What is the effect of energy prices on consumer prices in Austria? A production-side decomposition

Martin Schneider[1]
Refereed by: Bettina Landau, ECB

We analyze the role of energy in consumer price developments in Austria using a production-side decomposition based on input-output tables. The overall share of energy in total private consumption expenditure amounted to 7.7% in 2018 and from then more than doubled to reach 17.7% in November 2022. In 2018, the share of energy was substantial in spending on housing (29%) and transport (26%), while it was almost negligible (1.0%) in spending on other consumer goods. In addition, we estimated the impact of the increase in energy wholesale prices between January 2021 and November 2022 on consumer prices. Under the assumption of a full absolute pass-through of energy prices, our input-output approach suggests a contribution of energy prices to headline inflation of 14.5 percentage points, which is considerably higher than the contribution of the HICP energy component in this period (6.2%). The remaining 8.3 percentage points can be seen as "inflation backlog," which is due to the delayed adjustment of consumer prices for electricity, gas and district heating to wholesale energy prices. The degree to which this backlog will materialize and the adjustment path mainly depend on the future path of wholesale prices and the lag with which price changes feed through to end-user contracts and are therefore subject to considerable uncertainty. The Austrian government has implemented a cap on electricity prices ("Strompreisbremse"), which will reduce inflation by 0.9 percentage points in 2023. In 2024, the abolishment of the cap will increase inflation by 0.3 percentage points.

JEL classification: C6, E31
Keywords: inflation pass-through, inflation backlog, input-output model

Global energy prices have increased at an unprecedented pace for the past two years after having experienced a continuous downward trend over the past decade. A bundle of factors has contributed to this surge since the onset of the COVID-19 pandemic. Besides the post-COVID-19 recovery in combination with supply-side problems, the war in Ukraine and the particularities of the electricity market are the most important drivers.

As a result, Austria has seen a sharp rise in consumer price inflation. In November 2022, inflation as measured by the Harmonized Index of Producer Prices (HICP) reached 11.2%, a level even surpassing the peak during the first oil crisis in June 1974 (consumer price index (CPI): +10.4 %). Between January 2021 and November 2022, consumer prices in Austria increased by 15.8%. Disaggregated HICP data for Austria show that less than half (6.2 percentage points) of the increase since January 2021 is attributable to the energy component of the HICP, which includes household energy (electricity, gas, district heating) and fuels and lubricants for personal transport. Due to the structure of end-user contracts for

[1] *Oesterreichische Nationalbank, Business Cycle Analysis Section, martin.schneider@oenb.at. Opinions expressed by the authors of studies do not necessarily reflect the official viewpoint of the OeNB or the Eurosystem. The author would like to thank Friedrich Fritzer and Gerhard Fenz (OeNB) for helpful comments and valuable suggestions.*

electricity, gas and district heating, where prices are often fixed for one year in advance, it seems likely that there are price pressures in the pipeline which have not materialized yet. Another reason why HICP energy inflation understates the role of energy is that the production of other goods and services needs energy.

In this paper, we address the following questions: Firstly, what is the role of energy prices in consumer price growth beyond the HICP energy component, i.e. are there indirect effects via the production of goods and services consumed by households? Secondly, how strong has been the pass-through of energy prices to consumer price inflation so far? Thirdly, in case of an incomplete pass-through, how big is the inflation backlog that may materialize later? We use a cost-side approach based on input-output tables which we supplement with disaggregated data on energy consumption per industry. This enables us to calculate the energy content of each consumer good category and the impact of energy price increases on consumer prices. In addition, we can estimate the pass-through.

The paper is structured as follows: In section 1, we look into the role of energy in household consumption. In section 2, we present the input-output framework that we apply to decompose consumer prices and the results of this decomposition. Section 3 shows the decomposition of the consumer price increases since January 2021. Section 4 concludes.

