How do prices of primary energy carriers influence the competitiveness of the Polish economy

Michał Przybyliński
University of Łódź

17th INFORUM World Conference, Jurmala 2009
Previous research

General concept of the model developed for the purpose of the project:

Foreign trade part:
World price formation in IMPEC

- **Structure of energy inputs (electricity):**
  - Oil
  - Gas
  - Coal
  - Renewables
  - Nuclear

- **Prices of energy carriers:**
  - Oil
  - Gas
  - Coal
  - Renewables
  - Nuclear
  - Heat
  - Electricity

- **Cost of primary energy carriers per unit of electricity output**

- **Other costs per unit of electricity output**

- **Energy efficiency index (electricity)**

- **Cost of energy per unit of output**

- **World price of a product**

- **Other costs per unit**

- **Energy efficiency index**
Comments

1. Polish import deflators are treated as world prices of products, seen from the Polish perspective.

2. Lack of technological information:
   - Renewable resources
   - Heat
   - Coke and petroleum products

3. Lack of data on prices:
   - Nuclear power
   - Renewable resources
   - Lignite

4. No inflation loop abroad
World prices of products – import deflators

World price of product \(i\) is a function of energy cost of an unit of production

\[
P_i^M = \left[K_i^N (1 - \omega_i) + K_i^E F_i \omega_i \right] \cdot R
\]

- \(K_i^E\) – unit cost of energy for \(i\)-th category of products (index)
- \(K_i^N\) – other costs per unit of output for \(i\)-th group of products (index)
- \(F_i\) – technological index showing changes in energy consumption per unit of \(i\)-th group of products
- \(\omega_i\) – weight, share of energy in costs of production of \(i\)-th group of products in base year (2000)
- \(R\) – exchange rate (index)

\[
K_i^E = \sum_{s=1}^{S} C_s W_{is}
\]

- \(C_s\) – price of \(s\)-th energy carrier
- \(W_{is}\) – share of \(s\)-th energy carrier in production of \(i\)-th group of products
World price of electricity

World price of electricity is a function of energy cost of an unit of production

\[ C_{ele} = \left[ K^N_{ele} (1 - \omega_{ele}) + K^E_{ele} F_{ele} \omega_{ele} \right] \]

- \( K^E_{ele} \) – unit cost of energy (index)
- \( K^N_{ele} \) – other costs per unit of production (index)
- \( F_i \) - technological index showing changes in energy consumption per unit
- \( \omega_i \) – weight, share of energy in costs of production in base year (2000)

\[ K^E_{ele} = \sum_{s=1}^{S} C_s W_{ele,s} \]

- \( C_s \) - price of s-th energy carrier
- \( W_{ele,s} \) - share of s-th energy carrier in energy cost
General layout of foreign trade block

1. Prices of primary energy inputs

2. World prices of products

3. Import shares

4. Exports

5. Domestic prices

6. World exports

7. World prices of products

8. Import shares

9. Exports

10. Domestic prices
Assumptions:

Price of oil

2000=1 (30.9 euro/bbl)

Fast growth scenario. Original forecasts made by Lodz Technical University at the beginning of 2008.

Base scenario. For 2009 price was assumed at the level of market data at the end of 2008 (35 euro/bbl), and then growth rate was assumed 1 p.p less than in forecasts made by LTU.

Prices frozen at the level of 35 euro/bbl
Price of natural gas

2000=1 (10.84 euro/MWh)

Assumptions:
Assumptions:

Price of coal

2000=1 (30,9 euro/t SKE)
Assumptions:

Energy efficiency index ODEX
## Share of energy in output in 2000
average for 18 EU countries, based on SIOT published by EUROSTAT

