

Migration and the Wage Curve: A New Approach to Measure the Wage and Employment Effects of Migration

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What are the questions?

- Does migration affect wages?
- Do capital stocks adjust in the long- and short run?
- What is the impact on (un-)employment in labour markets with wage rigidities?
- How are the gains and losses distributed across a labour force of heterogeneous workers?
- What are the consequences for migration regulation?

State of the literature

- Substantial empirical literature which tempts to identify wage and employment effects of migration using the variance across regions (Surveys: Borjas, 1995; Friedberg/Hunt, 1995)
 - Natural experiments (e.g. Card, 1990; Hunt, 1992)
 - Other controls for endogeneity (Borjas/Freeman/Katz, 1997; Grossmann, 1982; DeNew/Zimmermann, 1994; 1995; Hatizius, 1994; Pischke/Velling, 1997)
 - Small, insignificant effects on low-skilled wages and unemployment (Card, 1990; Friedberg, 2001; Lewis, 2005; Bauer, 1997; Hatizius, 1995; Venturini/Villosio, 2002)
 - Larger adverse effects (Borjas/Freemann/Katz, 1997; DeNew/Zimmermann, 1994; 1995)
 - Meta-studies: wage elasticity of -0.1 percent, insignificant unemployment effects (Longhi et al., 2006a; 2006b)

State of the literature (cont.)

- National level studies avoid endogeneity of locational choices using the variance across education and experience groups (Borjas, 2003; Bonin, 2005; Ottaviano/Peri, 2006)
- Employing different assumptions
 - Native and foreign workers are perfect vs. imperfect substitutes (Borjas, 2003 and Bonin, 2005 vs. Ottaviano/Peri, 2006 and Card/Lemieux, 2001)
 - Fixed capital stocks vs. capital stock adjustment (Borjas, 2003; Borjas/Freeman/Katz, 1997 vs. Ottaviano/Peri (2006; Brücker, 2007)
- Measuring partial elasticities vs. total effects (Borjas, 2003; Bonin, 2005 vs. Ottaviano/Peri, 2006)

This paper

- Presents a model which considers the employment and wage effects of migration simultaneously
 - Considers wages rigidities employing a 'wage curve' approach (Blanchflower/Oswald, 1994; 1995)
 - Uses a nested CES-production function which considers heterogeneity across education groups, experience groups, natives and migrants
- Simulates short- and long-run impact of migration on the German labor market
- Compares the findings with the US evidence from Ottaviano/Peri (2006)
- Discusses implications for migration regulation

Part I

Outline of the model

Outline of model

- Analysis is based on a structural model in the spirit of Ottaviano/Peri (2006), Boeri/Brücker (2005) and Levine (1999)
- Nested constant-returns to scale production function (CES)
- Heterogeneity of labour market: labour force is distinguished by education, experience, native and foreign workers (Borjas, 2003; Bonin, 2004; Ottaviano/Peri, 2006)
- Models wage rigidities employing a wage curve approach (Blanchflower and Oswald, 1994a; 1994b; Card, 1995)
- Considers capital stock adjustment

Production

- Aggregate production function:

$$Y_t = A_t \tilde{L}_t^\alpha K_t^{(1-\alpha)} \quad (1)$$

- First nest: education

$$\tilde{L}_t = \left[\sum_{q=1}^4 \theta_{qt} \tilde{L}_{qt}^{(\delta-1)/\delta} \right]^{\delta/(\delta-1)}, \quad \sum_{q=1}^4 \theta_{qt} = 1, \quad (2)$$

- Second nest: experience

$$\tilde{L}_{qt} = \left[\sum_{k=1}^8 \theta_{qkt} \tilde{L}_{qkt}^{(\rho-1)/\rho} \right]^{\rho/(\rho-1)}, \quad \sum_{k=1}^8 \theta_{qkt} = 1, \quad (3)$$

- Third nest: native and foreign workers

$$\tilde{L}_{qkt} = \left[\theta_{qkHt} L_{qkHt}^{(\sigma_q-1)/\sigma_q} + \theta_{qkFt} L_{qkFt}^{(\sigma_q-1)/\sigma_q} \right]^{\sigma_q/(\sigma_q-1)}. \quad (4)$$

