A dynamic North-South Model of Demand-Induced Product Cycles

Reto Foellmi [1]   Sandra Hanslin [‡, 2]   Andreas Kohler [3]

[1]University of St. Gallen

[2]Swiss National Bank

[3]Agroscope

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The product cycle

- ▶ Product cycle idea by Vernon (1966):
    1. A new good is introduced in a high income country
    2. After a while demand for these goods emerges abroad → good is exported
    3. Good is imitated and produced by less advanced countries which have a relative cost advantage → good is eventually imported by rich countries

Literature on product cycles

Theoretical contributions

- Krugman (1979): North-South model of expanding product varieties with **exogenous** innovation and imitation rates
- Grossman and Helpman (GH, 1991) endogenize innovation and imitation rates, but **CES preferences**
- Stokey (1991): North-South trade in a **static** model of vertical product differentiation and non-homothetic preferences

Empirical evidence

- ▶ Feenstra and Rose (1999) rank goods according to the year goods are first exported (to the US)
- ▶ Mullor (1983) finds support for product cycle hypothesis for industrial product groups

Our contribution

- ▶ As CES preferences cannot capture the fact that countries with lower p.c. incomes consume products later in the cycle...

- ▶ ... we modify GH (1991) by replacing CES preferences with non-homothetic preferences

- ▶ This enables us to formalize the product cycle hypothesis (Vernon (1966)) and

- ▶ analyze the effects of the demand side on the product cycle

- ▶ We can analyze how the demand side and changes in inequality affects the **time length**f of the product cycle stages

- ▶ The model is consistent with the stylized fact that product adoption strongly correlates with per capita income
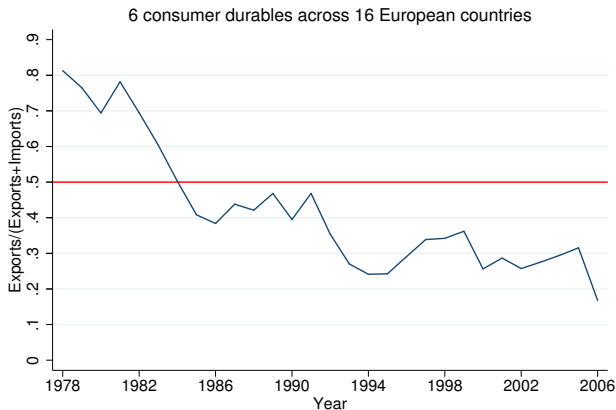
Some stylized facts: Demand lags

$$\log\left(\Delta_{ij}\right) = \beta_0 + \beta_1 \log\left(\frac{GDPpc_{ij}}{GDPpc_{US}}\right) + \beta_2 \log\left(\frac{Pop_{ij}}{Pop_{US}}\right) + \varepsilon_{ij}$$

log of ...	$\Delta mean$	$\Delta dish$	$\Delta dryer$	$\Delta freeze$	$\Delta micro$	Δvcr	$\Delta wash$
rel GDPpc	**-0.428**	**-0.399**	**-0.427**	**-0.702**	**-0.848**	-0.124	-0.249
	(-3.95)	(-9.75)	(-3.61)	(-2.49)	(-2.88)	(-0.88)	(-1.45)
rel pop	**-0.109**	**-0.107**	-0.098	0.094	**-0.221**	**-0.108**	**-0.235**
	(-2.41)	(-6.03)	(-1.77)	(0.75)	(-2.48)	(-3.86)	(-3.09)
adj. R^2	0.546	0.911	0.460	0.262	0.460	0.547	0.399
#obs	16	14	16	15	16	12	15

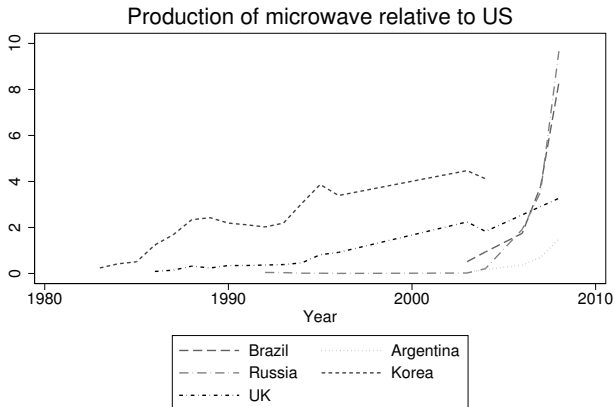Notes: t-values in parentheses. Figures in bold denotes significance at 5%