<table>
<thead>
<tr>
<th>Rank</th>
<th>Category</th>
<th>Share of Energy</th>
<th>Rank</th>
<th>Category</th>
<th>Share of Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Products of agriculture, hunting and related services</td>
<td>2.98%</td>
<td>19</td>
<td>Fabricated metal products, except machinery and equipment</td>
<td>1.68%</td>
</tr>
<tr>
<td>2</td>
<td>Products of forestry, logging and related services</td>
<td>1.42%</td>
<td>20</td>
<td>Machinery and equipment n.e.c.</td>
<td>1.15%</td>
</tr>
<tr>
<td>3</td>
<td>Fish and other fish products; services of incidental fishing</td>
<td>7.27%</td>
<td>21</td>
<td>Office machinery and computers</td>
<td>0.54%</td>
</tr>
<tr>
<td>4</td>
<td>Coal and lignite; peat</td>
<td>14.01%</td>
<td>22</td>
<td>Electrical machinery and apparatus n.e.c.</td>
<td>1.20%</td>
</tr>
<tr>
<td>5</td>
<td>Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying</td>
<td>6.42%</td>
<td>23</td>
<td>Radio, television and communication equipment and apparatus</td>
<td>0.74%</td>
</tr>
<tr>
<td>6</td>
<td>Food products and beverages</td>
<td>1.75%</td>
<td>24</td>
<td>Medical, precision and optical instruments, watches and clocks</td>
<td>0.78%</td>
</tr>
<tr>
<td>7</td>
<td>Tobacco products</td>
<td>0.63%</td>
<td>25</td>
<td>Motor vehicles, trailers and semi-trailers</td>
<td>0.95%</td>
</tr>
<tr>
<td>8</td>
<td>Textiles</td>
<td>3.01%</td>
<td>26</td>
<td>Other transport equipment</td>
<td>1.01%</td>
</tr>
<tr>
<td>9</td>
<td>Wearing apparel; furs</td>
<td>0.98%</td>
<td>27</td>
<td>Furniture; other manufactured goods n.e.c.</td>
<td>1.20%</td>
</tr>
<tr>
<td>10</td>
<td>Leather and leather products</td>
<td>1.07%</td>
<td>28</td>
<td>Recovered secondary raw materials</td>
<td>2.65%</td>
</tr>
<tr>
<td>11</td>
<td>Wood and of products of wood and cork (except furniture); articles of straw and plaiting materials</td>
<td>1.98%</td>
<td>29</td>
<td>Electrical energy, gas, steam and hot water</td>
<td>37.18%</td>
</tr>
<tr>
<td>12</td>
<td>Pulp, paper and paper products</td>
<td>4.49%</td>
<td>30</td>
<td>Collected and purified water, distribution services of water</td>
<td>5.45%</td>
</tr>
<tr>
<td>13</td>
<td>Printed matter and recorded media</td>
<td>1.04%</td>
<td>31</td>
<td>Construction work</td>
<td>0.99%</td>
</tr>
<tr>
<td>14</td>
<td>Coke, refined petroleum products and nuclear fuels</td>
<td>71.09%</td>
<td>32</td>
<td>Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel</td>
<td>1.46%</td>
</tr>
<tr>
<td>15</td>
<td>Chemicals and chemical products</td>
<td>7.11%</td>
<td>33</td>
<td>Wholesale trade and commission trade, except of motor vehicles and motorcycles</td>
<td>1.75%</td>
</tr>
<tr>
<td>16</td>
<td>Rubber and plastic products</td>
<td>2.43%</td>
<td>34</td>
<td>Retail trade services, except of motor vehicles and motorcycles; repair services of personal and household goods</td>
<td>2.01%</td>
</tr>
<tr>
<td>17</td>
<td>Other non-metallic mineral products</td>
<td>5.61%</td>
<td>35</td>
<td>Hotels and restaurants services</td>
<td>1.92%</td>
</tr>
<tr>
<td>18</td>
<td>Basic metals</td>
<td>6.19%</td>
<td>36</td>
<td>Land transport; transport via pipelines services</td>
<td>6.22%</td>
</tr>
</tbody>
</table>
Assumptions:

Structure of primary energy used for electricity production

Source: EUROSTAT, Electricity generation by origin
Other assumptions

- Fixed „real” weights
- Prices of other carriers following oil, gas, coal
- Non-energy unit costs extrapolated with time trends
- Exchange rate 4,50 PLN/Euro
- Exports of OECD countries as a demand factor in export equations

This means no demand effect abroad!
Assumptions:

Macroeconomic assumptions

- Investments
- Government expenditures

The graph shows the trend of investments and government expenditures from 2006 to 2020.
Multiplier analysis 1
Rise of world price of oil by 50%

Import prices rise for all products, but not much. For coke and petroleum products this effect is 7,9% and electrical energy 2,5%. Other products don’t change their prices more than 0,8%.