1 Energy consumption of households in 2018

Energy consumed by households comes from several different sources. Oil is the most important source, accounting for 38% of total household energy consumption (measured in terajoule), followed by renewables (23%), electricity (17%) and natural gas (15%).

We have estimated household expenditure on energy based on the input-output table for Austria for 2018; at purchasing prices, this expenditure amounted to EUR

Table 1

Energy consumption of households in Austria (2018)

	Goods category		Terajoule	EUR billion				
	CPA	COICOP		Energy consumption at basic prices	Trade and transport margins	Indirect taxes less subsidies	Energy consumption at purchasing prices	% of total private consumption[3]
Total			**399,667**	**7.1**	**1.6**	**4.1**	**12.8**	**7.3**
Primary energy			301,181	3.7	1.6	3.0	8.3	4.8
Fossile energy sources			212,538	3.4	1.5	3.0	8.0	4.6
Mineral oil products	C19	04.53/07.22	152,682	2.6	1.5	2.8	6.9	3.9
Processed gas	D35	04.52	59,050	0.8	–	0.3	1.1	0.6
Coal	B05-07	04.549	805	0.0	0.0	0.0	0.0	0.0
Renewables[1]	A02[2]	04.5	88,643	0.3	0.1	0.0	0.4	0.2
Transformed energy			98,486	3.4	0.0	1.1	4.5	2.6
Electricity	D35	04.51	66,175	2.6	–	0.8	3.4	1.9
District heating	D35	04.550	32,311	0.9	–	0.3	1.1	0.6

Source: Statistics Austria, author's own calculations.

[1] *Renweables include firewood (61%), pellets and wood briquettes (14%), ambient heat (8%), solar energy (5%), biodiesel (5%), wood waste (4%) and bioethanol (2%).*
[2] *Besides A02 (firewood, pellets and wood briquettes), some renewables are attributable to C19 (biodiesel, bioethanol) and D35 (ambient heat).*
[3] *Excluding imputed rents.*

12.8 billion or 7.3% of private consumption (excluding imputed rents) in 2018.[2] This share is very close to the weight of energy in the HICP (7.7%). Expenditure on energy at basic prices amounted to EUR 7.1 billion. Additionally, trade and transport margins (EUR 1.6 billion) and indirect (product) taxes less subsidies (EUR 4.1 billion) were important cost components.

2 An input-output approach to decompose private consumption expenditure into their cost components

There are basically three different types of theories that explain the inflation process: monetary, demand and cost-based theories (Przyblinski and Gorzackynski, 2022). We use a cost-based input-output approach to determine the role of energy in consumer price developments where the consumer price for a good is given by the sum of the costs of the production inputs. From the perspective of a single firm, these cost components are purchases of intermediate goods and value added within the firm (compensation of employees, gross operating surplus, depreciation, indirect taxes less subsidies). Intermediate goods can be bought from other domestic firms or imported. Firms also demand intermediate inputs from other firms and from abroad, generating a network of interindustry linkages. Therefore, we must perform a multiplier analysis to decompose private consumption into its cost components (details can be found in the annex). This decomposition gives us the shares of energy (as the sum of energy imports, valued added and indirect taxes less subsidies of energy goods) and nonenergy goods and services (other imports, value added and indirect taxes less subsidies) at the level of 64 CPA consumer goods categories. Finally, we aggregate the results to the COICOP-45 classification. This allows us to match them with the components of the HICP.

