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THE UNEMPLOYMENT INVARIANCE HYPOTHESIS: DOES THE GENDER MATTER?

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Abstract

This paper examines the unemployment invariance hypothesis by exploring the importance of labor force, capital stock change and productivity in unemployment determination in OECD (Organization for Economic Co-operation and Development) countries. Using the cross-sectional distributed lag (CS-DL) approach this study shows that aggregate unemployment-labor force participation linkage is not significant in OECD counties. Moreover, the result shows that capital stock change is a crucial determinant in male rather than female unemployment. These findings lead to questioning the empirical relevance of the unemployment invariance hypothesis. This article provides potentially valuable insights into the labor market inequality in OECD countries and has important policy implications.

Keywords: unemployment invariance hypothesis, labor market inequality, labor force participation, capital stock, productivity
JEL classification: J4, O1

I. *Introduction*

Investigating the behavior of unemployment and identifying the determinants that affect its dynamics has a decisive impact on macroeconomic theory and labor market policy modeling. It is well known that European, as well as other OECD economies; unemployment rates do not exhibit a long run trend even though growth in capital stock and the labor force have exhibited a positive trend (Layard et al., 2005). To illustrate this feature, Figures 1 and 2 show time series for unemployment and labor force participation, respectively, for a number of European Countries. One of the key things to observe in these figures is that, for example, the rise in labor force participation has not been more pronounced in European Countries in 1990s and

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FIGURE 1. THE UNEMPLOYMENT RATE IN EUROPEAN COUNTRIES

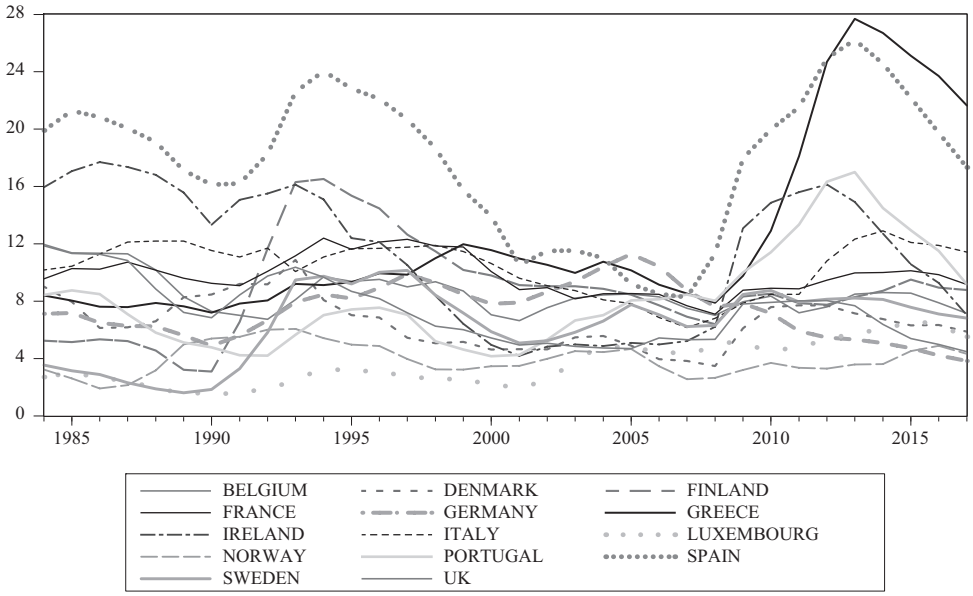
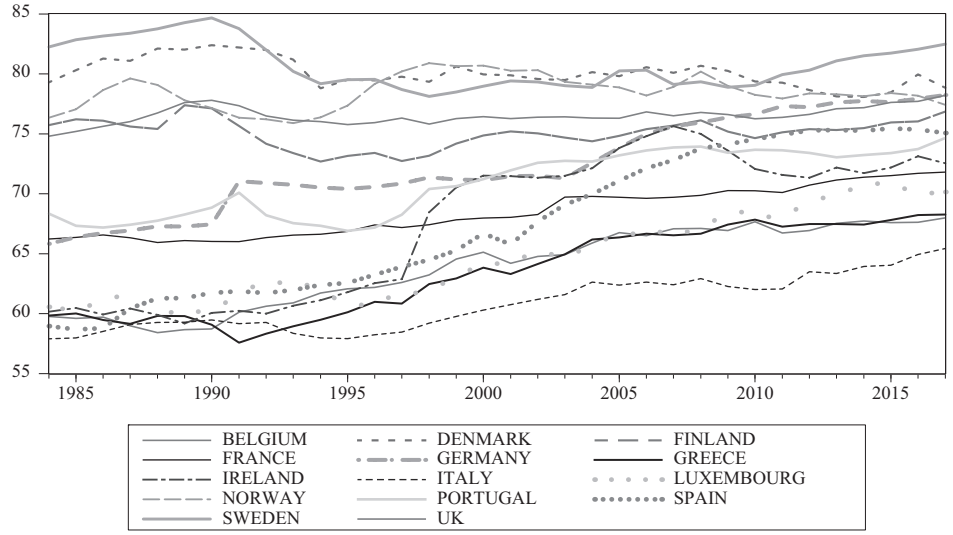


FIGURE 2. THE LABOR FORCE PARTICIPATION RATE IN EUROPEAN COUNTRIES



late 2000s, while the rise in unemployment has been.