This effect is stronger in case of domestic prices. Relations of import versus domestic prices go down by 1,6 to 6,4%. This result seems to be contrary to common opinion that Polish economy is based on coal, so rise in prices of other carriers should improve its competitiveness. Oil, however, is not a substitute for coal. Prices of Polish goods are more sensitive for changes in prices of oil because the economy consumes more energy per unit of production than EU average.

Because of unfavourable change in price relations exports of all groups of products fall, and total export falls by 1,9% (external demand was assumed constant).

For the same reason, total import goes up, but only by 0,4%. Price effect is, however, reduced here by demand effect. In approximately half of the product groups import falls.
Multiplier analysis 1b
Rise of world price of natural gas by 50%

• No significant changes

Multiplier analysis 1c
Rise of world price of coal by 50%

• No significant changes
Multiplier analysis 2
Rise of domestic coal price by 30%

World prices are not changed. Domestic prices rise by 1% to 4% except electricity (8.6%). Relation of import versus domestic prices goes down about 4% in total.
Export is of coal is reduced by 7.2%, and motor vehicles by 4.2%, and other transport equipment by 5.4%. In few other groups this effect exceeds 1%, and the total is 1.9%.
As a consequence, export goes down by 4%, and import rises by 0.8%.

Multiplier analysis 3
Rise of domestic electricity price by 30%

Almost all effects are almost three times higher than those of multiplier analysis 2. There are no significant deviations from this rule.
Multiplier analysis 1,2,3
deviations from base in %
Results:

Polish import deflators 2000=1

Coke and refined petroleum products

Other non-metallic mineral products

Basic metals

Chemicals and chemical products
Results:

Polish import deflators 2000=1

- **Products of agriculture**
  - 2000: 2.00
  - 2005: 1.38
  - 2010: 0.77
  - 2015: 1.43
  - 2020: 1.06

- **Food products and beverages**
  - 2000: 1.11
  - 2005: 0.90
  - 2010: 0.69
  - 2015: 1.11
  - 2020: 1.23

- **Textiles**
  - 2000: 1.23
  - 2005: 1.02
  - 2010: 0.81
  - 2015: 1.02
  - 2020: 1.11

- **Pulp, paper and paper products**
  - 2000: 0.81
  - 2005: 0.69
  - 2010: 0.90
  - 2015: 0.69
  - 2020: 1.11
## Results:

