

## CHAPTER 4

## RESPONSES TO INFLATION SHOCKS: DO G7 COUNTRIES BEHAVE DIFFERENTLY?

***Monetary policy responses to global inflation shocks have varied across countries***

After declining steadily since the early 1980s, domestic inflation picked up again in the early 2000s in most OECD countries and has accelerated significantly over the past year before receding very recently (Chapter 1). These movements can to a large extent be related to import prices and more specifically the commodity components of imports (Figure 4.1). Between 2000 and July 2008, oil prices expressed in US dollars and yen increased fivefold and non-energy commodity prices have more than doubled.<sup>2</sup> Since then, commodity prices (in particular oil prices) have declined but still remain above their level in early 2007. The monetary policy responses to higher inflationary pressures have differed across industrialised economies even using benchmarks that take into account the relative cyclical positions of the major economies. Some central banks have appeared more “hawkish” on inflation, while others, where the acceleration of commodity prices inflation coincided with the beginning of financial turmoil, have appeared more dovish.

***Different exposure to global price shocks and propagation mechanisms...***

These different behaviours could reflect a number of factors including: *i*) differences in the exposure to global price shocks as a result of differences in the commodity intensity of production and consumption; *ii*) differences in the propagation of shocks due to differences in inflation and wage dynamics.<sup>3</sup> In order to assess the role played by these factors, this chapter compares the exposure of the main OECD economies to recent global inflation shocks and the way in which the latter tend to pass into domestic inflation.<sup>4</sup> First, economies’ exposure to price shocks is assessed by calculating the direct mechanical impact of recent commodity price and

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2. In line with these developments, the acceleration of inflation has mainly concerned headline inflation, while measures of underlying inflation (whether statistical or exclusion-based) have remained comparatively stable.
  3. A large body of research has addressed other factors conditioning monetary policy reactions such as policy objectives, monetary policy transmission, and the role of domestic and global shocks for selected countries or economic regions. Overall, it suggests that policy objectives and transmission channels have been rather similar on both sides of the Atlantic, whereas the two regions have been hit by different shocks, prompting stronger interest rate adjustments in the United States. See notably the comparison by Smets and Wouters (2005) and Sahuc and Smets (2008) using dynamic general equilibrium models (DSGE).
  4. The chapter covers G7 economies, but with a focus on the differences between the United States and the euro area.



*... may have contributed to the differences in policy stance:*

The main finding of the chapter is that explanations related to exposure to global commodity prices shock and their propagation to prices and wages may have contributed to the differences in policy stances observed during the boom of commodity prices, but cannot explain them all. In particular:

*The initial shock faced by the euro area was smaller...*

- The increase in commodity prices from 2000 to mid-2008 has had a larger direct impact on domestic inflation in the United States than in the euro area reflecting both dollar depreciation and a higher energy intensity of the US economy. This impact has been even larger in the case of Japan.

*... but oil prices seem to have a larger long-term effect on domestic prices*

- On the other hand, and despite the higher oil intensity of the US economy, estimated past behaviour suggests that, for given wage developments, the long-term effect of oil prices on domestic prices is stronger in the euro area than in Japan and the United States.

*Other price and wage dynamics are more similar across countries*

- Repercussions from non-oil commodity prices on domestic prices are more similar among G7 countries and in particular relatively comparable in the euro area and the United States. Similarly, based on evidence over the past decade, wages do not appear more susceptible to react to inflationary impulses in consumer prices in the euro area than in the United States or Japan.

*Risks of inflationary wage developments were also assessed differently*

A price shock of the magnitude recently observed has not been experienced since the last oil shock, implying a risk that wages could react more than in the past decade to the increase in commodity prices. The extent to which this risk has affected the policy stance may have varied and may be a key factor behind the differences in policy stance, notably across the Atlantic. Moreover, the fall in commodity prices since mid-2008 and the decline in economic activity are likely to have sharply reduced this risk and any associated reason for policy divergence.

### **Measuring the direct impact of recent international price shocks**

*The commodity price shocks were stronger for United States and Japan*

The immediate exposure of an economy to the inflation effects of commodity price shocks depends on the share of the corresponding commodity in total demand and the respective rates of commodity price inflation in local currency.<sup>6</sup> According to back-of-the-envelope calculations reported in Table 4.1, the inflation impact has, on the whole and since 2001, been substantially larger for the United States and Japan than for the euro area. Since 2006, when prices of food and a number of other

6. More precisely, the direct inflationary effects of various commodity prices can be calculated by multiplying the share of the corresponding commodity in total demand by the respective rates of commodity price inflation relative to domestic inflation.

commodities, including metals, began to increase sharply, the mechanical contribution of commodity prices to inflation has gone up significantly but remains larger in the United States and Japan than in the euro area.