Framing labour market rigidities

- Wage curve: wages adjust to changes of unemployment rate, albeit imperfectly (Blanchflower/Oswald, 1994a; 1994b; Card, 1995)
- Different theoretical motivations
 - Wage bargain: bilateral bargaining monopoly of trade-unions and employer federations fixes wage
 - right-to-manage: profit-maximizing firms hire labour until marginal product of labour equals wage rate
 - Alternatively: Efficiency wage considerations

Wage curves

- We allow wage curves to differ by labour market segments

- Aggregate wage curve:

$$w_t = \phi(u_{qkit}), \quad \phi' < 0, \quad (5)$$

- Wage curve of education groups:

$$w_{qt} = \phi_q(u_{qt}), \quad \phi'_q < 0, \quad (6)$$

- Wage curve of natives:

$$w_{Hqt} = \phi_{Hq}(u_{Hqt}), \quad \phi'_{Hq} < 0, \quad (7)$$

- Wage curve of foreigners:

$$w_{Fqt} = \phi_{Fq}(u_{Fqt}), \quad \phi'_{Fq} < 0, \quad (8)$$

Capital stock adjustment

- Stylized fact on economic growth: capital-output ratio is constant in the long-run (Kaldor, 1961)
- If this holds true, migration does not change labour productivity at the macro level in the long-run
- Empirical evidence
 - constant capital-output ratio in the US
 - small trend-growth in Germany (from 3.0 1960 to 3.15 2006)
- Impact of short-term labour supply shocks
 - small negative impact in the US (Ottaviano/Peri, 2006)
 - insignificant small negative impact in Germany (see below)

Aggregate employment impact

$$\begin{aligned}
 \frac{dL_t}{dF_t} &= \frac{\eta(1-u_t)^2}{\eta(1-u_t)(1-\alpha)\mu_t} \frac{dN_t}{dF_t} & (9) \\
 &+ \frac{(1-\alpha)(1-u_t)}{\eta(1-u_t) + (1-\alpha)\mu_t} \frac{N_t}{K_t} \frac{dK_t}{dF_t} \\
 &= (1-u_t) \frac{dN_t}{dF_t} + \frac{(1-\alpha)}{\alpha} \frac{1}{\eta} \frac{N_t}{\kappa_t} \frac{d\kappa_t}{dF_t},
 \end{aligned}$$

- if $\eta \rightarrow \infty$: then $\frac{dL_t}{dF_t} \rightarrow \frac{dN_t}{dF_t}$
- if $\eta \rightarrow 0$ and $\frac{dK_t}{dF_t} \rightarrow 0$: then $\frac{dL_t}{dF_t} \rightarrow 0$.

Disaggregate employment impact (natives)

