DEMOGRAPHIC OPTIMUM IN THE CONTEXT OF MIGRATION. THE GERMAN CASE

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Abstract
The study aims to test whether the unbalanced structure of indigenous workforce offer in developed economies, such as Germany, originates both in the structure of rewards associated with each type of job in accordance with the required education level and also in the algorithm of their allocation so that the economy's workforce demand is met. The structural disequilibrium of the workforce offer reflected in the scarcity of workforce members which have attained only a primary education level determines the need to supplement indigenous labour force by accepting and even encouraging immigration.
The goal of using game theory as methodology is to estimate the strategy of player P_1 (considered to be the individual agent) in choosing a specific level of education, while taking into account the choices of future competitors on the labour market – associated in the game with collective player P_2. The resulted Nash equilibrium leads to the conclusion that an individual player, to the extent of approximately 40%, chooses to pursue a superior level of education (tertiary), while more than 95% out of total competitors opt for a similar level of education.
Therefore, any version of demographic optimum for Germany, built on the principle of economic efficiency cannot afford to ignore the contribution of immigrants towards achieving the required workforce level.

Keywords: demographic optimum, Nash equilibrium, migration.

JEL classification: C02, F22, O15, F66, J11.

Introduction

The demographic optimum generally believed to be the systemic state maximizing the productive capacity of an economy has two fundamental aspects: quantitative and the structural composition of the workforce. The hypothesis is based on the assumption that human resource is inclined to specialize in areas with a high degree of remuneration, therefore creating a systemic disequilibrium in the supply of workforce members with an elementary level of education aimed to occupy all specific jobs. The hypothesis

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confirmation provides specific evidence for supporting the idea that under current context of German economy, immigration is a phenomenon contributing extensively to overcoming the structural disequilibrium of workforce offer.

The demonstration consists in a decision game built on the differentiation of German human capital by education level of potential employees. By solving the payoff matrix, the resulting Nash equilibrium validates the scenario associated with the inclination to choose jobs requiring a tertiary education level. The three sections of the article will discuss the literature review, including an analysis of the theory on which the decision game is based, the methodology used for building the game, while the third section examines the research outcomes.

1. Literature Review

The demographic optimum is a concept belonging to social science and is the reason why it should be perceived as a dialectic notion, namely, a process of ongoing transformation and not perfectly separable single multitude (Georgescu-Roegen, 1971). Studying the concept history, it may be noted that its key element, the optimizing condition, changes depending on main concerns and limitations that define the anatomy and physiology of the studied period. First modern view on geographic optimum defines it in terms of capacity to produce the needed food for a specific size of population (Malthus, 1798; Boserup, 1965). Although the two authors wrote 150 years apart from each other and their perspectives were totally different, their specific concerns were similar: size of population and amount of available food.

The period between the two world wars brings new approaches to a concept freed from the Malthusian trap. The size aspect of food resources was replaced by such key elements as level of production per capita and state of trade balance (Hoover, 1930). Situated within the realm of the Great Depression, demographic optimum had been seen rather as an issue of productive resource allocation than ethics related to fair distribution of wealth (Wolfe, 1936). Right after World War II, the main concern regarding optimum became once again linked to the amount of available resources, and thus the concept ended up referring to the way in which successive generations of a population consume and maintain a limited and partially deplete stock of resources (Gottlieb, 1945). Four years later, the same author changes the perspective and looks at the demographic optimum in terms of trade balance and work hour productivity (Gottlieb, 1949), in practice returning to issues that had been discussed by Hoover 20 years earlier.

The50s and 60s marked for the demographic optimum a shift from the Malthusian perspective focused on the number of inhabitants to a Keynesian one that sees rate of population growth as the main topic of study (Petersen, 1955; Dasgupta, 1969). The serendipity theorem joined similar discourse (Samuelson, 1975, 1976) maintaining that a competitive economy converges to a stationary state of optimum if population dynamics follow an optimal growth rate. After 1970, the discourse on demographic optimum was influenced by correlations between the level of population wealth and various aspects of environmental sustainability. By introducing environmental constraints to a welfare function, Votey (1969) observed that demographic optimum value seemed to decrease, stabilizing at a lower level compared to the value at the time of study. In line with the ideational atmosphere created by the Club of Rome Report, the demographic optimum was defined as the value falling in the interval determined by the lowest viable size of population and the biophysical supporting capacity of the planet(Daily, Anne and Paul Ehrlich, 1994). As sustainability is a deeply dialectical notion, maintaining an entirely discrete nature of the optimum turned out to be impossible. Among the latest versions of the concept, one may find the idea presented as the result of a process of ethical assessment of the conflict between procreation and environmental protection, a conflict resolved by the conception of temporal horizon of each individual: existence may be perceived as life through time or life in time (Dasgupta, 2005).