Table 4.1. **The direct impact of higher commodity prices on domestic inflation**

*Annual average, percentage points (domestic currency terms)*

	Energy	Food	Other commodities	Total	Headline – core inflation
<b>2001-08<sup>1</sup></b>					
United States	0.5	0.2	0.1	0.7	0.8
Japan	0.5	0.4	0.2	1.1	2.1
Euro 3 <sup>2</sup>	0.2	0.1	0.0	0.4	0.5
Germany	0.3	0.1	0.0	0.4	0.7
France	0.2	0.1	0.0	0.3	0.4
Italy	0.2	0.1	0.0	0.3	0.3
United Kingdom	0.3	0.2	0.1	0.6	0.6
Canada	0.2	0.1	0.1	0.4	0.2
<b>2006-08</b>					
United States	0.7	0.4	0.1	1.2	0.7
Japan	0.7	0.9	0.3	2.0	2.0
Euro 3 <sup>2</sup>	0.4	0.4	0.1	0.9	0.6
Germany	0.4	0.4	0.1	0.9	0.8
France	0.4	0.3	0.1	0.8	0.4
Italy	0.4	0.5	0.2	1.0	0.5
United Kingdom	0.6	0.7	0.2	1.4	0.9
Canada	0.4	0.4	0.2	1.0	0.0

*Note:* These estimates combine the movements in individual commodity prices and exchange rates, weighted by the relevant shares in total demand.

1. For the rest of 2008, commodity prices and domestic inflation are assumed to be in line with the projections presented in this *OECD Economic Outlook*.

2. GDP weighted average of France, Germany and Italy.

*Source:* IEA Energy Statistics of OECD countries, OECD Economic Outlook 84 database, OECD STAN database and OECD calculations.

***This reflects a higher use of oil in the United States and exchange rate movements***

While greater exposure of the United States results partly from a larger use of oil in production and consumption, currency movements have also contributed to cross-country differences.<sup>7</sup> The appreciation of the European and Canadian currencies against the US dollar has significantly cushioned the inflationary impact of the *commodity* price shocks. For instance, in the euro area oil prices in local currency rose by a factor of three between 2001 and mid-2008 (compared with five in the United States).

7. The estimated commodity price effects are expressed in local currency terms, combining the direct effect on import prices at constant exchange rates with the full impact of exchange rate movements. It is realistic to assume an approximately full pass-through of exchange rate movements to corresponding domestic currency prices of imported commodities. However, such an assumption is less straightforward for those commodities, *e.g.* gas, for which a world market price does not prevail. This analysis does take into account possible interactions between commodity prices and exchange rates, nor the effects of indirect taxation on the pass-through of commodity prices into retail prices.

*The impact of exchange rate movements on non-commodity import prices...*

Exchange rate movements have also contributed to cross-country differences via their impact on *non-commodity* import prices. The pass-through of exchange rate movements to non-commodity imports is significantly weaker than the near one-to-one pass-through that prevails for commodity imports, and there are important cross-country differences. Table 1.2 reports the direct mechanical impact of nominal effective exchange rate developments on non-commodity imports prices based on recent pass-through estimates (see Box 1.1). The final column reports the corresponding impacts on domestic inflation, taking into account the import content of demand in the G7 economies and assuming no changes in profit margins.

Table 4.2. **The direct impact of exchange-rate movements on domestic prices via non-commodity import prices**

	Nominal effective exchange rate variation (per cent) <sup>1</sup>	Impact on non-commodity import prices (in domestic currency terms) (per cent) <sup>2</sup>	Impact on domestic prices (percentage points) <sup>3</sup>
<b>2001-08<sup>4</sup></b>			
United States	-1.6	0.3	0.0
Japan	-0.2	0.1	0.0
Euro 3 <sup>5</sup>	1.3	-0.5	-0.1
Germany	1.4	-0.5	-0.2
France	1.2	-0.1	0.0
Italy	1.3	-0.8	-0.2
United Kingdom	-1.5	0.9	0.2
Canada	2.8	-1.8	-0.6
<b>2006-08<sup>4</sup></b>			
United States	-1.1	0.2	0.0
Japan	3.8	-2.1	-0.2
Euro 3 <sup>5</sup>	0.8	-0.3	-0.1
Germany	0.8	-0.3	-0.1
France	0.8	-0.1	0.0
Italy	0.8	-0.5	-0.1
United Kingdom	-3.9	2.2	0.5
Canada	-1.0	0.7	0.2

1. An increase means an appreciation of the nominal effective exchange rate. Annual average rates.

2. The estimated impact is based on the pass-through estimates for non-commodity imports shown in the figure of Box 4.1.

3. Based on the share of non-commodity imports in total demand.

4. For the rest of 2008, nominal exchange rates are those assumed in the projections for this Economic Outlook.

5. GDP weighted average of France, Germany and Italy.

Source OECD calculations.

