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THE IMPACT OF GENDER WAGE GAP ON SECTORAL ECONOMIC GROWTH – CROSS-COUNTRY APPROACH

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ABSTRACT

We propose an empirical analysis of testing the relationship between gender wage gap and economic growth. The study takes into account 12 manufacturing sectors in 18 OECD countries for the period between 1970 and 2005.We use industrial statistics (EU KLEMS, 2008) on female and male wages that distinguish between wages paid to different groups of workers classified according to skill level: high, medium and low. We estimate augmented production function where the male-female wage differentials constitute a potential channel influencing growth (positively or negatively). Our research is motivated by the ambiguous results of previous empirical studies (e.g.: Seguiono, 2000; Busse and Spielmann, 2006; Seguino, 2011; Schober and Winter-Ebmer, 2011). Our main findings indicate that gender wage gap for high, medium and low-skilled workers is negatively correlated with sectoral growth. At the same time we confirmed the positive role of trade and human capital. The results are confirmed in number of robustness checks.

Keywords: gender wage gap, economic growth, manufacturing sectors

JEL: J16, J31, F43

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1. Introduction

There is a general agreement that gender inequality is harmful not only from the perspective of a given discriminated individual and her well-being, but also for the economy as a whole. This believe is the underpin of policy actions that focus on promoting female/male equity taking into account economic, political, educational and health-based context[1]. The main message of the latest World Development Report is that gender equity matters for development:

"*Gender equality is a core development objective in its own right. It is also smart economics. Greater gender equality can enhance productivity, improve development outcomes for the next generation, and make institutions more representative*". (World Bank, 2011 p.XX).

However, the relationship between economic growth and gender inequality is complex as being the consequence of direct and indirect factors. The vast part of the feminist literature focused on unequal access of females to education (among others: Klasen, (2002), Klasen and Lamanna, (2009), Knowles et al. (2002)). If females have a restricted access to the education it will lower the overall human capital which is harming for economic growth. Additionally, female education can impact long-run economic growth through reduced fertility, lower child mortality and better perspectives for the next generations (Berik et al, 2009). In a similar manner the restricted access to the labor market can impact negatively the economic growth as the optimal allocation of resources is distorted.

In this paper we concentrate on the gender wage gap understood as different level of remuneration of women and men that is not explained by the differences in their productivity.

The theoretical background of our study is Becker's discrimination theory (Becker, (1971) in which gender wage gap occur as a result of employers' taste of discrimination – employers are willing to pay over marginal productivity due to their preferences. Comparison

[1] For example incentives of International Labour Organistation (see projects of Bureau for Gender Equality), World Bank (e.g.: Gender Equality Agenda at the World Bank Group), United Nations (Goal 3 of Millennium Development Goals is dedicated to the promotions of gender equity and empowerment women), and others. At the European level activities are carried under the auspices of European Commission Directorate-General for Justice, Directorate General for Employment, Social Affairs and Inclusion, European Parliament Committee on Women's Rights and Gender Equality, and The European Institute for Gender Equality.

of profits of discriminating and nondiscrimiantiong firms is in favor of the latter. Thus, decrease of productivity (slower growth) is one of the main outcome of discrimination.

However, there are a few channels through which female-male wage differentials can influence economic growth. First of all, it is argued (Seguiono 2000) that gender wage inequality through export expansion can stimulate country's growth. The mechanism of this unintuitive hypothesis is quite simple. For example if exports is based on labor-intensive goods then lower renumeration of work force intensively used for its production (e.g women) would spur its price competitiveness and lead to export expansion. Then, income from export earnings can provide the financial resources to produce/purchase new technologies and hence stimulate country's growth. In the similar manner the gender wage gap can lead to higher investments.

Contrary view is based on the prediction that income inequality (also gender inequality) can produce social conflict that may retard economic growth. For example higher difference in wages obtained by men and women might discourage women from entering labour market and hence influence women's fertility decision. If women are paid lower wages then opportunity cost of children decreases which can lead to higher population growth, decrease capital per worker and slow down of economic growth (World Bank, 2011)

Further, then women's consumption pattern is different from men and they tend to spend more of their income on children's education and health which can also affect development in long run (Pervaiz et al. (2011)). Reducing gender wage gap can enhance women's labour participation and they will spend their earning rather on children's education and health and this investment in future generation will cause more productive and efficient labour force for the future which will be beneficial for long-run growth.

We can see that starting from the theoretical point of view the wage gap can either influence economic growth negatively or positively and in consequence the overall effect is ambiguous.