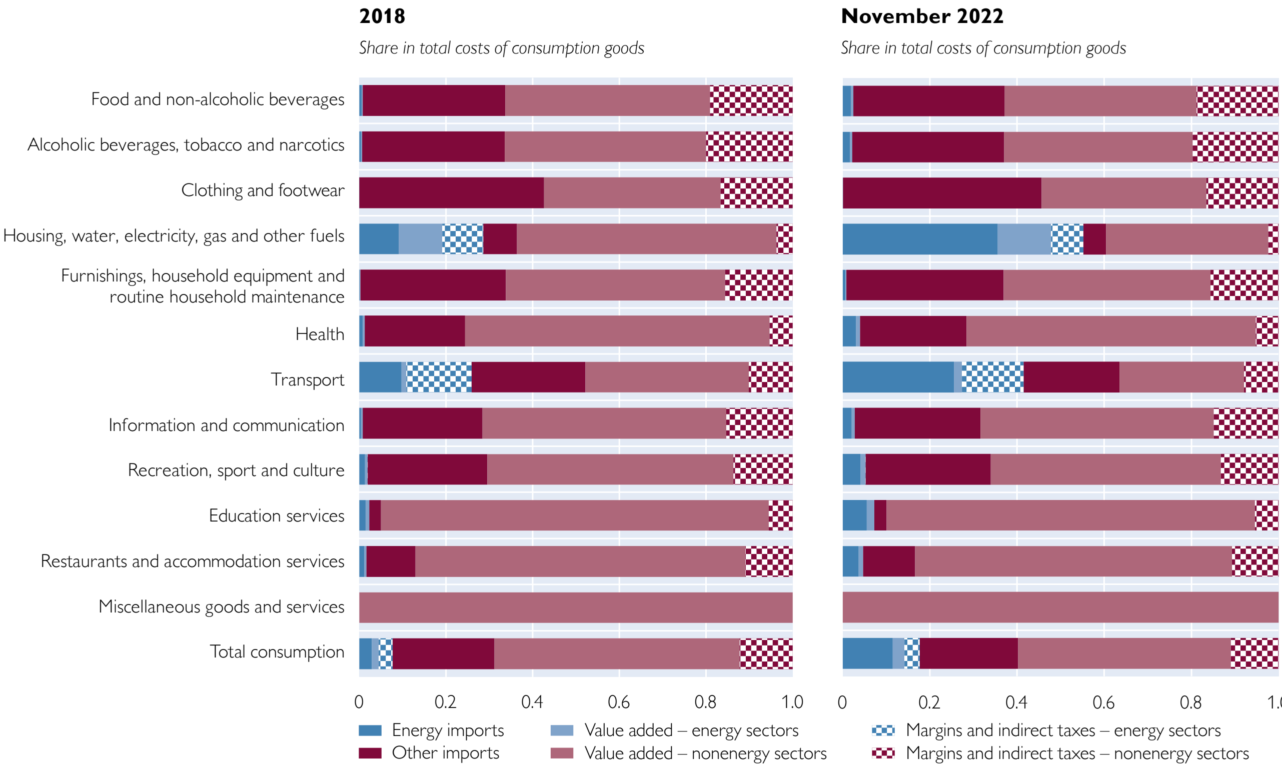
Compared to more common estimation approaches (see e.g. Baumeister and Kilian, 2014; Lopez et al., 2022), our approach has several advantages, including, most importantly, that it is not subject to structural breaks caused by the pandemic and the recent energy price hikes. Instead, we use disaggregated data on the cost structure of the production of consumer goods. The main drawbacks of our approach are that it does not capture dynamic relations and relies on a fixed production structure, i.e. there is no substitution due to changes in relative prices. In addition, we do not include second-round effects via income and employment. Although there are many examples of fully-fledged dynamic input-output models in the literature (see e.g. Kratena et al., 2017), we prefer our parsimonious approach for the sake of simplicity.

Chart 1 depicts the result of this decomposition for total private consumption and the 12 COICOP divisions for 2018 and November 2022. Energy consumption of households is concentrated in two goods categories: 04 (housing, water, electricity and other fuels) and 07 (transport). In housing, water, electricity and other fuels, energy accounted for 32.5% of total production costs in November 2022, in transport, the share amounted to 25.8%. In all other COICOP divisions, the share of energy in production costs was almost negligible at 1.0%. In aggregate private consumption, the share amounted to 7.7%. This is higher than the direct

[2] *We supplemented the input-output tables with data from the energy accounts and energy prices to break down consumption of goods B05–07 and D35 into energy sources.*

Chart 1

Cost structure of private consumption goods



Source: Statistics Austria, OeNB calculations.

share we derived from the input-output tables (7.3%; see table 1). The difference is attributable to the energy content of goods and services other than energy.