*... has been limited by partial pass-through*

Overall, recent exchange rate developments and their impact on non-commodity import prices account for differentials in inflation rates of at most 0.2 percentage points between the euro area and the United States, with the lower US pass-through serving to significantly moderate the potential inflationary impact of the dollar depreciation. More generally, compared with the impact of higher commodity prices, such estimates also point to limited additional inflationary pressure in other depreciating countries and disinflationary pressure in appreciating countries. A notable

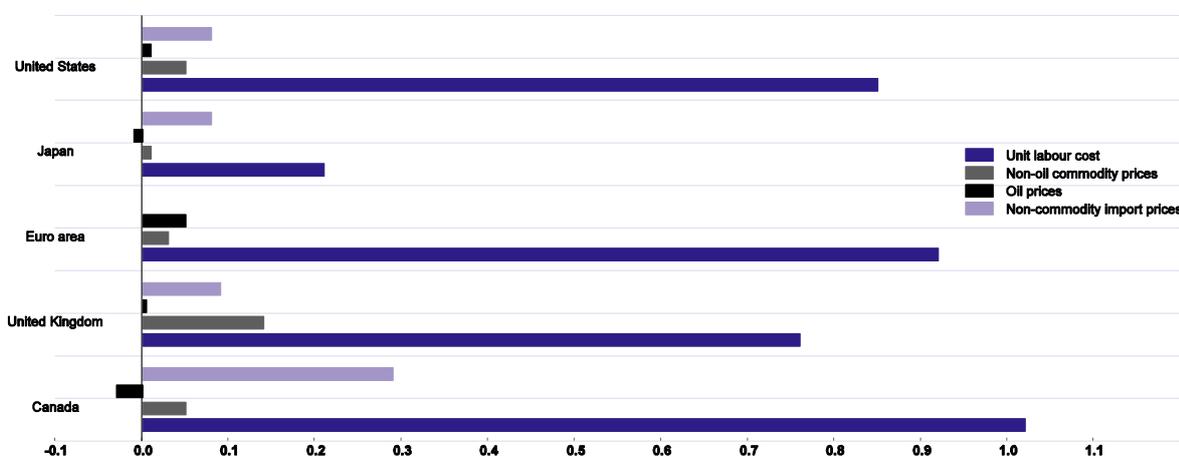
exception is the United Kingdom, where sterling depreciation over the past year is estimated to have added up to a full percentage point of inflation *via* its impact on non-commodity import prices alone.<sup>8</sup>

### Assessing the overall impact of import prices on domestic inflation

#### *Domestic cost still dominate consumer price levels*

A second source of cross-country differences in inflation effects from commodity prices and exchange rate changes may come from differences in the propagation of global price shocks to domestic inflation including through indirect or second-round effects captured by inflation dynamics. Long-run relationships between consumer prices, key commodity and non-commodity import prices and domestic labour costs, derived from Phillips curve estimates, show that consumer price levels are still, in the long run, largely driven by the domestic cost component, with between 20% and 100% of a change in the level of unit labour costs (used as proxy for domestic non-commodity factor costs) passing through into consumer prices in the long run.<sup>9</sup> (Figure 4.2) The euro area as a whole appears at the top of the range, with Japan and to some extent the United States and the United Kingdom at lower levels of pass-through, suggesting that risks of a wage-price feedback loop are slightly higher in the euro area.

Figure 4.2. The long-run impact of commodities, import prices and labour costs on consumer prices



Note: These estimates correspond to the estimated long-run price responses to changes in individual factors obtained for the period 1990-2007. Thus, for example, for the United States, the long-run response elasticities of consumer prices to unit labour costs, oil, non-oil commodities and non-commodity import prices are 0.85, 0.01, 0.08 and 0.05 respectively. See the appendix for more details.

Source: OECD estimates.