Additionally, the empirical studies on gender wage gap and economic growth nexus are far from the conclusive. In the seminal paper (Seguion, 2000) analyzed 20 semi-industrialized countries during 1975 – 1995 and showed that GDP growth and investments were positively related to gender wage inequality. Author explains it by the export lead hypothesis. However, these controversial results were highly discussed in the literature. Busse and Spielmann (2006) confirmed the positive linkages between gender inequality and trade flows of a sample of 92 developed and developing countries. They showed that countries with a larger gender wage gap have higher exports of the labor-intensive manufactured goods.

Contrary, Schober and Winter-Ebmer (2011) replicated the Seguino's empirical analysis with the use of different character of the data. They used the data coming from a meta-regression on the international gender wage gap (Weichselbaumer and Winter-Ebmer, 2005) and none of their regressions showed any positive impact of gender wage discrimination on economic growth. In a reply to Schober and Winter-Ebmer, Seguino (2011) questions the quality of data based on heterogeneous micro-level studies, discuss the possible measurement errors that such data introduce and notes concerns with the meta-regression they performed. She concludes that to test the hypothesis of the impact of the gender wage differentials on the growth one should take into account education-adjusted wages from manufacturing sectors.

In view of this discussion, we propose an empirical analysis of testing the gender wage gap and economic growth nexus on the basis of 12 manufacturing sectors in 18 OECD countries for the period between 1970 and 2005. We use industrial statistics (EU KLEMS, 2008) on female and male wages that distinguish between wages paid to different groups of workers classified according to skill level: high, medium and low The base of our empirical analysis is augmented production function where the male-female wage differentials constitute a potential channel influencing growth.

The rest of the paper is structured as follows: in Section 2, we present data and describe the trends in the female/male wage ratio across different industries, and skill specifications, in Section 3 we estimate an augmented production function revealing the effects of gender wage differentials on the evolution of sectoral growth, together with numerous robustness checks. Finally, Section 4 concludes.

2. The trend in the female/male wage ratio across countries and across industries

One of the main difficulties of cross-country studies considering gender wage gap is the limited access to the comparable data on female and male wages at relatively disaggregated industry level (see discussion in Seguino (20111) and Schober and Winter-Ebmer (2011)). In this study we use data coming from the EU KLEMS, 2008 on female and male wages that distinguish between wages paid to different groups of workers classified according to skill level: high, medium and low. The macroeconomic nature of the dataset has its price. We do not possess information about education, qualification, experience, etc. that would make it possible to calculate the residual gender wage gap, i.e. the gender wage gap that remains after controlling for differences in those factors. Because of that we are forced to

assume that female and male workers have similar abilities in the three skill categories (low, medium and high), and, consequently, we treat gender wage differentials as a proxy for the residual wage gap. A similar approach has been taken in other macroeconomic studies (e.g. Oostendorp, 2009; Dominguez-Villalobos and Brown-Grossman, 2010, Wolszczak-Derlacz 2013). The data take into account 34 industries (12 manufacturing) from 18 OECD countries for the period between 1970 and 2005. Table 1 and 2 in the Appendix present the final country and sector composition of our panel.

Rest of the sector-specific data: value added, labour, gross fixed capital formation also come from the EU KLEMS 2008. We use country- and industry-specific price indices to report all nominal values in constant terms (1995=1). The data on imports and exports come from the OECD STAN (2009 release). The country-level data on human capital are retrieved from the UNCTAD database, which in turn is based on interpolation and extrapolation of Barro and Lee's (2010) dataset.

Table 1 presents female/male wage ratio of high-skilled, medium-skilled and low-skilled workforce, by sector in 1970 and 2005. At all skill levels and in all industries, women earn significantly less than men. Taking into consideration total economy, the greatest differences are for low-skilled workers, where on average in 2005 women's earnings represented around 72 per cent of men's earnings and the smallest for medium-skilled workforces, where women's wages constituted 79 per cent of men's. When we compare gender wage gap across industries and skill categories then, for high-skilled and medium-skilled workers, the biggest difference in 2005 were for financial intermediation (female/male ratio of 0.668 and 0.732 respectively) and for low-skilled workers - maintenance and repair of motor vehicles and motorcycles 0.686. Between 1970 and 2005, the biggest increase in the ratio of female/male earning were experienced in real estate activities (both for high and medium skilled categories)., where the figure rose by 86 and 45% respectively while for the low-skilled workers by 20%. However it should be noted that despite the general trend of an increasing trend in the female-to-male earnings ratio, there are cases where the drop in the figures was observed e.g high skilled workers in agriculture experienced a decrease in the ratio, the same is true for medium and low skilled workers from sale, maintenance and repair of motor vehicles and motorcycles sector.