To derive the energy share in total costs for the latest available month (November 2022), we calculated the cost shares of the 64 CPA consumer good categories derived from the input-output table 2018 by updating the cost components with the evolution of the prices for production inputs. The cost share of energy more than doubled to 17.7% from 2018 to November 2022.[3] In housing, water, electricity, gas and other fuels, the share rose to 55%, and in transport to 42%. In all other COICOP divisions, the share of energy more than tripled to 3.2%. This is because gas and electricity (which showed larger price increases than petroleum products) are more important in the production of these goods and services than petroleum products.

3 A decomposition of consumer price increases since January 2021

In the next step, we calculated the effects of the increases in energy prices (as well as the prices of other production inputs) on consumer price inflation since January 2021.[4] Wholesale energy prices showed massive increases between January 2021

[3] *We did not consider seasonal variations in consumption patterns in our calculations.*

[4] *In a first step, we updated the cost shares of the 64 CPA consumer goods from 2018 to January 2021 with the prices for production inputs. We used these cost shares as the basis for a second update for the period until September 2022.*

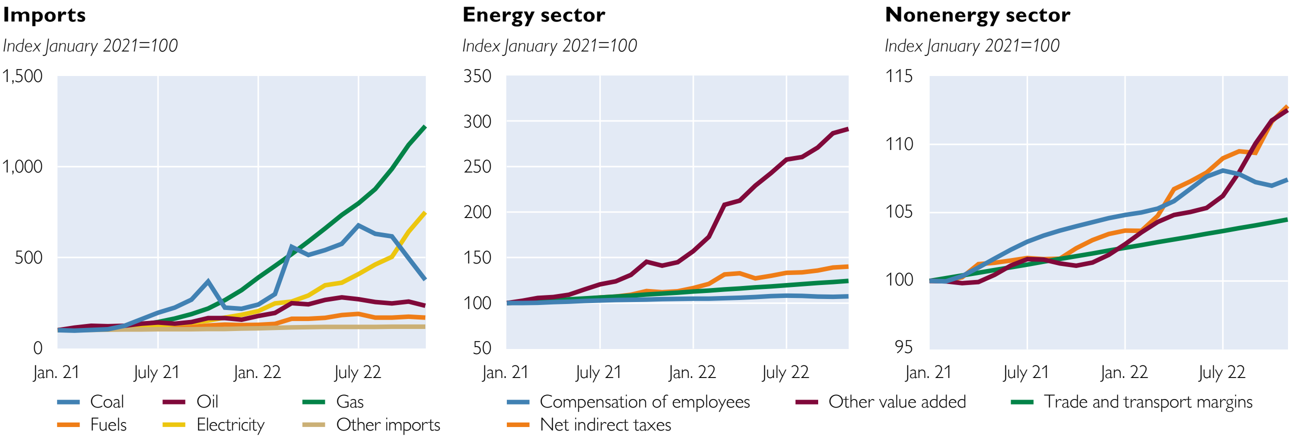
and November 2022 (gas: +1,124%, coal: +216%, electricity: +650%, oil: +96%).[5] As regards the growth of profits in the energy sector, we had to make our own assumptions. Based on the balance sheets of two major energy suppliers, OMV and Verbund,[6] we assumed that profits increased by 150% between January 2021 and November 2022. Wages in the energy sector were assumed to have increased in line with wages in the total economy (+7%) according to the national accounts. For nonenergy imports, we used the import deflator. The prices of nonenergy imports increased by 15% between January 2021 and November 2022, indicating continuing supply-side price pressures,[7] and the value added of nonenergy industries as well as trade and transport margins increased by 7%.[8]

For net indirect taxes, we considered the temporary reduction of both the electricity tax and the tax on natural gas from May 2022 to June 2023. Both tax rates were set to the minimum rate stipulated by EU law, which amounted to a temporary reduction in tax rates by about 90%. Furthermore, the ecological surcharge on electricity prices was set to zero in 2022. The introduction of the carbon tax was postponed from July 2022 to October 2022 (Prammer and Reiss, 2022).