8. Most of the average contribution for the United Kingdom shown in Table 2 for 2006-08 has in fact occurred during the past year.
9. The methodology used to assess the impact of import prices on domestic price inflation in a Phillips curve framework follows Pain *et al.* (2006) and Sekine (2006). It is based on an error-correction model relating domestic prices to unit labour costs, import prices and measures of output gaps. An innovation considered here is to separately identify the relative importance of non-commodity, energy and non-energy commodity imports as distinct sources of inflationary/disinflationary pressures. See the Appendix and Vogel *et al.* (2008).

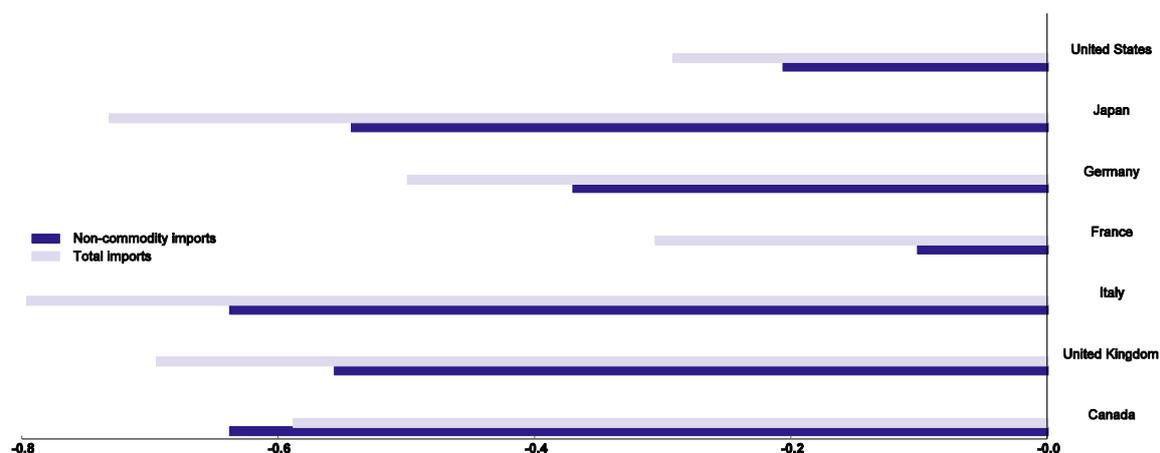
#### Box 4.1. Exchange rate pass-through into import prices varies across the G7 economies

The exchange rate pass-through represents the impact of changes in the nominal exchange rate on import prices in the local currency of the destination market. The strength of the pass-through varies across countries and sectors, depending on a number of factors (Goldberg and Hellerstein, 2008):

- Incomplete pass-through may result from mark-ups and marginal production costs varying with exchange rate appreciation or depreciation.
  - Mark-up fluctuations occur when the price elasticity of demand depends on the sales price and of competitors' sales prices. If the industry is competitive, exporting firms may absorb a proportion of the exchange rate change so as not to lose market share.
  - Situations where marginal production costs depend on the exchange rate are: the presence of local, non-traded costs in the destination market; the use of imported inputs in the production of export goods; decreasing returns to scale, where marginal costs depend on the quantity produced.
- Nominal price stickiness due to menu costs or contract duration leads prices to respond less to current changes in the economic environment. It may also reduce pass-through if changes in the exchange rate are expected to be short-lived, so that exporters chose not to adjust sales prices in the country of destination.

Recent empirical research summarised in Goldberg and Hellerstein (2008) finds a large role for non-traded local costs in the destination country and for imported inputs in explaining incomplete pass-through of exchange rate changes to import prices. Nominal price stickiness, on the other hand, is primarily found to delay the transmission of exchange rate fluctuations into import prices.

#### Elasticity of total import and non-commodity import prices to exchange rate variations



*Note:* The estimated pass-through measures the cumulative response of import prices in local currency in the first year after a change in the exchange rate. See Vogel *et al.* (2008) for more details.

*Source:* OECD estimates

The figure presents estimates of the pass-through in the G7 economies for total import and non-commodity import prices.<sup>1</sup> Overall, the rates of pass-through are generally below unity in the G7. The estimates also display substantial heterogeneity of the estimates across countries, however, with notably lower pass-through rates in France and the United States and higher ones in Canada, Italy, Japan and the United Kingdom.<sup>2</sup>

1. This work is based on conventional pass-through equations estimated on quarterly data for the period 1993-2007. For more details see Vogel *et al.* (2008).
2. The high pass-through for Canada is partly artificial, and due to assumptions made by the Canadian Statistical Office in the construction of import price series.