$$\begin{aligned}
\frac{dL_{qkHt}}{dF_t} &= - \left(\frac{\mu_{qkt}}{\rho} - \frac{\mu_{qkt}}{\sigma_q} \right) \frac{\eta_{qk}(1-u_{qkt})(1-u_{qkHt})}{\left[\eta_{qk}(1-u_{qkt}) + \frac{\mu_{qkt}}{\rho} \right] \left[\eta_{qkH}(1-u_{qkHt}) + \frac{1}{\sigma_q} \right]} \frac{H_{qkt}}{N_{qkt}} \frac{dN_{qkt}}{dF_t} \\
&- \frac{\left[\frac{\mu_{qt}}{\delta} - \frac{\mu_{qt}}{\rho} \right] \eta_q(1-u_{qt}) \left[\eta_{qk}(1-u_{qkt}) + \frac{\mu_{qkt}}{\sigma_q} \right] (1-u_{qkHt})}{\left[\eta_q(1-u_{qt}) + \frac{\mu_{qt}}{\delta} \right] \left[\eta_{qk}(1-u_{qkt}) + \frac{\mu_{qkt}}{\rho} \right] \left[\eta_{qkH}(1-u_{qkHt}) + \frac{1}{\sigma_q} \right]} \frac{H_{qkt}}{N_{qt}} \frac{dN_{qt}}{dF_t} \\
&+ \frac{\frac{\mu_t}{\delta} \left[\eta_q(1-u_{qt}) + \frac{\mu_{qt}}{\rho} \right] \left[\eta_{qk}(1-u_{qkt}) + \frac{\mu_{qkt}}{\sigma_q} \right] (1-u_{qkHt})}{\left[\eta_q(1-u_{qt}) + \frac{\mu_{qt}}{\delta} \right] \left[\eta_{qk}(1-u_{qkt}) + \frac{\mu_{qkt}}{\rho} \right] \left[\eta_{qkH}(1-u_{qkHt}) + \frac{1}{\sigma_q} \right]} \frac{H_{qkt}}{N_t} \frac{dN_t}{dF_t} \\
&+ \frac{\frac{(1-\alpha)}{\alpha} \left[\eta(1-u_t) + \frac{\mu_t}{\delta} \right] \left[\eta_q(1-u_{qt}) + \frac{\mu_{qt}}{\rho} \right] \left[\eta_{qk}(1-u_{qkt}) + \frac{\mu_{qkt}}{\sigma_q} \right] (1-u_{qkHt})}{\eta(1-u_t) \left[\eta_q(1-u_{qt}) + \frac{\mu_{qt}}{\delta} \right] \left[\eta_{qk}(1-u_{qkt}) + \frac{\mu_{qkt}}{\rho} \right] \left[\eta_{qkH}(1-u_{qkHt}) + \frac{1}{\sigma} \right]} \frac{H_{qkt}}{\kappa_t} \frac{d\kappa_t}{dF_t}, \tag{10}
\end{aligned}$$

Disaggregate employment impact (foreigners)

$$\begin{aligned}
\frac{dL_{qkFt}}{dF_t} &= \frac{\eta_{qkF}(1 - u_{qkFt})^2}{\eta_{qkF}(1 - u_{qkFt}) + \frac{1}{\sigma_q}} \frac{dF_{qkt}}{dF_t} & (11) \\
&- \left(\frac{\mu_{qkt}}{\rho} - \frac{\mu_{qkt}}{\sigma_q} \right) \frac{\eta_{qk}(1 - u_{qkt})(1 - u_{qkFt})}{\left[\eta_{qk}(1 - u_{qkt}) + \frac{\mu_{qkt}}{\rho} \right] \left[\eta_{qkF}(1 - u_{qkFt}) + \frac{1}{\sigma_q} \right]} \frac{F_{qkt}}{N_{qkt}} \frac{dN_{qkt}}{dF_t} \\
&- \frac{\left(\frac{\mu_{qt}}{\delta} - \frac{\mu_{qt}}{\rho} \right) \eta_q(1 - u_{qt}) \left[\eta_{qk}(1 - u_{qkt}) + \frac{\mu_{qkt}}{\sigma_q} \right] (1 - u_{qkFt})}{\left[\eta_q(1 - u_{qt}) + \frac{\mu_{qt}}{\delta} \right] \left[\eta_{qk}(1 - u_{qkt}) + \frac{\mu_{qkt}}{\rho} \right] \left[\eta_{qkF}(1 - u_{qkFt}) + \frac{1}{\sigma_q} \right]} \frac{F_{qkt}}{N_{qt}} \frac{dN_{qt}}{dF_t} \\
&+ \frac{\frac{\mu_t}{\delta} \left[\eta_q(1 - u_{qt}) + \frac{\mu_{qt}}{\rho} \right] \left[\eta_{qk}(1 - u_{qkt}) + \frac{\mu_{qkt}}{\sigma_q} \right] (1 - u_{qkFt})}{\left[\eta_q(1 - u_{qt}) + \frac{\mu_{qt}}{\delta} \right] \left[\eta_{qk}(1 - u_{qkt}) + \frac{\mu_{qkt}}{\rho} \right] \left[\eta_{qkF}(1 - u_{qkFt}) + \frac{1}{\sigma_q} \right]} \frac{F_{qkt}}{N_t} \frac{dN_t}{dF_t} \\
&+ \frac{\frac{(1-\alpha)}{\alpha} \left[\eta(1 - u_t) + \frac{\mu_t}{\delta} \right] \left[\eta_q(1 - u_{qt}) + \frac{\mu_{qt}}{\rho} \right] \left[\eta_{qk}(1 - u_{qkt}) + \frac{\mu_{qkt}}{\sigma_q} \right] (1 - u_{qkFt})}{\eta(1 - u_t) \left[\eta_q(1 - u_{qt}) + \frac{\mu_{qt}}{\delta} \right] \left[\eta_{qk}(1 - u_{qkt}) + \frac{\mu_{qkt}}{\rho} \right] \left[\eta_{qkF}(1 - u_{qkFt}) + \frac{1}{\sigma_q} \right]} \frac{F_{qkt}}{\kappa_t} \frac{d\kappa_t}{dF_t}.
\end{aligned}$$