Based on these assumptions about input price developments – and the assumptions of constant real shares – our model indicates an increase in consumer prices by 25.6% between January 2021 and November 2022 (solid blue line in chart 3), which is considerably more than the actual increase in the HICP (15.8%) in the same period (dashed line).

Chart 2

Price growth in production inputs



Source: E-Control, Statistics Austria, author's own assumptions.

[5] *For gas and electricity, we used the price indices issued by E-Control, which serve as a basis for the energy component of consumer prices in many contracts. For coal, we used the ICE Rotterdam coal index (USD), for oil the Brent oil price (USD).*

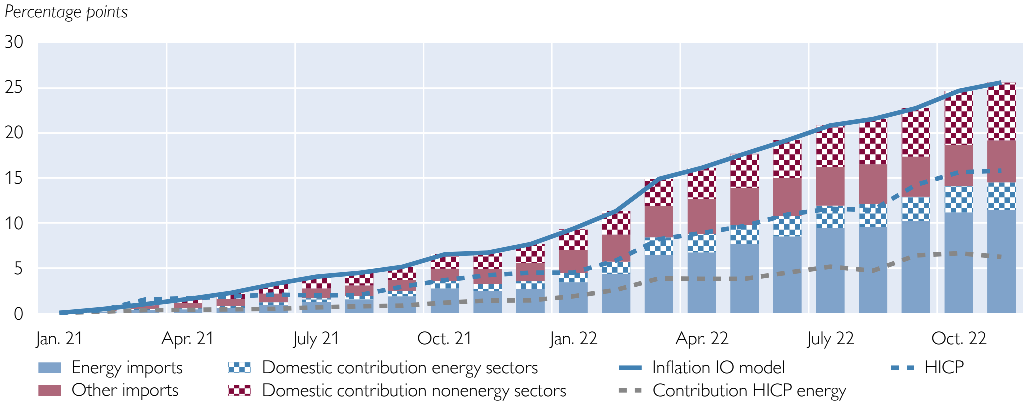
[6] *OMV's profit increased by 105% in the first half of 2022 relative to the first half of 2021. For Verbund, the increase amounted to +152%. https://www.derstandard.at/story/2000137852348/gas-und-oelpreise-treiben-gewinne-der-energiekonzerne-hoch.*

[7] *Note that nonenergy goods and services also include energy as input in their production process. We did not perform a decomposition of import prices since our analysis focuses on Austria.*

[8] *Since national accounts data are available at a quarterly frequency only, we used a cubic spline to interpolate quarterly to monthly series.*

Chart 3

Contributions to HICP inflation since January 2021 according to the input-output model



Source: Statistics Austria, OeNB calculations.

The difference of 8.3 percentage points between the contribution of energy inflation according to our input-output model (14.5 percentage points) and the HICP energy component (6.2 percentage points) can be interpreted as "inflation backlog." In relative terms, only 43% of the increases in wholesale prices was passed through to consumer prices of energy.[9]

The prices of nonenergy goods and services contributed 9.6 percentage points to HICP inflation between January 2021 and November 2022. This is slightly below the contribution calculated using our input-output approach (11.1 percentage points), which indicates that firms did not raise their prices more than input price developments would have suggested.

4 Summary and discussion of the results

In this paper, we analyze the role of energy in consumer price developments in Austria using a production-side decomposition based on input-output tables. We decomposed consumer prices for 2018 and found that the overall impact of energy prices on inflation (7.7%) was higher than the share of direct energy consumption (7.3%). The difference of 0.4 percentage points represents energy contained in the production of nonenergy goods and services. By November 2022, the share of energy in the overall HICP had increased to 17.7%.

