What drives relative wages? Evidence from Ukraine (2003-2012)

By

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ABSTRACT

In this paper I research Ukrainian relative wages and how they have changed over time. I explore dependence of relative wages on changes in demand and supply factors using the Katz and Murphy framework. The data on relative wages suggest that almost all wages increased substantially during 2003-2012 period. Based on the relative supply changes data over 2003-2012 period the biggest increase was of educated employees with 1-10 years of experience which is consistent with the smallest increase in the earnings of the same group. However, relative supply changes are not enough to explain relative wages in all periods. Therefore as a next step I look at the relative demand changes that suggest that people moved away from agriculture industry to sales. Finally, I have researched education wage premium that dropped severely during 2003-2004 period. I showed that the university/high school wage gap was mostly driven by the average supply. Additionally, there were no evidence found that education premiums are different across experience groups. Finally, it appears that not all of the relative wage changes can be explained by supply and demand framework.

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INTRODUCTION

Wages are one of the most important indicators of the development of a nation. According to Kataranchuk (2016) salary changes are correlated with economic development. Therefore changes in wages and factors that are driving them play a great role in explaining economy.

In this paper I explore trends in relative wages during 2003-2012 period and their potential causes. There are number of papers that have analyzed potential causes of wage changes.

One of the factors is changes in the minimum wages. According to Ganguli and Terrell (2005) increase in the minimum wage lead to a decrease in the gender gap in the bottom of the distribution.

Another possible explanation is introduction of new policies targeting discrimination (Pignatti, 2012; Hunt, 1997). According to Pignatti (2012) in spite of the government attempt to eliminate gender inequality in Ukraine it did not succeed. However, the policy led to the reduction of the gap in the public sector (Pignatti, 2012). On the other hand Hunt (1997) came to the conclusion that monetary union in Germany increased women's wages and as a result decreased the gender gap.

The third possible explanation is demand shifts. For example, Danzer (2015) found that demand shift in Ukraine in 2005 due to pension reform resulted in a wage increase of young and well educated workers. Additionally, in the 20^{s} century the same shifts towards younger skilled population occurred in US (Katz, Murphy, 1992 and Johnson, 1997). However, the timing of those changes is somewhere different. As Ukraine characterized by the strong protection of tenured workers, the changes toward young educated workers occurred only around 2005 when old unskilled employees reached pension age and left their jobs (Danzer, 2015).

The fourth possible explanation is shifts in supply. In their paper Katz and Murphy showed that a period of supply changes is followed by changes in the relative wages. But in 1970^{s} this relationship was negative which suggests that supply alone cannot explain variation in wages (1992).

This paper contributes to the existing literature by exploring recent trends in the relative wages in Ukraine. Based on the listed above probable drivers of wages I have decided to use classical factors such as supply and demand. One of the factors in favor of the demand and supply explanation of the wage structure is research by Katz and Murphy (1992) that found that relative supply and relative demand changes explained much of the variation in USA wages during 1963-1987 period. According to Katz and Murphy (1992) relative demand growth for the skilled workers is substantial in explaining rise of skill premium in wages. Additionally, Danzer found unexpected shift in demand towards younger employees resulted in their wage increase in Ukraine. Based on it I can conclude that demand and supply changes might play an important role in explaining relative wage changes.

According to Katz and Author (1999) wages are formed by interaction of competitive factors and individual deviation from this factors. In this paper I consider competitive wage factor which is formed by the intersection of relative demand and relative supply (Katz and Author, 1999). Thus if relative supply decreases, assuming the stable demand curve, relative wages of employees should increase. However, according to Katz and Author (1999) this approach can be misleading if companies act off their supply-demand curves but it would still give correct results if salaries are equal to marginal products.

Additionally, in this paper I use Card and Lemieux (2001) framework for explaining education wage premium. That expands Katz and Murphy (1992) analysis of the education

premium by focusing on the differences by experience rather than simple average return to education.

The question of the relative wages is especially interesting to examine in the case of Ukraine. As after the Soviet Union was dissolved in 1991, Ukraine went through a lot of political and economic changes. Starting from 2003-2007 Ukraine was characterized by economic stability and high growth of GDP and nominal salaries. While period of 2004-2005 is associated with the big event in country's history such as Orange revolution. After which several reforms were implemented that were targeting gender gap inequality such as:

- Presidential Decree No. 1135 on Improvement of Activity of National and Regional Executive Power Bodies on Ensuring Equal Rights and Opportunities of Men and Women (signed on 26 July 2005);
- The Law of Ukraine on Ensuring Equal Rights and Opportunities for Women and Men (in force since 1 January 2006);
- The State Programme for Ensuring Gender Equality in Ukrainian Society up to 2010 (approved by the Decree of the Cabinet of Ministers of Ukraine on 27 December 2006).

Following this during the world financial crisis situation in Ukraine changed dramatically. In 2008-2009 there was an immediate drop in GDP, followed by slow growth in 2010-2012 (Pronoza, 2014). In 2007 Ukraine started negotiations about an agreement of Association with the European Union (Ekonomics of Ukraine, 2017). And subsequent economic changes were partially driven by wish to join European Union. Despite the instable situation during 2003-2012 the average nominal monthly wages grew from 462 hryvnas in 2003 to 3026 in 2012 (Average montly salary in Ukraine, 2016). Therefore, it is interesting to if supply and demand factors were driving high growth in Ukrainian wages in the period of the instability in economy.

This paper structured as follows. First section describes data and patterns that occurred in the relative wages in Ukraine. Section 2 introduces the Katz and Murphy supply and demand model and analyzes if the only supply story is consistent with the changes in relative wages during 2003-2012 period. Next part of the paper presents changes in shares of employment between occupations and industries and analyzes between and within sectors demand changes. The last section is dedicated to research of university/ high school wage premium.

1. DATA

In this paper I use cross sectional data from the Ukrainian Longitudinal Monitoring Survey (IZA, 2014). The data set is derived from 4 waves: 2003, 2004, 2007 and 2012. This survey contains employment and individual information on working-age population (15-72 years) in Ukraine.

To estimate relative wage changes I divided data on 2 subsamples:

- wage subsample: wages of the demographic groups
- supply subsample: labor supplied by each demographic group.

The wage sample consists of the average logarithmic hourly wages of 40 groups divided by gender, education and experience. Freelancers, entrepreneurs and people who work for a family enterprise are excluded from the sample. The sample contains workers who received their last salary at least in December of the preceding survey year. Additionally workers with the salary less than half of the minimum wage during the survey year are eliminated from the wage sample. To secure steady proportion of the employees over time those who work less than 20 hours per week and 10 weeks per year were removed from the data. The wage measure that I used in this thesis is logarithmic hourly wages that are calculated as monthly wages divided by the usual hours per month. All earnings that are used through this thesis are real wages that obtained by deflating wages by consumer price index from World Bank's data (2016).

