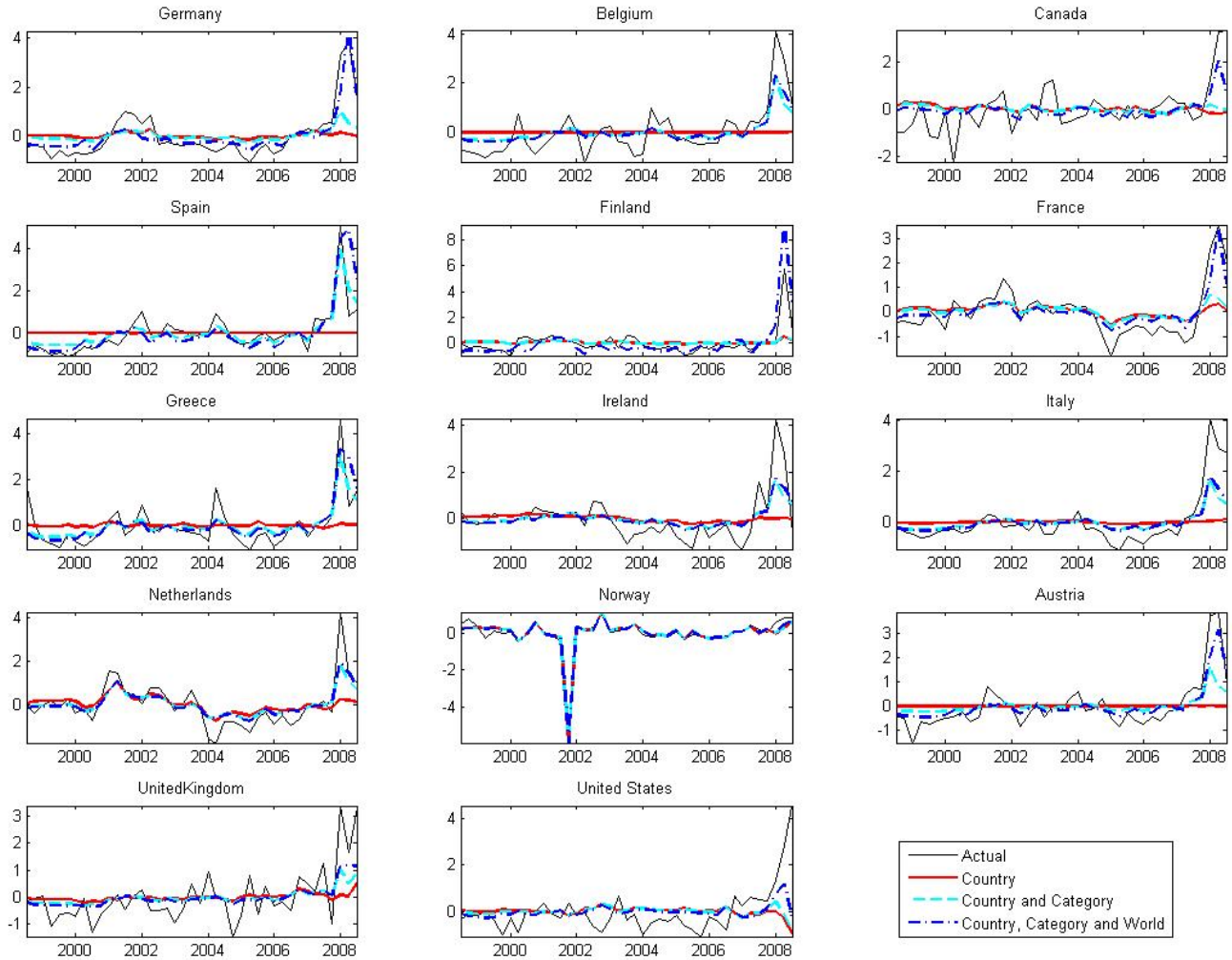
Bread - Actual and Country



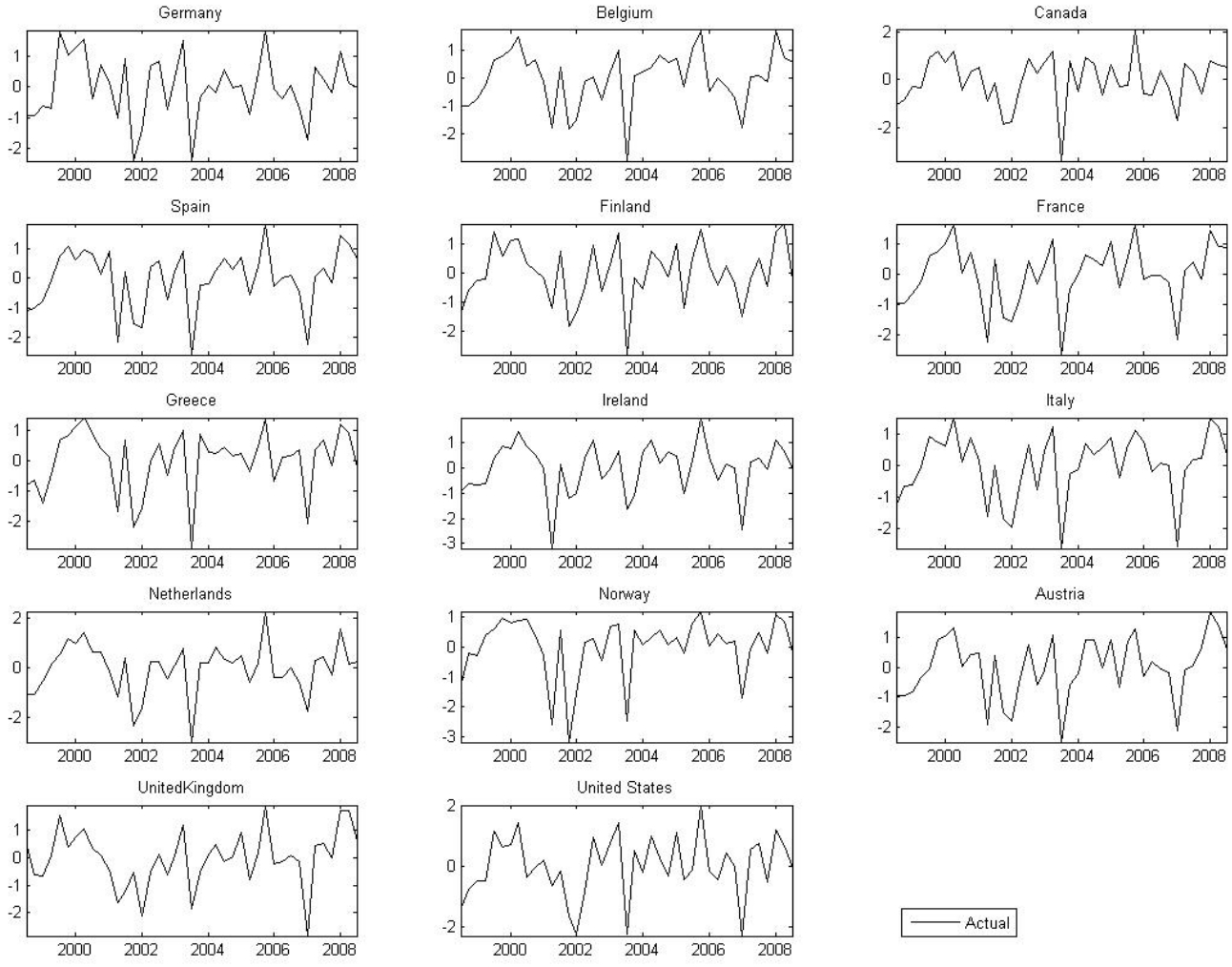
Bread - Actual, Country and Product



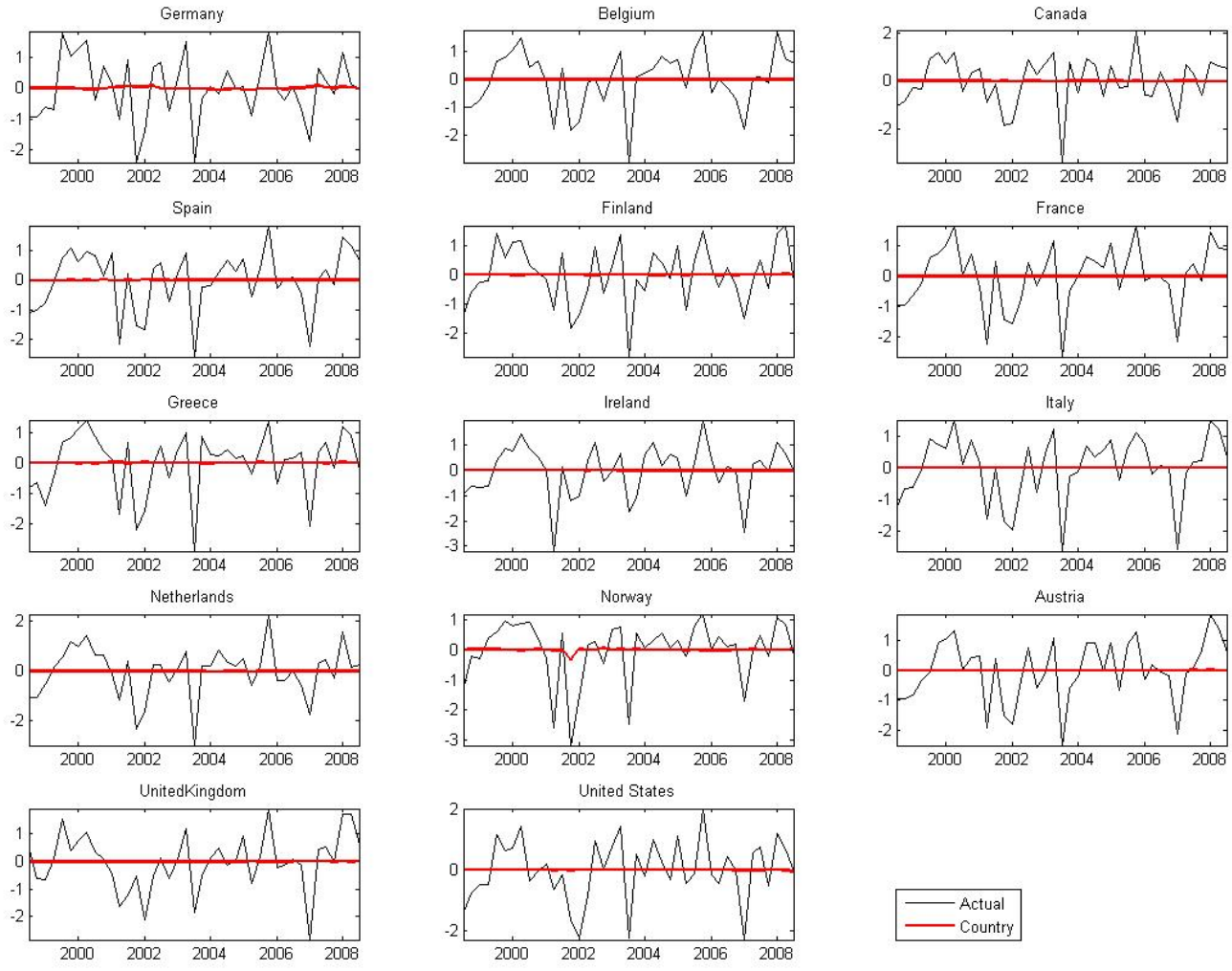
Bread - Actual, Country, Product and World