Disaggregate wage impact (natives)

$$\begin{aligned}
\frac{dw_{qkHt}}{w_{qkHt}} &= \frac{1}{\delta} \sum_n \sum_m \sum_j \left(s_{nmjt} \frac{dL_{nmjt}}{L_{nmjt}} \right)_{immigration} & (12) \\
&- \left(\frac{1}{\delta} - \frac{1}{\rho} \right) \frac{1}{s_{qt}} \left(\sum_m \sum_j s_{qmjt} \frac{dL_{qmjt}}{L_{qmjt}} \right)_{immigration} \\
&- \left(\frac{1}{\rho} - \frac{1}{\sigma_q} \right) \frac{1}{s_{qkt}} \sum_j \left(s_{qkjt} \frac{dL_{qkjt}}{L_{qkjt}} \right)_{immigration} \\
&- \frac{1}{\sigma_q} \left(\frac{dL_{qkHt}}{L_{qkHt}} \right)_{immigration} + \frac{(1-\alpha)}{\alpha} \left(\frac{d\kappa_t}{\kappa_t} \right)_{immigration} .
\end{aligned}$$

Part II

Data

The data set

- IAB Employment Sample (IABS)
 - 2 % sample of all employees and unemployed derived from social security records
 - censored: 5,800 Euro income ceiling
 - no self-employed
- identification of foreigners by citizenship
 - we treat individuals as foreigners if they are once reported as foreign nationals
- we restrict sample to Western Germany (without Berlin)
- we exclude part-time workers since no information on working hours available
- we use the 1980-2004 period (25 time series observations)

Foreigner shares by education group

education	1980	1990	2000	2004
no vocational degree	0.313	0.336	0.480	0.477
vocational degree	0.051	0.053	0.082	0.087
high school + vocational degree	0.063	0.045	0.066	0.070
college or university degree	0.075	0.054	0.055	0.063

Part III

Estimation

Three steps:

- Impact of labour supply shocks on capital-output ratio
- Elasticities of production function
 - Elasticity of substitution between native and foreign workers
 - Elasticity of substitution between experience groups
 - Elasticity of substitution between education groups
- Wage curves

Capital stock adjustment

- Long-run impulse

$$\ln(\kappa_t) = \beta_0 + \beta_1 \ln(\kappa_{t-1}) + \beta_2 \ln(N_t) + \beta_3 Trend_t + \varepsilon_t, \quad (13)$$

- Short-run impulse

$$\ln(\kappa_t) = \gamma_0 + \gamma_1 \ln(\kappa_{t-1}) + \gamma_2 \Delta \ln(N_t) + \gamma_3 Trend_t + \epsilon_t, \quad (14)$$

- Ottaviano/Peri (2006) estimated second regression and obtained similar results

Estimation of long- and short-term adjustment

	long-run		short-run	
$\ln(k_{t-1})$	0.85	***	0.74	***
	(0.13)		(0.09)	
$\ln(N_t)$	0.04			
	(0.04)			
$\Delta \ln(N_t)$			-0.08	
			(0.07)	
adjusted R^2	0.61		0.61	
Durbin-Watson statistics	1.47		1.39	

The dependent variable is $\ln(k_{t-1})$. Each regression includes a constant and a deterministic time trend.