To compute supply sample I calculated labor supplied by each of the 40 demographic groups using the formula from Katz and Murphy (1992):

$$\text{weighted\_hours}_{kt} = \sum_i (hours_{ikt} \times weight_{ikt}) \quad (1)$$

Then weighted hours were divided by the sum of hours through whole year to obtain fixed weights. Through this paper I used hours' measure as annual hours worked that I computed as

hours worked per week multiplied by weeks worked per year. In this paper I use supply in efficiency units that were described by the Katz and Murphy (1992). First, I compute relative wages as earnings divided by fixed weighted average salary in the following year. Fixed weights are obtained as an average share of employment through 2003-2012. Secondly, I compute efficiency unit wages as an average of relative wages through the entire period. Finally, to calculate efficiency unit supply I multiply groups supply by efficiency unit wages.

Education measure in this thesis is represented by 5 categories:

1. without a diploma of a high school (<11 grades of school);
2. high school diploma ("attestat");
3. vocational secondary education (ptu);
4. professional secondary education or/and incomplete professional higher education;
5. undergraduate/graduate professional higher education (bachelor, specialist, master, candidate of sciences or doctor of sciences degrees).

Experience is calculated as survey year-birth year -7-years of education.

Additionally, for the demand shifts occupation and industry categories are used. Occupation categories are represented by:

- Managers, Professionals and Technicians;
- Clerks and Sales Workers;
- Agricultural, Production Workers and Elementary Occupations.

And industries are divided on 10 categories:

1. Agriculture, Hunting and Forestry;
2. Manufacturing and Mining;
3. Electricity, Gas and Water Supply;

4. Construction;
5. Wholesale and Retail Trade, Repair of Motor Vehicles and Motorcycles; Hotels and Restaurants;
6. Transport, Storage and Communication;
7. Financial Intermediation, Real Estate, Renting and Business Activities;
8. Public Administration and Defense;
9. Education, Health and Social Work;
10. Other Community, Social and Personal Service Activities.

Table 1 represents average wage changes that appeared during 2003-2007 period. Wages of the more aggregate groups are represented by the fixed weighted average of the particular groups of employees. Fixed weights are calculated by dividing weighted hours worked of the specific group over whole time period by whole weighted hours worked of the more aggregate group. The numbers in the table are changes in logarithmic wages multiplied by 100.

Table 1 Relative wage changes (numbers are multiplied by 100).

Group	2003-2004	2004-2007	2007-2012	2003-2012
ALL	-0.085	0	0	-0.06
Male	-7.6	0.85	0.28	-3.67
Education:				
high school diploma	-0.7	0.2	0.21	0.95
undergraduate/graduate professional higher education	-21.49	3.05	-0.14	-13.01
Education and experience: undergraduate /graduate professional higher education				
Experience 1-10	-22.13	3.83	-0.91	-15.22
Experience 20-40	17.32	2.37	0.93	-5.56
Female	7.47	-0.83	-0.27	3.6
Education:				
high school diploma	17.04	-3.57	-0.25	5.1
undergraduate/graduate professional higher education	-6.07	1.6	-0.25	-2.52
Education and experience: undergraduate /graduate professional higher education				
Experience 1-10	-7.37	1.58	-0.88	-7.01
Experience 20-40	-4.89	1.34	-0.17	-1.72

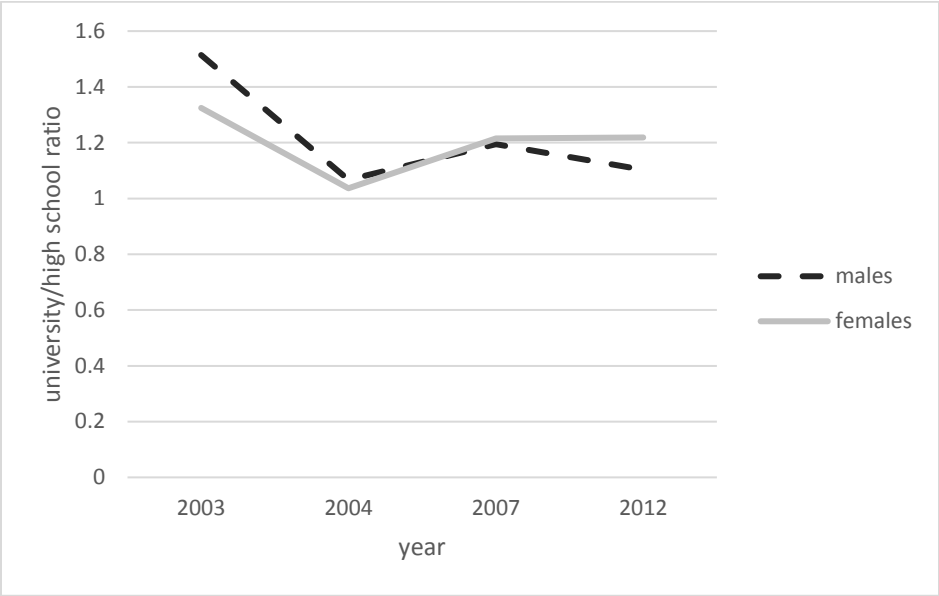
Table 1 shows that average relative wages of all workers in Ukraine decreased from 2003 to 2012.

It can be also seen that growth in average wages was slower for women than men during the 2004-2007 time period. This seems to contradict the government policy during this period that introduced important laws that were targeting gender inequality.

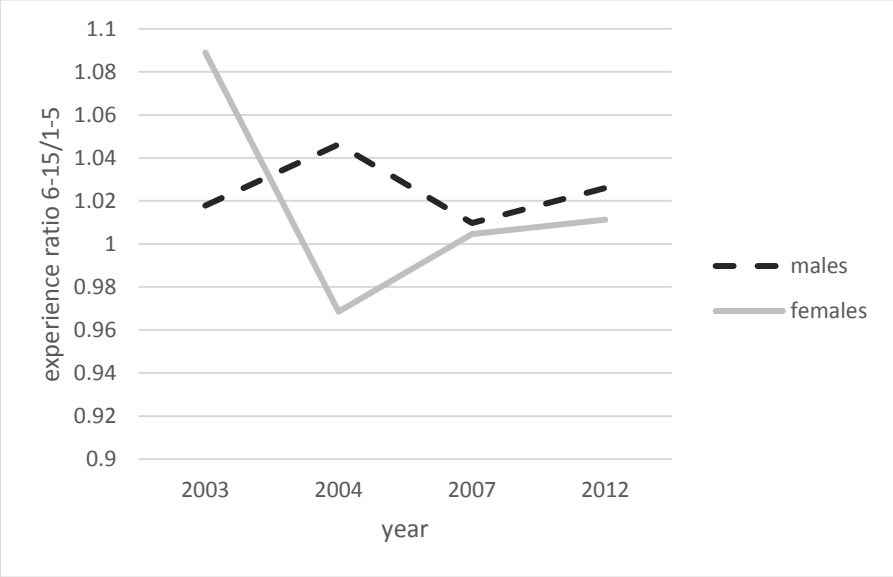
As a table shows period from 2003-2004 was characterized by higher growth in female's salary. The biggest contributors of this rise are females with high school diploma whose wages increased by 17.04 log points. The smallest growth over the entire period is of female university graduates with the 1-10 years of experience.