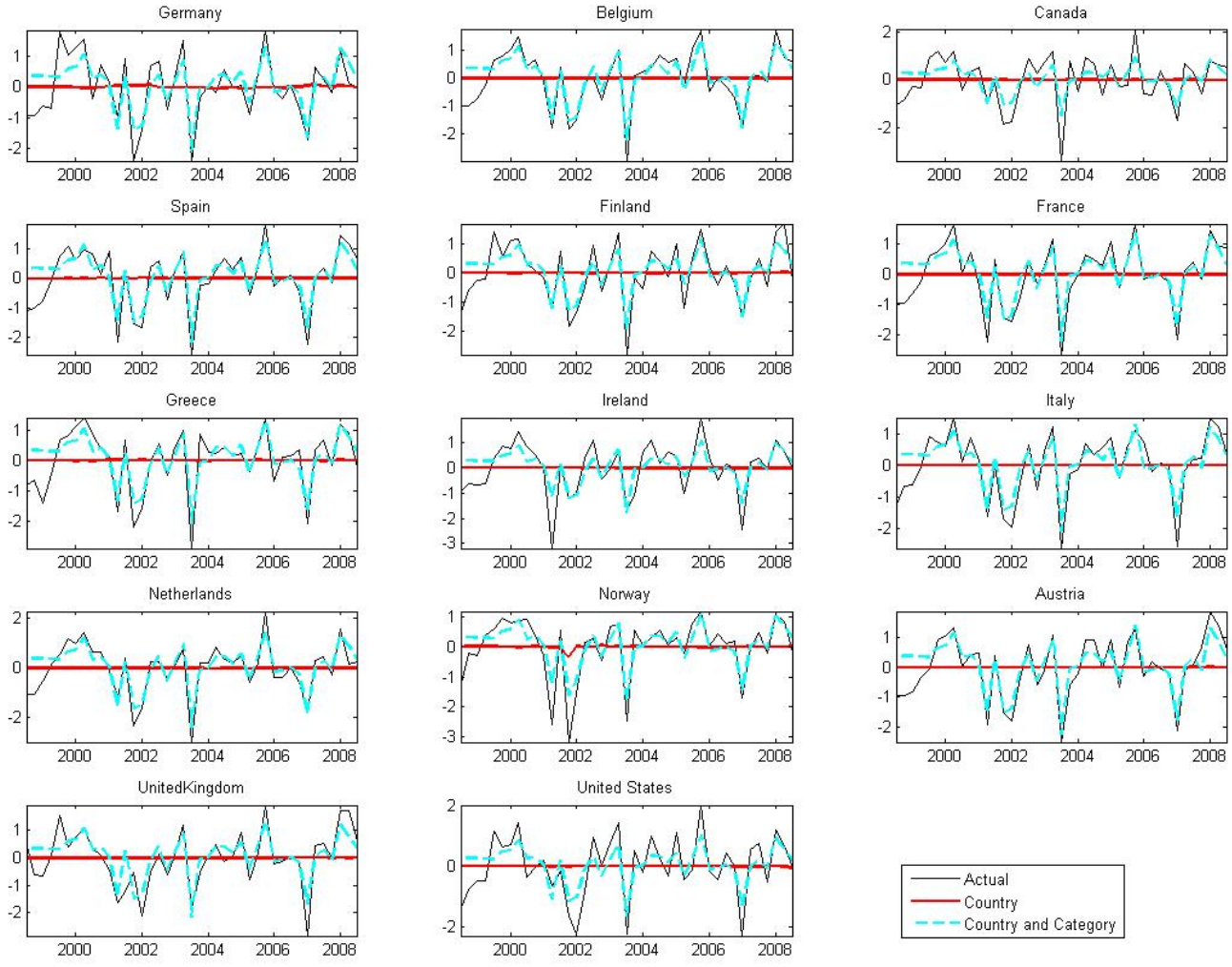
Fuel - Actual


Germany
Belgium
Canada
Spain
Finland
France
Greece
Ireland
Italy
Netherlands
Norway
Austria
UnitedKingdom
United States
2000
2002
2004
2006
2008
Actual