**Fast growing prices**  
– average deviations from growth rates

<table>
<thead>
<tr>
<th>IMP</th>
<th>EXP</th>
<th>IMP</th>
<th>EXP</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0,2</td>
<td>-0,0</td>
<td>16 Rubber and plastic products</td>
<td>-0,2</td>
</tr>
<tr>
<td>-0,1</td>
<td>-0,0</td>
<td>17 Other non-metallic mineral products</td>
<td>-0,1</td>
</tr>
<tr>
<td>-0,5</td>
<td>-0,0</td>
<td>18 Basic metals</td>
<td>-0,4</td>
</tr>
<tr>
<td>-17,2</td>
<td>0,4</td>
<td>19 Fabricated metal products, except machinery and equipment</td>
<td>0,1</td>
</tr>
<tr>
<td>-0,2</td>
<td>0,4</td>
<td>20 Machinery and equipment n.e.c.</td>
<td>-0,0</td>
</tr>
<tr>
<td>-0,1</td>
<td>-0,3</td>
<td>21 Office machinery and computers</td>
<td>-0,0</td>
</tr>
<tr>
<td>-0,2</td>
<td>-0,2</td>
<td>22 Electrical machinery and apparatus n.e.c.</td>
<td>-0,2</td>
</tr>
<tr>
<td>-0,2</td>
<td>-0,0</td>
<td>23 Radio, television and communication equipment and apparatus</td>
<td>-0,0</td>
</tr>
<tr>
<td>0,2</td>
<td>-0,1</td>
<td>24 Medical, precision and optical instruments, watches and clocks</td>
<td>-0,1</td>
</tr>
<tr>
<td>-0,3</td>
<td>-0,4</td>
<td>25 Motor vehicles, trailers and semi-trailers</td>
<td>-0,3</td>
</tr>
<tr>
<td>-0,1</td>
<td>-0,1</td>
<td>26 Other transport equipment</td>
<td>-0,3</td>
</tr>
<tr>
<td>-0,1</td>
<td>0,0</td>
<td>27 Furniture; other manufactured goods n.e.c.</td>
<td>-0,2</td>
</tr>
<tr>
<td>-0,1</td>
<td>-0,1</td>
<td>29 Electrical energy, gas, steam and hot water</td>
<td>0,4</td>
</tr>
<tr>
<td>-0,6</td>
<td>0,1</td>
<td>Services</td>
<td>-0,1</td>
</tr>
<tr>
<td>-0,1</td>
<td>-0,0</td>
<td>Total</td>
<td>-0,1</td>
</tr>
</tbody>
</table>
## Frozen prices

– average deviations from growth rates

<table>
<thead>
<tr>
<th></th>
<th>IMP</th>
<th>EXP</th>
<th>IMP</th>
<th>EXP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Products of agriculture, hunting and related services</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>2</td>
<td>Products of forestry, logging and related services</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>3</td>
<td>Fish and other fish products; services of incidental fishing</td>
<td>0.4</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>4</td>
<td>Coal and lignite; peat</td>
<td>24.1</td>
<td>-1.2</td>
<td>-0.5</td>
</tr>
<tr>
<td>5</td>
<td>Crude petroleum and natural gas; services incidental to oil and gas extraction excluding surveying</td>
<td>0.3</td>
<td>-1.5</td>
<td>-0.1</td>
</tr>
<tr>
<td>6</td>
<td>Food products and beverages</td>
<td>-0.1</td>
<td>0.3</td>
<td>-0.0</td>
</tr>
<tr>
<td>7</td>
<td>Tobacco products</td>
<td>-0.0</td>
<td>0.2</td>
<td>0.0</td>
</tr>
<tr>
<td>8</td>
<td>Textiles</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>9</td>
<td>Wearing apparel; furs</td>
<td>-0.2</td>
<td>0.1</td>
<td>-0.1</td>
</tr>
<tr>
<td>10</td>
<td>Leather and leather products</td>
<td>0.2</td>
<td>0.4</td>
<td>-0.0</td>
</tr>
<tr>
<td>11</td>
<td>Wood and of products of wood and cork (except furniture); articles of straw and plaiting materials</td>
<td>-0.1</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>12</td>
<td>Pulp, paper and paper products</td>
<td>0.1</td>
<td>0.0</td>
<td>0.2</td>
</tr>
<tr>
<td>13</td>
<td>Printed matter and recorded media</td>
<td>0.0</td>
<td>0.1</td>
<td>-0.4</td>
</tr>
<tr>
<td>14</td>
<td>Coke, refined petroleum products and nuclear fuels</td>
<td>0.4</td>
<td>-0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>15</td>
<td>Chemicals and chemical products</td>
<td>0.1</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Results:**

- Total IMP: 0.0
- Total EXP: 0.4
Conclusions

• Because of relatively high energy intensity of Polish economy, the increase in world prices of energy carriers weakens its competitiveness, but the effect is rather modest.
• Significant influence could be noticed only for rapid movements of oil prices. In other words, world prices of energy carriers are transferred to the Polish economy via products of oil refination rather than electricity.
• Much stronger effects could be noticed for increase in domestic prices of electricity caused by factors other than primary energy carriers.
• The previous conclusion will become more important parallelly to the development of renewable resources of energy. At this moment, the share of these kinds of resources is quite small.