Based on the results over the whole period I have plotted education and experience premiums by genders:

Graph1A. Return to education by gender (2003-2012)



Graph 1B. Return to experience by gender (2003-2012)



Graphs 1A and 1B represent changes in returns to education and experience by genders. Both graphs suggest that female education and experience wage premiums significantly decreased

from 2003 to 2004. In 2007 there was almost no difference between salaries of experienced and new entrants in the market. And after 2007 the experience premium rose a little bit for both genders, but men experienced a bigger increase that women.

Despite the huge drop in education premium in 2004 it was still above 0.10 points for the university graduates compared to school graduates.

2. MODEL OVERVIEW

3.1 Supply and demand analyzes

To examine relative wage changes I have used the supply and demand framework proposed by Katz and Murphy (1992) that helps analyze between group shifts. In this framework the sample is divided on the different demographic groups by sex, education and experience that are treated as imperfect substitutes in production. The relative wages in this model are constructed as "interaction of the relative supplies of the groups and an aggregate production function with associated factor demand schedules" (Katz and Autor, 1999, pages 1509-1510). So wage changes are generated from relative demand and supply shifts. The main requirement of the model is that "quantities and prices must be on the demand curve" (Katz and Autor, 1999, page 1510).

The basic framework by Katz and Murphy assumes the following factor demand function that consists from K types of labor inputs:

$$X_t = D(W_t, Z_t) \tag{2}$$

where

$X_t = K \times 1$ vector of labor inputs in the market in year t;

$W_t = K \times 1$ vector of market prices for these inputs in year t;

$Z_t = m \times 1$ vector of demand shifts variables in year t.

In equation (2) - Z_t represents non labor shifters for the demand input such as technology, product demand[1].

Assuming that aggregate production function is concave, the (K*K) matrix of cross-price effects on factor demand, D_w, is negative semidefinite (Autor and Katz, 1999). Therefore after taking differential of equation (2) it can be rewritten in the form:

[1] Supply and demand framework description is closely follows the Katz and Murphy (1992) model

$$dX_t = D_w dW_t + D_z dZ_t \quad (3)$$

After rearranging equation (3) for the relative wages it can be represented in the form:

$$dW_t = (D_w)^{-1}(dX_t - D_z dZ_t) \quad (4)$$

In equation (4) relative wages depend on changes in the labor supply excluding other non-labor demand shifts. Taking into account that D_w, is negative semidefinite the following is implied:

$$D_w = dW_t^{/}(dX_t - D_z dZ_t) = dW_t^{/} D_w dW_t \leq 0 \quad (5)$$

From Equation 5 it follows that net supply shifts are negatively correlated with the wage changes. Under the assumption that factor demand is stable equation (5) can be written as:

$$dW_t^{/} dX_t \leq 0 \quad (6)$$

Equation (6) implies that the main force that drives wage change is relative supply changes. To test this empirically I have used the following relationship from Katz and Murphy (1992):

$$(W_t - W_\tau)^{/}(X_t - X_\tau) \leq 0 \quad (7)$$

where

t – is the beginning year for which inequality is tested and τ – is the ending year for which inequality is tested.

The relative supply changes over 2003-2012 period are presented in Table 2. The numbers in the table are logarithmic differences in efficiency units supply multiplied by 100. Figures represent 1 year changes in relative supply. In the intervals bigger than 1 year, supply is divided by the number of years.

Table 2. Relative supply changes

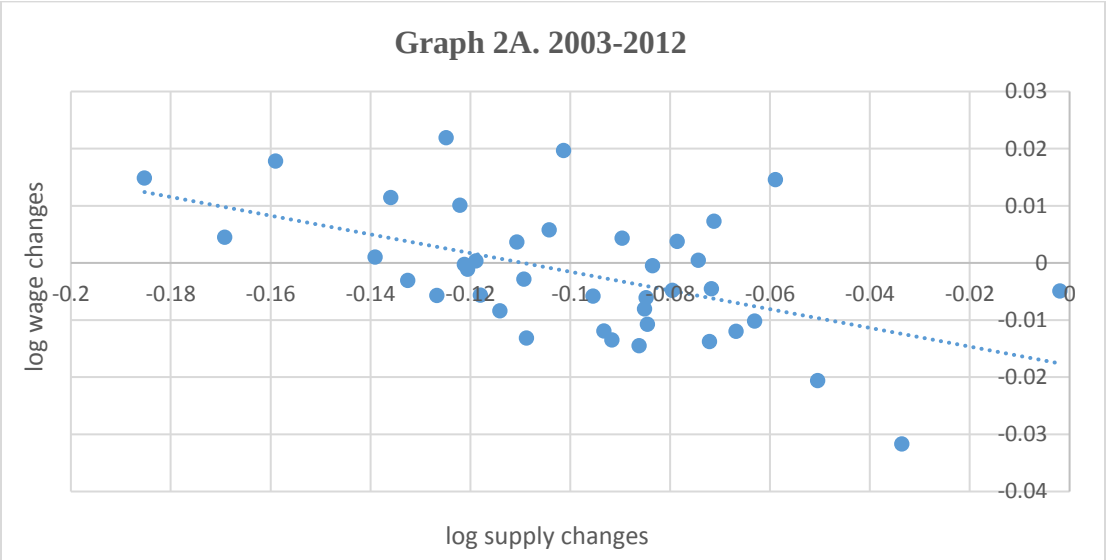
Group	2003-2004	2004-2007	2007-2012	2003-2012
Male	8.06	-4.17	-0.9	-8.98
Education:				
high school diploma	-31.17	-2.95	0.78	-36.12
undergraduate/graduate professional higher education	-3.5	-0.84	4.85	18.24
Education and experience: undergraduate /graduate professional higher education				
Experience 1-10	0.43	3.32	8.97	55.21
Experience 20-40	-1.39	-4.48	0.3	-13.33
Female	8.18	-3.76	-0.36	-4.87
Education:				
high school diploma	-43.2	0.55	0.94	-36.83
undergraduate/graduate professional higher education	6.68	-1.98	6.23	31.9
Education and experience: undergraduate /graduate professional higher education				
Experience 1-10	22.17	-3.77	14.14	81.54
Experience 20-40	2.06	2.32	0.79	12.96