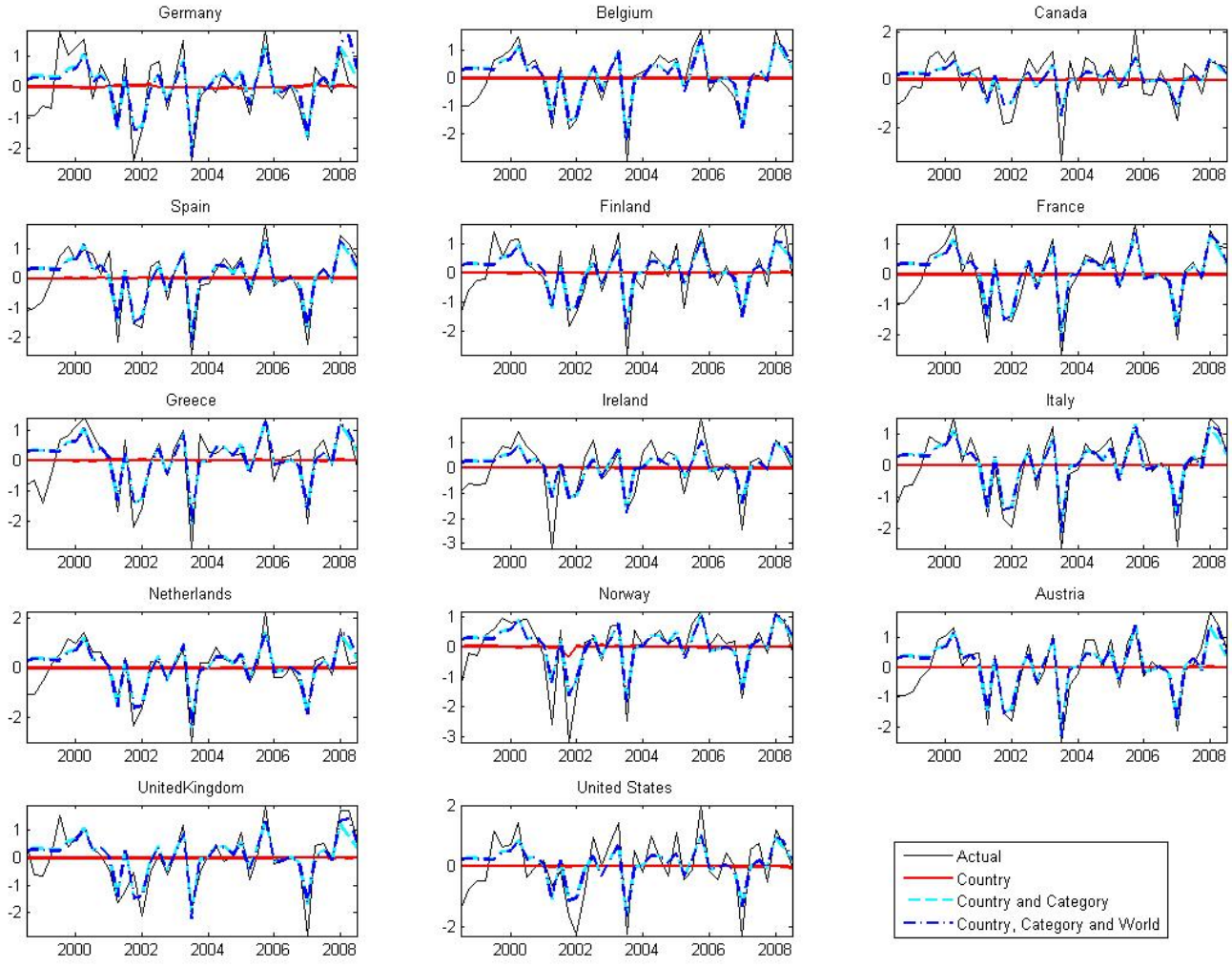
Fuel - Actual and Country



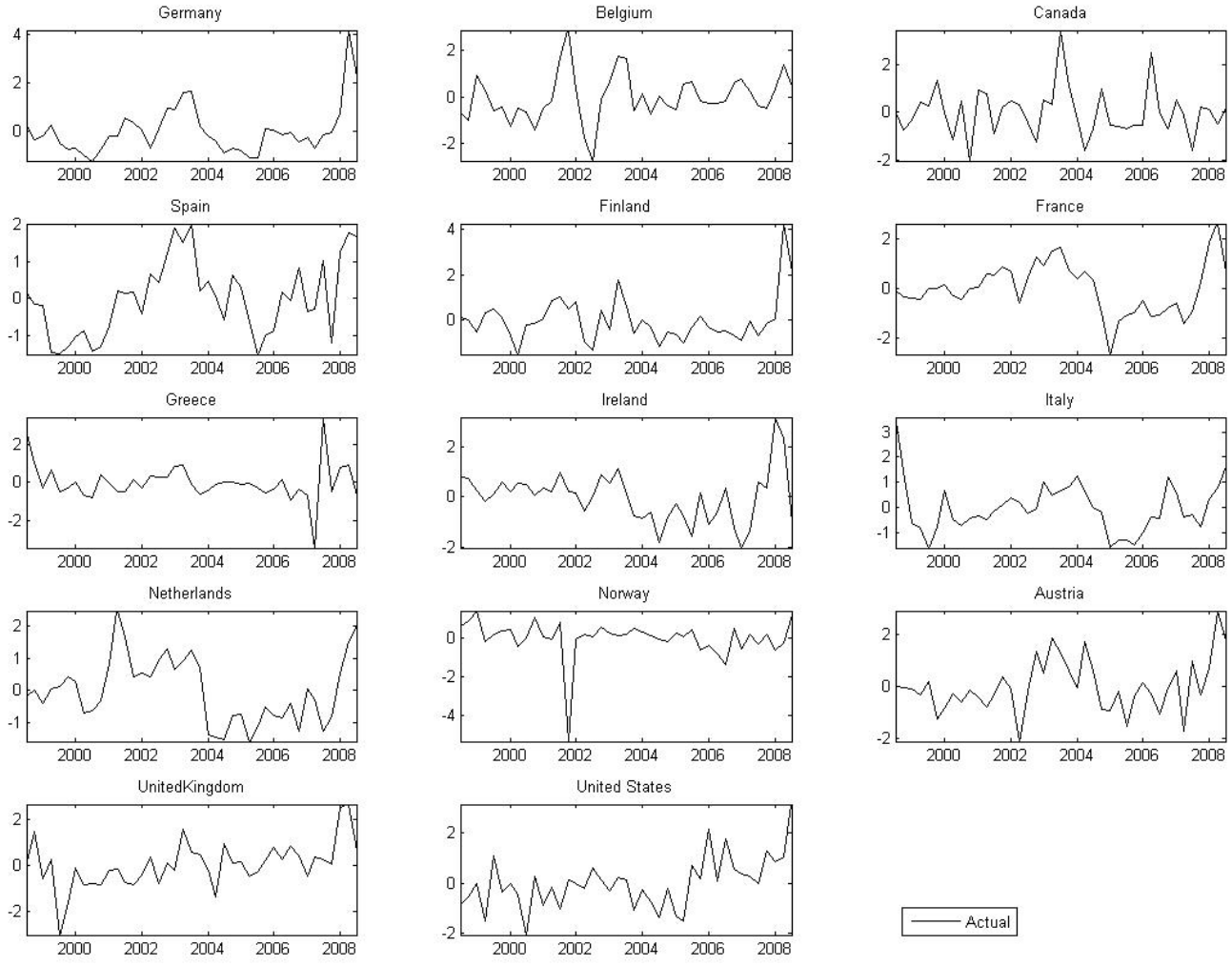
Fuel - Actual, Country and Product



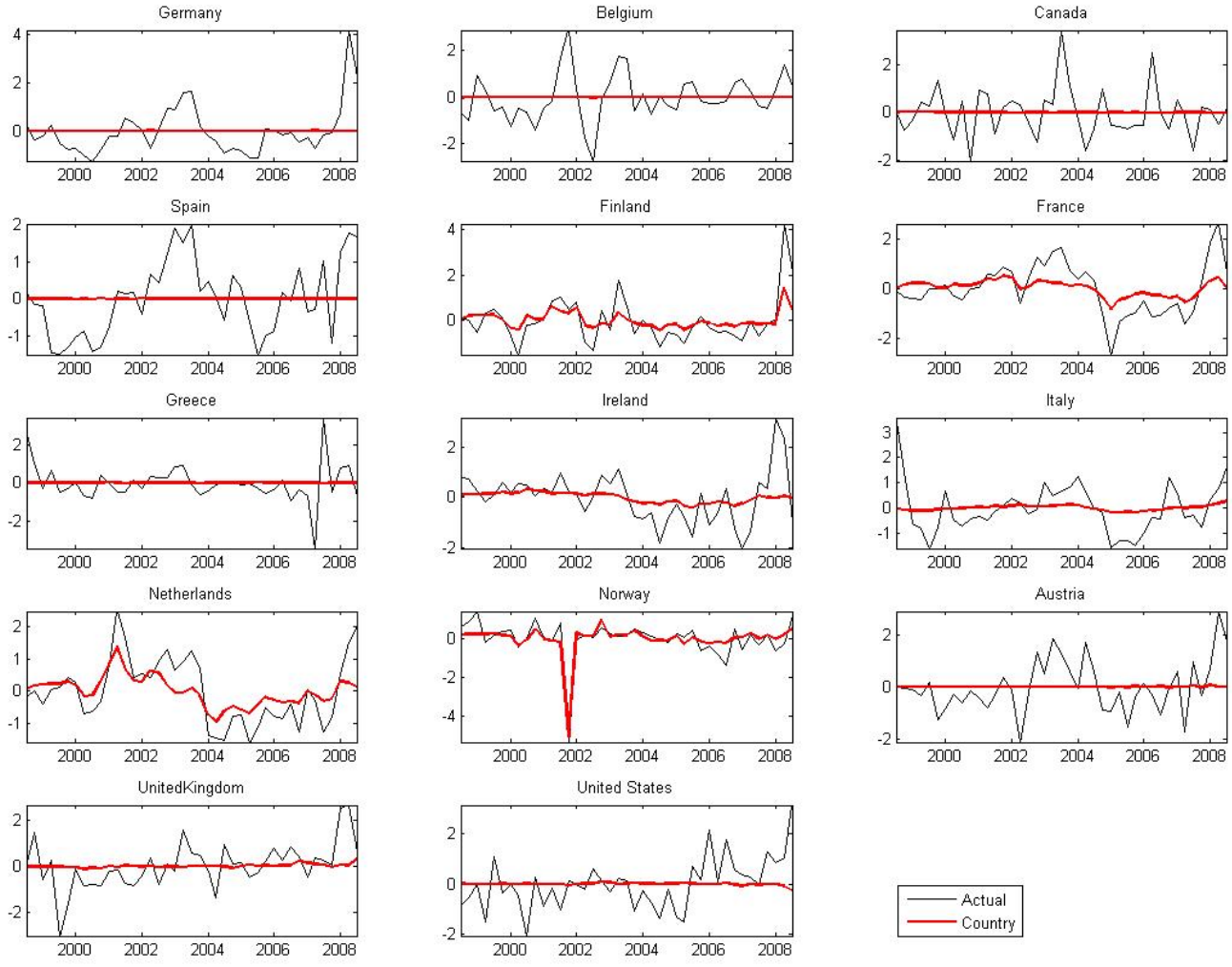
Fuel - Actual, Country, Product and World