One potential explanation for unemployment rate dynamics puzzle is the 'unemployment invariance hypothesis' that the long-run unemployment rate is not linked to the size of capital stock and the labor force.[1] This hypothesis as proposed by Layard et al. (2005) is illustrated in

FIGURE 3. THE UNEMPLOYMENT INVARIANCE HYPOTHESIS

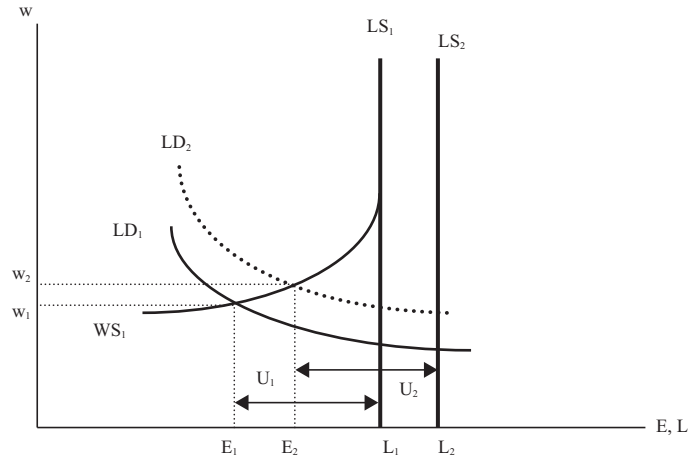


Figure 3. The wage-setting curve (WS_1) and the labor demand curve (LD_1) determine the first employment level equilibrium (E_1) and the real wage equilibrium (w_1). Moreover, the difference between the labor supply (LS_1) and employment (E_1) determines the unemployment level (U_1). The growth of capital accumulation improvement moves the labor demand curves from LD_1 to LD_2. However, the unemployment invariance hypothesis proposed that the labor supply curve moves from LS_1 to LS_2 because of labor force participation growth resulting in the unemployment rate not changing ($U_1 = U_2$) in the long run. A different form of the unemployment invariance hypothesis, namely, the exogenous change in workers may increase labor force participation but may not affect the steady state unemployment level and is addressed in a standard Mortensen-Pissarides (MP) search and matching model (Mortensen and Pissarides, 1994; Pissarides, 2000).

A few studies have investigated whether labor force participation changes impact unemployment rate. In addition, all of these studies are country specific and thus do not provide a global perspective. For example, Österholm (2010) examined the linkage between the unemployment and labor force participation rates in Sweden. He found a long-run connection for these two variables. A similar finding was arrived for Emerson (2011) in United States. However, Otoiu and Titan (2016) employed quarterly labor force data and found that there is no long-run equilibrium relationship between labor force participation and unemployment rates in Romania. The unemployment invariance hypothesis is also found in Australia (Nguyen Van,

[1] The unemployment rate dynamics puzzle involves several key facts in OECD unemployment that needed to be explained. For example, the OECD unemployment rate is characterized with high and persistent levels that caused the development of the structuralist theories or hysteresis hypothesis (Blanchard and Summers, 1987; Phelps, 1994; Blanchard and Juan, 1995). Another equally important fact is that OECD unemployment is not a trend over the very long run. The non-trending unemployment feature has been considered as "unemployment invariance hypothesis". The unemployment invariance hypothesis implies that most shocks, such as changes in labor force participation, only result in temporary demand or supply fluctuations in employment around the non-acceleration-inflation rate of unemployment (NAIRU). However, some social or institutional shocks cause a long-term change in the natural rate itself (Karanassou and Snower 2004; Layard et al., 2005).

2016).[2]

The aim of this paper is to extend the literature in two dimensions. First, this study argues that the confined unemployment-labor force participation relationship does not paint a clear picture with regard to the unemployment invariance hypothesis. We believe that a study of the unemployment invariance hypothesis simultaneously considering the labor force, capital stock, and productivity with different econometric techniques over the last three turbulent decades will provide potential valuable insights. The first objective of this study is to present new evidence for a link between physical capital formation and unemployment with different econometric approach with latest data coverage. The relationship between the capital stock and unemployment has been explored by several empirical studies and the general conclusion is that capital stock (or its rate of growth) is a significant long-run determinant of unemployment.[3] In contrast, Layard et al. (2005) imposed cross-equation restrictions and hypothesis that the unemployment is unaffected by changes in the capital stock. To further shed light on the empirical result, we include the variable of productivity. As new technology is introduced, some employees are fortunate to keep the jobs, but others will be allocated to new position or will become unemployed (Mortensen and Pissarides, 1994, 1998; Lentz and Mortensen, 2005).

Second, this study viewed the unemployment invariance hypothesis from an aggregate perspective as merely part of the story. Capital formation leads businesses to provide employment opportunities and lowers unemployment rate. However, other effects (such as the taste-based and quality sorting effects) on the labor market may make different impact on male and female unemployment through the search and matching process.[4] If these effects are substantial, it is possible that when the growth of capital accumulation increases, female unemployment rate may also increase. Moreover, there is no doubt that the composition of the labor supply, that is male and female labor force, differs widely across countries. As a result. it is important to explore whether the gender labor force attachment inequality matters for the unemployment-labor force participation linkage.

The remainder of this paper is organized as follows: Section II introduces the theoretical motivation of this study. Section III presents the data and the descriptive statistics. Section IV studies the unemployment invariance hypothesis from the gender perspective. Conclusions are presented in Section V.

II. *The Theoretical Motivation*

Over the last two decades several theoretical models has been developed to explain the behavior of unemployment rates in OECD countries. The purpose of this section is to briefly outline these theories and provide guidelines for further empirical analysis.[5]

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[2] Österholm (2010) first investigated the long-run relationship between unemployment and labor-force participation in Sweden based on the cointegration techniques. Since then the cointegration approaches are employed in following studies (Emerson, 2011; Tansel et al., 2015; Nguyen Van, 2016; Otoiu and Titan, 2016).

[3] See for example Rowthorn, (1995); Arestis and Biefang-Frisancho, (1998, 2000); Malley and Moutos, (2001); Palacio-Vera et al., (2008); Martinez-Canete and Palacio-Vera, (2011).

[4] The taste-based theory predicts that employer hiring particular types of employees (Becker, 1971). In contrast, quality sorting theory emphasizes manager sorting interviewers based on their quality and skills (Kremer, 1993; Kremer and Maskin, 1996).