It is also worth examining the wage gap for the manufacturing sectors more closely. Generally, for the aggregate of manufacturing sectors the female/male ratio rose by 30% for high skilled workers and by around 15% for medium and low-skilled workers. The highest increase between 1970 and 2005 was observed for the sector of basic metals and fabricated

metal products both for high skilled and low skilled workers which, however, were starting from the lowest point in 1970 (women's earnings represented around 50 and 58 per cent of men's earnings respectively). Among manufacturing sectors in 2005 the lowest female/male wage ratio for high skilled workers is for textiles, while for medium and low skilled workers for food products, beverages and tobacco.

There are, of course, cross-country differences which were not shown in the table 1. Table 2 provides description of the female/male wage ratio in the countries analysed, calculated as the average value for all sectors in 2005. For high-skilled workers (first column) the ratio varies from 0.632 in Poland to 0.927 in Austria. Similarly Austria has the lowest gender wage gap (highest female/male ratio) for medium and low-skilled workers, for example for the latter group in 2005 women's earnings were equal to men's.

Table 1 Female/male wage ratio of high-skilled, medium-skilled and low-skilled workforce, by sector in 1970 and 2005, (all countries pooled together)

	1970			2005		
Sectors	High skilled	Medium skilled	Low skilled	High skilled	Medium skilled	Low skilled
15t16	0.594	0.661	0.674	0.722	0.738	0.723
17t19	0.580	0.668	0.694	0.710	0.742	0.736
20	0.638	0.762	0.669	0.780	0.818	0.767
21t22	0.576	0.669	0.585	0.753	0.793	0.746
24	0.570	0.654	0.626	0.734	0.790	0.772
25	0.623	0.682	0.652	0.731	0.781	0.770
26	0.567	0.667	0.606	0.720	0.794	0.750
27t28	0.515	0.668	0.581	0.736	0.797	0.768
29	0.597	0.671	0.663	0.729	0.784	0.787
30t33	0.591	0.654	0.663	0.732	0.775	0.788
34t35	0.597	0.690	0.689	0.729	0.776	0.773
36t37	0.555	0.703	0.691	0.738	0.773	0.747
50	0.554	0.810	0.999	0.682	0.775	0.686
51	0.533	0.692	0.658	0.702	0.763	0.697
52	0.519	0.599	0.550	0.780	0.774	0.746
60t63	0.626	0.698	0.638	0.751	0.872	0.794
64	0.666	0.657	0.648	0.761	0.811	0.740
70	0.483	0.617	0.664	0.897	0.893	0.793
71t74	0.613	0.627	0.629	0.730	0.821	0.721
AtB	0.919	0.728	0.718	0.870	0.854	0.760
C	0.586	0.652	0.587	0.714	0.809	0.748
D	0.569	0.652	0.632	0.741	0.757	0.736
E	0.562	0.661	0.593	0.750	0.799	0.735

F	0.598	0.623	0.596	0.740	0.881	0.761
G	0.516	0.616	0.546	0.698	0.758	0.724
H	0.608	0.600	0.588	0.687	0.764	0.763
I	0.620	0.675	0.674	0.763	0.868	0.774
J	0.468	0.580	0.651	0.668	0.732	0.721
K	0.574	0.606	0.616	0.738	0.839	0.748
L	0.663	0.748	0.573	0.761	0.804	0.769
M	0.757	0.735	0.580	0.819	0.850	0.763
N	0.582	0.801	0.688	0.752	0.854	0.847
O	0.739	0.586	0.528	0.748	0.751	0.700
P	0.645	0.569	0.493	0.741	0.745	0.779
TOT	0.733	0.733	0.627	0.754	0.795	0.726

Source: own calculations based on data from EU KLEMS 2008

Table 2 Female/male wage ratio of high-skilled, medium-skilled and low-skilled in 2005, average across sectors

	High-skilled	Medium-skilled	Low-skilled
AUS	0.761	0.700	0.747
AUT	0.927	0.987	1.003
BEL	0.690	0.750	0.692
CZE	0.716	0.735	0.743
DNK	0.719	0.807	0.854
ESP	0.653	0.731	0.701
FIN	0.653	0.760	0.790
GER	0.644	0.690	0.625
HUN	0.775	0.912	0.851
ITA	0.908	0.924	0.659
JPN	0.661	0.678	0.627
KOR	0.669	0.766	0.758
NLD	0.810	0.852	0.839
POL	0.632	0.799	0.716
SVK	0.679	0.749	0.732
SVN	0.791	0.887	0.846
UK	0.735	0.612	0.596
USA	0.675	0.748	0.755