The most recent research direction in the field of demographic optimum focuses on evaluating it from the perspective of population ageing. The main point of interest focuses on the pressure that a low fertility rate and an ageing population impose on the growth rate of worker productivity in the context of maintaining a constant standard of living (von Gaessler and Ziesemer, 2016; Lee and Mason, 2010). An ageing population produces other systemic effects as well, especially concerning public policies on education and the pension system(Ono and Uchida, 2016), preferences on savings and investment behavior (Sunde and Dohmen, 2016) and the ability of older employees to keep their job or find another one in case of discharge (Lassus, Lopez and Roscigno, 2015). While the different elements have not yet been put together in the form of a complete model, it appears that they will be crucial in conceiving and understanding demographic optimum in the near future.

The definition of demographic optimum in a Platonic sense makes differentiations on the same topic irrelevant, but optimum can only be understood as a consequence of inserting the concept into a well-defined spatial-temporal context (Whitehead, 1957), an interaction that gives rise to myriads of formal expressions that have been attributed to the concept. From this perspective, it is important to provide our own definition of demographic optimum that would suit the aims of this study. The starting point in researching such a version of optimum is the evidence that economic growth attracts immigrants (Chiswick and Hatton, 2003; Islam and Khan, 2015). This reality is supported by the fact that no statistically significant correlation has been found between the level of expenditure for welfare policies and the number of immigrants coming from outside the European Union (Giulietti et al., 2013) and no adverse effects have been noticed on the local population employment level due to the entry of immigrants on the labour market (Friedberg and Hunt, 1995).

The aim of immigrants is not to destroy or distort the workforce structure of the adoptive countries but to integrate and be a part of that edifice. This has been in fact the leitmotiv of migratory movements since Antiquity: the vandals in Rome were not driven by the desire to destroy the empire, but on the contrary, most of them were attracted by the wealth and sophistication of the Roman world, a world they would have liked to integrate into and in no way destroy it. This perspective is supported by Altonji and Card(1991) and Card (2005) who state that there is not enough evidence to affirm that the wave of immigrants produce negative systemic effects on the likelihood of the local population with an elementary education level to find employment. We may even argue that due to low transaction costs that immigrants benefit from by changing their residence within the same country, they contribute to uniform the workforce structure in the host country. This effect is felt especially in areas where uncovered demand for workplaces does not justify the change of residence for the local population (Borjas, 2001). Also, it is important to mention that immigration cannot be a panacea for developed countries with aging population and generous social policies. This option is not realistic as the overwhelming majority of immigrants' work jobs that provide a low level of taxable income. Moreover, immigrants are most often among the beneficiaries of redistribution policies supported by the very welfare state that took them in precisely to help alleviate their poor financial condition (Borjas, 2006).

The scarcity of workforce with an elementary education level of developed systems is in itself the consequence of dynamics that maintains the optimum state. A state with the economy that sustains a high number of high paid jobs is therefore a state that has at its disposal a high level of financial resources. This state of affairs produces two effects: first, it permanently raises the accepted social standard of the level of utility associated with decent living and, secondly, the abundance of state resources is translated into social policies aimed to improve the living standard of those members of the active population who are not able to adapt to systemic conditions. So, the niche occupied by migrants is created by the ongoing transformation of workforce structure generated by locals. There are two tendencies working simultaneously: a) the steady revision of decency threshold determines potential employees to orient towards jobs that require intermediary or tertiary education levels; b) social benefits encourage those unable to adapt to choose facilities provided by the state at the expense of a job requiring only an elementary level of education, as the difference in income does not justify the additional investment in effort associated with the new payment level.

