Hochschule für
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Berlin School of Economics and Law

3. Endogenous productivity growth in a Kaleckian model

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Literature:

Hein, E., Tarassow, A. (2010): Distribution, aggregate demand and productivity growth – theory and empirical results for six OECD countries based on a Post-Kaleckian model, Cambridge Journal of Economics, 34: 727-754.

1. Introduction

2. The theoretical model
2.1 The demand regime
2.2 The productivity regime
2.3 The overall regime

3. Some stylised facts on GDP growth, productivity growth and distribution

4. Estimation results for productivity growth

1. Introduction

Here: integration of endogenously generated productivity growth into Bhaduri/Marglin model

Productivity growth in Kaleckian models:
Rowthorn (1981), Lavoie (1992, chapter 6.3), You (1994), Cassetti (2003), Dutt (2003; 2006), Lima (2000; 2004)

Model/procedure (Setterfield/Cornwall 2002, Naastepad 2006):

- Demand regime
- Productivity regime
- Overall regime

➔ Distribution as exogenous variable: partial model for a private open economy with endogenous productivity growth

2. The theoretical model

Procedure (Setterfield/Cornwall 2002)

1. Demand regime: based on Bhaduri/Marglin (1990), Blecker (1989), productivity growth is exogenous
2. Productivity regime: based on Rowthorn (1981), Dutt (2003), Cassetti (2003), determination of productivity growth taking GDP or capital stock growth as exogenous
3. Overall regime: interaction of demand and productivity regime, effects of a change in the profit share

Assumptions:

- Distribution is exogenous
- Technical progress is labour saving and capital-embodied

➔ Harrod-neutral technical progress: $K/Y^p = v$ is constant

- Prices of imported inputs, competing international final goods and exchange rates are given

2. The theoretical model

2.1. The demand regime

S: saving	Y: output
I: investment	K: capital stock
Ex: export	Π : profits
Im: import	u: rate of capacity utilisation
σ: saving rate	h: profit share
g: rate of capital accumulation	v: capital-potential output-ratio
b: net export rate	$e_{r:}$ real exchange rate
r: rate of profit	

Goods market equilibrium for an open economy

$$(1) \qquad S = I + (Ex - Im)$$

Normalised by the capital stock

$$(2) \qquad \sigma = g + b$$

Saving function a la Kaldor, Kalecki

$$(3) \qquad \sigma = \frac{S_\Pi + S_W}{K} = \frac{s_\Pi \Pi + s_W (Y - \Pi)}{K} = \left[s_W + (s_\Pi - s_W)h\right]\frac{u}{v},$$

$$0 \le s_W < s_\Pi \le 1$$

Bhaduri/Marglin investment function plus positive effect of technical progress

$$(4) \qquad g = \alpha + \beta u + \tau h + \omega \hat{y}, \quad \alpha, \beta, \tau, \omega > 0, \quad g > 0 \text{ für } r > r_{min}$$

Net export rate depends positively on international competitiveness which is affected positive by profit share and negatively on domestic activity (Marshall-Lerner condition assumed to hold)

$$(5) \quad b = \psi e_r(h) - \phi u, \qquad \psi, \phi > 0$$

Real exchange rate and hence international competitiveness is positively related to profit share

$$(6) \quad e_r = e_r(h), \qquad \frac{\partial e_r}{\partial h} \geq 0$$

Stability condition for goods market equilibrium

$$(7) \quad \frac{\partial \sigma}{\partial u} - \frac{\partial g}{\partial u} - \frac{\partial b}{\partial u} > 0 \qquad \Rightarrow \qquad \left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi > 0$$

Equilibrium

$$(8) \quad u^* = \frac{\alpha + \tau h + \omega \hat{y} + \psi e_r(h)}{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi}$$

$$(9) \quad g^* = \frac{\left\{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} + \phi\right\}(\alpha + \tau h + \omega \hat{y}) + \beta \psi e_r(h)}{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi}$$

Change of goods market equilibrium in the face of a change in the profits share is undetermined. We get positive partial effects via investment and net exports but a negative partial effect via consumption

(8') $$\frac{\partial u^*}{\partial h} = \frac{\tau - (s_\Pi - s_W)\frac{u}{v} + \psi \frac{\partial e_r}{\partial h}}{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi}$$

(9') $$\frac{\partial g^*}{\partial h} = \frac{\tau\left\{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} + \phi\right\} - \beta(s_\Pi - s_W)\frac{u}{v} + \beta\psi \frac{\partial e_r}{\partial h}}{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi}$$

$$\frac{\partial u^*}{\partial h} > 0, \frac{\partial g^*}{\partial h} > 0$$: Profit-led

$$\frac{\partial u^*}{\partial h} < 0, \frac{\partial g^*}{\partial h} < 0$$: Wage-led

2.2 The productivity regime

(10a) $\hat{y} = \eta + \rho u - \theta h, \qquad \eta, \rho, \theta > 0$

or

(10b) $\hat{y} = \eta + \varepsilon g - \theta h, \qquad \eta, \varepsilon, \theta > 0$

ρ: Verdoorn‘s law (Verdoorn 1949, Kaldor 1966)

ε: Kaldor‘s technical progress function (Kaldor 1957, 1961)

θ: wage-push effect (Marx 1867, Hicks 1932)