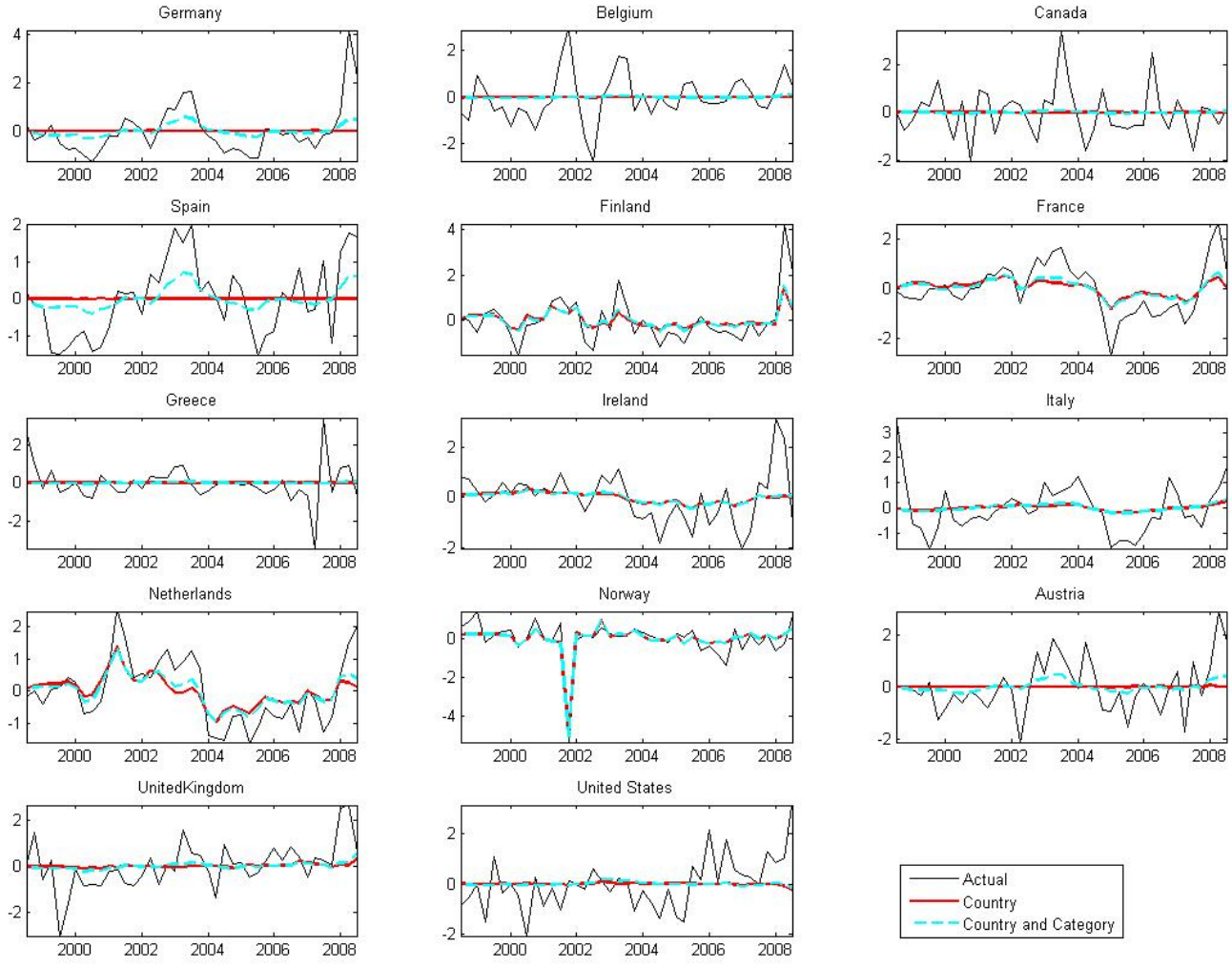
Sugar - Actual



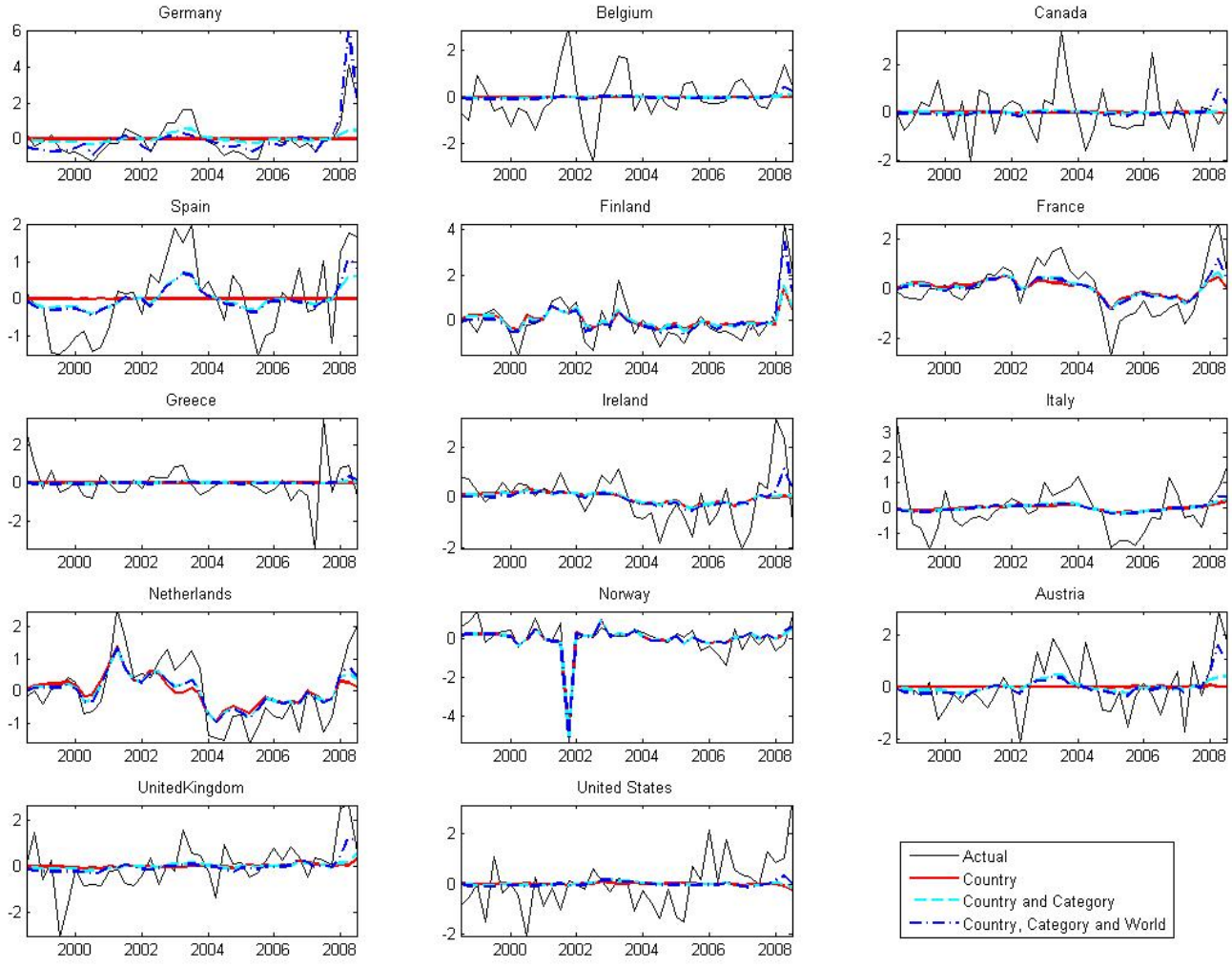
Sugar - Actual and Country