[5] We thank the Anonymous Referee for providing useful advice that improved the theoretical statement in Section 2.

The background structure of the Layard et al. (2005) framework begins with the inflation and wage result interaction from price-setters and wage-setters. The economy consists of goods and labor markets. There are many goods and many types of labor. All of the goods and labor are featured with imperfect substitutes. In other words, the good producers and labor market operate in a monopolistic competitive market. Agents need to decide prices and wages. The unemployment equilibrium is defined as the consistency between the intended mark-up of prices over wages and the intended mark-up of wages over prices (Blanchard, 1986).

The battle of mark-ups between price-setters and wage-setters results in the long-run non-acceleration-inflation unemployment rate (NAIRU). Increasing demand reduces unemployment, and then inflationary pressure grows. Employees had more confidence in driving wage claims. The higher wage process causes higher prices, leading to another wage increase. This is called a wage-price spiral. Moreover, increasing inflation will lead to increasing unemployment. Because of higher unemployment, the inflation will stop increasing eventually. The Layard et al. (2005) model emphasizes that the equilibrium level of unemployment is considered as the level of unemployment that inflation stabilizes in line with Blanchard (1986). Once demand or supply shocks move employment away from the NAIRU, it takes some time to return.

The wage-price spiral is developed by the way price-setters place prices (P_t) relative to the expected wages ($W^e_{i,t}$), and wage-setters arrange wages ($W_{i,t}$) relative to expected prices (P^e). The inflation and unemployment will be stable if the real wage expected by wage-setters is the same as that expected by price-setters. The price equation represents the price-employment conjunctions in accordance with profit-maximizing behavior by monopolistically competitive businesses.

$$P_t - W^e_{i,t} = \alpha_0 + \alpha_E E_{i,t} - \alpha_L L_{i,t} - \alpha_K K_t - \alpha_\phi \phi_t \tag{2.1}$$

where P_t is the price level, $W^e_{i,t}$ is the expected wage level for i = male (m) or female (f), $E_{i,t}$ is the employment, $L_{i,t}$ is the labor force, K_t is the capital stock, ϕ_t is the technology change. We assuming the labor markets for male and female are independent each other. The wage-setting equation is considered as firms set wage above the market-clear level.

$$W_{i,t} - P^e_t = \beta_0 - \beta_u u_{i,t} + \beta_K K_t + \beta_\phi \phi_t \tag{2.2}$$

where $u_{i,t}$ is the unemployment rate for $i = m, f$. The mark-up wage is due to wage efficiency or union bargaining. The unemployment rate is presented as

$$u_{i,t} \equiv \frac{U_{i,t}}{N_{i,t}} = \frac{L_{i,t} - E_{i,t}}{N_{i,t}} = l_{i,t} - e_{i,t} \tag{2.3}$$

The unemployed are people of working age who are without work, are available for work, and are looking for work. This indicator in main stream literature is measured in the numbers of unemployed people as a percentage of the labor force. In the present study, the unemployment rate is defined as unemployed divided by population. The main reason is that because official statistics have difficulty exactly calculating the number who is labor force or who is out of the labor force (Murphy and Topel, 1997). The second reason is that the population-based unemployment rate is more theoretical comparable between males and females than the general unemployment rate definition.

In order to make economic comparable across males and females, we define unemploy-

ment rate as the number of unemployed divided by the population with an implicit assumption that the population size of males and females are equal. If actual wages and prices are at their expected value ($P=P^e, W_m=W_m^e, W_f=W_f^e$), combining (2.1), (2.2) and (2.3) results in the labor market equilibrium unemployment rate:

$$u_{i,t}^*=\frac{\alpha_0+\beta_0}{\beta_u+\alpha_E}+\frac{\alpha_E-\alpha_L}{\beta_u+\alpha_E}L_{i,t}+\frac{\beta_K-\alpha_K}{\beta_u+\alpha_E}K_t+\frac{\beta_\phi-\alpha_\phi}{\beta_u+\alpha_E}\phi_t \tag{2.4}$$

The invariance unemployment hypothesis implies that unemployment is independent of the capital stock, the productivity and the labor force in the long run and expressed as follows:

$$\alpha_E=\alpha_L \ \alpha_K=\beta_K \ \alpha_\phi=\beta_\phi \tag{2.5}$$

Karanassou and Snower (2004) develops the model for an environment in which workers are homogenous, that is, there are no differences among male and female workers. Based on the gender perspective, unemployment rate and labor force participation rate can be re-defined by dividing by population. We assume that population size is exogenous in this model. The (2.4) is described as the expression for the male and female labor markets, respectively. In empirical modelling we modify the following equation as:

$$u_{m,t}^*=\theta_0+\theta_1 L_{m,t}+\theta_2 K_t+\theta_3\phi_t \tag{2.6}$$

$$u_{f,t}^*=\delta_0+\delta_1 L_{f,t}+\delta_2 K_t+\delta_3\phi_t \tag{2.7}$$

where $u_{m,t}^*$ and $u_{f,t}^*$ indicate the male and female unemployment rate, respectively. In the present study, we are interested in the long-term impact of labor force, capital accumulation and productivity on unemployment rate. We focus on whether in the long-term coefficients are different between male and female unemployment rates. Moreover, the capital accumulation and productivity are the common variables between males and females but they have different impact on the unemployment rates. Ceteris paribus, a significant negative θ_2 indicates higher capital accumulation would lead to a lower of male unemployment rate level. A significant negative rate δ_3 implies that higher productivity would cause a lower female unemployment rate. In this model, we expect that men have a higher impact on capital accumulation and a significant negative lower θ_2 than women δ_2, if men gain more employment opportunities than women. On the other hand, if the insignificant coefficients are found in both male and female unemployment rates, the invariance unemployment hypothesis is supported.