This disequilibrium inherent to the state of optimum seen as the maximization of productive capacity of an economy may be explained by referring to what Adam Smith (1776, pp.13-31) considered to be primordial elements governing productivity growth capacity: division of labor and principle of specialization. Basically, Smith states that specialization causes productivity growth that together with market size and trade freedom produce an increase in quality and quantity of goods and services to which businesses in a system have access. The flaw of this model is that the invisible Smithian hand seems to place all game pieces in a manner that confers a truly unnatural efficiency to the process of market coordination. Smith's inaccuracy consists in the way he captures the dynamic of the process and not in his understanding of its nature.

Therefore, Smith identifies correctly the link between specialization and the level of productivity growth. In addition, specialization involves an increase in the complexity of productive activities. The problem appears when the workforce must fill the job positions (it is important to understand that the value of an economy is given by the number and quality of available jobs and not by the number and quality of its workforce) as a certain level of education grants the future employee just the qualification to apply for a certain job but not the certainty of obtaining the position. Extended to entire economy, this process may be compared to Walrasian tatonnement (Walras, 1874), with the remark that here the aim of the auction is to close the job market, which does not also involve the depletion of available workforce. Contrary to the solution of Walras, in this case we cannot tend to equilibrium by manipulating the rate of equivalence between workforce and jobs. Contrary to money, there are several types of qualifications that are less, or not at all equivalent. Therefore, in the process of tatonnement, future employees that did not find a job befitting their education level cannot be hired except by accepting an inferior position in the hierarchy of productivity, and, implicitly, reduced rewards or undergoing retraining.

The problem of workforce structure in a developed economy originates both in the structure of rewards associated with each level of education and in the algorithm of workforce allocation so that they cover the required job demand of the economy. The validity of the theory will be tested by creating a decision game involving the application of economic dynamics previously discussed to the structure of rewards specific to the three levels of education – elementary, intermediary and tertiary – as they are generated in German economy.

2. Research methodology

Whitehead(1929, pp.2-5)proposes the idea of evolution contrary to the Darwinist canon, employing the example of an organism that modifies its environment to suit its objectives and not one that adapts to endogenous changes in the habitat that it populates. Translated into economic term, this type of dynamic manifests itself as the inclination of economic agents to search for jobs with a higher wage level than the standard defining the social decency threshold. These tendencies determine the pursuit of an education level that is high enough to transform rational expectations of individuals into factual reality.

The idea of optimum involves the existence of a choice influencing the association of factors that are the variables of an efficiency function so that its results always match the highest value of a pre-established set of potential results. Using this statement as a point of departure, demographic optimum can be defined as a systemic state maximizing the productive capacity of an economy – the value of wages associated with the job offer - by manipulating the quantity and quality of the workforce. The study aims to provide a purely economic assessment of migration in terms of workforce structure in the German economic system. To this end, a decision game simulating future structure of workforce offer by studying the best response of player P_1(individual agent) in choosing a specific type of education in the context of decisions made by future competitors on the job market– represented in the game by collective playerP_2.

The payoff equation is defined by relevant indices of cost/benefit analysis for a job– probability to find employment, financial reward, degree of social recognition, workplace safety, length of study perceived both as a drawback and an advantage, probability of failing to find employment, difference in wages between the expected level and the one achieved by working in an inferior position and work safety difference between the expected level and the one achieved by working in an inferior position- whose interaction is balanced by the application of a complementarity coefficient specific to each strategyprofile. Data have been collected from Eurostat database, the OECD reports and an UNESCO classification of ISCED education levels, and although time intervals of indices are not uniform, the homogeneity of data is ensured by the relative stability of the German system, as well as by their partially institutional nature, and institutions have very slow dynamics.

The space of strategies is defined as:

$S_1,S_2 \epsilon \{E,I,T\}$

where:

E – elementary education level – matching educational levels 1-2 based on ISCED 2011 classification;

I – intermediary education level – matching educational levels 3-4 based on ISCED 2011 classification;

T – tertiary education level – matching educational levels 5-8 based on ISCED2011classification.