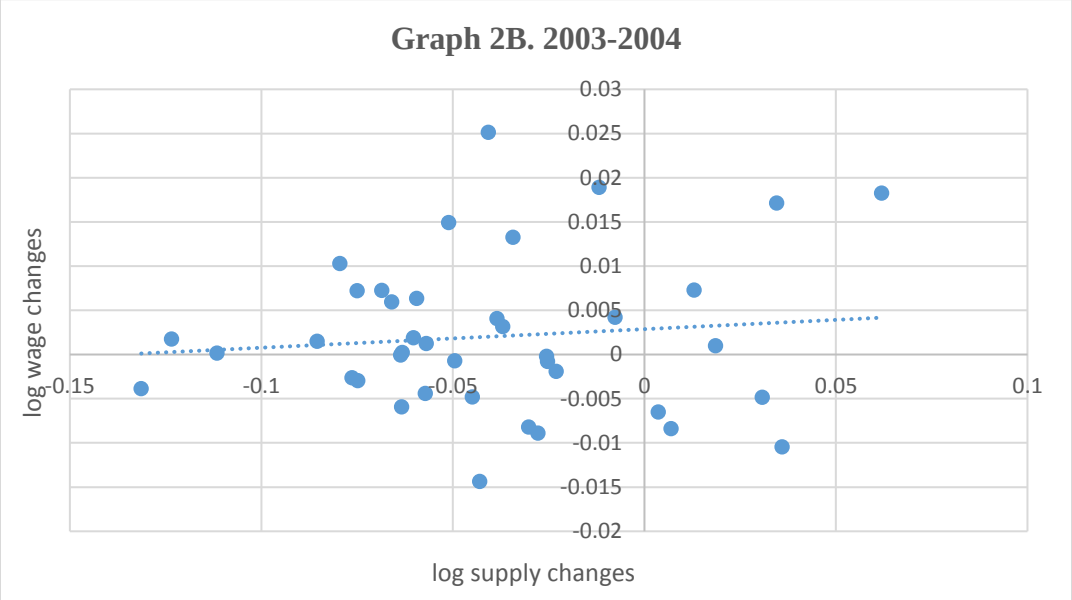
According to the results there was a significant rise in the supply of educated and modest experience workers during the entire period that coincides with the drop in the relative wages. However, growth in other employees' supplies is significantly smaller or even negative, as with high school graduates. According to the table 2 relative supply of high school graduates decreased substantially which coincides with the drop in the education premium during the same period.

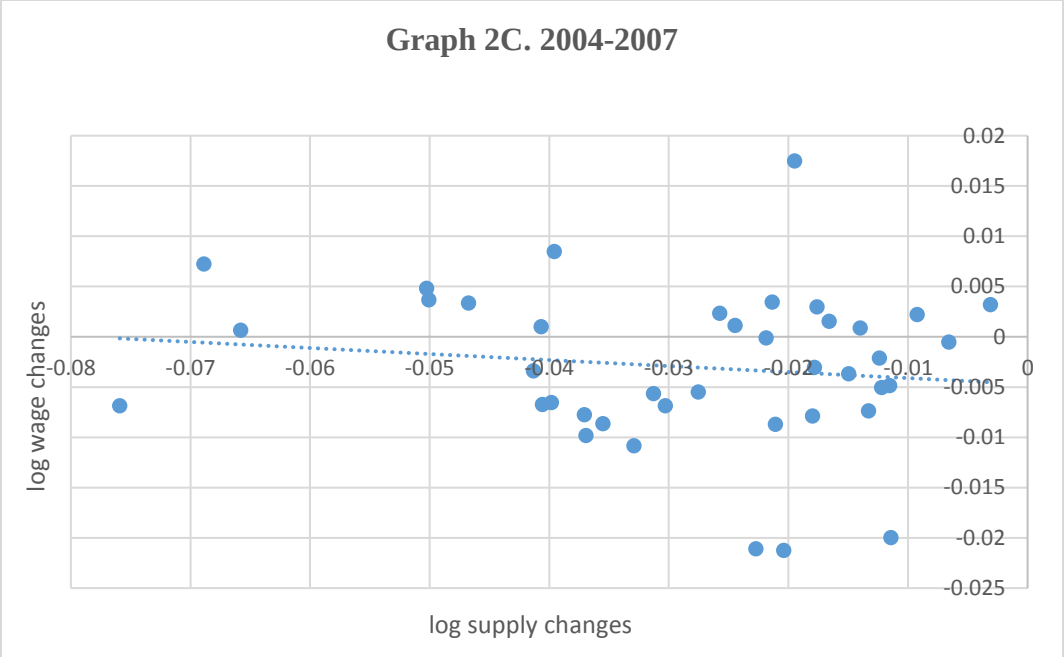
Male university graduates had both drop in the relative supply which coincides with the drop in relative wages. This suggests that relative supply factors might not be enough for explaining relative wage changes.

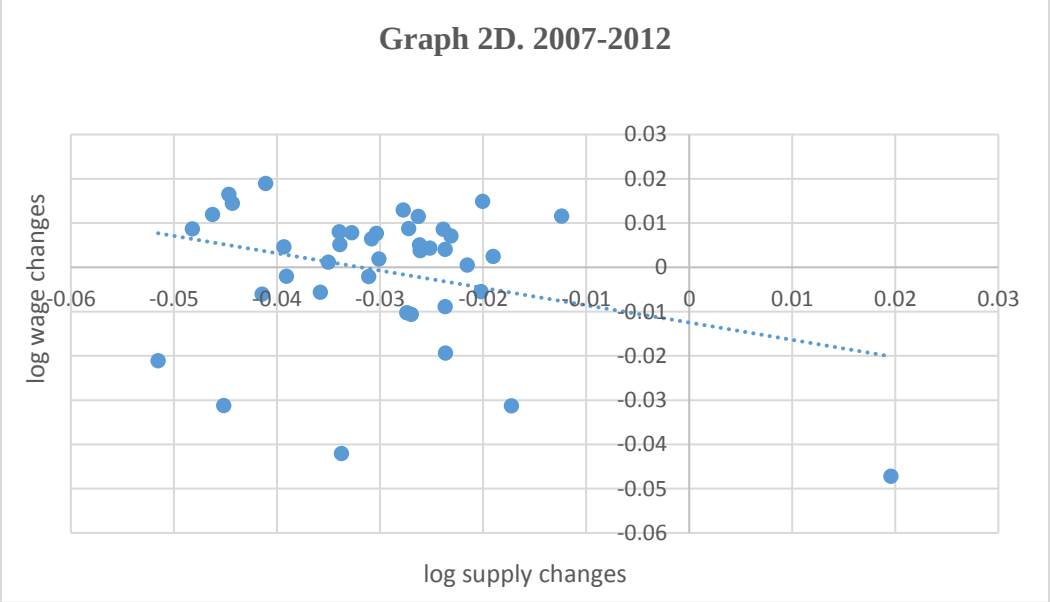
The next step is to empirically check equation (7). The results are represented on the graphs 2A-2D. They represent relationship between logarithmic relative changes in wages with logarithmic relative supply changes.