The main stream of unemployment invariance hypothesis remains silent on the issues of gender equality. Gender equality is defined as "equality under the law, equality of opportunity ... and equality of voice" (World Bank, 2001). The convention wisdom was proposed that female was more favorable for family care, while male makes money. This traditional view of female remained in the understandings of numerous families nowadays (Krainska, 2016). Addressing the underlying causes of unemployment invariance hypothesis from gender perspective is of crucial importance to improve gender equality. If social businesses prevent women from working outside of the house, increasing the labor force of females will not have a significant effect on female participation in the labor market. If businesses do not accept that women exercise parental leave, females with young age will have less chance to find a full-time employment. More research is needed to study the unemployment invariance hypothesis from both male and female orientations.

In contrast, Arestis et al. (2007) proposed a theoretical mod, based on the efficiency wage model (Shapiro and Stiglitz, 1984), that explains the effects of capital stock on unemployment. A business decides the real wage considering the effect that the real wage paid has on worker effort and productivity. If capital stock is decreased, conflict over income distribution increases. In order to control inflation, governments execute policies that restrain demand, which then increases unemployment.

Barnichon (2010) proposed an unemployment search model with nominal rigidities. The change in labor demand is caused by changes in productivity and productivity is considered as the central driving force of unemployment. Barnichon (2010) showed that an increase in productivity results in an increase the surplus from a firm-worker match causing firms to create more job vacancies, thereby reducing the unemployment rate. One stream of theoretical literature emphasized the demand side of the labor market to explain the unemployment-productivity growth linkage (Mortensen and Pissarides, 1998). In contrast, another stream of literature shifts the emphasis away from the demand side to supply side. Haruyama and Leith (2010) demonstrated that how the link between productivity and unemployment depends upon labor market institutions, such as employment protection legislation, in such a way that the mixed empirical results observed in U.S. and European economics.

In summary, we discussed several theories that possibly explain the determination of unemployment, with particular emphasis on the effects of labor force, capital stock and productivity. The 'unemployment invariance hypothesis' considered that the long-term unemployment rate is not linked to the capital stock and the labor force size (Layard et al., 2005). Under the efficiency wage approach, Arestis et al. (2007) highlighted the unemployment response to capital stock changes. Although different in emphasis, these theories may work together behind unemployment dynamics. We explore these implications in the empirical work below.

III. *The data*

A dataset combining data for the twenty OECD countries[6] selected solely on the basis of data availability and consistency is used to analyze unemployment determinants. What follows is a brief description of the variables and their sources. The aggregate unemployment rate, the unemployment rate by gender, the aggregate labor force participation rate, the labor force participation rate by gender were collected from the OECD Database. The data for the capital stock[7] for each country were collected from the Penn World Table 9.1 (Feenstra et al., 2015). We were able to collect annual data for the period 1984-2017.

This section investigates the basic features of unemployment rate and labor force participation rate, not only in the aggregate level, but also in the male and female levels. Table 1 represents the descriptive statistics of unemployment and labor force participation rates and changes in capital stock (first difference of the natural logarithm) for twenty OECD countries from 1984 to 2017. Several results are worth noting. First, unemployment rates vary

[6] Belgium, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, Netherland, Norway, Portugal, Spain and Sweden, Australia, Canada, Ireland, Japan, Korea, United Kingdom and United States.

[7] Capital stock is measured at current PPPs (in million 20011 US$).

TABLE 1a. DESCRIPTIVE STATISTICS: 1984-2017

	Australia	Belgium	Canada	Demark	Finland	France	Germany	Greece	Ireland	Italy	Japan	Korea	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	UK	US
Panel A: Aggregate Unemployment Rate																				
Mean	5.151	5.428	6.305	5.236	6.568	6.704	5.285	7.995	7.453	6.293	2.750	2.308	2.390	4.484	3.095	5.833	11.985	5.134	5.601	4.624
Median	4.786	5.539	5.962	5.041	6.471	6.691	5.525	6.287	7.829	6.578	2.758	2.338	1.916	4.335	2.854	5.088	12.087	5.623	5.540	4.372
Max.	7.967	7.143	8.600	8.825	12.012	8.276	8.330	18.687	11.516	8.247	4.081	4.579	4.753	8.379	4.602	12.419	19.746	7.985	8.870	7.219
Mini.	3.299	4.081	4.765	2.805	2.387	4.951	2.996	4.254	2.991	3.845	1.513	1.379	0.918	1.870	1.500	2.865	6.026	1.362	3.495	3.104
Std.	1.217	0.757	1.094	1.422	2.423	0.843	1.374	4.470	2.829	1.111	0.814	0.674	1.137	1.492	0.808	2.610	3.666	1.985	1.648	1.071
Panel B: Male Unemployment Rate																				
Mean	5.815	5.192	7.114	5.066	7.029	6.557	5.684	7.111	9.317	6.084	3.253	3.073	2.297	4.510	3.433	5.626	12.167	5.536	6.793	5.187
Median	5.431	5.343	6.621	4.893	6.868	6.533	5.532	4.958	9.774	5.986	3.259	2.966	1.845	4.195	3.203	4.947	12.535	5.888	6.653	4.950
Max.	9.713	6.644	10.042	8.999	13.793	8.040	9.274	18.980	14.651	8.924	4.926	6.237	4.674	11.178	5.479	13.016	20.816	9.124	10.686	8.498
Mini.	3.361	3.264	5.312	2.715	2.616	5.038	3.256	3.348	3.366	3.690	1.657	1.877	0.827	1.700	1.282	2.269	5.268	1.361	3.849	3.289
Std.	1.656	0.845	1.352	1.529	2.649	0.925	1.539	4.734	3.893	1.293	1.023	0.920	1.163	2.080	1.048	2.915	4.429	2.236	2.187	1.341
Panel C: Female Unemployment Rate																				
Mean	4.482	5.664	5.496	5.409	6.099	6.851	4.880	8.849	5.583	6.499	2.242	1.557	2.485	4.456	2.745	6.029	11.807	4.718	4.424	4.080
Median	4.297	5.287	5.264	5.212	6.153	6.685	5.114	7.609	5.896	6.854	2.249	1.597	2.012	4.455	2.589	5.293	11.420	5.181	4.384	3.891
Max.	6.201	8.264	7.279	8.648	10.545	8.597	7.369	18.401	8.821	8.219	3.230	2.955	4.835	6.606	3.715	11.855	18.666	7.365	7.170	5.968
Mini.	3.236	4.155	4.217	2.897	1.924	4.867	2.494	4.797	2.612	3.999	1.328	0.854	0.945	2.045	1.727	2.950	6.742	1.364	2.876	2.925
Std.	0.784	1.132	0.856	1.426	2.304	0.989	1.280	4.277	1.884	1.164	0.604	0.540	1.144	1.120	0.590	2.353	3.296	1.770	1.201	0.820