Source: own calculations based on data from EU KLEMS 2008

3. Empirical analysis

3.1 Empirical setting

We start from the classical production function augmented by the introduction of female and male labour force:

$$Y_{ij,t} = A_{ij,t} F(K_{ij,t}, L^{f}_{ij,t}, L^{m}_{ij,t}), \quad (1)$$

where $Y_{ij,t}$ *is* the value added of sector *j* in country *i*, produced at time *t* with physical capital ($K_{ij,t}$) and labour input that is the sum of female and male workers $L_{ij,t} = (L^{f}_{ij,t} + L^{m}_{ij,t})$ which are assumed to be perfect substitutes in production; $A_{ij,t}$ is an index of technical efficiency or total factor productivity (TFP). We assume the function *F* to be homogenous of degree one and characterized by diminishing marginal returns to the accumulation of *K* and *L* respectively. Following Seguino (2000) we model TFP as the function of external factors and gender wage gap:

$$A_{ij,t} = C_{ij}(1 + Xt)e^{\delta WGAP} \quad (2)$$

Where: C_{ij} – is is the country-sector specific time-invariant effect, *X* – reflects all other factors which influence the productivity growth, *WGAP* is the gender wage gap. We substitute (2) into (1), take natural logs and differentiate with respect to time which yields the final version of our empirical model:

$$\Delta y_{ijt} = \beta_1 \Delta l^{f}_{ijt} + \beta_2 \Delta l^{m}_{ijt} + \beta_2 \Delta k_{ijt} + \beta X_{ij,t} + \delta WGAP + \upsilon_t + c_{ij} + e_{ijt} \quad (3)$$

where the lower letters are used to express logs of a given variables, υ_t is the time specific intercept reflecting for example a common technology shock or business cycle fluctuation. c_{ij} is an unobserved time invariant sector/country specific effect. This growth model (3) is in line with the econometric approach of productivity growth measure. It shows which country would have higher productivity growth rate when the differences in capital and labour growth have been taken into account. It should be noted that however we assume the substitution between female and male labour we treat them as separate inputs (for a discussion of production function with disaggregated labour inputs see e.g Field-Hendrey 1998 or for CES function – Acemoglu et al. 2004).

The coefficient we are mainly interested in is δ which measures the relationship between gender wage gap and the growth rate. We define the gender wage gap (*WGAP*) as the log-wage differential between males (*M*) and females (*F*) possessing comparable skills:

$$WGAP = w_{ij,t}^{S} = \ln W_{ij,t}^{M,S} - \ln W_{ij,t}^{F,S} \quad (4)$$

where as before *i* refers to sector, *j* to country, *S* to skill classification (high-skilled wage-*whs*, medium-skilled wage-*wms* and low-skilled wage-*wls*) and *t* to time period. Note that the wage gap expressed in (4) is reversal of the female/male wage ratio introduced in the previous section, hence the negative value of the parameter δ would indicate that higher gender wage gap is connected with the lower rate of growth and vice versa.

Among other factors that may have an impact on the economic growth $X_{ij,t}$ we include trade openness of a given sector and proxy of human capital. For the trade variable, we used the ratio of imports and export to value added, while human capital is measured as the relative skill intensity defined as the share of hours worked by persons with higher education both women and men, of the total hours worked.

3.2 Results

The first step in our analysis is to investigate the time series properties of the variables in order to avoid a spurious regression. We apply panel unit roots, which have higher power than those based on individual time series, especially when the latter are not very long. Because our panel is not balanced we opt for Fisher-type tests – a suitable approach for testing for panel-data unit roots from a meta-analysis perspective which does not require a balanced dataset. We employ two different versions of the test: ADF and Phillips-Perron with and without trend. The outcomes of these tests, presented in the Table A3 in Appendix, indicate no evidence of unit roots in most of our variables and thus spurious regression should not be a problem in the empirical analysis which follows.

We start with basic regression without the variable describing capital stock – however we do include country/sector effects and time dummies (Table 3 Columns (1) to (4)). The coefficients in front of labour inputs (measured by the number of hours worked by females and males respectively) are positive and highly significant as expected. The main concern of this paper is the role of gender wage gap in economic growth. Firstly, we include in the regression the skill specific gender wage gap separately (Columns (1) to (3), then in Column (4) they are introduced simultaneously). For all skill classification we found negative and statistically significant coefficient – higher the gender wage gap lower the rate of sectoral

growth. An increase in gender wage gap by 1 percent translates into a decrease in average growth rate of between 0.033 to 0.06 percentage points - taking into consideration that the average value of growth rate is 0.04 the effect seems to be economically significant.