The payoff equations of the two players:

$$U_1(S_1,S_2)=\left(Pa_{S1}\cdot Rp_{S1}\cdot Rs_{S1}\cdot Sm_{S1}\cdot Dsb_{S1}-Pe_{S1}\cdot Dsc_{S1}\cdot Rp'_{S1}\cdot Sm'_{S1}\right)\cdot Cs_{(S1,S2)} \quad (1)$$

$$U_2(S_1,S_2)=\left(Pa_{S2}\cdot Rp_{S2}\cdot Rs_{S2}\cdot Sm_{S2}\cdot Dsb_{S2}-Pe_{S2}\cdot Dsc_{S2}\cdot Rp'_{S2}\cdot Sm'_{S2}\right)\cdot Cs_{(S2,S1)} \quad (2)$$

where:

Pa – probability to find employment

Rp – financial remuneration according to education level

Rp' – difference in wages between the expected level and the one achieved by working in an inferior position

Rs – social recognition associated with education level

Sm – job safety

Dsc – length of study needed to obtain the desired educational level(drawback)

Dsb –length of study needed to obtain the desired educational level (advantage)

Pe – non-materialized work object

Sm' – difference in work safety between the expected leveland the one achieved by working in an inferior position

Cs – complementarity coefficient between strategies

Complementarity coefficient is conceived as a ratio between the value ascribed to finding a job corresponding to the acquired education level and the product of failing to get the job due to overabundance of labour force in areas requiring that specific education level and migratory pressure determined by the resulted level of economic development. The coefficient has been calculated by attributing a set of chosen values so as to reflect the economic state of each strategy, the only condition for validating this method is to ensure the proportionality of chosen values.

In regard to the value set used to represent migratory pressure, number 4 has been chosen to highlight a case in which the majority of the agents of the system (P_2) choose to pursue a tertiary education level, which implies the existence of a strong economy, with a workforce structure that cannot meet the demand for jobs that require only an elementary education level. Therefore, the use immigrants to supplement workforce offer is much more widespread in this type of economy, leading to the creation of a much more intense migratory pressure then the kinds experienced in less developed economies. (Table no. 1)

Table no. 1: Complementarity coefficient calculations

P_1	P_2		v	r	i	v /(r · i) (Cs)
E	E	$Cs_{(S1,S2)}$	2	7	1	2/7
		$Cs_{(S2,S1)}$	2	7	1	2/7
I	I	$Cs_{(S1,S2)}$	5	8	2	5/16
		$Cs_{(S2,S1)}$	5	8	2	5/16
T	T	$Cs_{(S1,S2)}$	9	9	4	1/4
		$Cs_{(S2,S1)}$	9	9	4	1/4
E	T	$Cs_{(S1,S2)}$	1	9	4	1/36
		$Cs_{(S2,S1)}$	7	9	4	7/36
E	I	$Cs_{(S1,S2)}$	2	6	2	1/6
		$Cs_{(S2,S1)}$	4	8	2	2/8
I	E	$Cs_{(S1,S2)}$	4	4	1	1
		$Cs_{(S2,S1)}$	3	7	1	3/7
I	T	$Cs_{(S1,S2)}$	6	4	4	3/8
		$Cs_{(S2,S1)}$	8	8	4	1/4
T	E	$Cs_{(S1,S2)}$	7	3	1	7/3
		$Cs_{(S2,S1)}$	2	7	1	2/7
T	I	$Cs_{(S1,S2)}$	8	5	2	4/5
		$Cs_{(S2,S1)}$	6	8	2	3/8

Note: v – job value in accordance with education level; $v \in \{1,2,3,4,5,6,7,8,9\}$

r –risk of failing to find employment; $r \in \{1,2,3,4,5,6,7,8,9\}$

i – migratory pressure; $i \in \{1,2,4\}$

The probability of finding employment in Germany is calculated as a weighted average of the average employment rate corresponding to each of the three levels of education –tertiary education, upper secondary non tertiary and below upper secondary – between1991 and2015. Higher influence share will be attributed to employment rates of recent years and these will decrease as the time series advances towards its origin, in order to highlight the idea that the perception on the likelihood of finding a job is influenced in a higher proportion by recent employment patterns than by historical trends. The failure probability will be calculated by deducting the percentage of employment rate from the total. (Table no. 2)