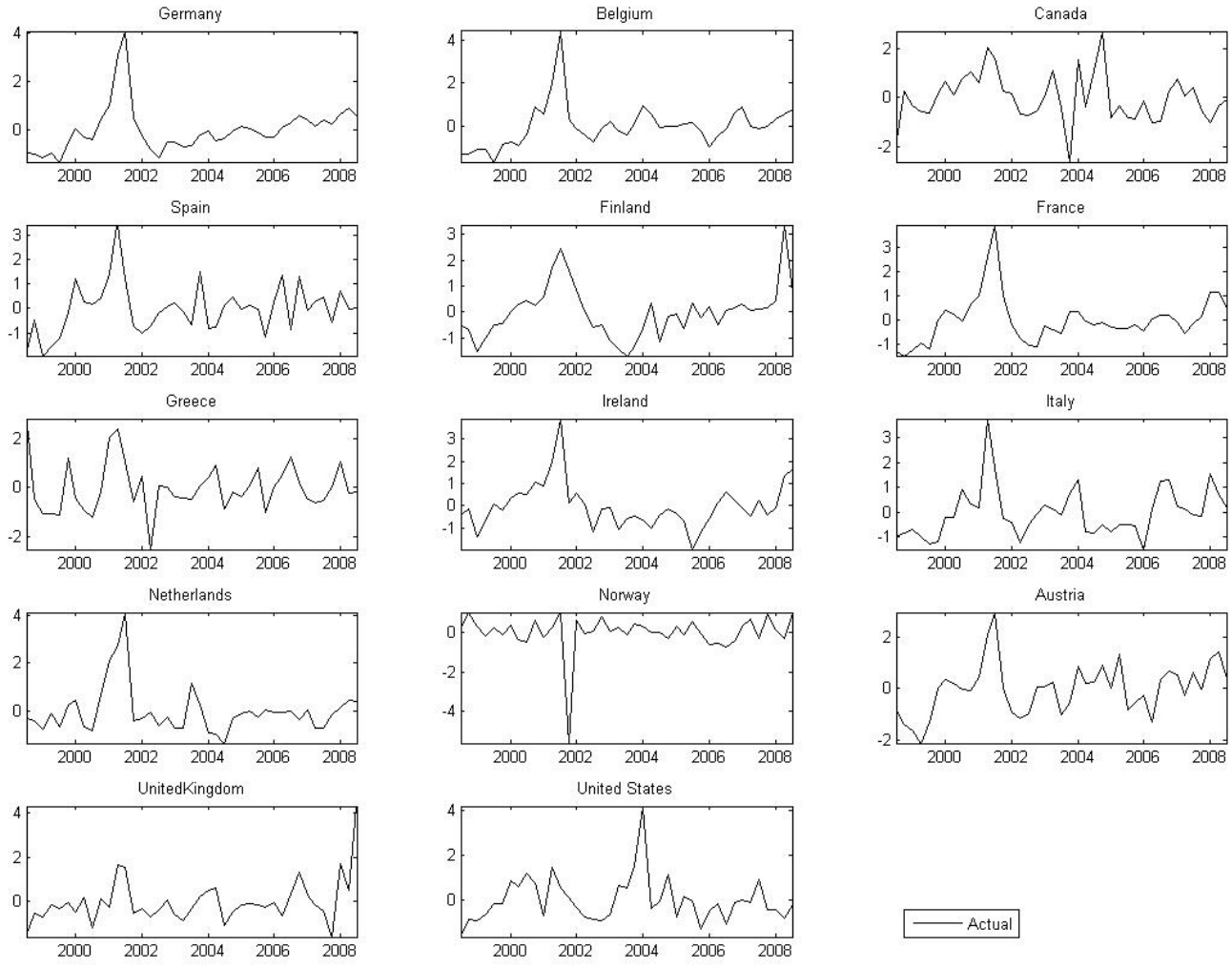
Sugar - Actual, Country and Product



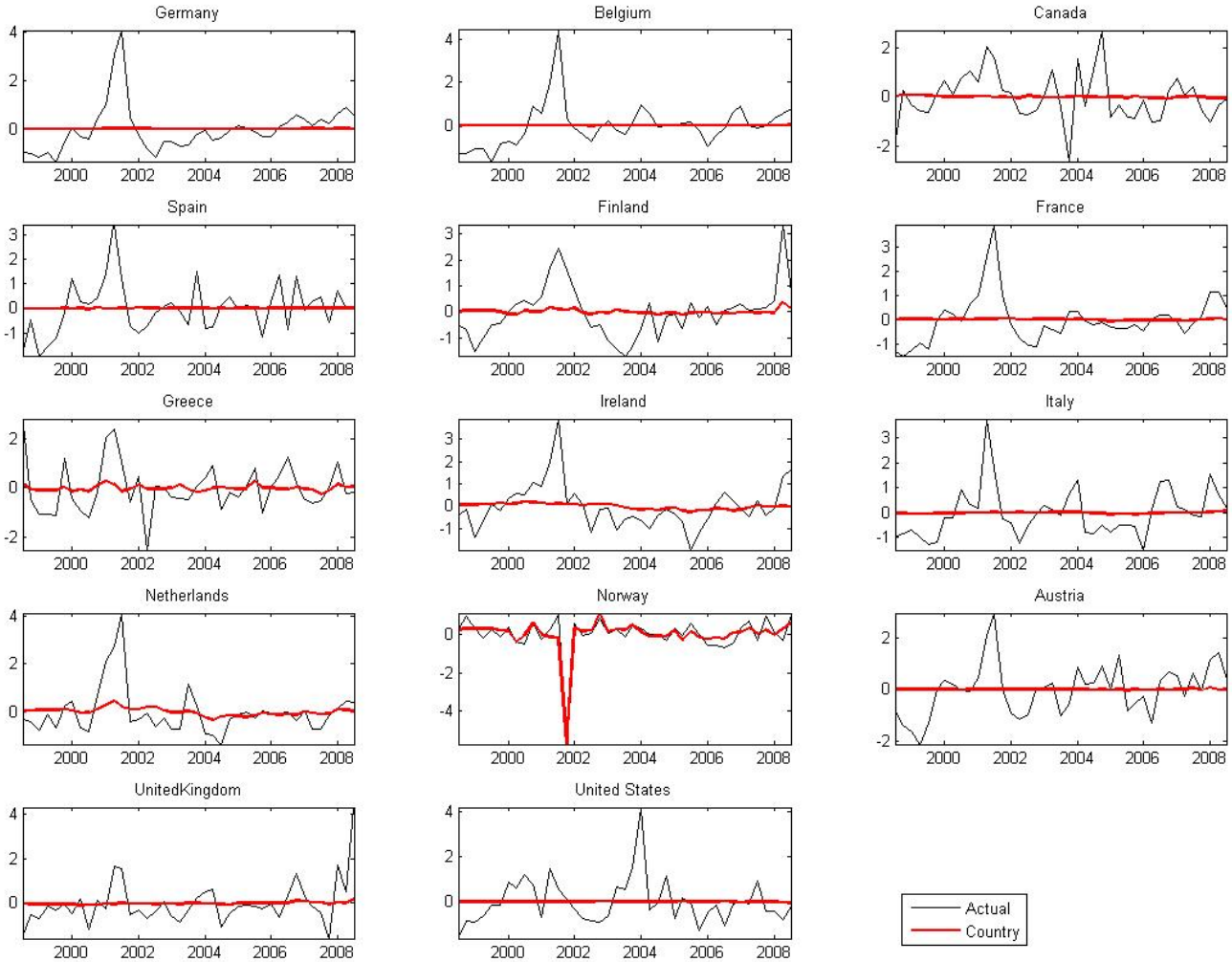
Sugar - Actual, Country, Product and World



