Supplementary Appendix: Determinants of Relative Sectoral Prices: The Role of Demographic Change

A Appendix to the Model

A.1 Derivation of Equation (8)

From the market clearing condition for non-tradables in period t, $Y_t^N = \pi_t C_t^N$, and the first-order conditions of households and firms, we obtain a dynamic implicit function of the relative price of non-tradables given by

$$\Phi\left(P_{t}, P_{t-1}\right) = L_{t}^{N} \frac{W_{t}^{N}}{P_{t}\left(1 - \alpha_{N}\right)} - \pi_{t} \frac{\beta\left(1 + R^{*}\right)}{P_{t}} W_{t-1}^{N} L_{t-1}^{N} \left[1 + \left(\frac{W_{t-1}^{T}}{W_{t-1}^{N}}\right)^{1+\rho}\right] = 0, \quad (1)$$

where wages in both sectors are given by

$$W_t^T = (1 - \alpha_T) \left(\frac{\alpha_T}{R^*}\right)^{\frac{\alpha_T}{1 - \alpha_T}} \left(A_t^T\right)^{\frac{1}{1 - \alpha_T}} \tag{2}$$

$$W_t^N = (1 - \alpha_N) \left(\frac{\alpha_N}{R^*}\right)^{\frac{\alpha_N}{1 - \alpha_N}} \left(P_t A_t^N\right)^{\frac{1}{1 - \alpha_N}}.$$
(3)

We evaluate Φ at steady state. Time indices may be omitted now and (1) simplifies to

$$\Phi(P) = \frac{1}{(1 - \alpha_N) \pi \beta (1 + R^*)} - 1 - \left(\frac{W^T}{W^N}\right)^{1+\rho} = 0$$
(4)

Inserting wages, (2) and (3), and solving for P immediately yields (8)

$$P = k \left(\frac{\left(A^T\right)^{\frac{1-\alpha_N}{1-\alpha_T}}}{A^N} \right) \left(\frac{\pi\varkappa}{1-\pi\varkappa}\right)^{\frac{1-\alpha_N}{1+\rho}},\tag{5}$$

where

$$k = \left(\frac{(1-\alpha_T)\alpha_T^{\frac{\alpha_T}{1-\alpha_T}}}{(1-\alpha_N)\alpha_N^{\frac{\alpha_N}{1-\alpha_N}}}\right)^{1-\alpha_N} (R^*)^{\frac{\alpha_N-\alpha_T}{1-\alpha_T}},$$

$$\varkappa = (1-\alpha_N)\beta(1+R^*).$$

To rule out negative prices, it must hold that

$$1 - \pi \varkappa > 0, \tag{6}$$

which is the case even for extreme parameter constellations and which we hence assume to be fulfilled continuously.¹

A.2 Proofs of Proposition 1 and 2

To assess the effect of an increase in the OADR π on the relative price P in steady state and to prove Proposition 1, we differentiate (5) with respect to π :

$$\frac{\partial P}{\partial \pi} = k \left(\frac{\left(A^T\right)^{\frac{1-\alpha_N}{1-\alpha_T}}}{A^N} \right) \frac{1-\alpha_N}{1+\rho} \left(\frac{\pi\varkappa}{1-\pi\varkappa}\right)^{\frac{1-\alpha_N}{1+\rho}-1} \frac{\varkappa(1-\pi\varkappa)+\pi\varkappa\varkappa}{(1-\pi\varkappa)^2} \\
= P \frac{1-\alpha_N}{1+\rho} \frac{1}{\pi(1-\pi\varkappa)},$$
(7)

which is greater than zero as long as (6) holds.

In order to prove Proposition 2, we take the derivative of (7) with respect to ρ :

$$\frac{\partial \left(\frac{\partial P}{\partial \pi}\right)}{\partial \rho} = -K \left(\frac{\pi \varkappa}{1 - \pi \varkappa}\right)^{\frac{1 - \alpha_N}{1 + \rho}} \frac{1 - \alpha_N}{\left(1 + \rho\right)^2} \left[\ln\left(\frac{\pi \varkappa}{1 - \pi \varkappa}\right) \frac{1 - \alpha_N}{1 + \rho} + 1\right],\tag{8}$$

where

$$K = k \left(\frac{\left(A^T\right)^{\frac{1-\alpha_N}{1-\alpha_T}}}{A^N} \right) \frac{1}{\pi \left(1 - \pi \varkappa\right)}$$

¹As an example consider the following values in the upper range of the parameters involved: A capital share in the non-tradables sector of 20% ($\alpha_N = 0.2$), an annual real interest rate of 4% and an annual discount factor of 0.99 with a length of a generation of 30 years ($1 + R^* = 1.04^{30}$, $\beta = 0.99^{30}$) yield $\varkappa = 1.92$. The highest value of the OADR in our sample is about 0.35, such that $\pi \varkappa = 0.672 < 1$.

This expression is less than zero (i.e. Proposition 2 is fulfilled) if

$$\ln\left(\frac{\pi\varkappa}{1-\pi\varkappa}\right) > -\frac{1+\rho}{1-\alpha_N}$$
$$\ln\left(\frac{\pi\varkappa}{1-\pi\varkappa}\right) > 0$$

where the last step followed since $\rho > 0$ and $0 < \alpha_N < 1$. The only restriction for this to be case is again that (6) has to hold.

B Additional Results







Notes: Fitted values and counterfactual values of the relative price of non-tradables for whole sample and all individual countries. All graphs are derived from regression (11) using the continuous LRI and the CCEP estimator.