Graph2. Supply and wages changes









Linear trends from graphs 2A-2D suggest that 2003-2012 can explained by supply. It suggest that increase in supply results in the decrease in the relative wages. However, wages in the 2003-2004 period suggest that rise in the relative earnings cannot be explained by the relative supply. Graph 2B suggest that increase in relative supply results in an increase in relative earnings which contradicts inequality (7) but the angle of the trend is really small that could be due to the

sampling error. Graphs 2C and 2D both are consistent with the stable demand hypothesis. So graphs 2A-2D suggest that most of the changes in the relative wages can be explained by the supply but in some periods it is not enough so demand analysis is needed to be added.

3.2 Demand change analysis

From the calculations above I can conclude that supply alone cannot explain relative changes in wages. To account for the skill-biased technological change, appearance of foreign companies in Ukraine, etc. I have used demand framework. Between group demand changes could have influenced wages significantly.

Table 3 and table 4 present industry and occupation distribution over the entire period. Numbers represent percentage of people employed in the specific occupation or industry over the entire period from 2003 to 2012.

Table 3. Employment by occupation

Education	high school	professional secondary education/incomplete professional higher education	university
Managers, professionals and technicians	48.88	35.3	58.64
Clerks and sales workers	5.88	53.92	20.55
Agricultural, production workers and elementary occupations	45.24	10.78	20.81

Table 4. Employment by industry

Education	high school	professional secondary education/incomplete professional higher education	university
Agriculture, hunting and forestry	14.18	8.23	5.66
Manufacturing and mining	25.07	19.92	17.29
Electricity, gas and water supply	4.02	3.34	3.03
Construction	7.40	4.91	4.87
Wholesale and retail trade, repair of motor vehicles and motorcycles; hotels and restaurants	16.68	17.07	14.45
Transport, storage and communication	9.10	9.90	5.13
Financial intermediation, real estate, renting and business activities	0.78	2.92	6.25
Public administration and defense	2.15	3.10	7.31
Education, health and social work	12.18	23.41	28.57
Other community, social and personal service activities	8.44	7.21	7.45

From table 4 it can be derived that the biggest share works in the Education, Health and Social Work industry; educated employees are the vast contributors to this. On the other hand high school graduates mostly work in Manufacturing and Mining industry. The leading occupation is Professionals followed by Clerk and Sales occupations. It is interesting to see that majority of people with the university education as well as high school graduates work as managers, professionals and technicians.

The next step is to look at the changes in composition that appeared during 2003-2012. Those changes are presented in table 5. Figures present 1 year changes in employment between industries/occupations. In the intervals bigger than 1 year, demand changes are divided by the number of years.

Table 5. Changes in employment shares by industry and occupation

	Percentage employment shares			
Year	2003-2004	2004-2007	2007-2012	2003-2012
Industry				
Agriculture, hunting and forestry	-0.06	-2.07	0.39	-4.32
Manufacturing and mining	-0.36	-0.10	-0.17	-1.50
Electricity, gas and water supply	0.09	0.11	-0.16	-0.37
Construction	1.34	0.48	-0.15	2.04
Wholesale and retail trade, repair of motor vehicles and motorcycles; hotels and restaurants	-1.30	0.95	0.14	2.22
Transport, storage and communication	0.56	-0.31	0.13	0.30
Financial intermediation, real estate, renting and business activities	-0.12	0.44	0.01	1.26
Public administration and defense	0.59	-0.03	-0.06	0.21
Education, health and social work	-0.77	0.12	0.42	1.69
Other community, social and personal service activities	0.03	0.41	-0.56	-1.54
Occupation				
Managers, professionals and technicians	-1.57	0.02	0.64	1.71
Clerks and sales workers	-0.28	0.27	0.63	3.71
Agricultural, production workers and elementary occupations	1.85	-0.29	-1.28	-5.42

From table 5 it can be seen that employees shifted away from low skill agriculture industries in 2003-2004 toward more profitable industries such as wholesale and retail trade, repair of motor vehicles and motorcycles; hotels and restaurants and construction. This shift can explain drop in education premium as workers with high school degree shifted to more profitable industries where university graduates work.

On the occupation side people moved away from agricultural, production workers and elementary occupations to sales and clerks that is consistent with the rise of high school graduates' wages as they shifted towards more profitable occupations.

Finally, to correctly explain rise in relative wages between-industry shares should fall in all occupation/industries cells where earnings increased. However, during the entire 2003-2012 period shares of employment in almost all industries and occupations increased. This suggest that between-industry demand shifts alone cannot fully explain changes in relative wages. So the next step is to look at the within-industry and between-industry demand changes together.

3.3 Demand framework

To model demand between group demand changes I assume that within groups demand is stable. To model those shift I use Katz and Murphy (1992) framework which is based on Freeman (1975,1980) "manpower requirements" index:

$$X_j = C_w^j(W)Y_j \tag{8}$$

where

j- sectors/industries/occupations;

Y_j –output vector in sector j (it is assumes constant return to scale);

X_j – $K \times 1$ vector of factor demand;

$C_w^j(W)$ - $K \times 1$ vector of unit demand curves.

By assuming stable within industry demand and differentiating equation (8) the following is derived:

$$dX_j = C_w^j(W)dY_j + Y_jC_{ww}^j(W)dW \tag{9}$$

By multiplying equation 8 by W and using the fact that unit factor demands are homogeneous of degree zero in factor prices the following is implied:

$$W/dX_j = W/X_j(dY_j/Y_j) \tag{10}$$

After rearranging equation (10) can be rewritten in the form:

$$\frac{dY_j}{Y_j} = \frac{W/dX_j}{W/X_j} \tag{11}$$

Using results from equation (11) and by aggregating equation (9) across sectors the following equality is derived:

$$dX = \sum_j X_j \frac{dY_j}{Y_j} + C_{ww} dW = \sum_j X_j \frac{W/dX_j}{W/X_j} + C_{ww} dW \tag{12}$$

where

dX- $K \times 1$ vector of employment changes;

C_{ww} - $K \times K$ matrix that corresponds to the production-weighted average of the Hessians (second partial derivatives) of the unit cost functions for the J industries and it is negative semidefinite.