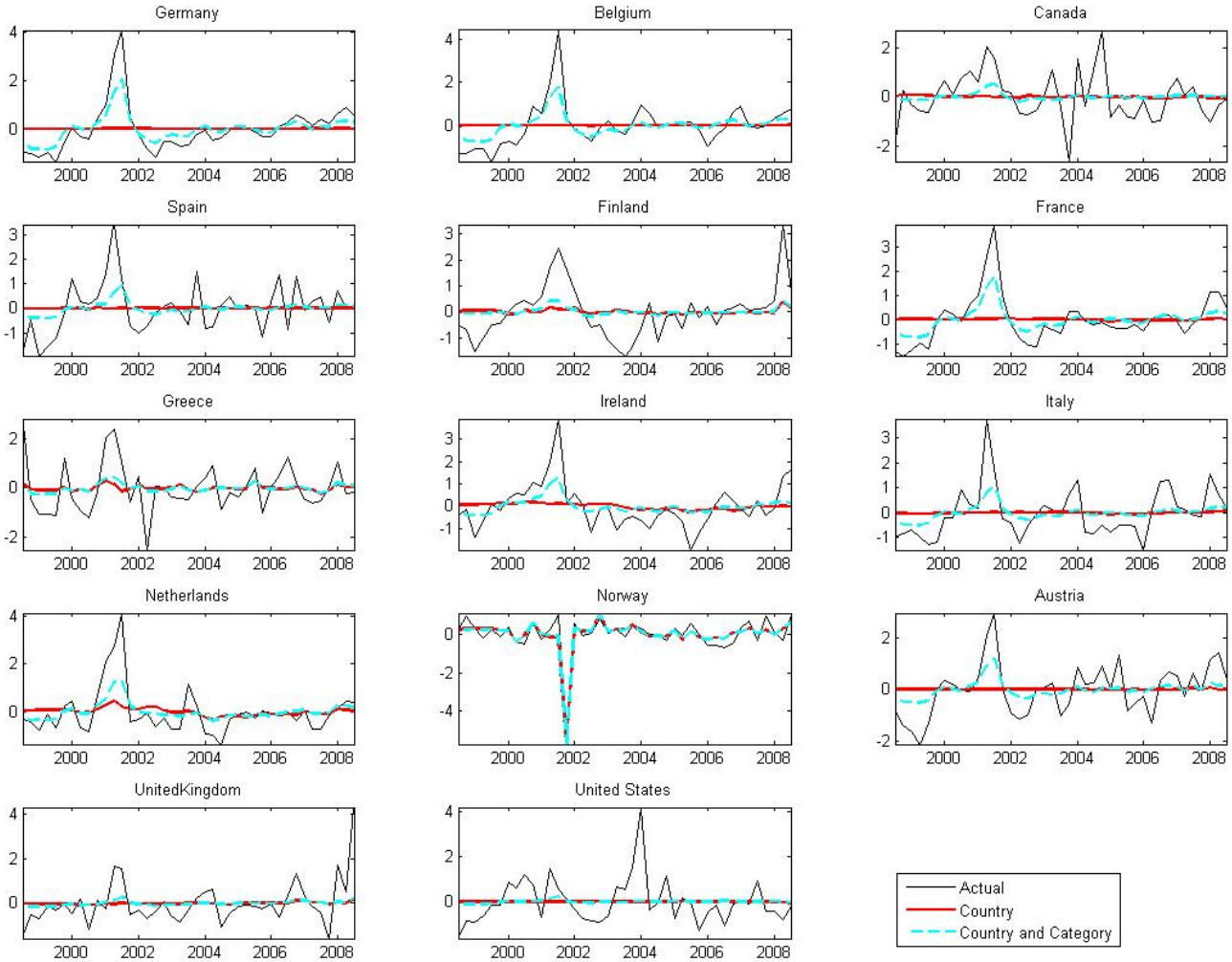
Meat - Actual


Germany
Belgium
Canada
Spain
Finland
France
Greece
Ireland
Italy
Netherlands
Norway
Austria
UnitedKingdom
United States
2000
2002
2004
2006
2008
Actual