(10a’,b’) $\frac{\partial \hat{y}}{\partial h} = -\theta < 0$

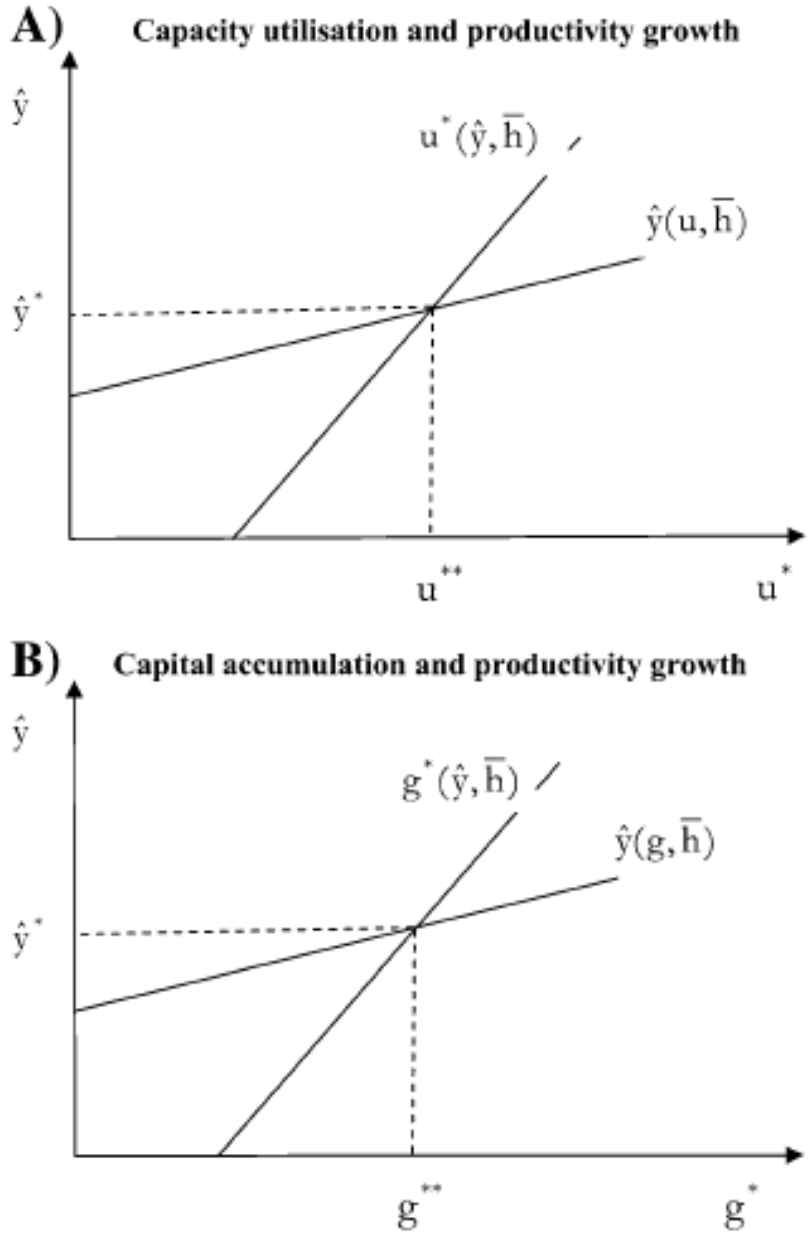


Fig. 1. *Growth equilibrium with endogenous productivity growth. (A) Capacity utilisation and productivity growth. (B) Capital accumulation and productivity growth*

Existence and stability condition for overall equilbrium

(11) $$\left[s_W + \left(s_\Pi - s_W\right)h\right]\frac{1}{v} - \beta + \phi - \omega\rho > 0$$

(12) $$\left(1 - \omega\varepsilon\right)\left\{\left[s_W + \left(s_\Pi - s_W\right)h\right]\frac{1}{v} + \phi\right\} - \beta > 0$$

Inserting equations (10a) and (8) yields the overall equilibrium rates of capacity utilisation and productivity growth:

$$u^{**} = \frac{\alpha + (\tau - \theta\omega)h + \psi e_r(h) + \omega\eta}{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi - \omega\rho}. \tag{A1}$$

$$\hat{y}^* = \frac{(\eta - \theta h)\left\{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi\right\} + \rho\left[\alpha + \tau h + \psi e_r(h)\right]}{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi - \omega\rho}. \tag{A2}$$

➔ Endogenous growth model with endogenously determined: u**, g**, r** and y^*

$$\frac{\partial u^{**}}{\partial h} = \frac{\tau - \left(s_{\Pi} - s_{W}\right)\frac{u}{v} + \psi\frac{\partial e_{r}}{\partial h} - \theta\omega}{\left[s_{W} + \left(s_{\Pi} - s_{W}\right)h\right]\frac{1}{v} - \beta + \phi - \rho\omega}, \qquad \text{(A1')}$$

- Denominator has to be positive from the existence and stability condition of the overall equilibrium (equation 11).

- Positive effects of an increasing profit share via investment (τ) and net exports [$\psi\left(\partial e_{r} / \partial h\right)$],

- Negative effect via consumption [$-\left(s_{\Pi} - s_{W}\right)\left(u / v\right)$], and via productivity growth ($-\theta\omega$)

➔ Overall effect may be positive (profit-led) or negative (wage-led)

$$\frac{\partial \hat{y}^*}{\partial h} = \frac{\rho\left[\tau - (s_\Pi - s_W)\frac{u}{v} + \psi\frac{\partial e_r}{\partial h}\right] - \theta\left\{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi\right\}}{\left[s_W + (s_\Pi - s_W)h\right]\frac{1}{v} - \beta + \phi - \rho\omega} \qquad \text{(A2')}$$

- The effect via goods market activity $\{\rho[\tau - (s_\Pi - s_W)(u/v) + \psi(\partial e_r/\partial h)]\}$ may be positive or negative depending on the nature of the demand regime.