In addition, we estimated the impact of the increase in energy prices (and the prices of other production inputs) between January 2021 and November 2022 on consumer prices. We found that only 43% of the cost increases in the energy sector were passed through to consumer prices, implying a substantial inflation backlog of 8.3 percentage points. This is attributable to the fact that price increases in household energy (gas, electricity, district heating) come with a long delay due to the structure of consumer contracts.[10] Although household prices for new

[9] *Note that prices for fuels, which amounted to 42% of households' total energy expenditure in 2022, are passed through without delay. This implies that the pass-through for electricity, gas and district heating is much lower.*

[10] *Typical delays amount to 15 to 18 months for electricity and 12 to 18 months for gas.*

customers were significantly higher, prices for existing customers[11] went up only modestly because in most contracts, prices are fixed for one year.[12]

There are two reasons why we can expect the inflation backlog to materialize only partially. First, wholesale energy prices started to decline in August 2022.[13] Futures for most wholesale prices are trending down, indicating lower prices in the next months. Second, policy measures such as the electricity cap ("Strompreisbremse"), which came into force in Austria in December 2022, will limit consumer price increases. The electricity cap is estimated to reduce inflation by 0.1 and 0.9 percentage points in 2022 and 2023, respectively (Fritzer et al., 2022); in 2024, the abolishment of the cap will increase inflation by 0.3 percentage points.

References

Baumeister, C. and L. Kilian. 2014. Do oil price increases cause higher food prices? Economic Policy 29(80). 691–747.

Fritzer, F., D. Prammer, M. Schneider, R. Sellner and A. Stiglbauer. 2022. Only mild recession over the turn of the year despite high energy prices. Economic outlook for Austria from 2022 to 2025 (December 2022).

Kratena, K., S. Streicher, S. Salotti, M. Sommer and J. Valderas-Jaramillo. 2017. FIDELIO 2: Overview and theoretical foundations of the second version of the fully interregional dynamic econometric long-term input-output model for the EU-27. JRC Technical Report JRC105900. EUR 28503 EN. doi:10.2760/313390.

López, L., S. Párraga and D. Santabárbara. 2022. The pass-through of higher natural gas prices to inflation in the euro area and in Spain. Box 4. In: Banco de España Economic Bulletin 3/2022. 49–52.

Prammer, D. and L. Reiss. 2022. Fighting (the effects of) inflation: measures in Austria and the EU. In: Monetary Policy and the Economy Q4/2022–Q1/23. Vienna: OeNB. 95–106.

Przyblinski, M. and A. Gorzackynski. 2022. Applying the input-output price model to identify inflation processes. In: Journal of Economic Structures 11:5. 1–11.

Annex: formal representation of the decomposition

We start by decomposing private consumption at purchasers' prices $C_{i,t}^{PP}$ *(i=1..., 64)* into its components for each of the 64 CPA goods categories. Since input-output tables are valued at basic prices, our first step is to decompose $C_{i,t}^{PP}$ into trade and transport margins and indirect taxes less subsidies on products $TTMT_{i,t}$, and private consumption at basic prices ($C_{i,t}^{BP}$).

$$C_{i,t}^{PP} = TTMT_{i,t} + C_{i,t}^{BP} \tag{1}$$

[11] *A list of price changes for existing customers can be found on E-Control's website (https://www.e-control.at/konsumenten/aktuelle-preisaenderungen)*

[12] *Among Austria's large electricity providers, only Wien Energie (September 1, 2022: +144%) and EVN (Sepember 1, 2022: +140%) have recently increased their prices for existing costumers (as of December 2022). According to E-Control, the average electricity price for households increased from 21.4 cent/kwH in the first half of 2021 to 22.2 cent/kwH in the first half of 2022. For gas, only two of the regional providers (Carinthia, Tyrol) increased their prices until December 2022.*

[13] *Due to the construction of these indices, both indices exhibit strong smoothing.*