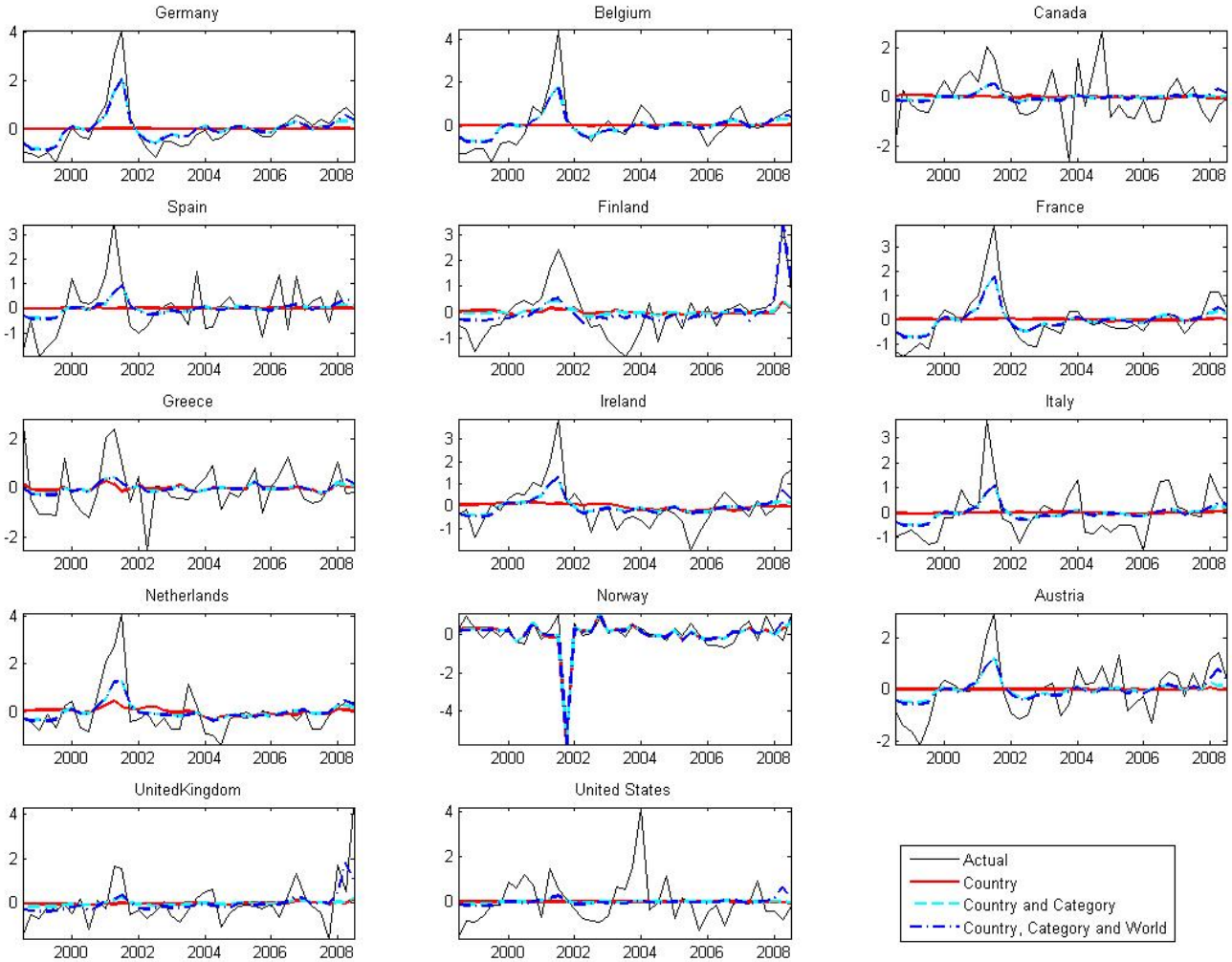
Meat - Actual and Country



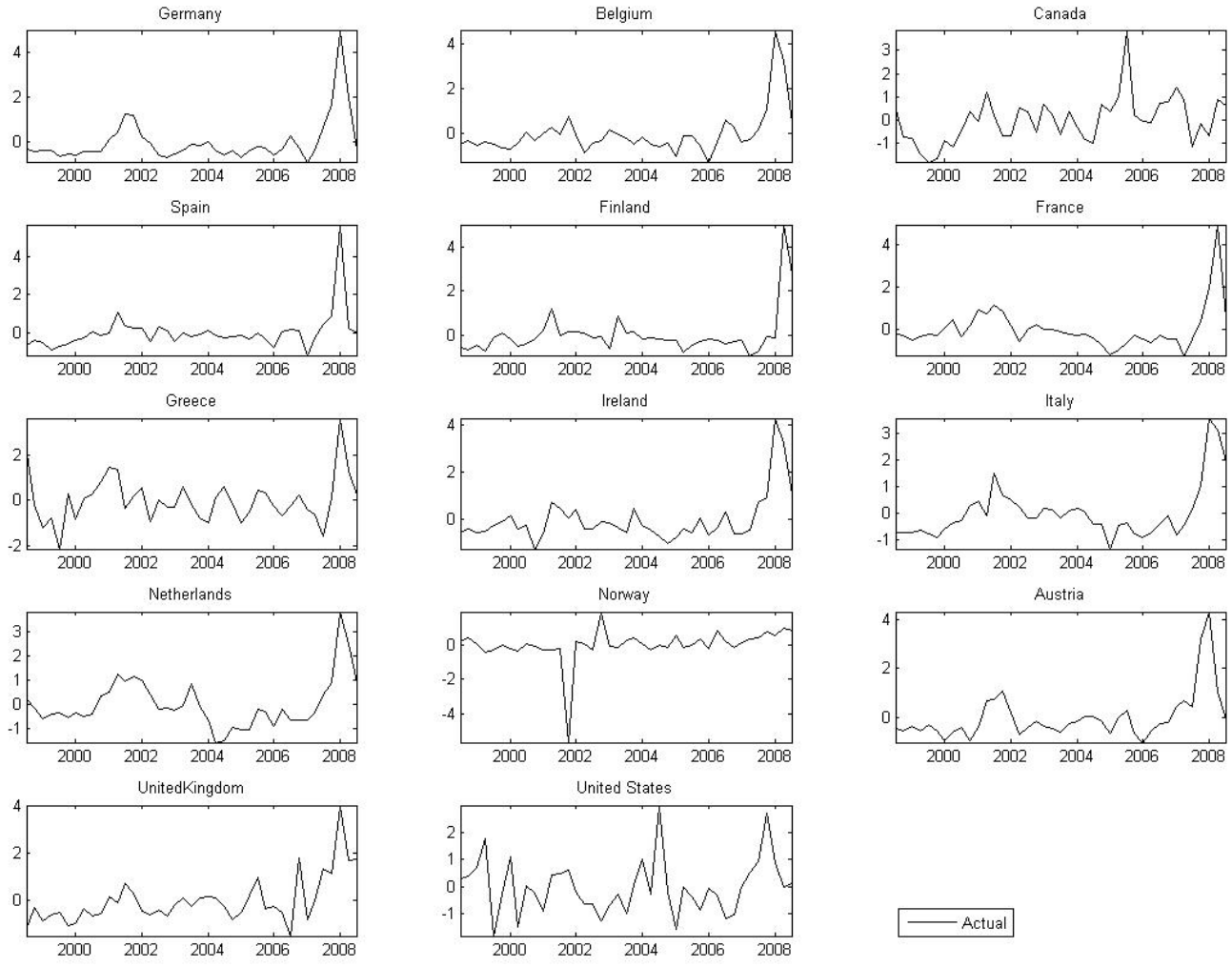
Meat - Actual, Country and Product



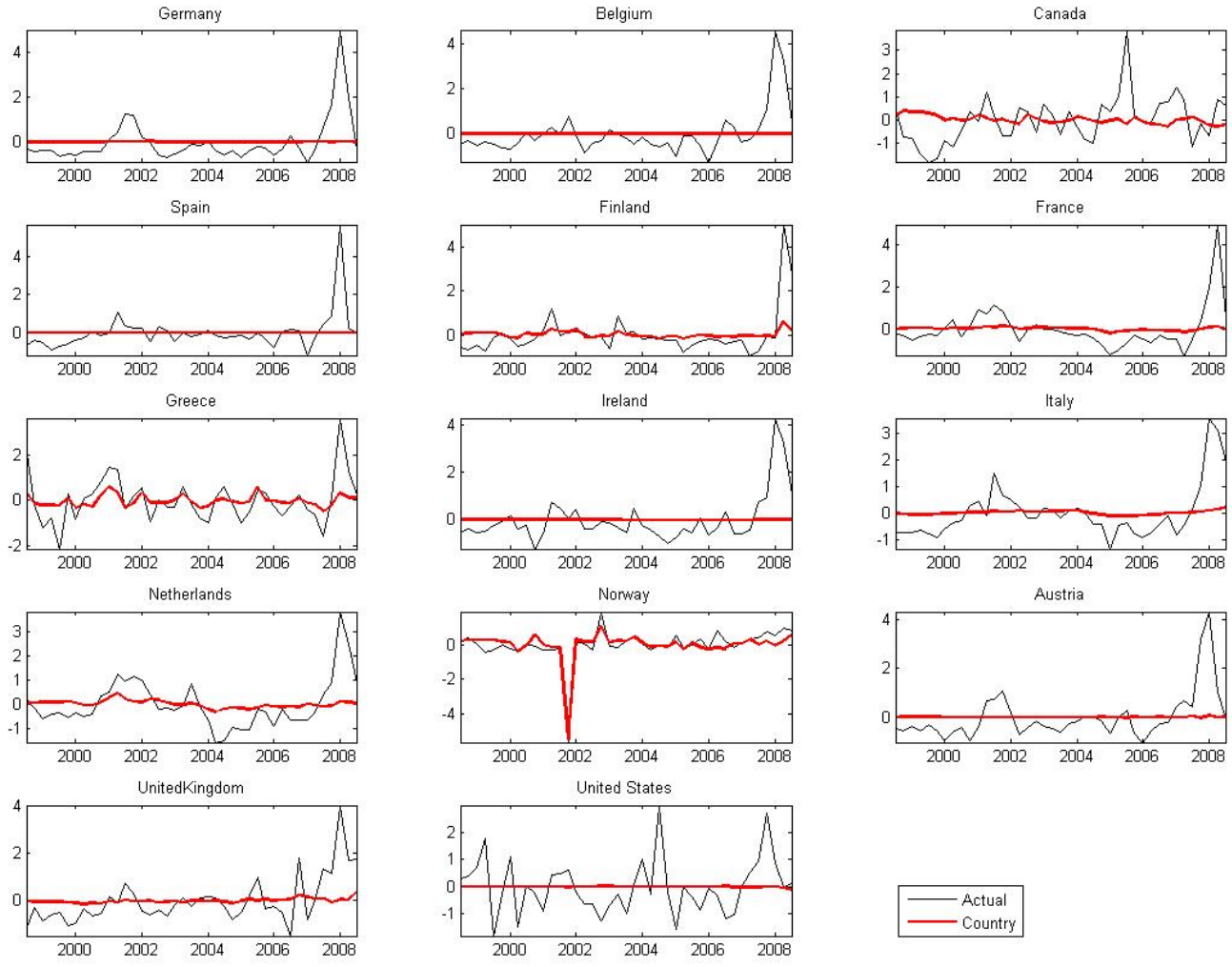
Meat - Actual, Country, Product and World