- The second term $(-\theta\{[s_W + (s_\Pi - s_W)h](1/v) - \beta + \phi\})$ captures the directly negative effect of an increase in the profit share on productivity growth via the cost-push channel and is negative in any case, because the term in brackets has to be positive from the goods market stability condition.

➔ In a wage-led demand regime, the overall effect of an increasing profit share on productivity growth will be negative, whereas in a profit-led demand regime the overall effect of a rising profit share on productivity growth may be either positive or negative.

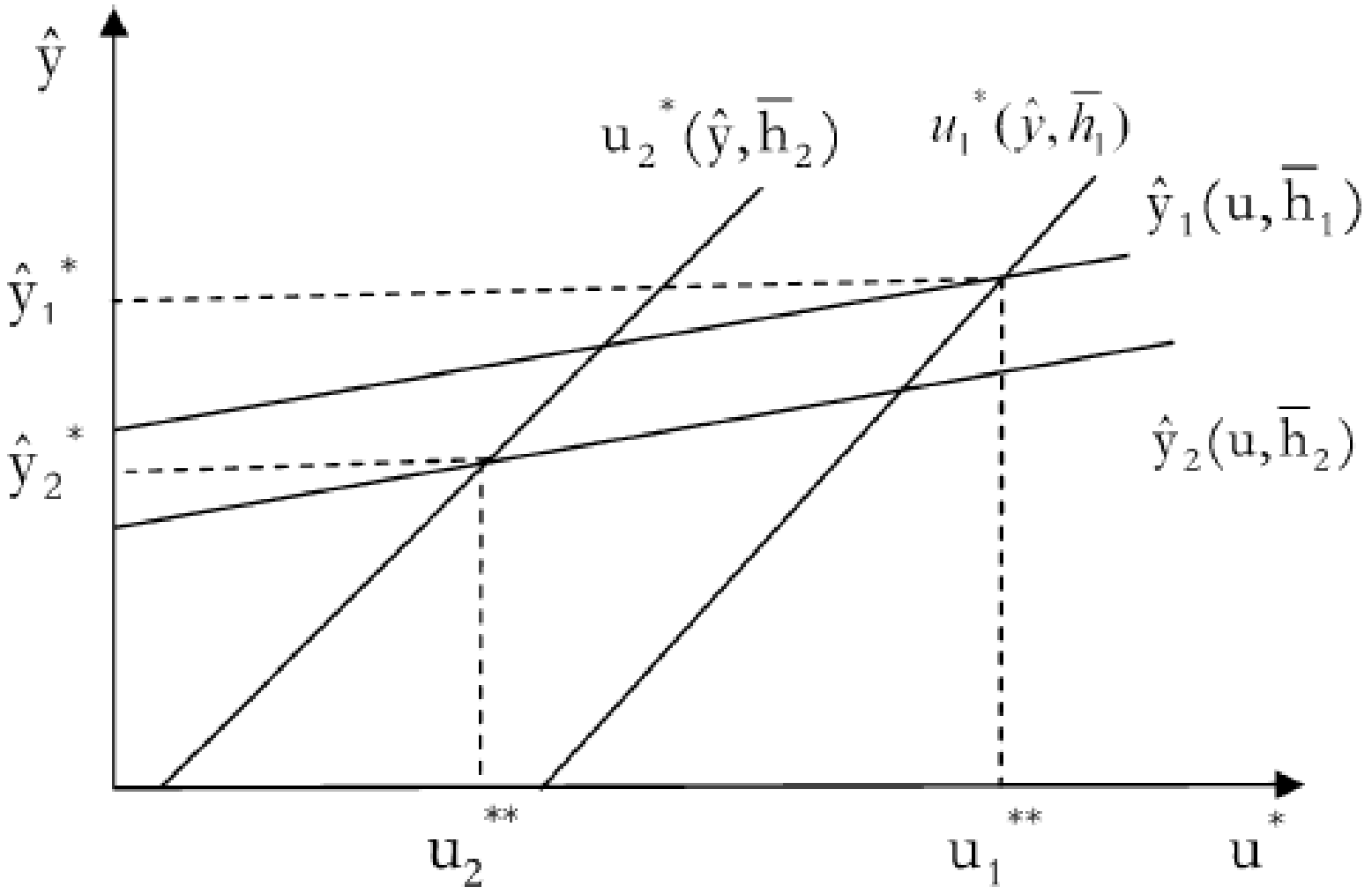
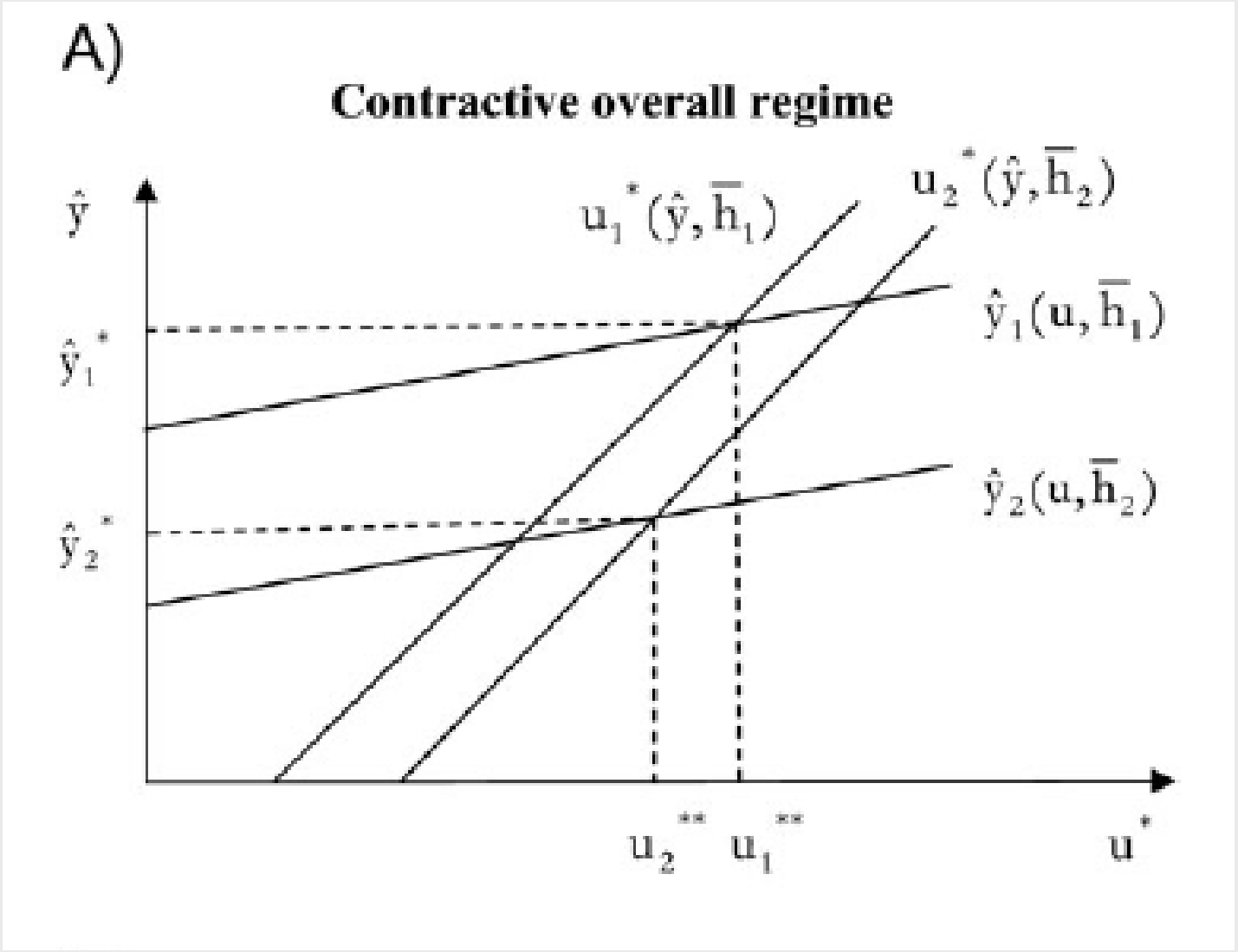
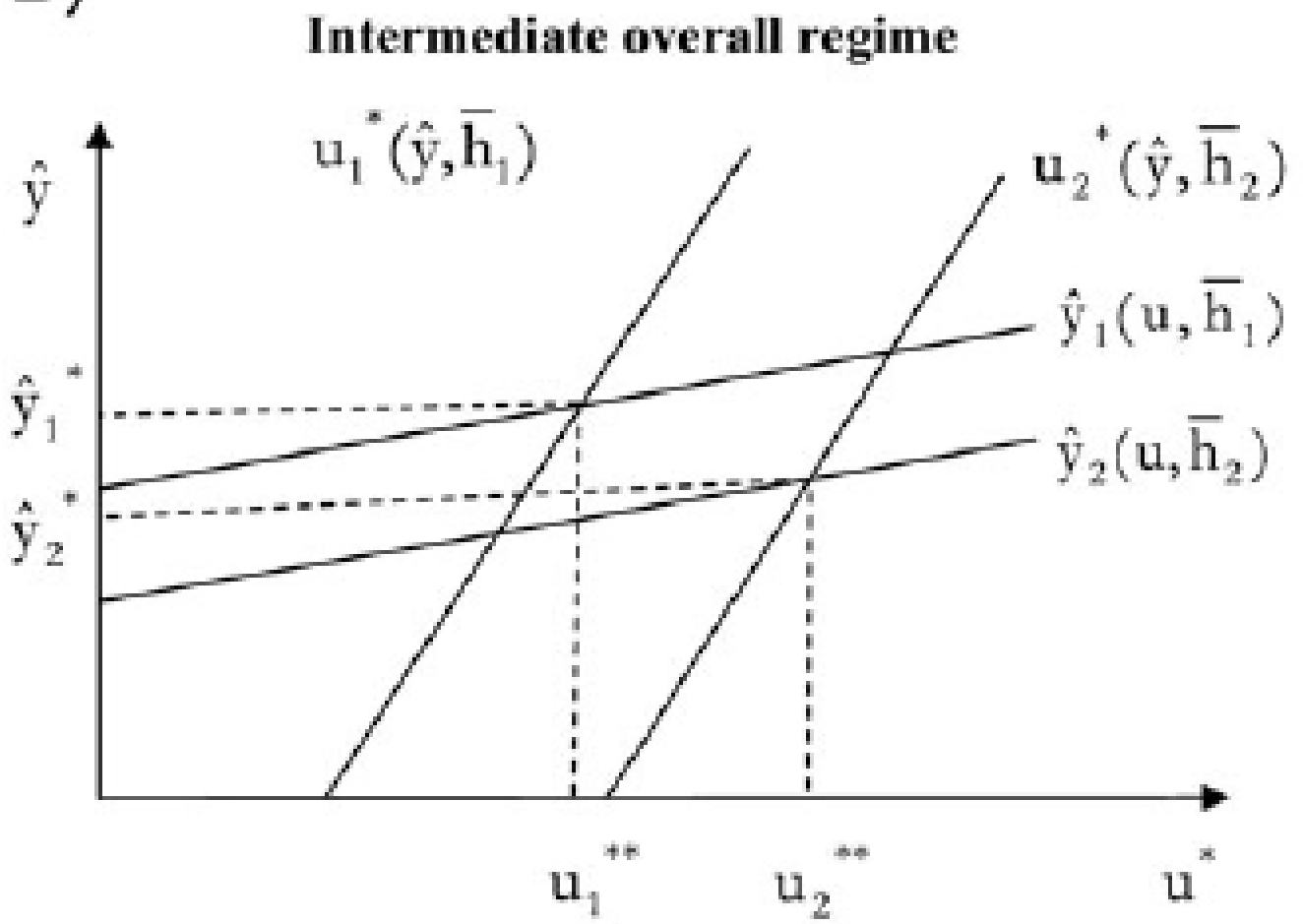