TABLE 1b. DESCRIPTIVE STATISTICS: 1984-2017

	Australia	Belgium	Canada	Demark	Finland	France	Germany	Greece	Ireland	Italy	Japan	Korea	Luxembourg	Netherlands	Norway	Portugal	Spain	Sweden	UK	US
Panel D: Aggregate Labor Force Participation Rate																				
Mean	74.217	63.850	76.540	80.074	75.067	68.449	72.368	63.432	67.524	60.827	72.380	64.800	64.652	72.247	78.490	70.874	67.440	80.750	76.524	75.364
Median	74.044	64.668	76.617	79.915	75.258	68.005	71.328	63.568	71.337	60.517	72.441	65.282	64.172	74.362	78.386	71.586	66.231	80.225	76.402	75.516
Max.	77.450	67.995	78.457	82.390	77.392	71.808	78.245	68.265	75.635	65.434	77.544	69.236	70.878	79.727	80.900	74.661	75.452	84.674	78.213	77.367
Mini.	69.096	58.419	72.964	78.076	72.687	65.935	65.822	57.583	59.181	57.894	68.763	59.279	59.997	58.308	75.895	66.909	58.671	78.123	74.804	72.606
Std.	2.165	3.323	1.542	1.176	1.186	1.992	3.919	3.644	5.995	2.264	2.290	2.429	3.645	6.422	1.398	2.713	6.044	1.914	0.737	1.549
Panel E: Male Labor Force Participation Rate																				
Mean	83.134	72.676	82.553	84.177	77.691	75.048	80.684	77.453	79.851	74.406	84.411	77.492	76.572	81.802	82.739	78.515	80.831	82.986	84.594	82.605
Median	82.858	72.487	82.016	84.044	77.430	74.880	80.718	77.217	79.193	74.301	84.621	77.763	76.060	82.442	82.399	78.810	80.906	82.426	83.815	83.446
Max.	85.005	74.158	85.490	87.568	81.034	77.259	82.707	80.610	84.688	76.349	85.514	79.317	79.952	84.551	86.340	81.546	82.954	86.820	88.326	85.899
Mini.	81.969	71.339	81.287	80.592	75.982	73.954	78.001	75.879	75.804	72.828	82.404	74.835	74.012	74.926	79.447	75.398	77.974	80.743	82.465	78.469
Std.	0.891	0.752	1.323	1.831	1.186	0.783	1.398	1.073	2.844	0.878	0.906	1.202	1.444	2.464	2.013	1.629	1.386	1.898	1.962	2.574
Panel F: Female Labor Force Participation Rate																				
Mean	65.191	54.897	70.466	75.860	72.352	61.917	63.901	49.942	55.019	47.350	60.284	52.366	52.414	62.640	73.969	63.547	53.920	78.358	68.452	68.318
Median	65.599	56.116	70.561	76.069	72.598	61.758	63.553	50.144	59.410	46.785	59.756	52.862	51.821	65.333	75.485	64.295	52.257	77.687	69.024	68.500
Max.	72.365	63.191	75.012	78.175	74.931	67.921	73.996	60.449	66.820	55.926	69.396	59.001	66.168	75.249	77.355	71.626	70.201	82.461	73.256	70.733
Mini.	53.079	44.958	61.555	73.286	69.058	55.292	51.017	39.894	36.197	39.862	54.471	43.950	40.618	40.578	65.802	54.163	34.288	75.420	61.718	62.920
Std.	5.136	6.428	3.766	1.255	1.574	4.074	7.032	7.048	10.572	4.853	3.839	3.612	8.356	10.435	2.896	5.722	11.875	1.983	2.736	1.869
Panel G: Capital Stock Growth Rate																				
Mean	0.047	0.043	0.041	0.040	0.032	0.039	0.035	0.041	0.070	0.045	0.034	0.084	0.050	0.043	0.041	0.057	0.054	0.037	0.045	0.029
Median	0.042	0.040	0.041	0.039	0.031	0.029	0.037	0.043	0.070	0.052	0.023	0.082	0.065	0.041	0.035	0.065	0.052	0.034	0.038	0.029
Max.	0.129	0.148	0.087	0.133	0.120	0.170	0.108	0.198	0.302	0.142	0.096	0.179	0.202	0.172	0.125	0.159	0.275	0.172	0.130	0.070
Mini.	0.001	-0.030	-0.021	-0.023	-0.032	-0.033	-0.018	-0.057	-0.025	-0.079	-0.057	-0.129	-0.070	-0.111	-0.011	-0.046	-0.067	-0.018	-0.043	-0.016
Std.	0.033	0.039	0.026	0.032	0.039	0.045	0.027	0.060	0.062	0.048	0.043	0.075	0.059	0.057	0.034	0.038	0.062	0.040	0.045	0.018

significantly across countries. In developed countries, notably UK and the US, about six to seven percent of labor force are unemployed and a similar percent of labor force are unemployed by male and female. By contrast, there are higher unemployment rates in the developing economies, such as Greece. A possible explanation is that labor institutions and gender differences in human capital accumulation increase the female unemployed people in Mediterranean countries as compared to advanced countries (Azmat et al., 2006). Recently, Albanesi and Sahin (2018) studied the U.S. unemployment gender difference between female and male that was converged since 1980. Based on a calibrated three-state search model, they found that the increasing in female labor force participation and the decreasing in male attachment is the important element for the gender unemployment convergence. Albanesi and Sahin (2018) also found the decline gender labor force participation accounts for the decrease in the gender unemployment difference in the nineteen OECD countries.