***Commodity and non-commodity import prices do also play a role***

Non-oil commodity import prices appear to have a very significant impact on long-term consumer price levels in the United States, Canada and the United Kingdom, and only weakly significant in the euro area. Oil prices also have a significant impact on long-term consumer price levels in the euro area, and the United States. Finally, prices of non-commodity imports, which by far account for most of total imports, are found to have a robust long-run effect on consumer price levels in the United States and Canada.<sup>10</sup>

***There are noticeable cross-country differences in the transmission of oil prices shocks***

Cross-country differences in the long-term impact of non-oil commodity prices are limited and long-term responses to non-oil commodity prices are not statistically different between the euro area and the United States. On the other hand, in sharp contrast with priors associated with the higher oil intensity of the US economy and the possible buffer role played by higher indirect taxes in the euro area, the impact of an oil-price shock seems stronger in the euro area than in the United States. These differences in oil-price effects may not have shown up in the context of the recent run-up in oil prices because the oil price increase faced by the United States was much stronger (because of the dollar depreciation *vis-à-vis* the euro) and the speed of adjustment is slightly slower in the euro area. But to the extent these differences are real, they might be seen to justify greater caution from the European Central Bank on inflation risks from higher oil prices.

***Second round effects could come from wage dynamics***

Much of the inflation risk and uncertainty associated with recent commodity price shocks has been associated with potential second-round effects via wages and the possibility of a wage-price spiral, often judged to be more likely in Europe. Europe may indeed have a lower ability to absorb adverse terms-of-trade shocks because of automatic wage indexation still present in a few countries and collective bargaining institutions that may lead to real wage rigidity.<sup>11</sup>

***Wage resistance seems to have disappeared in all regions...***

However, based on various empirical estimates on wage behaviour there seems to be no compelling evidence of significant real wage resistance (*i.e.* a situation where workers resist the loss in purchasing power of their wages resulting from adverse terms-of-trade shocks) over the recent period neither in the euro area as a whole and its three largest member countries, nor in the United States and Japan. Rolling estimations show that real wage resistance, as captured by the long-run effect of commodity shocks on real wage costs, has declined noticeably after the oil price shocks

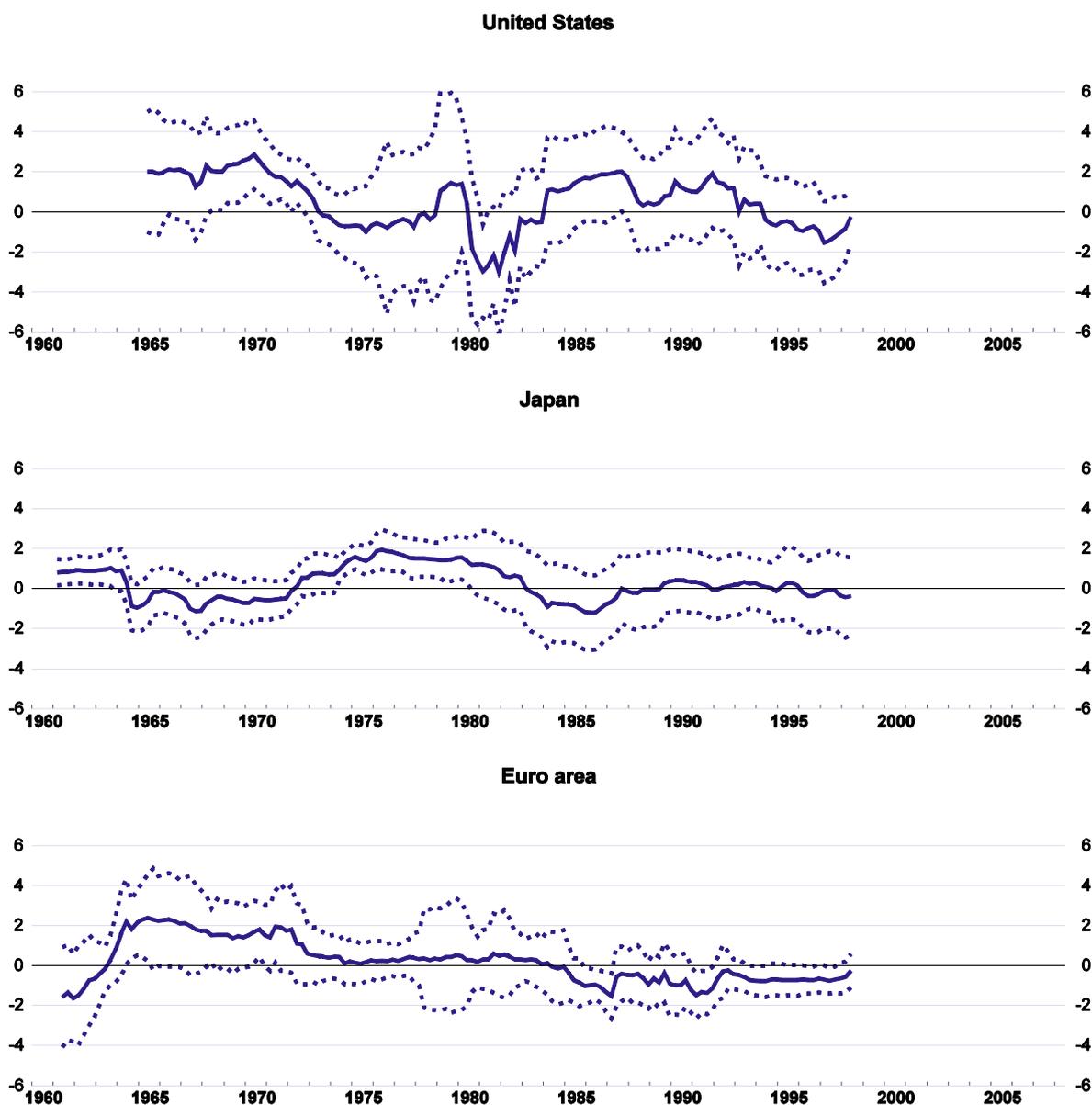
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10. Estimations on the three largest euro area countries presented in Vogel *et al.* (2008) show noticeable cross-country differences within the euro area, with notably oil prices having a very significant impact on long-term consumer price level in Germany, non-oil commodity prices having a very significant impact on long-term consumer price levels in France and Italy and non-commodity import price playing a role in France only.