The next relationship follows from equation (12) and negative semidefiniteness of the C_{ww}:

$$dW/(dX - \sum_j X_j \frac{W/dX_j}{W/X_j}) = dW/C_{ww} dW \leq 0 \tag{13}$$

From equation 5 and the stable factor demand the following equality is derived:

$$\Delta D = \sum_j X_j \frac{W/dX_j}{W/X_j} \tag{14}$$

From equation (14) it follows that people who are employed by growing sectors would have rising demand and those who work for the shrinking sector would have decreasing demand.

Under the condition that relative wages change over time the demand shift index from equation (14) would be biased. This bias can appear due to the fact that changes in salaries can lead to redistribution of sectoral outputs. If the sector hires people with rising relative wages then corresponding output could be lower than that with the stable demand which leads to downward bias of ΔD. To account for those output can be written as:

$$dY = dY^* + Y_p dP = dY^* + Y_p C_w dW \tag{15}$$

where

dY^*- J × 1 vector of "true" product demand shifts computed at fixed factor prices;

P- J × 1 vector of sector output prices;

Y_p- J × J matrix of derivatives with respect to the price vector of the sectoral demand functions;

C_w- J × K matrix of derivatives of the unit cost function with respect to own wages.

Under the assumption of the constant returns to scale $dP = C_w(W)$ and from equations (15),(14),(10),(8) equation (16) follows:

$$\Delta D = \sum_j C_w^j(W)dY_j = (C_w)'dY = (C_w)'dY^* + (C_w)'Y_p C_w dW \quad (16)$$

3.4 Empirical measure of the demand shifts

To implement demand analyses I have divided data on 30 categories by occupation and industries. In Katz and Murphy (1992) between industry demand shift index that corresponds to the one in equation (14) construct as presented below:

$$\Delta X_k^d = \frac{\Delta D_k}{E_k} = \sum_j \left(\frac{E_{jk}}{E_k}\right)\left(\frac{\Delta E_j}{E_j}\right) = \frac{\sum_j \alpha_{jk}\Delta E_j}{E_k} \quad (17)$$

where

j-sector;

E_j – total labor input in sector j measured in efficiency units;

$\alpha_{jk} = \frac{E_{jk}}{E_k}$ – group k's share of total employment in efficiency units in sector j in the base year.

Division of the data on industry and occupation allows me to measure within industry changes. So equation (17) with the j indexing occupations and industries are used to measure overall demand changes. When j is indexing only industries it measures between-industry

demand shifts. Finally, to calculate within-industry demand between-industry demand shifts are subtracted from overall measure of demand changes. Results of the empirical evaluation of equation (17) are presented in the table 6.

Table 6. Demand shifts (2003-2012)

	Demand shifts								
	Industry-occupation			Within industry			Between		
	2003-2004	2004-2007	2007-2012	2003-2004	2004-2007	2007-2012	2003-2004	2004-2007	2007-2012
males									
1	4.98	-0.10	-0.94	1.41	0.40	-0.98	3.57	-0.50	0.04
2	3.39	0.45	-0.76	1.67	0.59	-0.77	1.72	-0.14	0.01
3	3.97	0.37	-0.74	1.97	0.37	-0.78	2.00	0.00	0.04
4	2.16	0.24	-0.05	1.18	0.21	-0.03	0.99	0.04	-0.01
5	-0.56	0.91	1.53	-1.12	0.37	1.23	0.56	0.54	0.30
females									
1	-1.11	0.03	-0.11	-0.89	0.88	-0.58	-0.22	-0.85	0.47
2	-0.33	0.49	0.33	-0.06	0.58	0.22	-0.28	-0.09	0.11
3	-0.12	0.62	0.43	0.04	0.65	0.39	-0.16	-0.03	0.04
4	-0.69	0.39	1.28	-0.40	0.29	1.11	-0.29	0.10	0.17
5	-1.65	0.69	1.57	-1.24	0.08	1.23	-0.41	0.61	0.33

*Where 1-employees without a diploma of a high school (<11 grades of school); 2-high school diploma ("attestat"); 3- vocational secondary education (ptu); 4- professional secondary education or/and incomplete professional higher education; 5- undergraduate /graduate professional higher education (bachelor, specialist, master, candidate of sciences or doctor of sciences degrees).

From the table 6 I can conclude that overall demand for employees who have not finished high school fell over the entire period whereas other groups demand increased. The biggest increase in demand occurred for university education and employees with university degree. The between-sector demand shifts suggest that there was an increase in demand for university employees among both genders, for males without a diploma of a high school and for vocational secondary education men. However, the growth in demand for university graduates is the highest and over all period it is 10 percent, it is still smaller than rise in supply. So even interaction of both supply and demand factors is not enough to explain huge rise in Ukrainian wages.

3.5 Education premiums

The university premium declined substantially during 2003-2004 and did not recover through 2004-2012 to the previous level in 2003. According to Katz and Murphy (1992) there are 2 possible explanations to it: change in earnings of groups according to their skill sets; the second explanation is change in combination of employees. In their paper Autor, Katz and Kearney (2008) found that changes in prices for the skills are enough to explain premium in wages for the college graduates in 1963-1987 but it fails to do so after 1987. Therefore to account for both factors I use form of the CES function proposed by Card and Lemieux (2001) to investigate university/high school premium. The model assumes that the same education level employees with the different years of experience are imperfect substitutes and according to it CES function constructed as shown below:

$$\log\left(w_{ujt}/w_{hjt}\right) = \log\left(\theta_{ut}/\theta_{ht}\right) + \log\left(\beta_j/\alpha_j\right) + \left[\left(\frac{1}{\sigma_A}\right) - \left(\frac{1}{\sigma_E}\right)\right]\log\left(\frac{U_t}{H_t}\right) - \left(\frac{1}{\sigma_A}\right)\log\left(\frac{U_{jt}}{H_{jt}}\right) + e_{jt} \quad (18)$$

where

w_{ujt} –wages of university students of j experience group;

w_{hjt} – wages of high school students of j experience group;

θ_{ut} , θ_{ht} – technological efficiency parameters of university and high school students accordingly;

β_j, α_j – relative efficiency parameters of university and high school students accordingly;

σ_A – partial elasticity of substitution between different age groups with the same level of education;

σ_E –elasticity of substitution between university and high school students;

U_t – supply of university students in efficiency units;

H_t - supply of high school students in efficiency units;

U_{jt} – supply of university students of experience group j in efficiency units;

H_{jt} - supply of high school students of experience group j in efficiency units;

e_{jt} -sampling variation in the wage premium.[2]

By rearranging equation (18) to more convenient form Card and Lemieux (2001) obtained the following model:

$$\log\left(w_{ujt}/w_{hjt}\right) = \log\left(\theta_{ut}/\theta_{ht}\right) + \log\left(\beta_j/\alpha_j\right) - \left(\frac{1}{\sigma_E}\right)\log\left(\frac{U_t}{H_t}\right) - \left(\frac{1}{\sigma_A}\right)\left[\log\left(\frac{U_{jt}}{H_{jt}}\right) - \log\left(\frac{U_t}{H_t}\right)\right] + e_{jt} \quad (18a)$$

To evaluate equation 18 and 18a empirically I have divided wage and supply data on 11 experience groups and 5 educational categories. Relative wages are constructed as logarithm of average wages of university students divided by average wage of high school students. Supply of high school and university students constructed as sum of their supplies and weighted supplies of the other education groups. Weights are calculated as it is described in Katz and Murphy (1992) by running a regression of average wages of high school dropouts, vocational secondary education and professional secondary education or/and incomplete professional higher education students on high school and university students without constant. Results of below presented in the table 7.