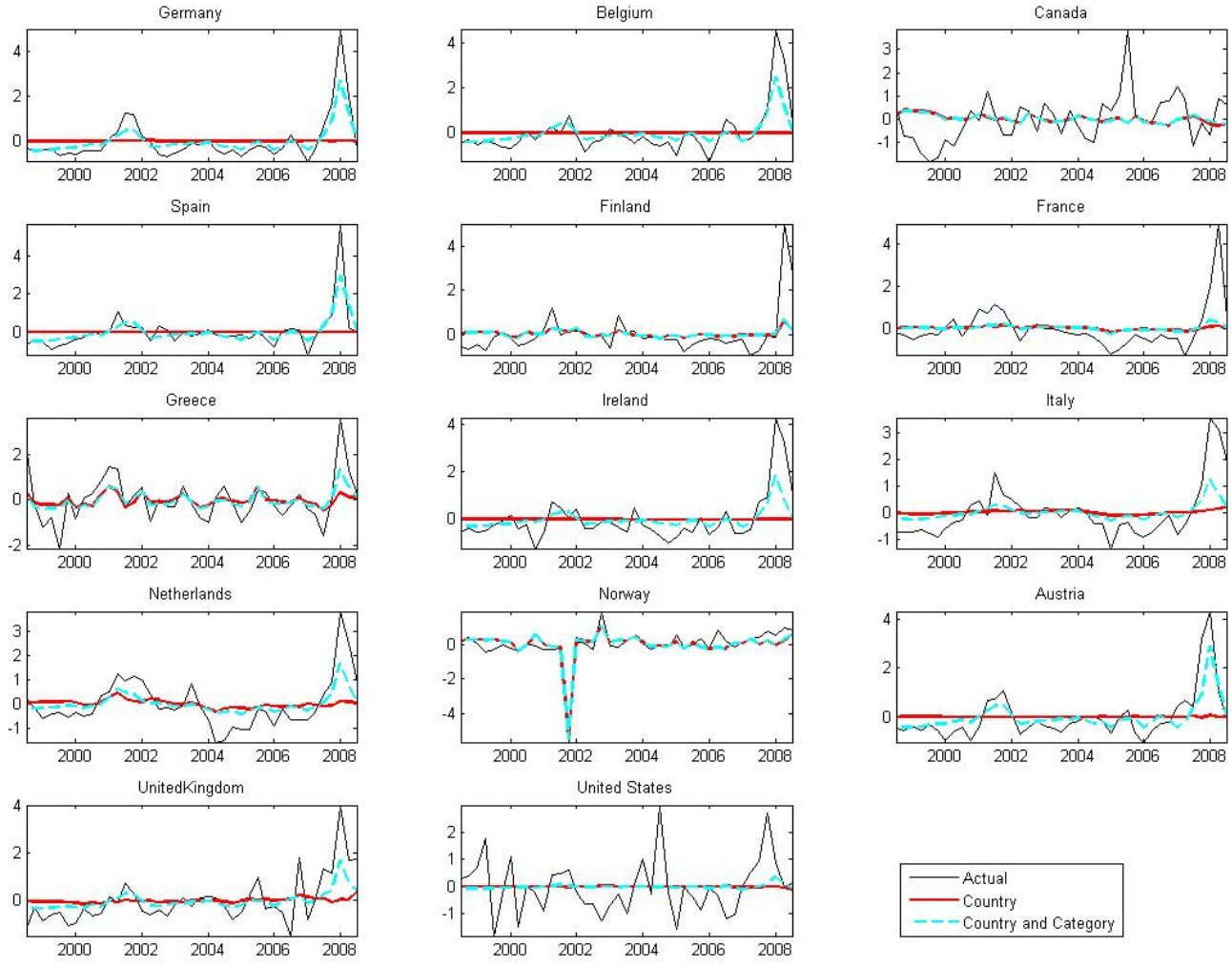
Dairy - Actual



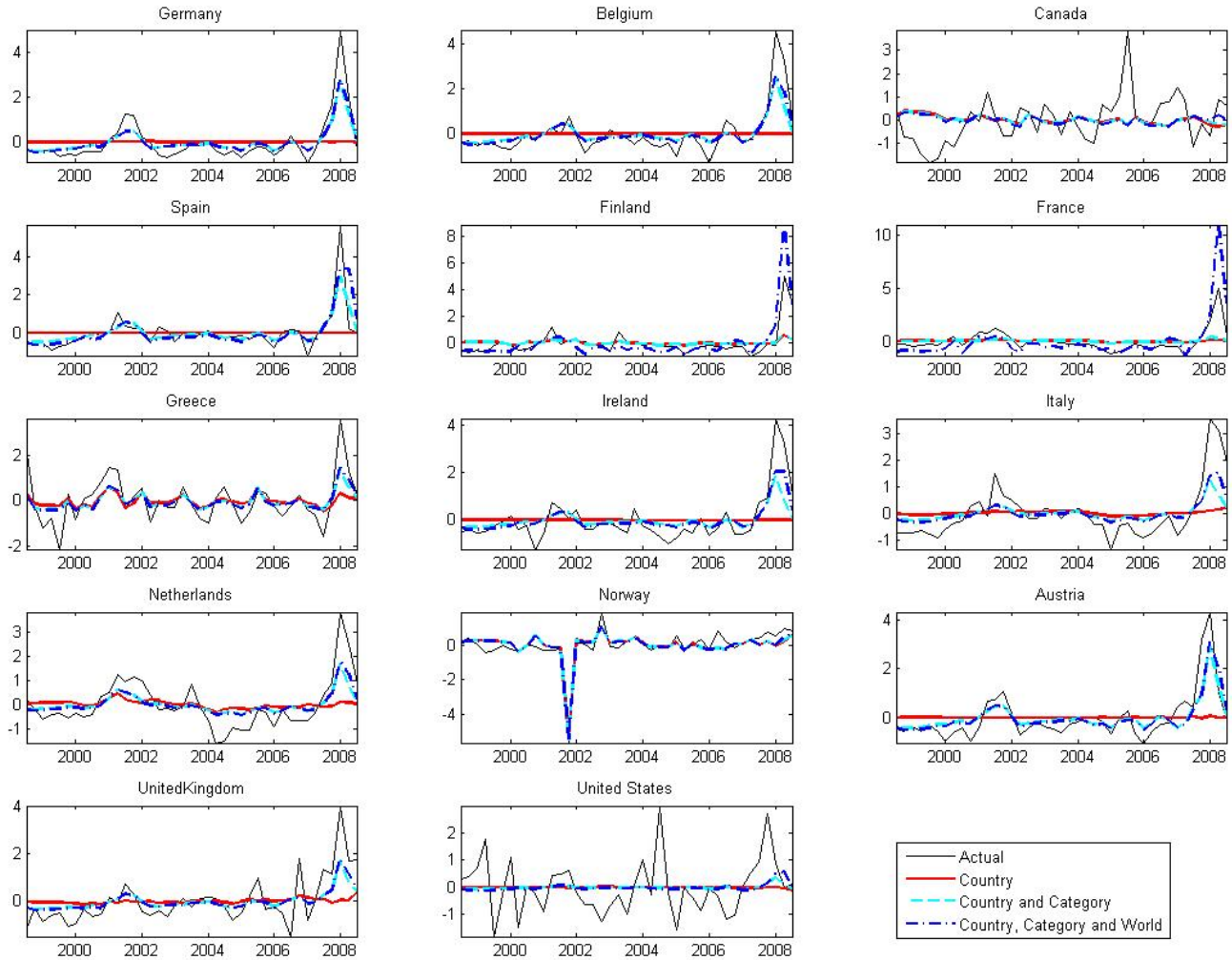
Dairy - Actual and Country



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