Table no. 2: Probability of finding employment based on education level

	Share	Tertiary education	Upper secondary non tertiary	Below upper secondary
1991	0.028181	72.36	85.01	49.9
1992		71.75	84.65	51.9
1994		70.18	83.36	49
1995		70.96	84.15	49.2
1997		68.22	82.29	45.7
1998		67.92	82.21	46.1
1999		69.88	82.97	48.7

	Share	Tertiary education	Upper secondary non tertiary	Below upper secondary
2000	0.028181	70.38	83.4	50.6
2001		70.54	83.42	51.8
2002		70.33	83.56	50.9
2003		69.73	82.97	50.2
2004	0.04	69.46	82.65	48.6
2005		70.59	82.87	51.6
2006		72.53	84.34	53.8
2007		74.38	85.47	54.6
2008		75.34	85.82	55.3
2009		75.5	86.41	54.9
2010	0.05	76.32	86.93	55.3
2011	0.06	77.59	87.85	56.5
2012	0.07	78.18	87.89	57.5
2013	0.08	78.82	87.76	57.9
2014	0.09	79.66	88.08	58
2015	0.1	79.92	88.13	58.7
Employment probability (Pa)		**74.69**	**85.70**	**53.98**
Failure probability (Pe)		**25.31**	**14.30**	**46.02**

Source: Lauer, 2004

The financial payoffs indicators will be computed as a weighted average of the wage premium – to take into account the degree of workforce structure dispersion corresponding to each education level–which each potential employee with a certain qualification level can claim over the reference level associated with unskilled workers or those whose training is limited to middle school. (Table no. 3)

Table no. 3: Financial payoffs attributed to education level

Educational attainment	Educational reference level (1.0, 1.1)	Wage premium (A)	Share (B)	A · B	Payoff indicator (Rp)
Below upper secondary(E)	Level 12	0.16	0.33	0.0528	1.168
	Level 20	0.11	0.33	0.0363	
	Level 21	0.24	0.33	0.0792	
Upper secondary non tertiary(I)	Level 30	0.21	0.25	0.0525	1.21
	Level 31	0.20	0.25	0.05	
	Level 32	0.20	0.25	0.05	
	Level 33	0.23	0.25	0.0575	
Tertiary education(T)	Level 40	0.45	0.8	0.36	1.47
	Level 41	0.55	0.2	0.11	

Source: OECD, 1997

In the case of strategy E, because there is no lower indicator of financial reward – the alternative to not finding a job with an appropriate educational requirement is the lack of a job – value 1.168 is to be used, the indicator associated with an elementary education level. (Table no. 4)

Table no. 4: Difference in wages between the expected level and the one achieved by working in an inferior position (Rp')

P_1	P_2		$Rp'=1+(Rp_{s1}-Rp_{s2})$
E	E	Rp'_{S1}	1.168
		Rp'_{S2}	
I	I	Rp'_{S1}	1.042
		Rp'_{S2}	
T	T	Rp'_{S1}	1.26
		Rp'_{S2}	
E	T	Rp'_{S1}	1.168
		Rp'_{S2}	1.26
E	I	Rp'_{S1}	1.168
		Rp'_{S2}	1.042
I	E	Rp'_{S1}	1.042
		Rp'_{S2}	1.168
I	T	Rp'_{S1}	1.042
		Rp'_{S2}	1.26
T	E	Rp'_{S1}	1.26
		Rp'_{S2}	1.168
T	I	Rp'_{S1}	1.26
		Rp'_{S2}	1.042

The social recognition indicators from table no. 5 have been attributed different weights so as reflect their influence within the composition of the aggregate indicator.

Table no. 5: Social recognition associated with education level

Likelihood of reporting to volunteer at least once a month, by educational attainment			
Educational attainment	Percentage (A)	Share (B)	A · B
Tertiary education	23.32	0.1	2.332
Upper secondary non tertiary	22		2.2
Below upper secondary	19.14		1.914
Likelihood of reporting to trust others, by educational attainment			
Tertiary education	11.2	0.4	4.48
Upper secondary non tertiary	10		4
Below upper secondary	9.9		3.96

Likelihood of reporting to believe that they have a say in government, by educational attainment			
Tertiary education	23.31	0.5	11.655
Upper secondary non tertiary	21		10.5
Below upper secondary	19.95		9.975
Payoff indicators for social fulfilment (Rs)			
Tertiary education	1.85		
Upper secondary non tertiary	1.67		
Below upper secondary	1.58		

Source: OECD, 2015

The three indicators of table no. 5 are being attributed shares in accordance with their respective degree of importance. Therefore, it can be stated that for an individual agent, the awareness of his capacity to influence the workings of government brings him greater social benefits then his availability to engage in volunteering activities.

