DETERMINANTS OF TAKEOFF AND SLOWDOWN OF INNOVATION IN A SITUATION OF UNCERTAINTY ABOUT ENVIRONMENTAL AND HEALTH RISKS

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   • Estimated results
   • Over- and under-consumption of bisphenol A
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5. Discussion
Every innovation has its own inherent uncertainty.

Prior research on uncertainty and diffusion of innovation:
- performance of innovation or its profitability (Jensen, 1982; Oren & Schwartz, 1988)
- expectations of future price (Chandrasekaran et al., 2013; Song & Chintagunta, 2003)

Not much literature on uncertainty about environmental and health risks and innovation (Olson, Birge, & Linton, 2014)

First evidence of determinants of adoption of nanotechnology: Arora et al., 2014; Köhler & Som, 2014

Previous experience & rejection: GMO, asbestos…
Background information

Number of publications: bisphenol A and toxicity

Early 1950s: commercial production of bisphenol A began
Unsuspected estrogenic activity of bisphenol A was revealed
1998: first commercial application of nanosilver

Hazard, Risk, Exposure

Source: Ostapchuk, based on PubMed

Source: Berube et al. (2010); Wiesner et al. (2006)
Background information

Nanomaterials
- Colloid
- Powder
- Master batch

Nanointermediates
- Coating
- Fabrics

Nano-enabled products
- Computers
- Soap
- Containers (packaging)
- Clothing

Intermediate products with bisphenol A
- Polycarbonate
- Epoxy resins
- Flame retardants
- Packaging
- Sunglasses
- Food and drink cans
- Rackets, helmets
- Home appliances

Finished goods incorporating bisphenol A
- CD, DVD, Blue-Ray

Source¹: Adapted from Frederick (2011)
Source²: Ostapchuk, based on (Brignon & Gouzy, 2010)
The relationship between economic growth and BPA has not yet been studied.

Not much literature on the Environmental Kuznets Curve in a situation of uncertainty about environmental and health risks.

Is there an Environmental Kuznets Curve (EKC) for bisphenol A consumption?
Empirical methodology

Model (extended)

\[ \text{Bisphenol}_{it} = \beta_0 + \beta_1 \text{Inc}_{it} + \beta_2 \text{Inc}_{it}^2 + \beta_3 \text{Inc}_{it}^3 + \alpha_t \text{Year} + (u_i + v_{it}) + \beta_4 X_{it} \]

X:
- Country characteristics
- Market characteristics
- Industry characteristics
- Regulations

log of GDP \( p_c \) in region \( i \) at time \( t \)
dummy variables

log of BPA consumption \( p_c \) in region \( i \) at time \( t \)
unobserved time-invariant effect, idiosyncratic error

Estimation methods:
RE GLS with robust standard errors,
FGLS with heteroscedastic error structure

\( \text{EKC} : \beta_1 > 0, \beta_2 < 0, \beta_3 = 0 \)

Source: Dinda (2004)

Data sources
Chemical Economics Handbook: Bisphenol A, IHS Chemical
The World Bank
Passport/Euromonitor International + national data sources
Hofstede et al. (2010)
PIE: Plastics Information Europe
PubMed
A conceptual framework for the factors influencing BPA consumption: Model

- Economic growth
- Information access
- Price of polycarbonate
- Final goods demand
- Bans on use of BPA in baby bottles production

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Model (extended) FGLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>GDP</td>
<td>-12.90*** (4.790)</td>
</tr>
<tr>
<td>GDP^2</td>
<td>1.797*** (0.560)</td>
</tr>
<tr>
<td>GDP^3</td>
<td>-0.0749*** (0.0215)</td>
</tr>
<tr>
<td>Cable TV</td>
<td>0.0330*** (0.00211)</td>
</tr>
<tr>
<td>CD</td>
<td>0.00421 (0.00323)</td>
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<tr>
<td>Constant</td>
<td>16.53 (13.40)</td>
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<tr>
<td>Time dummies</td>
<td>Yes</td>
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<tr>
<td>Observations</td>
<td>190</td>
</tr>
<tr>
<td>N of regions</td>
<td>12</td>
</tr>
</tbody>
</table>

*** denotes statistical significance at 1% level, ** denotes statistical significance at 5% level, * denotes statistical significance at 10% level

Source: Ostapchuk, based on World Bank and IHS Chemicals
Is there a link between the introduction of new scientific knowledge about potential risks and consumption of bisphenol A?
The PubMed search engine keywords:
“Bisphenol A” + “epidemiology/toxicity/endocrinology”
1469 abstracts over the 1960-2013 period were evaluated

4 groups:
“Risk”: 464
“No risk”: 120
“Uncertain”: 334
“Irrelevant”

Source: Ostapchuk, based on PubMed
2. Results: over- and under-consumption of bisphenol A
(drawing on the study of Ghimire and Woodward (2013))

Over-consumption and under-consumption: actual values - predicted values

Scatter plot: over- and under-consumption of bisphenol A against “BPA”

Uncertainty avoidance index (UAI)
- UAI<43
- China, India, Southeast Asia
- UAI>78
- Central Europe, South Korea, Japan

The more negative the value of the residual, the more likely it is that bisphenol A is under-consumed.

The more positive the value of the residual, the more likely it is that bisphenol A is over-consumed.

Source: Ostapchuk, based on World Bank, Passport/Euromonitor International, PIE: Plastics Information Europe and IHS Chemicals
1. An inverted N-shape relationship between consumption of bisphenol A \(pc\) and economic growth is found.

2. Uncertainty avoidance has a moderating effect on the relationship between scientific knowledge about potential risk and over/under-consumption of BPA. The hypothesis that the higher the number of scientific articles related to potential risks of BPA, the greater the under-use of BPA, could not be rejected.

Potential limitations:
- Unavailability of disaggregated data
- Price of BPA + other factors which influence BPA consumption are not addressed in this study
- Further research on the relationship between the introduction of new scientific knowledge about potential risks of BPA and its over- and under-consumption
Over the studied period:
- Sales of nanosilver: the development stage
- Sales of Bisphenol A: the period of transition from the growth to maturity stage across multiple countries

Previous findings:
- Decrease in income increases the probability of slowdown \textsuperscript{(Golder & Tellis, 2004)}
- Controversial evidence of the impact of health information on demand \textsuperscript{(Van Ravensway and Hoehn 1991, Moon and Ward 1999, Kenkel and Chen, 2000)}

But under conditions of uncertainty:
- It is likely that an increase in income increases the probability of slowdown
- Information shock may be one of the factors which decreases the time to takeoff and increases the time to slowdown

\textbf{Discussion}

\textbf{The Generalized Product Life Cycle}

\textbf{Sales}

\textbf{Development} \hspace{1cm} \textbf{Growth} \hspace{1cm} \textbf{Maturity} \hspace{1cm} \textbf{Decline}

\textit{Source: Levitt (1965)}
Thank you!

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