Elasticities of substitution

- Between natives and foreign workers:

$$\ln(w_{qkHt}/w_{qkFt}) = D_{kj} - \frac{1}{\sigma_{qk}} + \nu_{qkt}, \quad (15)$$

- Between experience groups:

$$\ln w_{qkt} = D_t + D_{qt} + D_{qk} - \frac{1}{\rho} \ln(\tilde{L}_{qkt}) + \nu_{qkt}, \quad (16)$$

- Between education groups:

$$\ln w_{qkt} = D_t + D_q + \lambda_q \text{Trend}_q - \frac{1}{\delta} \ln(\hat{L}_{qkt}) + \vartheta_{qkt}. \quad (17)$$

Elasticities of substitution: results

- Between natives and foreign workers: σ_q
 - all: 55***
 - ed1: 37***
 - ed2: 83***
 - ed3: 30***
 - ed4: 111
- Between experience groups: ρ
 - 200*
- Between education groups: δ
 - 4***

Estimation of wage curves

- total labour force:

$$\ln(w_{qkt}) = \beta_q \ln(w_{qk,t-1}) - \eta_q u_{qkt} + \gamma'_q \tau_q + e_{qkt}, \quad (18)$$

- natives

$$\ln(w_{Hqkt}) = \beta_{Hq} \ln(w_{Hqk,t-1}) - \eta_{Hq} u_{Hqkt} + \gamma'_{Hq} \tau_q + e_{Hqkt}, \quad (19)$$

- foreigners

$$\ln(w_{Fqkt}) = \beta_{Fq} \ln(w_{Fqk,t-1}) - \eta_{Fq} u_{Fqkt} + \gamma'_{Fq} \tau_q + e_{Fqkt}, \quad (20)$$

Wage curve: Results for total labour force

dependent variable ln wage	ln wage($t - 1$)		unemployment rate		R ²
			short-run	long-run	
all	0.82	***	-0.17	***	0.91
	(0.03)		(0.03)		
no vocational degree	0.70	***	-0.23	***	0.93
	(0.06)		(0.03)		
vocational degree	0.69	***	-0.34	***	0.94
	(0.07)		(0.06)		
high school with vocational degree	0.57	***	-0.16	***	0.88
	(0.07)		(0.06)		
university or college degree	0.31	***	-0.01		0.93
	(0.11)		(0.05)		

Wage curve: Results for native labour force

dependent variable ln wage	ln wage($t - 1$)		unemployment rate		R ²	
			short-run	long-run		
no vocational degree	0.75 (0.05)	***	-0.21 (0.04)	***	-0.86	0.94
vocational degree	0.70 (0.07)	***	-0.34 (0.06)	***	-1.13	0.95
high school with vocational degree	0.56 (0.07)	***	-0.17 (0.06)	***	-0.39	0.89
university or college degree	0.30 (0.11)	***	-0.01 (0.05)		-0.01	0.93

Wage curve: Results for foreign labour force

dependent variable ln wage	ln wage($t - 1$)		unemployment rate		R ²	
			short-run	long-run		
no vocational degree	0.45	***	-0.25	***	-0.49	0.89
	(0.06)		(0.03)			
vocational degree	0.52	***	-0.25	***	-0.52	0.89
	(0.07)		(0.03)			
high school degree	0.38	***	-0.02	***	-0.04	0.38
	(0.07)		(0.07)			
university or college degree	0.40	***	0.04		0.07	0.77
	(0.09)		(0.08)			

Estimation: Summarizing

- Capital stock adjustment
 - No long-run impact of labour supply on capital-output ratio
 - No significant or small impact of short-term labour supply shocks
- Elasticities of production function
 - Native and foreign workers imperfect substitutes
 - Experience groups almost perfect substitutes
 - Education groups imperfect substitutes

Estimation: Summarizing (cont.)