Columns (5) to (8) report the results when the capital stock is included. The capital stock was calculated using the perpetual inventory method with the utilisation of gross fixed capital formation and a depreciation rate of 6% (see, for example, Caselli, 2005 for a description of methodology). Note the drop in the number of observation – there is no data for Australia, Japan and Korea. The growth of both inputs (labour and capital) are positively correlated with economic growth. Again the correlation of gender wage gap of different skill categories with economic growth is confirmed – in each case we obtain a negative and statistically significant parameter.

Next, we augment the regression with other variables that can have an impact on the economic growth (Columns (9) to (12). Among variables that can impact economic growth we include trade penetration (measured as the ratio of import and export to the sectoral value added) and human capital express as the skill intensity (defined as the share of hours worked by persons with higher education both women and men, of the total hours worked). For both variables we obtained a positive and highly significant coefficients – trade openness and human capital are positively correlated with economic growth. Additionally, the negative association between high, medium, low skilled wage differentials and growth is sustained.

Table 3 The determinants of economic growth ($\Delta y_{ij,t}$),

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
$\Delta l^{f}_{ij,t}$	0.0983***	0.1064***	0.1079***	0.1082***	0.0834***	0.0918***	0.0903***	0.0941***	0.0712**	0.0830***	0.0784**	0.0816***
	[0.0306]	[0.0303]	[0.0305]	[0.0305]	[0.0281]	[0.0279]	[0.0281]	[0.0281]	[0.0305]	[0.0302]	[0.0305]	[0.0306]
$\Delta l^{m}_{ij,t}$	0.2539***	0.2435***	0.2416***	0.2432***	0.5033***	0.4986***	0.4903***	0.4929***	0.2614***	0.2493***	0.2520***	0.2516***
	[0.0781]	[0.0768]	[0.0771]	[0.0780]	[0.0442]	[0.0440]	[0.0442]	[0.0440]	[0.0775]	[0.0764]	[0.0768]	[0.0773]
$W^{HS}_{ij,t}$	-0.0325***			-0.0131*	-0.0325**			-0.0205**	-0.0393***			-0.0199**
	[0.0078]			[0.0077]	[0.0080]			[0.0081]	[0.0080]			[0.0079]
$W^{MS}_{ij,t}$		-0.0597**		-0.0478**		-0.0811***		-0.0478***		-0.0673***		-0.0548***
		[0.0110]		[0.0111]		[0.0121]		[0.0132]		[0.0109]		[0.0112]
$W^{LS}_{ij,t}$			-0.0327***	-0.0187**			-0.0656***	-0.0494***			-0.0240***	-0.0089
			[0.0086]	[0.0078]			[0.0098]	[0.0097]			[0.0087]	[0.0080]
$\Delta k_{ij,t}$					0.1444***	0.1439***	0.1501***	0.1421***				
					[0.0413]	[0.0411]	[0.0411]	[0.0412]				
$Trade_{ij,t}$									0.0137***	0.0150***	0.0129***	0.0148***
									[0.0024]	[0.0025]	[0.0024]	[0.0025]
$HC_{ij,t}$									0.0202***	0.0185***	0.0205***	0.0182***
									[0.0029]	[0.0027]	[0.0028]	[0.0028]
Sector/country fixed effect	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
R^2	0.174	0.176	0.174	0.176	0.265	0.269	0.268	0.274	0.188	0.19	0.187	0.19
N	6893	6947	6947	6893	3614	3631	3631	3614	6579	6626	6626	6579

Notes: all computations made using StataSE 9.0.

Constant not reported.

Robust Standard errors in parentheses. Statistically significant at ***1, ** 5, * 10 percent level

We check the stability of our conclusion by number of model alternation**.** First of all we consider an alternative measure of human capital - the average number of years of schooling. The data are obtained from the UNCTAD database, which in turn is based on interpolation and extrapolation of Barro and Lee's (2010) dataset.[2] Due to data availability, this variable is country specific. The results are presented in Table 4. The estimated coefficient are similar to the previous ones – with the exception of the human capital variable which magnitude are much higher now. It can be explained by possible externalities of human capital across sectors.