The drawback and advantage associated with the length of study period are determined through comparison with the maximal value of each category. As such, tertiary education is associated with the highest drawback and the education level below upper secondary yields the highest advantage. (Table no. 6)

Table no. 6: Length of study program

Education level	Number of years	Benefit indicator (Dsb)	Cost indicator (Dsc)
Tertiary education	22	0.45	1
Upper secondary education	13	0.77	0.59
Below upper secondary	10	1	0.45

Source: UNESCO, 2013

Workplace security and insecurity levels are calculated for each of the three education levels by reference to a maximum level defined in relation with the education level that performs best in each category. (Table no. 7)

Table no. 7: Assessment of job security

Changes in work safety over time (% of employees worried about work safety)									
Years	1985	1987	1989	1991	1992	1993	1994	1995	Average
Secondary Education	54.8	53.9	44.5	37.6	49.2	48.3	54.5	52.7	49.4
Upper Secondary Education	44.2	44.1	37.6	31.4	40.5	39.3	47.1	45.7	41.2
Tertiary Education	20.8	20.3	17.2	16.1	20.2	20.1	28.9	26.5	21.3

Workplace security (reference level – tertiary education)									
Years	1985	1987	1989	1991	1992	1993	1994	1995	Average (Sm)
Secondary Education	0.620	0.623	0.613	0.572	0.589	0.584	0.470	0.497	0.571
Upper Secondary Education	0.529	0.540	0.543	0.487	0.501	0.489	0.386	0.420	0.487
Tertiary Education	1	1	1	1	1	1	1	1	1
Workplace insecurity levels (reference level – secondary education)									
Years	1985	1987	1989	1991	1992	1993	1994	1995	Average (Sm’)
Secondary Education	1	1	1	1	1	1	1	1	1
Upper Secondary Education	0.81	0.82	0.84	0.84	0.82	0.81	0.86	0.87	0.83
Tertiary Education	0.38	0.38	0.39	0.43	0.41	0.42	0.53	0.50	0.43

Source:OECD, 1997

The two hypotheses to be tested using the game are:

- Cost/benefit that the German system attributes to different levels of education makes labor force orient towards an unbalanced workforce structure relative to the demand of the German economy.

- The unbalanced workforce structure is a consequence of the structure of payoffs attributed to each level of education and not the result of active population scarcity.

3. Results and discussion

Using equations (1) and (2), the value of the payoffs associated with the strategies of the two players can be calculated as it follows, thus constructing the formal representation of the game: (Table no. 8)

$U_1,U_2(T,T)=(74.69\cdot1.47\cdot1.85\cdot1\cdot0.45-25.32\cdot1\cdot1.26\cdot0.43)\cdot1/4=(91.403-13.718)\cdot1/4=19.42$

$U_1,U_2(I,I)=(85.7\cdot1.21\cdot1.67\cdot0.487\cdot0.77-14.3\cdot0.59\cdot1.042\cdot0.83)\cdot5/16=(64.938-7.296)\cdot5/16=18.01$

$U_1,U_2(E,E)=(53.98\cdot1.168\cdot1.58\cdot0.571\cdot1-46.02\cdot0.45\cdot1.168\cdot1)\cdot2/7=(56.881-24.188)\cdot2/7=9.34$

$U_1(T,I)=(74.69\cdot1.47\cdot1.85\cdot1\cdot0.45-25.32\cdot1\cdot1.26\cdot0.43)\cdot4/5=(91.403-13.718)\cdot4/5=62.15$

$U_2(T,I)=(85.7\cdot1.21\cdot1.67\cdot0.487\cdot0.77-14.3\cdot0.59\cdot1.042\cdot0.83)\cdot3/8=(64.939-7.297)\cdot3/8=21.61$