Second, Table 1b shows the phenomenon of higher male and lower female labor force. In the UK, for example, the annual male labor force participation rate was 85 per cent. the average annual female labor force participation over the period 1984-2017 were 68 per cent. Moreover, labor market participation rates vary across OECD countries, across male and female. In comparison, there is much more variation in female participation profiles, except Demark and United States. The explanation is that culture and social norms lead some of the female to make a decision, such as marriage, fertility and maternity leave, and choose to leave the labor force.[8]

Moreover, change in capital stock increased at an average rate of 3 per cent per annual during these thirty-four years. Physical capital stocks, such as buildings and machinery, are measured as cumulating the depreciated past investments (Feenstra et al., 2015). Capital stock growth in Korea had a relatively higher rate of increase (8.4 per cent per year). East Asian, such as Korea, economic performance has given rise to a large literature studying its growth 'miracle' and its connection with capital formation. The main reason for the relative high capital stock growth in Korea is it housing and land prices have been high compare to national income levels (Lee and Yoon, 2017).

IV. *The Unemployment Invariance Hypothesis by Gender*

1. The Model Specification

Based on the Layard et al. (2005) theoretical framework, this study analyzes if labor force participation (physical capital accumulation or productivity) causal affects unemployment in the long term. The related literature has not paid much attention to the potential reverse causation effect (e.g. the effect of unemployment on labor force participation) or by the confounding effect of an unobservable third variable on dependent and independent variables.[9]

[8] Balleer et al. (2014) studied the impact of cohort effects on female labor force participation in six European countries. The cohort effect is defined as unobserved reasons connected with culture and social norms of parallel movements in the age-participation profile in different generations. They found the cohort effect explains the major rising in participation in Netherlands, Spain and Germany, and a minor part of rising in participation of the UK, Italy and France.

[9] We sincerely thank referee for guiding us in this direction.

In the independent labor force participation variable, for example, various mechanisms may relate labor force participation to unemployment. These contain observable and unobservable features that run in the OECD economies as well as true causal effects of labor force participation on unemployment. Observable feedback effects, such as married women joining the labor market when their partners become unemployed. Moreover, unobserved third variables, such as international trade, world commodity prices and global business cycles are correlated across OECD economies and may affect labor force participation and unemployment simultaneously. To derive appropriate policy recommendations, it is crucial to disentangle the causal effect of labor force participation from the influence of reverse causation effects and cross-sectional dependencies characteristics. Moreover, the direction of the causal effect on unemployment is a priori unclear: supplementary labor force participation may be associated with less unemployed, but it may also increase the time that employment opportunity is not available in the labor market. In comparison with other methodologies, such as least squares estimation and co-integration analysis, the great advantage of the cross-section augmented distributed lag (CS-DL) approach overcomes the feedback effect and the cross-sectional dependence problem and then identifies the long-term causal effect of labor force participation on unemployment.

Based on the theoretical model in Section 2 we initial consider the following augmented distributed lag (DL) model (Chudik et al., 2016) regression equation:

$$u_{it}=c_i+\theta'_i x_{it}+\sum_{l=0}^{p-1}\delta'_{il}\Delta x_{i,t-l}+e_{it} \tag{4.1}$$

where u_{it} is the aggregate (or male, female) unemployment rate, x_{it} is the set of independent variables of the aggregate (or male, female) labor force participation rate and the changes in capital stock, and e_{it} is the error term. We employed mean group and pooled estimators of the mean long long-run coefficients.[10] As the degree of international trade openness rises, linkage among countries becomes closer and so extent of co-movement across labor markets also raises. The synchronization of unemployment rates needed to be considered in econometric modelling.[11] It is important to check the robustness of empirical results with the cross-section augmented distributed lag (CS-DL) model.

$$u_{it}=c_i+\theta'_i x_{it}+\sum_{l=0}^{p-1}\delta'_{il}\Delta x_{i,t-l}+w_{iu}\overline{\Delta u}_t+\sum_{l=0}^{3}w'_{i,xl}\bar{x}_{t-l}+e_{it} \tag{4.2}$$

As addressed by Chudik et al. (2016), the CS-DL model has several advantages, such as robustness to the potential non-stationarity in regressors, the time dimension T of data is not very large and heterogeneity or homogeneity of long-run coefficients, Moreover, the distinctive advantage of the CS-DL is able to deal with the potential international linkage that emerges in the regression equation due to global integration, that is cross-sectional dependence in the idiosyncratic errors, e_{it}.

[10] Please see Chudik and Pesaran (2016) for further technical details on the application of the mean group and pooled estimators to heterogeneous panels.

[11] When cross-section dependence is resulting from the exist of unobserved common elements, parameter inconsistency may arises if the elements and the regressors are related (Pesaran, 2006; Chudik et al., 2016).