Fig. 2. *Increasing profit share and wage-led demand regime*

Fig. 3. *Increasing profit share and profit-led demand regime. (A) Contractive overall regime; (B) intermediate overall regime; (C) expansive overall regime*



B)


Intermediate overall regime
$u_1^*(\hat{y}, \overline{h}_1)$
$u_2^*(\hat{y}, \overline{h}_2)$
$\hat{y}$
$\hat{y}_1(u, \overline{h}_1)$
$\hat{y}_1^*$
$\hat{y}_2(u, \overline{h}_2)$
$\hat{y}_2^*$
u_1^{**}
u_2^{**}
u^*

C)

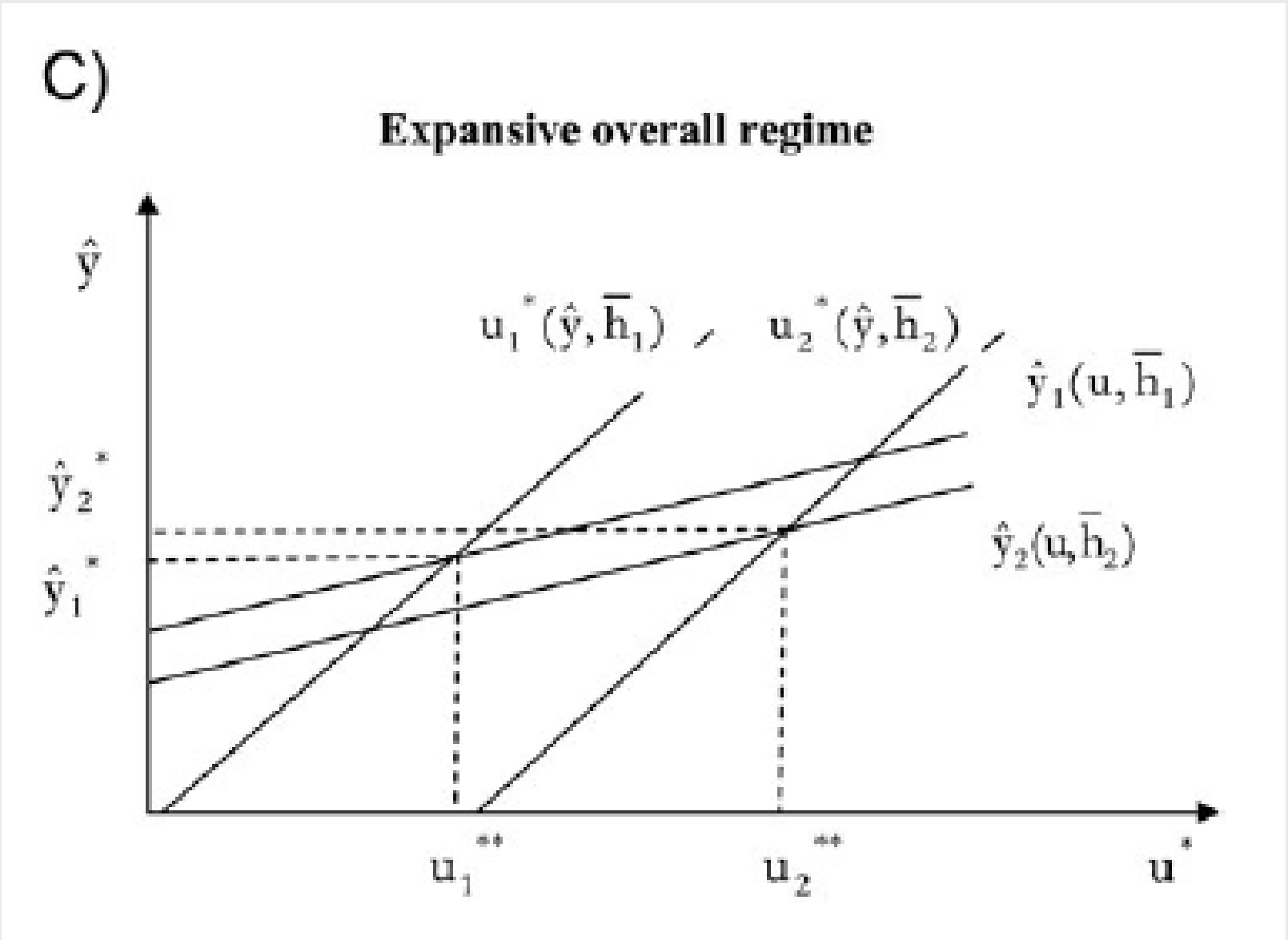

Expansive overall regime
$\hat{y}$
$u_1^*(\hat{y}, \bar{h}_1)$
$u_2^*(\hat{y}, \bar{h}_2)$
$\hat{y}_1(u, \bar{h}_1)$
$\hat{y}_2^*$
$\hat{y}_2(u, \bar{h}_2)$
$\hat{y}_1^*$
u_1^{**}
u_2^{**}
u^*