B.2 Sensitivity Analysis

Additional Results to Section 7.1

Table 1: Alternative Demographic Variables - DOLS				
Dependent Variable:	(I)	(II)		
Relative Price of Non-Tradables				
Working-Age Population Share	-0.81***			
	(0.25)			
Old-Age Population Share		0.19***		
		(0.041)		
Relative Sectoral Productivity	0.55***	0.58***		
	(0.035)	(0.035)		
GDP per capita	0.16***	-0.076*		
	(0.052)	(0.043)		
Government Consumption (% of GDP)	0.054	-0.059		
	(0.035)	(0.040)		
Net Foreign Assets (% of GDP)	-0.0023***	-0.0021***		
	(0.00018)	(0.00017)		
Residual diagnostics				
CD_P	-3.04***	-3.24***		
CIPS	-1.34	0.13		
Observations	501	501		

Notes: All variables except net foreign assets are measured in logs. Method of estimation: DOLS. Regressions based on (11) without interaction term using alternative demographic variables. Country and time dummies included in both regressions. Standard errors in parentheses. Asterisks mark significance at 10% (*), 5% (**), 1% (***). Residual diagnostics: CD_P cross-sectional dependence test statistic by Pesaran (2004), Residual stationarity tested by Pesaran's (2007) CIPS test using bootstrapped critical values.

Table 2 presents results from estimation model (15). The coefficients ω_k of the auxiliary demographic variables are highly significant. The control variables behave similar to those in the main regressions. Non-stationarity of residuals can be rejected.

Table 2: Age Polynomial				
Dependent Variable:				
Relative Price of Non-Tradables CCEP				
Auxiliary Demographic Variable Z_{1it}	0.035***			
	(0.0091)			
Auxiliary Demographic Variable Z_{2it}	-0.0071***			
	(0.0019)			
Auxiliary Demographic Variable Z_{3it}	0.00037***			
	(0.000098)			
Relative Sectoral Productivity	0.28***			
	(0.056)			
GDP per capita	0.38***			
	(0.073)			
Government Consumption (% of GDP)	0.10**			
	(0.052)			
Net Foreign Assets (% of GDP)	-0.00052***			
	(0.00020)			
Residual diagnostics				
CD_P	-2.68***			
CIPS	-12.391***			
$F(Z_{1it}, Z_{2it}, Z_{3it} = 0)$	5.04***			
N	546			

Notes: Relative Sectoral Productivity, GDP per capita and Government Consumption are measured in logs. Method of estimation: CCEP. Regression based on (15). Country dummies included. Standard errors in parentheses. Asterisks mark significance at 10% (*), 5% (**), 1% (***). Residual diagnostics: CD_P cross-sectional dependence test statistic by Pesaran (2004), Residual stationarity tested by Pesaran's (2007) CIPS test using bootstrapped critical values. $F(Z_{1it}, Z_{2it}, Z_{3it} = 0)$ denotes F-test about joint significance of all Z_{kit} variables.

	Table 3: Approximated Coefficients of the Age Bins			
Age Bin	Coefficient ν_l	Standard Errors		
15 - 19	-0.009	0.0074		
20 - 24	0.006	0.012		
25 - 29	0.012	0.014		
30 - 34	0.011	0.014		
35 - 39	0.004	0.014		
40 - 44	-0.005	0.013		
45 - 49	-0.016	0.012		
50 - 54	-0.025**	0.011		
55 - 59	-0.030***	0.011		
60 - 64	-0.030***	0.011		
65 - 69	-0.021**	0.011		
70 - 74	-0.002	0.0013		
74 - 79	0.029	0.020		
80+	0.076**	0.031		

Table 3 shows the approximated coefficients ν_l and standard errors of the age bins age_{lit} , on which Figure 4 is based.

Notes: Coefficients on age bins age_{lit} extracted from the regression in Table 2 according to the procedure in (14). Asterisks mark significance at 10% (*), 5% (**), 1% (***).

Additional Results to Section 7.2

Table 4: ALTERNATIVE LRI AND SAMPLE SPLIT - DOLS					
Dependent Variable:	(I)	(II)	(III)		
Relative Price of Non-Tradables	Alternative Variable	Sample split			
		$LRI < \overline{LRI}$	$LRI \ge \overline{LRI}$		
Old-Age Dependency Ratio	0.12	-0.060	0.49***		
	(0.079)	(0.057)	(0.096)		
OADR × Labour Market Rigidity (LRI ^{EPI})	0.00032 (0.0083)				
Relative Sectoral Productivity	0.66***	0.49***	0.72***		
	(0.064)	(0.061)	(0.060)		
GDP per capita	-0.14	0.20***	-0.22*		
	(0.10)	(0.063)	(0.11)		
Government Consumption (% of GDP)	-0.17**	0.23***	0.088		
- ~ /	(0.070)	(0.085)	(0.070)		
Net Foreign Assets (% of GDP)	-0.0018***	-0.0027***	-0.0014***		
	(0.00021)	(0.00038)	(0.00028)		
Residual diagnostics					
CD_P	-2.28**	1.76^{*}	-0.08		
CIPS	-0.033	-0.11	-0.69		
F(OADR, Interaction = 0)	1.29				
Observations (countries)	315	233(7)	268(8)		

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Notes: All variables except net foreign assets are measured in logs. Method of estimation: DOLS. Regressions based on (11). Country and time dummies included in all regressions. The low rigidity set (column II) contains Austria, Belgium, Canada, Japan, Korea, United Kingdom, and United States, while the high rigidity set (column III) covers Denmark, Finland, France, Italy, Netherlands, Norway, Portugal, and Spain. Standard errors in parentheses. Asterisks mark significance at 10% (*), 5% (**), 1% (***). Residual diagnostics: CD_P cross-sectional dependence test statistic by Pesaran (2004), Residual stationarity tested by Pesaran's (2007) CIPS test using bootstrapped critical values. F(OADR, Interaction = 0)denotes F-test about joint significance of OADR and the interaction term.