- Wage curve
 - Total elasticity very similar to findings in international literature (-1.1)
 - High elasticity of no vocational training group
 - Average elasticity of vocational training group
 - Low elasticity of high school degree group
 - Zero elasticity of university and college degree group!
- The flexibility of labour markets is thus declining with education!
- Do efficiency wages matter?

Part IV

Simulation of results

Simulation assumptions

- Marginal impact: simulation of a 1% increase of labour force through migration
- Using the sample average of the foreigner share for assessment of labour shock by skill and experience groups
- Short-run scenario: considering short-run semi-elasticity of wage curve and (small) negative impact on capital-output ratio
- Long-run scenario: considering long-term elasticity of wage curve and complete capital stock adjustment
- Comparing with the US: Wage results from Ottaviano/Peri (2006) calculated at 1% of workforce (1/11)

US simulation results (Ottaviano/Peri, 2006): wage effects

	native wages		foreign wages		all	
	short-run	long-run	short-run	long-run	short-run	long-run
	<i>change in % at an immigration of 1%</i>					
average	0.06	0.16	-1.90	-1.80	-0.10	0.00
high-school dropouts	-0.20	-0.10	-1.58	-1.48	na	na
high school graduates	0.12	0.21	-2.24	-2.14	na	na
college dropouts	0.21	0.31	-1.22	-1.12	na	na
college graduates	-0.03	0.06	-2.30	-2.20	na	na

German simulation results: perfect labour markets

	native wages		foreign wages		all	
	short-run	long-run	short-run	long-run	short-run	long-run
	<i>change in % at an immigration of 1%</i>					
average	-0.01	0.02	-0.32	-0.29	-0.04	-0.00
no vocational training	-0.50	-0.46	-0.64	-0.61	-0.54	-0.50
vocational training	0.05	0.08	-0.06	-0.02	-0.04	0.07
high school graduates	0.08	0.10	0.31	-0.33	0.05	0.09
university graduates	0.15	0.18	0.36	0.40	0.16	0.19

Part V

Summary and conclusions

Summary of estimation results

- We find strong evidence for capital stock adjustment
- We find relatively high elasticities of substitution between native and foreign workers, experience and education groups – at least compared to the US evidence
- We find evidence for existence of a wage curve in Germany
- Elasticity between wages and unemployment declines with education levels
- Elasticity between wages and unemployment is smaller for foreign workers
- This has important implications for migration effects

Summary of simulation results

- We find that immigration *reduces* aggregate unemployment by 0.2%-points and *increases* aggregate wages by 0.1%
- Migration into the the low-skilled sector involves higher employment of skilled workers
- Only moderate wage effects due to wage rigidities
- The native labour force gains from less-skilled immigration
 - unemployment rate: -0.46 %-points (short-), -0.38%-points (long-run)
 - wages: +0.08% (short-), +0.12% (long-run)
- The foreign labour force suffers from less-skilled immigration
 - unemployment rate: +2.25 %-points (short-), +1.77%-points (long-run)
 - wages: -0.06% (short-), -0.11% (long-run)

Comparing with the US

- Ottaviano/Peri (2006) find larger wage effects for the US:
 - native wages: +0.06% (short-), +0.16% (long-run)
 - foreign wages: -1.90% (short-), -1.80% (long-run)
 - total wages: -0.10% (short-), 0.00% (long-run)
- Comparing the results with perfect labour market scenario for Germany yields comparable results in the aggregate, but smaller differences between education groups and natives and foreigners
 - native wages: -0.01% (short-), +0.02% (long-run)
 - foreign wages: -0.32% (short-), -0.29% (long-run)
 - total wages: -0.04% (short-), 0.00% (long-run)
- Future research: estimating wage curve model for the US

Conclusions

- Consideration of labour market rigidities can change our views on migration impacts
- Countries can benefit from immigration, if migrants move into labour market segments with higher wage flexibility
- Interestingly enough, this is the low-skilled segment in Germany
- If the estimates of the wage curve are correct, high-skilled immigration would increase unemployment in Germany
- Regulation of migrant influx by skill levels has to consider therefore labour market conditions carefully
- Evidence from other countries needed