[2]Education premium model description is closely follows the Card and Lemieux (1992) paper

Table 7. Supply weights

Education category	high school dropouts	vocational secondary education	professional secondary education/incomplete professional higher education
high school	0.714	0.586	0.494
university	0.257	0.398	0.469

According to Card and Lemieux (2001) equation 18 depends on $\log\left(\theta_{ut}/\theta_{ht}\right) + \left[\left(\frac{1}{\sigma_A}\right) - \left(\frac{1}{\sigma_E}\right)\right]\log\left(\frac{U_t}{H_t}\right)$ –factors specific to the years and do not change with the experience and $\log\left(\beta_j/\alpha_j\right)$- experience specific factors. Based on this I estimated the following regression:

$$\log\left(w_{ujt}/w_{hjt}\right) = \alpha_0 + \alpha_1 \log\left(\frac{U_{jt}}{H_{jt}}\right) + \gamma * \mathrm{t} + \beta_j + e_{jt} \qquad (19)$$

where

j-is indexing experience categories;

β_j – are experience group effects;

t- are year effects;

Results of it are presented in the table 8.

Table 8. University/high school wage premium by experience categories

VARIABLES	(1) Year dummies	(2) Linear trend
relative_supply	0.0856	-0.0327
	(0.161)	(0.199)
year2004	-0.232***	
	(0.0486)	
year2007	-0.00378	
	(0.0410)	
year2012	-0.0115	
	(0.0395)	
t		0.0123**
		(0.00556)
Constant	0.294**	0.167
	(0.111)	(0.137)
Observations	44	44
R-squared	0.653	0.282

Regression (19) contains experience dummies to approximate for the experience group effects that were not included in the resulting table 8.

In the table 8 there are 2 specifications of the model presented: one with the year effects and another with the linear time trend. Both models suggest that there is no significant effect of the relative supply on the relative wages. However, it can be seen from the second model that over the time wages of university graduates relative to school graduates rose by 1.2% per year.

The second specification of the model presented by equation 18 where following Card and Lemieux (2001) model $\log\left({\theta_{ut}}/{\theta_{ht}}\right)$ represents relative demand shifts and can be approximated by linear time trend.

Based on the model from equation 18a the following regression was constructed:

$$\log\left({w_{ujt}}/{w_{hjt}}\right) = \alpha_0 + \alpha_1 \log\left(\frac{U_t}{H_t}\right) + \alpha_2 \left[\log\left(\frac{U_{jt}}{H_{jt}}\right) - \log\left(\frac{U_t}{H_t}\right)\right] + \alpha_4 t + \beta_j + e_{jt} \quad (20)$$

Results from the regression above are presented in the table 9. In the second model I added term used by Author, Katz and Kearney (2005) time^2/100.

Table 9. University/high school wage premium by experience categories (including aggregate supply)

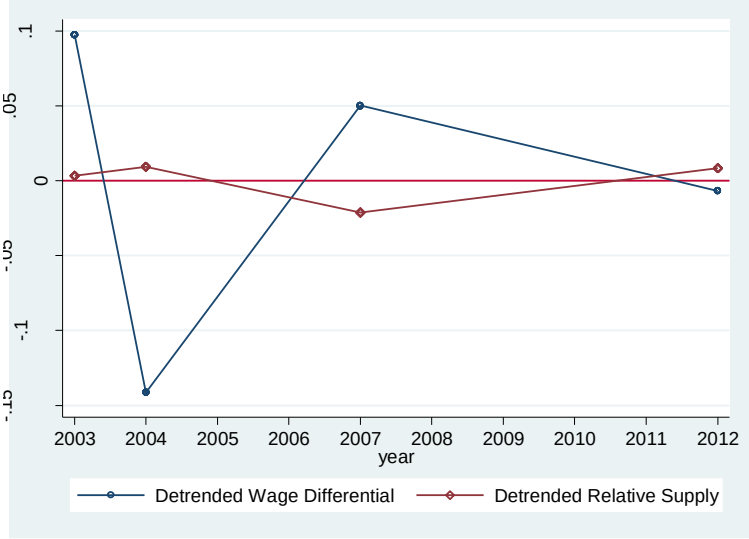
VARIABLES	(1) Model 1	(2) Model 2
Difference between supply and aggregate supply	0.0192	0.0856
	(0.196)	(0.161)
Aggregate supply	-3.461**	-14.05***
	(1.498)	(2.777)
t	0.0690**	0.0704***
	(0.0271)	(0.0225)
tsq		1.888***
		(0.403)
	(0.155)	(0.103)
Constant	-0.486	-2.362***
	(0.348)	(0.513)
Observations	44	44
R-squared	0.366	0.653

Regression (20) contains experience dummies to approximate for the experience group effects that were not included in the resulting table 8.

Table 9 suggest that linear and squared time trends and aggregate by education supply are significant. Results from table 9 imply that elasticity of substitution between university and high school students is around 0.29 in model 1 and around 0.07 in the model 2. Small elasticity of substitution suggest that most of the changes in relative wages can be explained by the changes in

As a result of calculations above appears a question: what fraction of the relative wages can be explained by the relative supply and what by the relative demand? In the graph 3 there are illustrated residuals of the relative supply and relative wage regressions on the linear time trend.