11. See Du Caju *et al.* (2008) for recent information on wage bargaining institutions in Europe and comparison with the United States.

of the 1970s in the United States, the euro area and Japan (Figure 4.3).<sup>12</sup> It increased, however, in the United States in the aftermath of the strong dollar depreciation in the second part of the 1980s.

Figure 4.3. The evolution of wage resistance over time



Note: Long-run effect of the wedge between consumer and output prices on real wage costs and 95% confidence interval. The dates on the horizontal axis correspond to the start of the 10-year estimation window. See appendix for more details.

Source: OECD Economic Outlook 84 database; and OECD calculations.

12. Within the euro area, similar analysis shows that Germany appears to have experienced very little real wage resistance even in the 1970s. In contrast, France and the Italy exhibited real wage resistance in the 1970s and 1980s, but not later. Results are not reproduced here but reported in Vogel *et al.* (2008).

***... but could have come back as a result of the large commodity price shock***

While the apparent absence of real wage resistance since the mid-1990s may be due to structural changes (associated with labour market reforms and central bank credibility), it may also reflect the absence of large adverse shocks between then and the recent past. The recent commodity price shock is of a magnitude not experienced since the two oil-price shocks. As concerns oil and commodities strong demand from emerging market countries implies that recent increases are less likely to be reversed to the extent they did in past episodes.

***Different assessments of risks have contributed to policy divergence***

Overall, in addition to stronger concern for activity associated with financial turmoil in the United States, an apparently stronger long-term impact of oil prices on inflation and greater concern that wages could react more than in the past decade to the increase in commodity prices are likely to have contributed to a tighter monetary stance in the euro area than in the United States. However, the recent fall in commodity prices and the global slowdown in economic activity have sharply reduced inflation risks and, thereby, reasons for policy divergence.

***Implications of falling commodity prices for inflation***

Since they peaked at an historic high around \$150 a barrel in mid-July, oil prices have more than halved and non-oil commodity prices have also declined sharply. Looking forward, these falls and especially much weaker oil prices should result in a lower commodity import prices and should bring headline inflation below core inflation in coming quarters in most OECD countries. The effect on the euro area should be less than in the United States and Japan because of the recent depreciation of the euro against the US dollar.

**APPENDIX 4.A1:  
SUPPORTING ANALYTICAL MATERIAL**

This appendix describes the general methods and more detailed empirical estimates underlying the analysis of inflation responses to price shocks discussed in the main text of the chapter. It first describes the calculation of the direct impact of higher commodity prices on domestic inflation and then presents background information on price and wage inflation estimates.

**Assessing the direct impact of rising commodity prices on inflation in the G7 over the recent past**

*Back-of-the-envelope calculations of the direct impact of commodity prices shocks...*

Consistent with previous OECD work (see Pain *et al.*, 2006) the analysis of the direct impact of commodity import prices was done within a simple accounting framework, where the impact of energy, food and other commodity prices has been considered separately. The *ex ante* inflationary pressure from commodity prices is determined multiplying commodity price inflation (relative to domestic inflation) by the share of the corresponding commodity category in total demand.