Table 4. The determinants of economic growth ($\Delta y_{ij,t}$), human capital measured as – the average number of years of schooling

	(1)	(2)	(3)	(4)
$\Delta l^{f}_{ij,t}$	0.1127***	0.1210***	0.1211***	0.1206***
	[0.0355]	[0.0351]	[0.0352]	[0.0356]
$\Delta l^{m}_{ij,t}$	0.4143***	0.4012***	0.4009***	0.4053***
	[0.0407]	[0.0401]	[0.0402]	[0.0408]
$Trade_{ij,t}$	0.0113***	0.0120***	0.0101***	0.0120***
	[0.0022]	[0.0022]	[0.0022]	[0.0022]
$HC_{i,,t}$	0.4378***	0.4351***	0.4537***	0.4393***
	[0.1637]	[0.1627]	[0.1629]	[0.1636]
$W^{HS}_{ij,t}$	-0.0386***			-0.0247**
	[0.0095]			[0.0104]
$W^{MS}_{ij,t}$		-0.0541***		-0.0376***
		[0.0120]		[0.0134]
$W^{LS}_{ij,t}$			-0.0267**	-0.0137
			[0.0105]	[0.0109]
Sector/country fixed effect	YES	YES	YES	YES
Time dummies	YES	YES	YES	YES
R^2	0.224	0.225	0.223	0.226
N	5921	5975	5975	5921

Notes: all computations made using StataSE 9.0.

Constant not reported.

Robust standard errors in parentheses. Statistically significant at ***1, ** 5, * 10 percent level.

[2] The database can be downloaded from UNCTAD website (http://r0.unctad.org/ditc/tab/index.shtm), this version May 2011. The yearly figures were obtained through interpolation and extrapolation of Barro and Lee's (2010) dataset (because Barro and Lee (2010) report values only for each five years).

In previous estimation we have obtained a statistically significant parameter on trade when the variable represented import plus export. We check this through employing separately import and export penetration instead of the sum of trade flows, as import and export can have different impact on the growth. The results with import penetration are presented in the first four columns of Table 5 and with export penetration in columns (5) to (8). When the trade is measured by import penetration we obtained positive and statistically significant coefficient, however when the trade is expressed as export penetration the coefficients loses their statistical significance. These results confirm that positive relationship between openness and growth is due to the import-lead rather than export-lead hypothesis. The findings considering the negative correlation between skill-specific wage gap and growth rate are in line with the previous estimations.

Table 5. The determinants of economic growth ($\Delta y_{ij,t}$), openness measure as import or export penetration

	Trade=import				Trade=export			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta l^{f}_{ij,t}$	0.0836***	0.0960***	0.0935***	0.0935***	0.0698**	0.0796***	0.0780**	0.0774**
	[0.0318]	[0.0315]	[0.0318]	[0.0318]	[0.0305]	[0.0302]	[0.0305]	[0.0307]
$\Delta l^{m}_{ij,t}$	0.3138***	0.3006***	0.3013***	0.3043***	0.2621***	0.2518***	0.2525***	0.2549***
	[0.0834]	[0.0821]	[0.0825]	[0.0832]	[0.0776]	[0.0766]	[0.0769]	[0.0775]
$Trade_{ij,t}$	0.0089***	0.0097***	0.0086***	0.0094***	0.0015	0.0016	0.001	0.0017
	[0.0026]	[0.0026]	[0.0026]	[0.0026]	[0.0024]	[0.0024]	[0.0024]	[0.0024]
$HC_{ij,,t}$	0.0224***	0.0209***	0.0223***	0.0208***	0.0189***	0.0174***	0.0189***	0.0173***
	[0.0030]	[0.0028]	[0.0029]	[0.0029]	[0.0030]	[0.0028]	[0.0029]	[0.0030]
$W^{HS}_{ij,t}$	-0.0337***			-0.0169**	-0.0291***			-0.0165**
	[0.0081]			[0.0082]	[0.0078]			[0.0077]
$W^{MS}_{ij,t}$		-0.0624***		-0.0509***		-0.0477***		-0.0367***
		[0.0117]		[0.0122]		[0.0119]		[0.0121]
$W^{LS}_{ij,t}$			-0.0239***	-0.0087			-0.0205**	-0.0092
			[0.0086]	[0.0080]			[0.0087]	[0.0081]
R^2	0.195	0.196	0.194	0.197	0.172	0.173	0.172	0.173
N	6440	6487	6487	6440	6692	6739	6739	6692

Notes: all computations made using StataSE 9.0.
Constant not reported. Sector/country fixed effects and time dummies included.
Robust Standard errors in parentheses. Statistically significant at ***1, ** 5, * 10 percent level.

The next robustness check involves the country, industry and time composition of our analysis. We performed the analysis for sub-sample of European countries, for the 1980–2005 and 1990-2005 subsamples and sequentially excluding industries one by one to check the sensitivity of the results for specific industries – in most of the specifications (with or without

additional right-hand side variables: capital stock, trade, human capital) we obtained a negative and statistically significant coefficients on skill specific gender wage gap. Due to the space constraints this result are available from author upon request.