2. The Empirical Result

For comparison purposes, the unemployment determinant model is initially estimated using the ordinary least squares (OLS) approach as the traditional method used in previous literature, such as McHugh and Widdows (1984) and Stegman and Stegman (2004). The OLS model results show the factor effects associated with unemployment rates, as shown in Table 2. In the aggregate unemployment rate (Second column), capital accumulation is a consistent determinant of the aggregate unemployment rate. For males, there does appear to be a physical capital accumulation induced decreasing unemployment pattern. Within the female group, there is a suggestion that women also tend to obtain employment opportunity through capital accumulation because a significant negative coefficient is obtained. As a result, OLS estimation implies the suggestion of a non-gender difference in the case of capital accumulation. Women will probably get equal employment opportunities like men. On the other hand, the labor force plays an insignificant role for both men and women in terms of reducing unemployment. However, the OLS estimation is not without limitations. First, the OLS approach is silent with the potential reverse causation effect or the confounding effect of an unobservable third variable. Second, the long-run parameters are not addressed in the traditional OLS estimation.

In the following step, this section employs both DL and CS-DL models to explore the possible determinants behind unemployment dynamics in OECD countries. The initial DL regression results for OECD countries are presented in Table 3. The pooled and mean group estimate results are reported in Panel A and B. The mean group estimates in Table 3 show an insignificant labor force participation effect on unemployment in OECD countries.[12] This finding is not in line with Österholm (2010) for Sweden, who found a long-term negative relationship between the unemployment and labor force participation rates. The results for both estimators confirm the insignificant impact of male and female labor force participation on gender unemployment, respectively. Moreover, the coefficients for change in capital stock indicate negative statistical significance in the both pooled and mean group specifications. An interesting feature detected in Table 3 is that change in capital stock has a significantly negative impact on the male rather than female unemployment rate. This finding is different from that in the OLS estimation.

In order to explore the cross-sectional linkage of labor markets across twenty OECD countries, cross-sectional dependence Test (Pesaran, 2004, 2015) are employed to examine the existence of the global connection. The cross-sectional dependence Test statistics across the three variables (aggregate, male and female unemployment rates) are reported in Table 4, respectively. In Table 4 the results based on the cross-sectional dependence Test establish a significant association between the labor markets across the twenty OECD Countries, irrespective of the variable considered. The high degree of linkage motivates us to move to the CS-DL model to investigate the unemployment invariance hypothesis among the twenty countries.

Thus far, our analysis is based on the DL models and it would be useful to check whether the result is robust from the CS-DL model. The CS-DL estimation results reported in Table 5.

[12] The choice of lag is decided on the basis of the likelihood criterion (for example, Akaike Information Criterion – AIC and Schwarz criterion - SC). However, it is interesting to check whether the results are robust to alternative lag settings.

TABLE 2. THE EFFECTS OF LABOR FORCE PARTICIPATION AND CAPITAL ACCUMULATION ON UNEMPLOYMENT BASED ON THE OLS REGRESSION, 1984-2017

	Aggregate Unemployment Rate	Male Unemployment Rate	Female Unemployment Rate
Model A (Lags)			
Participation	-0.079	-0.124	-0.001
	(0.058)	(0.105)	(0.031)
Participation (P=1)	0.026	0.056	-0.032
	(0.058)	(0.105)	(0.031)
Capital Stock	-5.190*	-5.887**	-5.118*
	(2.648)	(2.851)	(2.626)
Capital Stock (P=1)	-5.410**	-6.078**	-4.716*
	(2.606)	(2.852)	(2.579)
Model B (Lags)			
Participation	-0.079	-0.117	-0.001
	(0.058)	(0.105)	(0.031)
Participation (P=1)	-0.016	-0.079	-0.012
	(0.082)	(0.151)	(0.043)
Participation (P=2)	0.043	0.132	-0.021
	(0.059)	(0.105)	(0.031)
Capital Stock	-4.901*	-5.725**	-4.950*
	(2.666)	(2.867)	(2.645)
Capital Stock (P=1)	-4.070	-5.025	-3.917
	(2.873)	(3.106)	(2.845)
Capital Stock (P=2)	-2.440	-2.342	-2.537
	(2.623)	(2.869)	(2.595)
Model C (Lags)			
Participation	-0.078	-0.110	-0.001
	(0.058)	(0.105)	(0.031)
Participation (P=1)	-0.015	-0.070	-0.012
	(0.082)	(0.151)	(0.043)
Participation (P=2)	-0.011	-0.023	-0.008
	(0.082)	(0.151)	(0.043)
Participation (P=3)	0.054	0.147	-0.014
	(0.059)	(0.105)	(0.031)
Capital Stock	-4.875*	-5.449*	-4.893*
	(2.673)	(2.871)	(2.654)
Capital Stock (P=1)	-4.209	-5.525*	-4.043
	(2.896)	(3.125)	(2.872)
Capital Stock (P=2)	-2.854	-3.670	-2.929
	(2.895)	(3.125)	(2.870)
Capital Stock (P=3)	1.835	3.204	0.457
	(2.629)	(2.873)	(2.604)

Notes: standard deviation in parentheses. * and ** denote significance at the 10% and 5% levels, respectively.

A crucial feature revealed from Table 5 is that both male and female labor force participation does not have a significant effect on male and female unemployment in OECD countries, respectively. The coefficients for capital stock growth indicate negative statistical significance in the mean group specification. The relationship between capital stock change on male unemployment is negative and statistically significant. Finally, we observe that Table 5 provides the same qualitative analysis and the mean group estimate results are more clear-cut with

TABLE 3. THE LONG-RUN EFFECTS OF LABOR FORCE PARTICIPATION AND CAPITAL ACCUMULATION ON UNEMPLOYMENT BASED ON THE DISTRIBUTION LAG (DL) MODEL, 1984-2017