*... using data from various sources*

The shares of the various commodities in total demand were based on the share of net imports plus domestic value added using the OECD Structural Analysis (STAN) Database.<sup>13</sup> The prices of energy commodities were proxied by the international (Brent) price of crude oil, and the price of food by the Hamburg Institute of International Economics (HWWA) food index. Non-food non-energy commodity import prices were computed as the import weighted average of three HWWA international prices (tropical beverages, agricultural raw materials and minerals, ores and metals). All commodity import prices were expressed in local currency terms, so that the direct measure of inflationary pressures combines the direct effect on import prices at constant exchange rates and the impact of exchange rate fluctuations.

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13. Data updated to 2006 were available for all countries except the United Kingdom, Canada and Japan, for which data were taken from the 2005 version of STAN stopping in 2003. For missing years, the share of energy was extrapolated on the basis of the shares of crude oil in total demand, with the shares of other commodities assumed to be stable. Given the absence of data on the value-added of energy commodities as well as metals and minerals in France, only imports were considered here.

### Estimating the impact of import prices on inflation within a Phillips curve framework

#### *A Phillips curve framework...*

The methodology used to assess the impact of import prices on domestic price inflation<sup>14</sup> in a Phillips curve framework follows Pain *et al.* (2006) and Sekine (2006). More precisely, an error correction model relating domestic prices to unit labour costs, import prices and measures of output gaps is estimated in order to assess simultaneously the short-term dynamics and the long-run price level effects of shifts in prices both of manufactured imports and of commodity imports. Batini *et al.* (2005) show how such an empirical specification can be derived from models of staggered price setting.<sup>15</sup>

#### *... including commodity import prices...*

An innovation considered here is the disaggregation in non-commodity, energy and non-energy commodity imports as separate sources of inflationary/disinflationary pressure. The different effect of commodity and non-commodity import penetration on consumer price inflation has also been taken into account by interacting the long-run price coefficients with the respective share of these factors in domestic demand. The general equation specification underlying the estimates is:

$$\begin{aligned} \Delta \ln P_t = & c + A(L)\Delta \ln P_{t-1} + B(L)\Delta \ln P_t^{M,oil} + C(L)\Delta \ln P_t^{M,noil} + \\ & D(L)\Delta \ln P_t^{M,non-com} + E(L)\Delta \ln ULC_t - \lambda(\ln P_{t-1} - \alpha M_{t-1}^{SH,oil} \ln P_{t-1}^{M,oil} - \\ & \beta M_{t-1}^{SH,noil} \ln P_{t-1}^{M,noil} - \gamma M_{t-1}^{SH,non-com} \ln P_{t-1}^{M,non-com} - \delta(1 - M_{t-1}^{SH,oil} - M_{t-1}^{SH,noil} \\ & - M_{t-1}^{SH,non-com}) \ln ULC_{t-1}) + \xi GAP_t + \varepsilon_t \end{aligned} \quad [1]$$

where P represents the domestic price level measured by the private consumption expenditure deflator,  $P_t^{M,oil}$  the oil import price measured in local currency,  $P_t^{M,noil}$  the non-oil commodity import price in local currency,  $P_t^{M,non-com}$  the non-commodity import prices, ULC the domestic unit labour costs and GAP the domestic output gap.<sup>16</sup>  $M_{t-1}^{SH,oil}$ ,  $M_{t-1}^{SH,noil}$  and  $M_{t-1}^{SH,non-com}$  indicate the shares of oil supply, non-energy and non-commodity imports in total demand, respectively. All data

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14. The literature sometimes refers to the link between import and consumer prices as *second-stage* pass-through, in distinction from the *first-stage* pass-through of foreign price and exchange rate movements to import prices measured in the currency of the destination country (Sekine, 2006).
  15. Ihrig *et al.* (2007) use an identical specification to assess both the pass-through from foreign production costs to destination-currency import prices and from import prices to the aggregate CPI. Integrating import prices in a Phillips curve framework seems a richer approach, however, as it allows a more explicit testing of theoretical hypotheses and also provides additional information on the long-run relationship between import prices, domestic production costs and domestic consumer prices.
  16. The foreign output gap -a trade-weighted average of foreign output gaps for each country - was also tested, but the respective coefficient has never been significantly different from zero. Inflation expectations could not be included because of limited data availability outside the United States

come from the *Economic Outlook* database, with the exception of oil-supply data taken from the IEA *World Energy Statistics and Balances* database. A(L), B(L), C(L), D(L) and E(L) denote polynomial functions of the lag operator.