We are aware that the main problem in our specification (3) is due to the potential endogeneity between the growth rate and some of the independent variables. For example higher growth rate of a given sector can be deterministic to the rise of trade activities. It is often assume in the literature that more productive firms are self-selected into export market (Wagner (2007)) and in similarly manner productivity growth can stimulate imports (Djankov and Murrelli (2002)). Additionally, we have to take into account the possibility of gender wage gap being influenced by the growth (not vice versa). However, as it is stated in the literature (World Bank, 20111) it is highly difficult to find out a valid instruments for a gender wage gap. As the final robustness check we use instrumental variables framework where the endogenous variables are instrumented by their lags.

Table 6. The determinants of economic growth ($\Delta y_{ij,t}$) – IV estimation

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$\Delta l^{f}_{ij,t}$	0.100**	0.106***	0.108***	0.110***	0.075*	0.083**	0.078**	0.084**
	[0.039]	[0.039]	[0.039]	[0.039]	[0.040]	[0.040]	[0.040]	[0.040]
$\Delta l^{m}_{ij,t}$	0.252***	0.244***	0.242***	0.241***	0.258***	0.250***	0.252***	0.249***
	[0.043]	[0.042]	[0.042]	[0.043]	[0.043]	[0.043]	[0.043]	[0.043]
$W^{HS}_{ij,t}$	-0.030***			-0.011	-0.033***			-0.015
	[0.010]			[0.011]	[0.010]			[0.011]
$W^{MS}_{ij,t}$		-0.060***		-0.048***		-0.064***		-0.053***
		[0.013]		[0.014]		[0.014]		[0.015]
$W^{LS}_{ij,t}$			-0.033***	-0.019			-0.022*	-0.008
			[0.012]	[0.012]			[0.012]	[0.012]
$Trade_{ij,t}$					0.014***	0.015***	0.013***	0.015***
					[0.002]	[0.002]	[0.002]	[0.002]
$HC_{ij,,t}$					0.018***	0.017***	0.020***	0.017***
					[0.003]	[0.003]	[0.003]	[0.003]
R^2	0.175	0.176	0.174	0.177	0.184	0.186	0.183	0.186
N	6925	6947	6947	6925	6607	6629	6629	6607
Sargan test (p-value)	0.67	0.92	0.89	0.99	0.01	0.05	0.02	0.03
F test (p-value)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Notes: all computations made using IVREG2 for StataSE 9.0.Constant not reported. Standard errors in parentheses. Statistically significant at ***1, ** 5, * 10 percent level. Country/industry fixed effects and year dummies are included in all regressions. In all specifications the wage differentials and trade penetration instrumented by their first and second lags. Sargan is the test of the model's overidentifying restrictions asymptotically $\chi 2$. F – test is the test of excluded instruments in the first-stage regression. P-values reported.

Table 6 presents the results of instrumental variables estimation. The wage differentials and trade penetration are instrumented by their first and second lags. We test whether the instruments are correlated with growth residuals using a Sargan test of the model's overidentifying restrictions. We cannot reject the null hypothesis so the instruments are valid in the sense that excluded exogenous variables are uncorrelated with the second stage residuals. Additionally, in each specification the instruments are highly statistically significant in the first-stage regression and we can reject the hypothesis that the coefficients on the excluded exogenous variables are equal to zero in the first stage – see F test. In all specifications the results consistently confirm a negative association between skill-specific gender wage gap and productivity growth.

4. Conclusion

This paper has examined the impact of gender wage gap on productivity growth in 18 OECD countries at the sectoral level. The empirical study covers 12 manufacturing sectors between 1970 and 2005. We estimated an augmented production function where skill-specific gender wage gap constituted a potential determinant of growth. Neither theoretical framework nor previous empirical analysis give clear answer about the sign of the relationship between gender wage differentials and growth.

One of the main contributions of our study is to make estimates at sector level, compared to previous articles, which mostly make them at country or micro level. The utilization of three-dimensional panel data (sectors, countries, time) allows us to assess the disaggregated forces underlying productivity performance while accounting for unobserved heterogeneity. Additionally, a novelty of the present paper is the distinguishing between wages paid to different groups of workers classified according to skill level: high, medium and low.

The result indicate a negative relationship between gender wage gap and sectoral growth: other things being equal, higher the differences between female/male wages, slower the rate of productivity growth. Additionally, we confirmed the positive role of trade openness on productivity growth – due to the import rather than export activities and the positive role of human capital. Our main conclusions are robust across numerous alternations of specification and variations, especially concerning the use of a different measure of human capital, the country composition in our analysis, industry heterogeneity and estimation techniques.