Table 2. *Overall effects of a change in the profit share*

	Wage-led demand regime: $(\partial u^{\star}/\partial h) < 0$, $(\partial g^{\star}/\partial h) < 0$		Profit-led demand regime: $(\partial u^{\star}/\partial h) > 0$, $(\partial g^{\star}/\partial h) > 0$	
$\partial u^{\star\star}/\partial h$	−	−	+	+
$\partial g^{\star\star}/\partial h$	−	−	+	+
$\partial \hat{y}^{\star}/\partial h$	−	−	−	+
Overall regime when profit share is increasing	Contractive	Contractive	Intermediate	Expansive

3. Some stylised facts on GDP growth, productivity growth and distribution

Table 1: GDP growth, productivity growth, real wage growth and labour income share on average over the business cycle in Austria, France, Germany, the Netherlands, UK and the USA, 1960 – 2007, in percent

	Growth of real GDP [c]	Growth of real labour productivity [d]	Growth of real compensation per employee	Labour income share [e]
Austria				
1961-1967 [a]	4.18	4.61	5.06	80.65
1968-1975	4.69	4.29	4.88	79.77
1976-1984	2.35	2.43	1.46	80.01
1985-1993	2.68	2.18	2.29	74.88
1994-2002	2.32	1.89	0.62	69.62
2003-2007 [a]	2.43	1.50	0.46	63.40
France				
1961-1968 [a]	5.37	4.92	5.32	73.35
1969-1975	4.29	3.49	4.39	72.50
1976-1981	2.82	2.46	2.21	75.96
1982-1993	2.04	2.02	1.01	70.73
1994-2003	2.23	1.26	1.19	66.64
2004-2007 [a]	2.02	1.47	1.48	66.19

Table 1: GDP growth, productivity growth, real wage growth and labour income share on average over the business cycle in Austria, France, Germany, the Netherlands, UK and the USA, 1960 – 2007, in percent

	Growth of real GDP [c)]	Growth of real labour productivity [d)]	Growth of real compensation per employee	Labour income share [e)]
Germany [b)]				
1961-1967 [a)]	3.78	3.93	4.72	68.25
1968-1975	3.74	3.54	5.36	69.20
1976-1982	2.41	1.87	1.13	70.28
1983-1993 [d)]	2.70	1.80	1.35	66.83
1994-2003	1.56	2.11	1.44	65.79
2004-2007 [a)]	1.54	1.64	-0.21	63.23
The Netherlands				
1961-1966 [a)]	4.47	3.06	6.03	67.29
1967-1975	4.44	4.15	6.04	72.58
1976-1982	1.58	1.70	0.78	74.93
1983-1993	2.72	1.53	0.53	68.78
1994-2002	3.14	1.40	0.90	66.87
2003-2007 [a)]	1.96	1.71	0.85	65.95

Table 1: GDP growth, productivity growth, real wage growth and labour income share on average over the business cycle in Austria, France, Germany, the Netherlands, UK and the USA, 1960 – 2007, in percent

UK	**Growth of real GDP** [c)]	**Growth of real labour productivity** [d)]	**Growth of real compensation per employee**	**Labour income share** [e)]
1961-1966 [a)]	2.87	1.97	2.40	72.87
1967-1974	2.77	2.87	3.56	74.20
1975-1980	1.36	1.20	1.73	75.20
1981-1991	2.27	1.90	2.06	74.31
1992-2002	2.74	2.09	1.62	72.93
2003-2007 [a)]	2.76	1.91	2.35	72.76
USA				
1961-1970	4.22	2.30	2.67	69.89
1971-1974	3.54	1.54	1.50	70.83
1975-1982	2.32	0.84	0.88	69.54
1983-1991	3.47	1.44	0.76	68.41
1992-2001	3.40	1.63	1.54	67.46
2002-2007 [a)]	2.63	1.94	1.66	66.49

Source: European Commission (2008), authors' calculations

Austria, Germany, France, Netherlands:

Reduction of GDP growth in post-golden age (since mid 1970s) compared to ‚golden age' is accompanied by reduction in productivity growth, real wage growth, and since early 1980s with a reduction in the labour income share/ an increase in the profit share

UK, USA:

Drop in GDP growth and productivity growth in mid 1970s, but recovery already in the 1980s, recovery of real wage growth in 1980s (UK) and 1990s (USA), more moderate decline in labour income share/ rise in profit share than in Continental European countries

4. Estimation results for productivity growth

- Six OECD countries: Austria, Germany, France, the Netherlands, the UK, the USA

- Data: AMECO, annual data, 1960-2007, level variables in logs

- We tried to estimate an ECM using the method by Pesaran et al. (2001), but got only once a signifcant one

- Instead, we estimate dynamic first difference models for the other countries and periods (lags up to 4 years)

- Real wages or the profit share as indicating cost-push effects

- *Variables:*
  1. Labour productivity growth (full-time equivalent)
  2. GDP growth for the Verdoorn effect

  3a. Real wage growth for cost-push effect

  3b. Profit share for cost-push effect!!