*... with a focus on cross-country differences*

A system of equation including the United States, Japan, the euro area, the United Kingdom and Canada has been estimated by the seemingly unrelated regression method (SUR) and following a general-to-specific approach. The estimations were done over the period 1990Q1-2007Q4 as tests for parameter stability initially carried out on estimates over a much longer period suggested changes in inflation dynamics around 1990 in several countries. The restriction of static homogeneity of degree one, which implies the mark-up of prices over costs to be independent of the price level, was found to hold for all countries but Canada and Japan, and assumed only for the United-States, the euro area and the United Kingdom.<sup>17</sup> Corresponding estimates of the error-correction terms are reported in Table 4.3. The existence of significant long-run co-integration relationships in the error-correction model has been tested and accepted in all cases. Details on the dynamics are available in Vogel *et al.* (2008) and show that most, but not all, changes in imports prices were rightly signed and had a significant impact on short term inflation. They also show an only very weak impact of domestic output gaps on inflation.

Table 4.3. Consumer price Phillips curves-long-run specification

	ECM term	Non-commodity imports (-1)	Oil imports (-1)	Non-oil commodity imports (-1)	Unit labour cost (-1)	adj. R <sup>2</sup>
United States	-0.11 (0.00)	-0.08 (0.04)	-0.01 (0.13)	-0.05 (0.00)	-0.85	0.63
Japan	-0.16 (0.01)	-0.08 (0.21)	0.01 (0.41)	-0.01 (0.58)	-0.21 (0.07)	0.46
Euro area	-0.08 (0.00)	0.00	-0.05 (0.00)	-0.03 (0.26)	-0.92	0.63
United Kingdom	-0.11 (0.00)	-0.09 (0.28)	0.00 (0.84)	-0.14 (0.00)	-0.76	0.63
Canada	-0.12 (0.00)	-0.29 (0.00)	0.03 (0.29)	-0.05 (0.06)	-1.02 (0.00)	0.30

Note: These estimates correspond to the estimated long-run error correction mechanism (ECM) relationships (see equation [1] in the appendix) for the period 1990-2007. P-values of a t-test on the significance of estimated coefficients are provided in brackets. For details on the dynamics part of the equation see Vogel *et al.* (2008).

Source: OECD estimates.

17. Moreover, the parameter estimates for the long-run impact of non-commodity import prices in the equation for the euro area, which was clearly not significant but had counterintuitive signs, has been constrained to zero.

### Real wage resistance in response to commodity price shocks

#### *Gauging workers' resistance to losses in purchasing power from terms-of-trade shocks*

To examine the issue of how the response of real wages to commodity price shocks may have changed in the United States, the euro area, Japan and selected European countries, the following simple autoregressive distributed lag equation is estimated in a rolling ten-year window:<sup>18</sup>

$$\Delta ulc_t = c + \sum_{i=1}^m \alpha_i \Delta ulc_{t-i} + \sum_{i=0}^n \beta_i \Delta wedge_{t-i} + \sum_{i=0}^w \pi_i \Delta unempgap_{t-i} + \varepsilon_t \quad [2]$$

where *ulc* is the log of the total economy unit labour cost, *wedge* is the log of the private consumption deflator to GDP deflator ratio and *unempgap* is the unemployment gap (the unemployment rate-NAIRU). The *wedge* term is inserted to capture commodity price shocks as the consumption deflator is expected to increase by a greater amount than the GDP deflator in response to an increase in commodity prices. This will drive the real consumption wage below the real production wage, potentially generating real wage resistance. If there is real wage resistance to a commodity price increase (decrease) then the initial fall (rise) in the real consumption wage will provoke a compensating increase (decrease) in nominal wages and hence real wage costs. The magnitude of this effect should be captured by the long-run elasticity:

$$\theta = \frac{\sum_{i=0}^n \beta_i}{1 - \sum_{i=1}^m \alpha_i} \quad [3]$$

#### *Results are robust to changes in methodology*

As a sensitivity check, the exercise has been repeated but with real wages (compensation per employee relative to the GDP deflator) instead of unit labour costs as the dependent variable in Equation 2 and productivity growth (contemporaneous and lagged) included as a separate regressor. The results regarding the size and significance of the wedge variable were similar. Estimating a more comprehensive wage equation does not change the main conclusions.

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18. This equation is not a “comprehensive” wage equation, but rather specified to examine a particular feature of wage setting, *i.e.* how real wage resistance to commodity price shocks may be changing over time.

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