A part of private consumption at basic prices ($C_{i,t}^{BP}$) is imported directly from abroad. Deducting direct imports $MD_{i,t}$ of consumption goods gives us domestically produced private consumption at basic prices ($C_{i,t}^{BPD}$).

$$C_{i,t}^{BP} = C_{i,t}^{BPD} + MD_{i,t} \qquad 2)$$

Combining (1) and (2) gives us the following decomposition

$$C_{i,t}^{PP} = TTMT_{i,t} + MD_{i,t} + C_{i,t}^{BPD}. \qquad (3)$$

To produce one unit of good $C_{i,t}^{BPD}$, the following inputs are needed: intermediate inputs from other domestic industries, imports (energy and other imports) used in the production and domestic value added (wages and other value added). The use of intermediate inputs by industry *i* generates output in other industries of the economy. These industries also demand intermediate inputs from other industries and from abroad, generating a network of interindustry linkages. Therefore, we must perform a multiplier analysis to calculate the economy-wide value added and indirect imports generated by $C_{i,t}^{BPD}$.[14] Using the multipliers $m_{i,t}^{*}$, we calculate domestic value added for the energy sector ($VAE_{i,t}$) and the nonenergy sector ($VANE_{i,t}$) and indirect imports for the energy sector ($MIE_{i,t}$) and the nonenergy sector ($MINE_{i,t}$) generated by consumer demand for good *i* by multiplying the vector of private consumption by the respective multiplier.[15]

$$VAE_{i,t} = C_{i,t}^{BPD} \cdot m_{i,t}^{VAE} \qquad (4)$$

$$VANE_{i,t} = C_{i,t}^{BPD} \cdot m_{i,t}^{VANE} \qquad (5)$$

$$MIE_{i,t} = C_{i,t}^{BPD} \cdot m_{i,t}^{MIE} \qquad (6)$$

$$MINE_{i,t} = C_{i,t}^{BPD} \cdot m_{i,t}^{MINE} \qquad (7)$$

Equation (8) gives us the decomposition of the domestically produced consumption good $C_{i,t}^{BPD}$ into value added for the energy and the nonenergy sector and indirect energy and nonenergy imports.

$$C_{i,t}^{BPD} = VAE_{i,t} + VANE_{i,t} + MIE_{i,t} + MINE_{i,t} \qquad (8)$$

Plugging (2) and (8) into (1) gives us (9):

$$C_{i,t}^{PP} = TTMT_{i,t} + MD_{i,t} + VAE_{i,t} + VANE_{i,t} + MIE_{i,t} + MINE_{i,t} \qquad (9)$$

[14] *A multiplier m gives the components of value added and imports generated in the whole economy for one unit of final demand. It can be derived as follows: Total demand q is the sum of intermediate demand Aq plus final demand f ($q=Aq+f$) where A is the matrix of input coefficients of intermediate demand. Solving this matrix equation for q gives us $q=(1-A)^{-1}f$, where q is the amount of output of each industry induced by final demand f. We can obtain the multiplier $m_{i,t}^{*}$ for each good i by solving this equation for one unit of final demand for this good and by multiplying q with the share of the respective value added (import) component in output per industry.*

[15] *Please note that these four quantities refer to the economy-wide aggregates.*

Finally, we split margins and net indirect taxes and direct imports between energy ($TTMTE_{i,t}$) and nonenergy sectors ($TTMTNE_{i,t}$) and sum up direct and indirect imports. This gives us our final decomposition

$$C_{i,t}^{PP} = TTMTE_{i,t} + TTMTNE_{i,t} + VAE_{i,t} + VANE_{i,t} + MIE_{i,t} + MINE_{i,t} \tag{10}$$

Total energy costs for households are given as the sum of imported energy, value added of the energy sectors, trade and transport margins for energy and direct taxes less subsidies for the energy sector

$$E_{i,t} = TTMTE_{i,t} + VAE_{i,t} + ME_{i,t} \tag{11}$$