Some stylized facts: Relative export development

6 consumer durables across 16 European countries

Source: U.S. Import and Export Data 1978–2006 http://cid.econ.ucdavis.edu/

Some stylized facts: Production patterns

Source: UN Industry Statistics (2011)
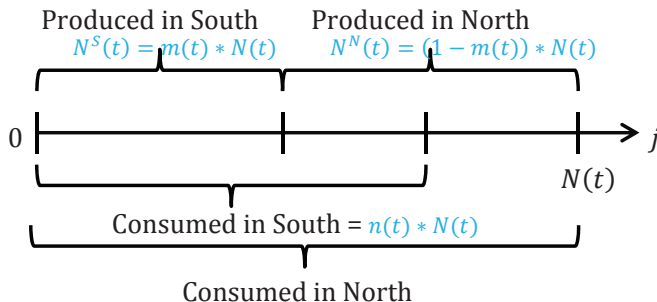
The Model

Basic assumptions

- ▸ 2 regions: Rich North (N) and poor South (S)
- ▸ population size (= labor supply): $(1 - \beta)L$ in N and βL in S
- ▸ Households within a region are identical
- ▸ No trade costs
- ▸ International capital markets are perfect $\rightarrow$ interest rates equalize between N and S
- ▸ Allow for income transfer from N to S: $T \geq 0$
- ▸ Innovation in the North and imitation in the South (monopolistic competition in both regions)

The Model

Basic assumptions

- Number of firms/set of available products: $N(t) = N^N(t) + N^S(t)$
- Rich North consumes all $N(t)$ goods
- Poor South consumes all Southern but can afford only some Northern goods: $n(t) > m(t)$

Produced in South $N^S(t) = m(t) * N(t)$ Produced in North $N^N(t) = (1 - m(t)) * N(t)$

0 j

$N(t)$

Consumed in South $= n(t) * N(t)$

Consumed in North

Technology

Innovation technology in the North:

- ▶ Costs for creation of new product: $F^N(t) = F^N/N(t)$ units of labor

- ▶ Linear production: $b^N(t) = b^N/N(t)$ units of labor

Imitation technology in the South:

- ▶ Southern firms target Northern goods for imitation at random (GH,1991)

- ▶ Fix costs for imitation of a Northern product: $F^S(t) = F^S/N(t)$ units of labor

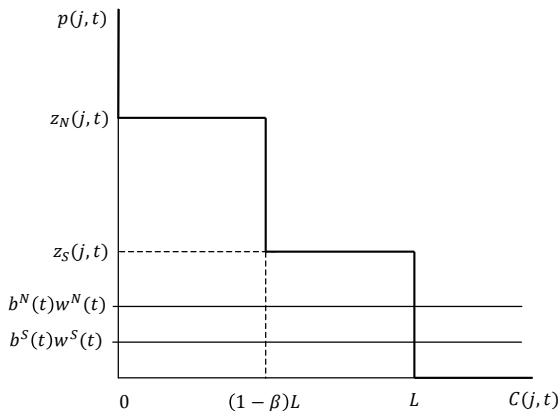- ▶ Linear production: $b^S(t) = b^S/N(t)$ units of labor

Preferences

- (0,1)-preferences
- Households maximize intertemporal utility s.t. lifetime budget constraint

  $\Rightarrow$ individual demand function:

  $$c(j, t) = \begin{cases} 1, & p(j, t) \leq z(j, t) \\ 0, & p(j, t) > z(j, t) \end{cases}$$

  where $z(j, t)$ denotes the willingness to pay

World demand

Assume: Marginal costs of producing one unit is smaller in South than in North: $w^S(t)b^S(t) < w^N(t)b^N(t)$