The results of our study have straightforward policy implications, especially considering promoting gender equality and providing antidiscrimination actions

Nevertheless, more research is needed to provide detail evidences on the importance of gender equality (both from the perspective of micro and macro level) for growth.

Appendix

Table A1. List of sectors

Sector (NACE)	Description of sectors
15t16	C15T16 Food products, beverages and tobacco
17t19	C17T19 Textiles, textile products, leather and footwear
20	C20 Wood and products of wood and cork
21t22	C21T22 Pulp, paper, paper products, printing and publishing
24	C24 Chemicals and chemical products
25	C25 Rubber and plastics products
26	C26 Other non-metallic mineral products
27t28	C27T28 Basic metals and fabricated metal products
29	C29 Machinery and equipment, n.e.c.
30t33	C30T33 Electrical and optical equipment
34t35	C34T35 Transport equipment
36t37	C36T37 Manufacturing n.e.c. and recycling
50	C50 Sale, maintenance and repair of motor vehicles and motorcycles - retail sale of automotive fuel
51	C51 Wholesale, trade and commission excl. motor vehicles
52	C52 Retail trade excl. motor vehicles - repair of household goods
60t63	C60T63 Transport and storage
64	C64 Post and telecommunications
70	C70 Real estate activities
71t74	C71T74 Renting of mach. and equip. - other business activities
AtB	C01T05 AGRICULTURE, HUNTING, FORESTRY AND FISHING
C	C10T14 MINING AND QUARRYING
D	C15T37 MANUFACTURING
E	C40T41 ELECTRICITY GAS AND, WATER SUPPLY
F	C45 CONSTRUCTION
G	C50T55 WHOLESALE AND RETAIL TRADE - RESTAURANTS AND HOTELS
H	C55 Hotels and restaurants
I	C60T64 TRANSPORT, STORAGE AND COMMUNICATIONS
J	C65T67 Financial intermediation
K	C70T74 Real estate, renting and business activities
L	C75 Public admin. and defence - compulsory social security
M	C80 Education
N	C85 Health and social work

O	C90T93 Other community, social and personal services
P	C95 Private households with employed persons
TOT	CTOTAL TOTAL

Source: own calculations based on data from EU KLEMS 2008

Table A2. List of countries

Lp.	Country ISO	Country name
1	AUS	Australia
2	AUT	Austria
3	BEL	Belgium
4	CZE	Czech Republic
5	DNK	Denmark
6	ESP	Spain
7	FIN	Finland
8	GER	Germany
9	HUN	Hungary
10	ITA	Italy
11	JPN	Japan
12	KOR	Korea
13	NLD	Netherlands
14	POL	Poland
15	SVK	Slovak Republic
16	SVN	Slovenia
17	UK	United Kingdom
18	USA	United States of America

Source: own

Table A3 Fisher panel unit root test

	Based on augmented Dickey-Fuller tests		Based on Phillips-Perron tests	
	$\chi 2$ (p-value) without trend	$\chi 2$ (p-value) with trend	$\chi 2$ (p-value) without trend	$\chi 2$ (p-value) with trend
$\Delta y_{ij,t}$	3282.9 (0.000)	2848.6 (0.000)	6100.3 (0.000)	5273.5 (0.000)
$\Delta l^{f}_{ij,t}$	1691.1 (0.000)	1571.5 (0.000)	2812.8 (0.000)	2611.8 (0.000)
$\Delta l^{m}_{ij,t}$	1898.4 (0.000)	1657.2 (0.000)	2901.4 (0.000)	2585.7 (0.000)
$\Delta k_{ij,t}$	857.4 (0.000)	1115.3 (0.000)	1166.3 (0.000)	1329.2 (0.000)
$W^{HS}_{ij,t}$	1549.8 (0.000)	1368.7 (0000)	1286.1 (0.000)	1068.1 (0.000)
$W^{MS}_{ij,t}$	586.5 (0.000)	611.1 (0.000)	686.5 (0.000)	600.1 (0.000)
$W^{LS}_{ij,t}$	360.4 (0.056)	426.5 (0.045)	969.5 (0.000)	964.4 (0.000)
$Trade_{ij,t}$	904.3 (0.000)	713.2 (0.000)	3229.4 (0000)	3101.5 (0.000)
$HC_{i,,t}$	555.7 (0.001)	877.2 (0.000)	519.8 (0.002)	939.8 (0.000)

Source: own elaboration

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