$U_1(T,E)=(74.69\cdot 1.47\cdot 1.85\cdot 1\cdot 0.45-25.32\cdot 1\cdot 1.26\cdot 0.43)\cdot 7/3=(91.403-13.718)\cdot 7/3=181.27$

$U_2(T,E)=(53.98\cdot 1.168\cdot 1.58\cdot 0.571\cdot 1-46.02\cdot 0.45\cdot 1.168\cdot 1)\cdot 2/7=(56.881-24.188)\cdot 2/7=9.34$

$U_1(I,T)=(85.7\cdot 1.21\cdot 1.67\cdot 0.487\cdot 0.77-14.3\cdot 0.59\cdot 1.042\cdot 0.83)\cdot 3/8=(64.938-7.296)\cdot 3/8=21.61$

$U_2(I,T)=(74.69\cdot 1.47\cdot 1.85\cdot 1\cdot 0.45-25.32\cdot 1\cdot 1.26\cdot 0.43)\cdot 1/4=(91.403-13.718)\cdot 1/4=19.42$

$U_1(I,E)=(85.7\cdot 1.21\cdot 1.67\cdot 0.487\cdot 0.77-14.3\cdot 0.59\cdot 1.042\cdot 0.83)\cdot 1=(64.938-7.296)\cdot 1=57.64$

$U_2(I,E)=(53.98\cdot 1.168\cdot 1.58\cdot 0.571\cdot 1-46.02\cdot 0.45\cdot 1.168\cdot 1)\cdot 3/7=(56.881-24.188)\cdot 3/7=14.01$

$U_1(E,T)=(53.98\cdot 1.168\cdot 1.58\cdot 0.571\cdot 1-46.02\cdot 0.45\cdot 1.168\cdot 1)\cdot 1/36=(56.881-24.188)\cdot 1/36=0.9$

$U_2(E,T)=(74.69\cdot 1.47\cdot 1.85\cdot 1\cdot 0.45-25.32\cdot 1\cdot 1.26\cdot 0.43)\cdot 7/36=(91.403-13.718)\cdot 7/36=15.10$

$U_1(E,I)=(53.98\cdot 1.168\cdot 1.58\cdot 0.571\cdot 1-46.02\cdot 0.45\cdot 1.168\cdot 1)\cdot 1/6=(56.881-24.188)\cdot 1/6=5.45$

$U_2(E,I)=(85.7\cdot 1.21\cdot 1.67\cdot 0.487\cdot 0.77-14.3\cdot 0.59\cdot 1.042\cdot 0.83)\cdot 2/8=(64.939-7.297)\cdot 2/8=14.41$

Table no. 8: Formal representation of the game (1)

$P_1 \backslash P_2$	T	I	E
T	(19.42; 19.42)	(62.15; 21.61)	(181.27; 9.34)
I	(21.61; 19.42)	(18.01; 18.01)	(57.64; 14.01)
E	(0.9; 15.10)	(5.45; 14.41)	(9.34; 9.34)

$P_1(E)$ and $P_2(E)$ are dominant strategies. Both will be eliminated from the formal representation of the game, thus obtaining a simplified matrix. (Table no. 9)

Table no. 9: Formal representation of the game (2)

$P_1 \backslash P_2$	T	I
T	(19.42; 19.42)	(62.15; 21.61)
I	(21.61; 19.42)	(18.01; 18.01)

Variable p defines the probability for P_1 to choose T and (1-p) represents probability for P_1 to choose I.μ_2 represents the mix of strategies that P_2 chooses to play given a number of n game simulations.

$$\begin{cases} u_1(T,\mu_2) = 19.42 \cdot p + (1-p)\cdot 62.15 \\ u_1(I,\mu_2) = 21.61 \cdot p + (1-p)\cdot 18.01 \end{cases}$$

The expected value of payoffs for both strategies of player P_1. when P_2 chooses to play the mixt strategy μ_2, will be equal only if $u_{1(T,\mu2)}=u_{1(I,\mu2)}$:

$19.42\cdot p+(1-p)\cdot 62.15=21.61\cdot p+(1-p)\cdot 18.01$

$19.42\cdot p+62.15-62.15\cdot p=21.61\cdot p+18.01-18.01\cdot p$

$19.42\cdot p - 62.15\cdot p-21.61\cdot p+18.01\cdot p=18.01-62.15 \Rightarrow 46.33\cdot p=44.14 \Rightarrow$ $\boxed{p=95.27\%}$

Interpretation

If player 1 assumes that the probability of player 2 to play T is lower than 95.27%, then player 1 should play I and the reverse, namely, if player 1 assumes that the probability of player 2 to play I is higher than 95.27% then player 1 should play T.