  4. Share of manufacturing sector as % of GDP to control for structural change (sh_m)
  5. Difference of labour productivity to the USA (GAP) to control for catching-up

Approach:

1. Tested the variables for stationarity (ADF, ADF-GLS)
   → most of them I(1), except the US and UK profit share
2. Estimate ECM (Pesaran et al. (2001)
   → Test for the null that all level coefficients = 0
3. Run dynamic difference models, instead
4. Test for robustness

The following functions were estimated:

1st: Following Naastepad (2006) and Vergeer/Kleinknecht (2007)

$$\hat{y} = f(\hat{Y}, \hat{w}, sh\_m, GAP)$$

2nd: Due to theoretical reasons we decided to include the profit share instead of the real wage rate

$$\hat{y} = f(\hat{Y}, h, sh\_m, GAP)$$

Determinants of productivity growth, Germany, France, Netherlands, Austria, UK and USA, 1960-2007, I-II

$$\hat{y} = f(\hat{Y}, \hat{w}, sh\_m, GAP)$$

	1960-2007					
	Germany	**France**	**Netherlands**	**Austria**	**UK**	**USA**
Model type	*ECM*	*Dynamic Difference Model*				
	Endogenous: d[log(y)]					
Const	-0.17				0.02***	0.01***
$log(Y_{t-1})$	0.12**					
$log(y_{t-1})$	-0.28***					
$log(w_{t-1})$	0.09**					
sh_m_{t-1}	-0.10					
$log(GAP_{t-1})$	0.04***					
$d[log(y_{t-1})]$		0.74***	0.58***	0.76***		0.20**
$d[log(Y_t)]$		0.60***	0.63***	0.76***	0.51***	0.56***
$d[log(Y_{t-1})]$		-0.69***	-0.65***	-0.81***		-0.47***
$d[log(Y_{t-2})]$	-0.35***	0.10**		0.13***	-0.58***	
$d[log(Y_{t-3})]$	-0.29**	0.13***	0.21***		0.12***	
$d[log(Y_{t-4})]$					0.18***	
$d[log(w_t)]$			0.14***		0.25***	0.29***
$d[log(w_{t-1})]$				0.16***		
$d[log(w_{t-3})]$		0.08**				
$d(sh\_m_t)$						-1.02***
$d(sh\_m_{t-1})$				-0.53***	0.39***	
$d(sh\_m_{t-2})$				0.46**	0.41***	
$d(sh\_m_{t-3})$	0.76**	-0.93***				
$d[log(GAP_t)]$			-0.02*			
$d[log(GAP_{t-2})]$				0.03**		
(dy/y)/(dY/Y)	***0.43***	***0.54***	***0.45***	***0.33***	***0.23***	***0.11***
(dy/y)/(dw/w)	***0.32***	***0.31***	***0.33***	***0.67***	***0.25***	***0.36***
Adj. R^2	0.71	0.98	0.97	0.96	0.90	0.89
D-W statistics	2.10	1.97	2.22	1.80	1.88	1.68

***, ** and * indicate statistical significance at 1, 5 or 10 percent level.

- Long-run coefficients: Verdoorn-effects and wage-push effects are confirmed for all countries

- Verdoorn coefficients are lower than in other studies – we have introduced lagged effects, not only contemporaneous.