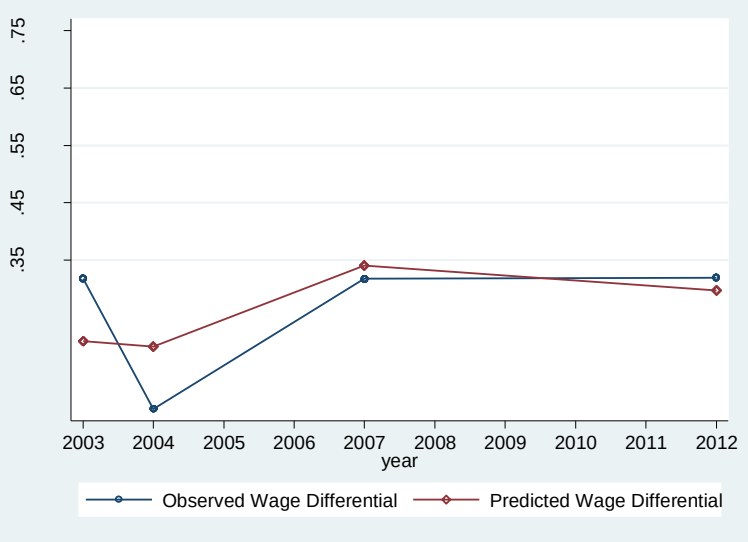
Graph3. Detrended University Wage Premium and Relative Supply



Graph 3 suggests that almost during entire period there is negative correlation between supply and wages. This means that approximation of relative demand shifts by linear trend fits data quite good. However, wage movements were much bigger than shifts in relative supply.

Based on the values predicted from regression (20) I have made graph 4.

Graph 4. Predicted values for the university/high school wage premium



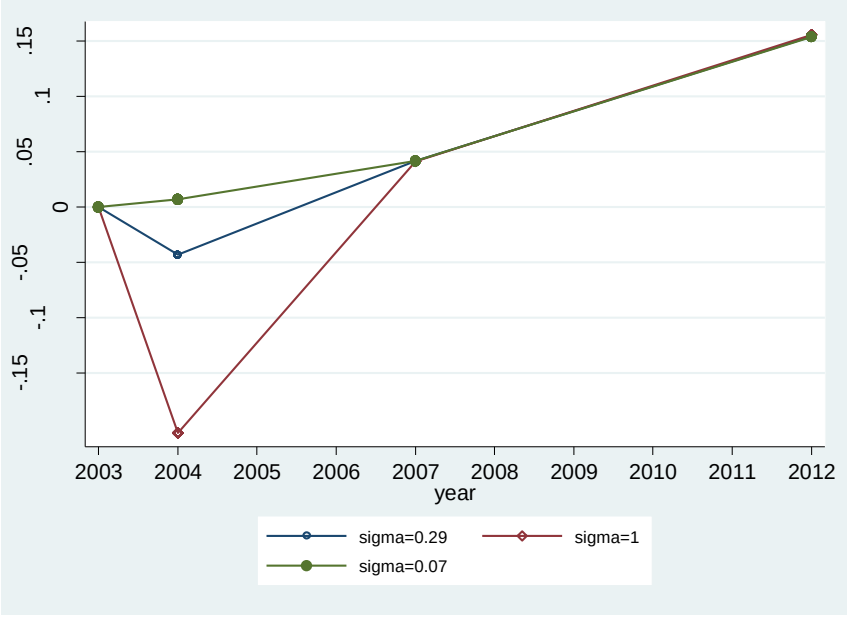
Graph 4 illustrates actual time series and fitted values. It shows that in 2007 and 2012 predicted values are close to the observed in the data patterns. The only discrepancies appear in 2003-2004 period.

Based on the table 9 I can make a conclusion that groups own supply is not significant in explaining relative wages. Therefore, return to education is similar across different experience groups. Following this relative demand shifts can be constructed using only aggregate relative supply. In their paper Katz and Murphy derived that relative demand shifts can be approximated by equation:

$$D(t) = \sigma_0 \log\left({}^{W_{ujt}}/_{W_{hjt}}\right) + \log\left(\frac{U_t}{H_t}\right) \quad (21)$$

Substituting different values of elasticities: 0.07, 0.29, 2 the log relative demand was predicted. Results of this are presented in the graph 5.

Graph 5. Predicted values of demand



Graph 5 shows demand with the different elasticities of substitution between education groups. From it I can make a conclusion that sigma around 1-2 would fit the observed wages and supply data in 2003-2007 period.

The next step is to see how movements in observed relative demand coincide with the previous demand shifts. To do this I summarize results from table 6 and regression (20) in the table 10.

Table 10. University/high school relative wages, supplies, demands

Variable	2003-2004	2004-2007	2007-2012	2003-2012
University/high school wage ratio	-26.01	25.97	0.06	0.02
relative supply	2.27	1.88	11.22	15.38
demand shifts industry-occupation	-4.48	0.63	-0.82	3.80
demand shifts within industry	-2.70	1.69	-1.11	-3.47
demand shifts between industries	-8.87	-1.12	0.10	1.17

Table 10 summarizes year supply, demand and wage movements. Results suggest that demand and supply framework does a good job in explaining relative wage changes in 2003-2004. However, earnings drop is smaller than drop in demand and rise in supply. In the 2004-2007 period rise in demand and supply cannot fully explain big rise in the relative wage premium for university graduates. And in the third period there was a small rise in relative wages that is not consistent with the big change in relative supply. So additional factors are needed to fully explain wages in Ukraine.

CONCLUSION

The main goal of this thesis is to analyze Ukrainian relative wages during 2004-2012 period. In order to explaining relative wages in Ukraine I used supply and demand framework proposed by Katz and Murphy (1992).

During this period Ukraine is characterized by the colossal growths of the real average wages by as much as 150 per cents for the entire period (Average montly salary in Ukraine, 2016). Although, Ukraine is characterized by the high education level and literacy rate around 99.7% in 2008-2012 (Unicef, 2013) it still one of the lowest income countries in Europe (Wikipedia, 2017). Therefore, question of changes in relative wages in Ukraine are important and interesting topic to consider.

Based on the data Ukrainian average wages grew by almost twice during 2003-2012 period. However, this substantial growths in earnings was not always combined with decrease in the relative supply. For example, in 2003-2004 rise in supply led to the increase of relative earnings which contradicts stable demand hypothesis. Therefore as a next step I looked at the demand changes that suggest that large between-industry demand shifts combined with the negative changes in supply in 2003-2004 are necessary to explain relative wage decline. However, not in all periods combined changes in relative supply and demand are enough to explain relative wage changes and additional factors are needed.

Finally, I have investigated supply and demand changes in terms of university/high school wage differentials. According to the data Ukrainian wage premium for education changed substantially during the 2003-2012 period, with the massive decline in 2004 and moderate growth after for females and rise in 2007 and drop in 2012 for males. To research this topic I used model proposed by Card and Lemieux (2001) that treats experience groups as imperfect substitutes in

production. Results suggest that education premium can be explained by the changes in relative supply of university/high school students, however no evidence found that this wage premium changes are different across experience groups. However, based on the predicted values time trend and relative supply changes are not enough to explain relative wages fully, especially during 2003-2004 period.

In this paper I investigated dependence of relative wage changes on supply and demand factors. Although, relative demand and supply explain some wage changes further research of different factors can improve explanation of relative wage changes.

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