In order to determine the Nash equilibrium, the strategies of the two players are assigned a set of values, (1-q, q) and (1-p, p), that represent the probabilities of playing each strategy. (Table no. 10)

Table no. 10: Nash equilibrium

P_1 \ P_2		**1-q** **T**	**q** **I**
1-p	**T**	(19.42; 19.42)	(62.15; 21.61)
p	**I**	(21.61; 19.42)	(18.01; 18.01)

Note: q represents the probability that P_2 played I and 1-q is the probability that P_2 played T.

If P_1 plays T, the payoff may be calculated as:

$(1-q) \cdot 19.42 +q \cdot 62.15 = 19.42 + 42.73 \cdot q$

If P_1 plays I, the expected payoff is:

$(1 - q) \cdot 21.61+ q \cdot 18.01=21.61-3.6\cdot q$

P_1 chooses mixed strategy if:

$19.42+42.73\cdot q=21.61-3.6\cdot q$

$46.33\cdot q=2.19 \Rightarrow \boxed{q=0.047.}$ and $\boxed{1-q=0.953}$

The best response of P_1 is a mixed strategy if P_2 plays:

$$P_1: \begin{cases} 1 - p \rightarrow T \\ \quad p \rightarrow I \end{cases}$$

If P_2 plays T $\Rightarrow (1-p)\cdot 19.42+p\cdot 19.42\cdot 19.42$

If P_2 plays I $\Rightarrow (1-p)\cdot 21.61+p\cdot 18.01=21.61-3.6\cdot p$

$19.42=21.61-3.6\cdot p$

$3.6\cdot p=21.61-19.42 \Rightarrow \boxed{p=0.608.}$ and $\boxed{1-p=0.392}$

The Nash equilibrium of the game consists of a profile of mixed strategies for which neither player can increase his payoff by changing his strategy, while the other player keeps his strategy unchanged. The profile of mixed strategies that matches the Nash equilibrium is (0.392;0.608), (0.953;0.047).

Conclusions

By analyzing the mixed profile of strategies attributed to Nash equilibrium, we may observe that job distribution in German economy is clearly oriented towards the cultivation of a workforce with tertiary education level. In accordance with the described game, under Pareto optimality of decisions, an individual player chooses almost 40%of the time to attain a tertiary level of education provided that more than 95% of total competitors opt for an equivalent level of instruction. This trend is reflected also by the set of game rationalized strategies whose interpretation suggests that if player 1 estimates that the probability of player 2 to opt for a tertiary level of education is higher than 95.27%, then player 1 should choose each time the strategy of reaching an equivalent level of education.

These results are relevant in order to understand the economic effect of migration because in the context of a workforce offer that systematically neglects areas whose jobs require only elementary level of education, the German economy has no other alternative for supplementing labor force in the mentioned fields but the import of immigrants. This statement is even more relevant in the context of negative birth rate evolution and even if the situation was the other way around, the statement remains justified as the distribution is not influenced by labor force quantity but by economic development of the analyzed system.

In this context, any version of demographic optimum attributed to Germany and built on the principle of economic efficiency cannot afford to ignore the contribution of immigrants to the effort of balancing the workforce structure. This perspective refers strictly to the economic effects of migration and although the introduction of material and social costs attributed to accommodating a new culture on a foreign land could have added more details to the analysis, the authors deliberately chose to ignore them as they may have diluted the concrete nature of the causal links employed through the introduction of highly subjective factors. The limitations of the study consist in the sociological assumptions that were necessary for constructing the game, especially in regards to the definition and calculation of the complementarity coefficient. Improving this research would require the construction of a game in which the choices concerning the education level should be expressed in the form of an infinite space of strategies, thus leading to more precise estimations of the player's decisions. A future direction of research in this field could consist in application of the decision game on a version of demographic optimum defined in relation with the ageing rate of the population.

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