Profit share and labour productivity growth, 1960-2007

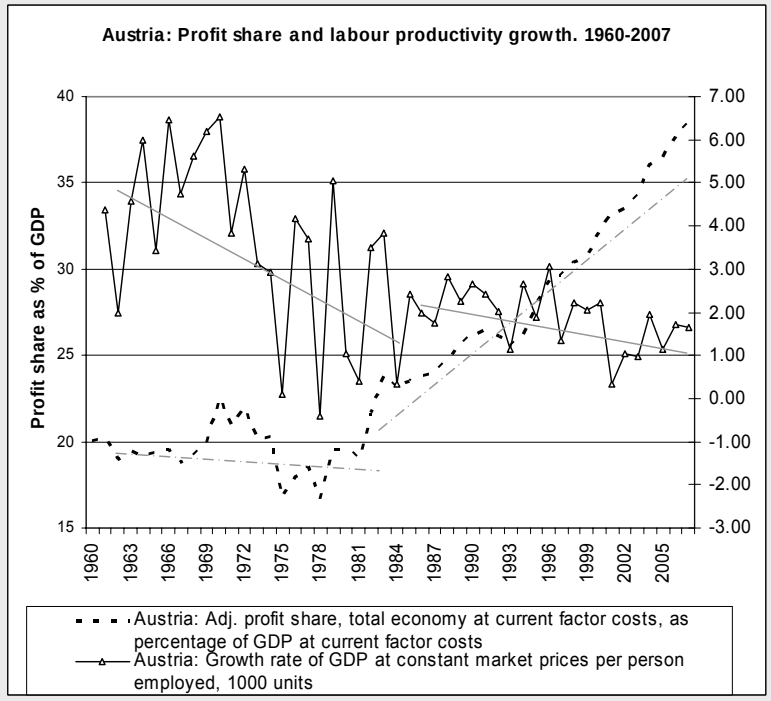
Germany

France

Profit share and labour productivity growth, 1960-2007

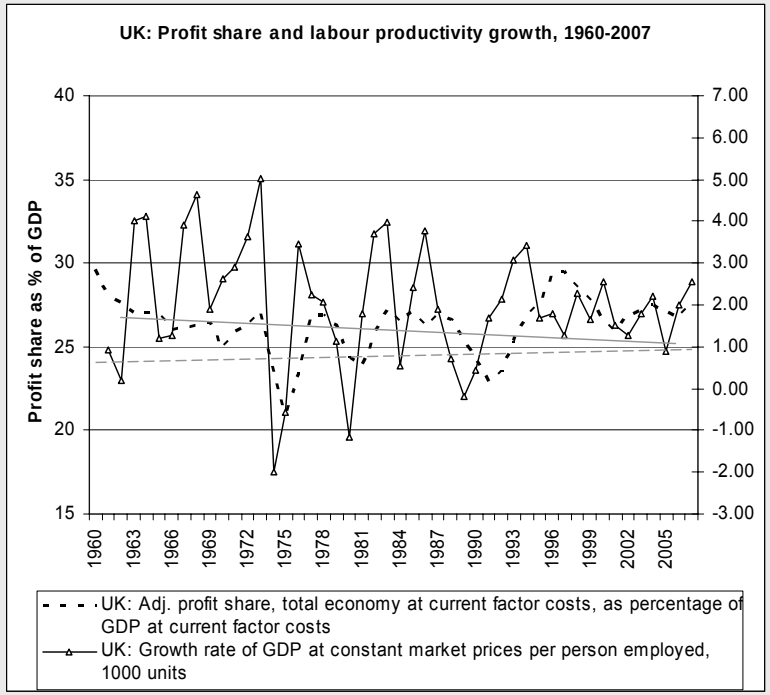
Netherlands

Austria



Profit share and labour productivity growth, 1960-2007

UK



USA

- Estimation of productivity growth with profit share has to take into account that since the mid 1980s the relation between labour productivity growth and the profit share has reversed in Germany, France, the Netherlands and Austria. Wheras in the UK and the US this is not so.

Determinants of productivity growth, UK and USA, 1960-2007

	1960-2007	
	UK	**USA**
	Endogenous variable: d[log(y)]	
Const	0.01***	0.00**
d[log(Y_t)]	0.61***	0.39***
d(h_{t-2})	-0.46***	
d(h_{t-3})		-0.33**
d(sh_m_{t-1})		-1.53***
d(sh_m_{t-2})	0.21	
d[log(GAP_t)]	-0.08***	
(dy/y)/(dY/Y)	**0.61**	**0.39**
(dy/y)/dh	**-0.46**	**-0.33**
Adj. R^2	0.69	0.73
D-W statistics	1.65	1.67
Reset-Test, p-value	0.39	0.40
White's Test, p-value	0.29	0.93
Breusch-Pagan, p-value	0.09	0.92
Normal distribution, p-value	0.48	0.63
LM-Test (3), p-value	0.66	0.57
Cusum, p-value	0.27	0.52
Dummies and Determinants	Dummy 1988	Dummy 1964, 1979, 1987 and 1992

***, ** and * indicate statistical significance at 1, 5 or 10 percent level.

$$\hat{y} = f(\hat{Y}, h, sh\_m, GAP)$$

Verdoorn effect plus negative effect of the profit share on productivity growth is confirmed for US and UK for the whole period.

Determinants of productivity growth, Germany, France, Netherlands, and Austria, 1960-2007

$$\hat{y} = f(\hat{Y}, h, sh\_m, GAP)$$

	1960-1984	1985-2007	1960-1982	1983-2007	1960-1983	1984-2007	1960-1983	1984-2007
	Germany		**France**		**Netherlands**		**Austria**	
	Endogenous: d[log(y)]							
Const		0.01**	0.01***	0.03***	0.01***	0.01**	0.05***	0.01***
d[log(Y_t)]	0.59***	0.13*	0.70***	0.36***	0.66***	0.27***	0.32***	0.48***
d[log(Y_{t-1})]	-0.35**							-0.18**
d[log(y_{t-1})]	0.72***	0.52***						0.32***
d(h_t)	0.80***				0.29***		0.67***	
d(h_{t-1})	-0.71***	-0.42***		-0.07				-0.46***
d(h_{t-2})			0.15***	-0.1		-0.33***		
d(sh_m_t)		0.37**						
d(sh_m_{t-1})		-0.98***						
d(sh_m_{t-2})		-0.34*						
d[log(GAP_{t-1})]		-0.07***						
d[log(GAP_{t-2})]			0.03***		-0.05**			
(dy/y)/(dY/Y)	**0.86**	**0.27**	**0.70**	**0.36**	**0.66**	**0.27**	**0.32**	**0.44**
(dy/y)/dh	**0.32**	**-0.87**	**0.15**	**-**	**0.29**	**-0.33**	**0.67**	**-0.68**
Adj. R^2	0.96	0.85	0.96	0.56	0.90	0.60	0.94	0.91
D-W statistics	2.24	2.46	1.51	1.82	1.60	2.48	1.97	2.45
Reset-Test, p-value	0.98	0.85	0.78	0.22	0.81	0.70	0.98	0.75
White's Test, p-value	0.23	0.47	0.85	0.43	0.48	0.53	0.31	0.25
Breusch-Pagan, p-value	0.42	0.72	0.34	0.18	0.80	0.42	0.47	0.13
Normal distribution, p-value	0.85	0.98	0.19	0.61	0.83	0.39	0.79	0.52
LM-Test (3), p-value	0.87	0.53	0.48	0.96	0.65	0.26	0.40	0.58
Cusum, p-value	0.64	0.12	0.59	0.99	0.20	0.26	0.83	0.96
Dummies and Determinants		Dummies 2005 and 2006	Dummy 1968	Dummy 2001, time trend	Dummies 1979 and 1980	Dummies 1984 and 2004	Dummy 1965, time trend	Dummy 1996

***, ** and * indicate statistical significance at 1, 5 or 10 percent level.

Austria, France, Germany, Netherlands:

- Verdoorn effect remains significant in both periods.
- Negative effect of the profit share only in the second period for Germany, the Netherlands and Austria, not for France.
- In the first period, profit share has a positive effect on productivity growth.
- This change in the sign of the coefficient remains to be explained: non-linearity in the relationship?
- Lima (2004): Profit share does not only affect the incentive to innovate negatively, but also the funds to innovate positively.