Key equilibrium conditions: Steady state

- Euler equation: $g = r - \rho$
- Balance of payments: $(n - m)\left[\beta + (1 - \beta)z_N\right]\beta = m(1 - \beta) + \beta T$
- Labor market clearing conditions in North and South
  N: $(1 - \beta)L = gF^N + Lb^N(n - m) + (1 - \beta)Lb^N(1 - n)$
  S: $\beta L = gmF^S + mb^S L$
- Zero profit conditions of Northern and Southern firms:
  $\frac{[z_N - 1](1 - \beta)L}{r + \mu} = \frac{F^N}{b^N}$ and $\frac{\left[1 - \omega^S b^S\right]L}{r} = \omega^S F^S$
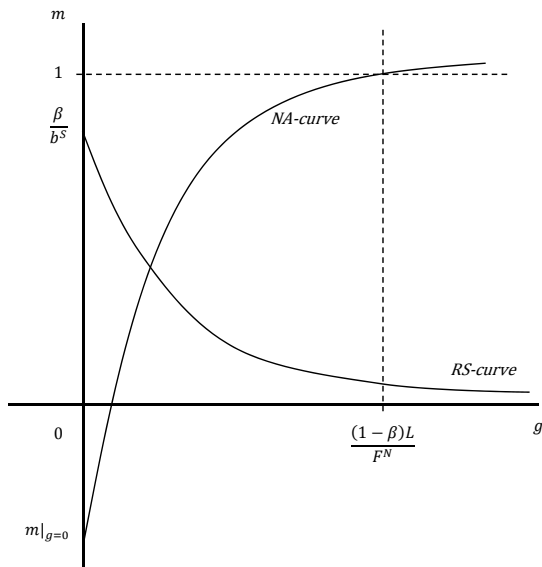 Monopolistic firms are indifferent between selling only to households in the North and selling to all
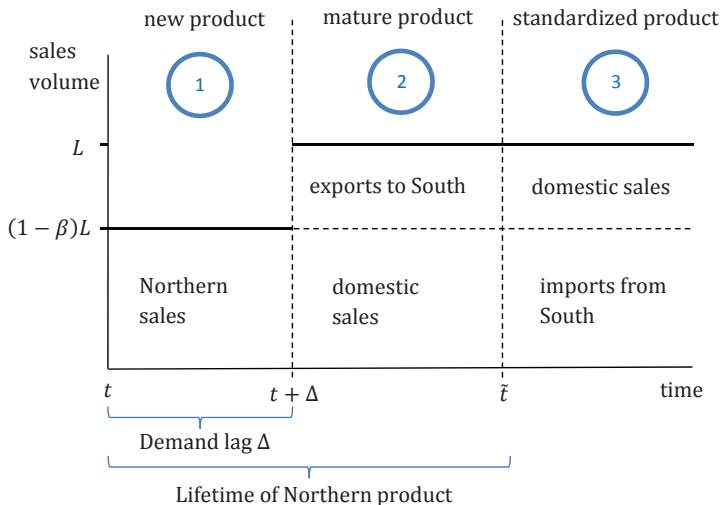
Steady state

NA-curve:

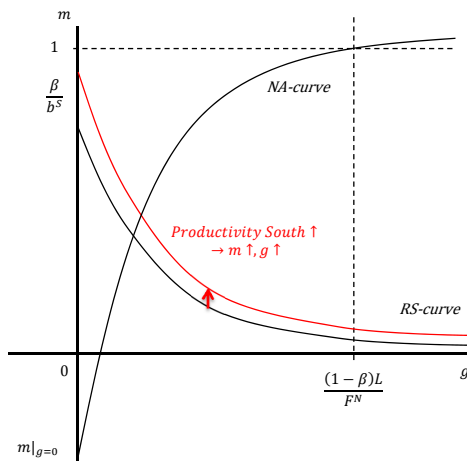Consistent with labor market clearing South

RS-curve:

Consistent with labor market clearing North, balance of payments, free entry in North and arbitrage condition
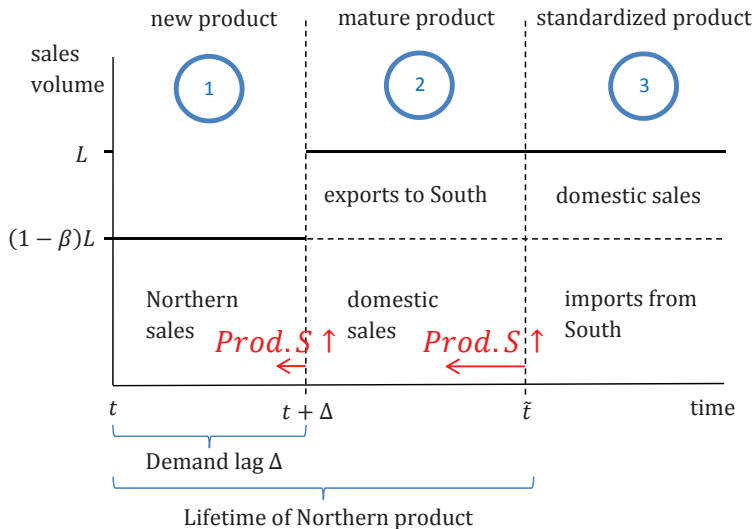
The average life cycle

Productivity increase in S: Effect on g and m

# Productivity increase in S: Effect on product cycle

Intuition

Higher productivity in S $\Rightarrow$

- its cheaper to produce imitated goods $\Rightarrow$ imitation rate and share of imitated goods $\uparrow \Rightarrow$ real income $\uparrow$ as set of cheaper goods $\uparrow \Rightarrow$ willingness to pay $\uparrow \Rightarrow$ consumption share of S $\uparrow$ and innovation more attractive as present discounted value of profits $\uparrow \Rightarrow g \uparrow$

- Southern households consume Northern goods earlier as they are relatively richer

- The average time span a product is being manufactured in N becomes shorter as the imitation rate increases

Transfer from N to S: Effect on g and m
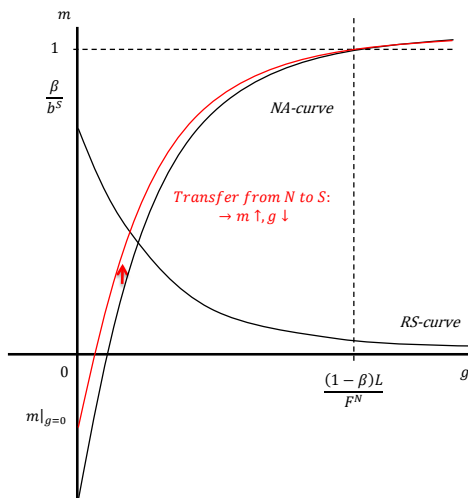
Transfer from N to S: Effect on product cycle
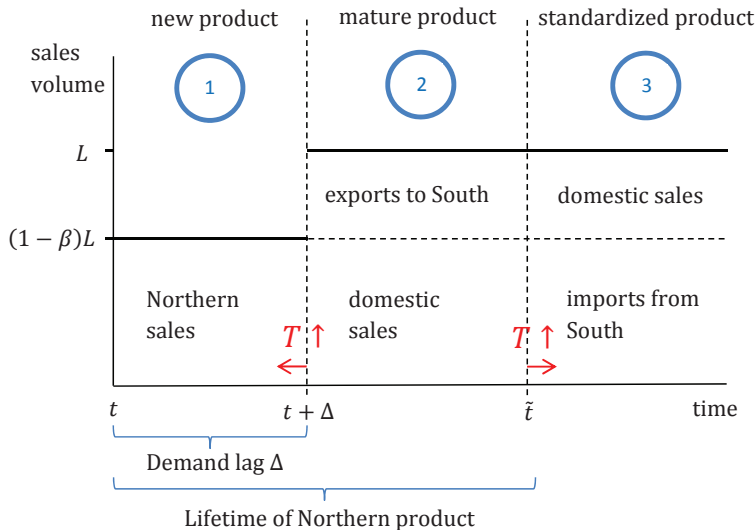
Conclusion

- ▶ We constructed a dynamic general equilibrium model that is able to generate the three product cycle stages described by Vernon (1966)

- ▶ Non-homothetic preferences are crucial for the first stage: product is exclusively produced and consumed in North

- ▶ The model implies:
  - ▶ Higher p.c. incomes/higher productivity/higher population in South ⇒ shorter demand lag (first stage)
  - ▶ Higher productivity/higher population in South ⇒ shorter lifetime of Northern good (second stage)