	Aggregate Unemployment Rate			Male Unemployment Rate			Female Unemployment Rate		
Panel A: Pooled estimates									
Model (Lags)	P=1	P=2	P=3	P=1	P=2	P=3	P=1	P=2	P=3
Labor Force Participation	-0.293	-0.194	0.042	-0.022	0.100	0.199	-0.127	-0.100	-0.026
	(0.215)	(0.233)	(0.254)	(0.128)	(0.118)	(0.192)	(0.150)	(0.202)	(0.297)
Capital Stock	-7.165	-11.260	-17.401*	-14.642**	-22.176**	-28.737**	-4.820	-7.483	-15.890
	(5.725)	(8.999)	(9.308)	(4.303)	(7.720)	(10.870)	(3.924)	(6.881)	(10.615)
Panel B: Mean Group estimates									
Model (Lags)	P=1	P=2	P=3	P=1	P=2	P=3	P=1	P=2	P=3
Labor Force Participation	0.071	0.172	0.119	0.136	0.244	0.567*	0.039	0.134	0.290
	(0.150)	(0.164)	(0.184)	(0.163)	(0.226)	(0.320)	(0.131)	(0.148)	(0.163)
Capital Stock	-14.497**	-21.008*	-22.962*	-21.603**	-33.105**	-33.718**	-8.770	-12.521	-11.219
	(7.154)	(11.842)	(15.517)	(7.027)	(12.683)	(17.022)	(6.315)	(10.390)	(12.699)

TABLE 4. CROSS-SECTIONAL DEPENDENCE TEST

Variable	P=1	P=2	P=3
Aggregate unemployment rate	10.89**	10.18**	9.80**
Male unemployment rate	10.15**	10.09**	9.74**
Female unemployment rate	10.31**	8.06**	6.96**

Note: *** denote statistical significance at the 1% levels. The CD statistic or the null of cross-sectional independence is distribution as two-tailed standard distribution. ** denote statistical significance at the 5% level.

respect to the initial finding of an insignificant impact by labor force participation on unemployment.

As showed in Table 6, including productivity[13] as the third independent variable, the qualitatively similar results regarding the heterogenous impact of capital growth on male and female is also arrived. The empirical results for the insignificant relationship between unemployment-labor force participation are generally robust. After controlling for cross-sectional linkage, the results found that productivity change has not a significant association with unemployment in OECD countries. This finding is consistent with Bean and Pissarides (1993) and Basile and Luca (2008). Bean and Pissarides (1993) investigated cross-country correlations between unemployment and productivity growth in OECD and found no relationship between these two variables. In contrast, Muscatelli and Tirelli (2001) found a significant negative linkage between productivity and unemployment for Japan, Germany, Italy, France and Canada, while no significant correlation was arrived for the U.S. and the UK.

This study has conducted a number of robustness checks.[14] First, in both DL and CS-DL

[13] The data for the productivity (Total factor productivity level at current PPPs) were drawn from the Penn World Table 9.1 (Feenstra et al., 2015).

[14] Results of DL and CS-DL regressions with different specifications are available on Appendix Table A1 and Table A2.

TABLE 5. THE LONG-RUN EFFECTS OF LABOR FORCE PARTICIPATION AND CAPITAL ACCUMULATION ON UNEMPLOYMENT BASED ON THE CROSS-SECTIONAL AUGMENTED DISTRIBUTION LAG (CS-DL) MODEL, 1984-2017

	Aggregate Unemployment Rate			Male Unemployment Rate			Female Unemployment Rate		
Panel A: Pooled estimates									
Model (Lags)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)
Labor Force Participation	-0.327	-0.222	0.051	-0.020	0.094	0.243	-0.148	-0.107	-0.044
	(0.230)	(0.263)	(0.290)	(0.119)	(0.120)	(0.240)	(0.147)	(0.195)	(0.311)
Capital Stock	-5.746	-8.758	-16.291	-14.158**	-21.929**	-28.457**	-4.731	-8.502	-17.965
	(5.748)	(9.434)	(11.500)	(3.957)	(7.609)	(12.476)	(3.460)	(6.488)	(10.889)
Panel B: Mean Group estimates									
Model (Lags)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)
Labor Force Participation	0.066	0.215	0.282	0.089	0.235	0.487	-0.040	0.019	0.172
	(0.160)	(0.174)	(0.196)	(0.169)	(0.241)	(0.379)	(0.127)	(0.155)	(0.174)
Capital Stock	-12.320*	-19.094*	-30.905*	-19.971**	-30.483**	-32.459*	-6.876	-12.240	-17.466
	(6.760)	(10.700)	(15.991)	(7.207)	(12.762)	(16.620)	(6.042)	(9.800)	(14.738)

Notes: standard deviation in parentheses. * and ** denote statistical significance at the 10% and 5% levels, respectively.

TABLE 6. THE LONG-RUN EFFECTS OF LABOR FORCE PARTICIPATION, CAPITAL ACCUMULATION AND PRODUCTIVITY ON UNEMPLOYMENT BASED ON THE CROSS-SECTIONAL AUGMENTED DISTRIBUTION LAG (CS-DL) MODEL, 1984-2017

	Aggregate Unemployment Rate			Male Unemployment Rate			Female Unemployment Rate		
Panel A: Pooled estimates									
Model (Lags)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)
Labor Force Participation	-0.022	0.067	0.123	-0.132	-0.013	-0.019	-0.022	0.067	0.462
	(0.120)	(0.088)	(0.275)	(0.123)	(0.125)	(0.230)	(0.120)	(0.088)	(0.450)
Capital Stock	-1.963	-4.584	-5.449	-3.765	-6.913*	-10.139	-1.963	-4.584	21.838
	(3.672)	(6.485)	(25.052)	(3.023)	(3.764)	(9.618)	(3.672)	(6.485)	(19.281)
Productivity	-4.729	-2.257	-2.924	-5.191**	-6.018*	4.999	-5.729*	-2.257	44.063
	(3.312)	(4.217)	(10.921	(2.297)	(3.246)	(6.898)	(3.312)	(4.217)	(19.441
Panel B: Mean Group estimates									
Model (Lags)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)
Labor Force Participation	0.030	0.011	0.740**	0.022	0.193	0.220	0.030	0.011	0.258
	(0.157)	(0.193)	(0.350)	(0.118)	(0.117)	(0.345)	(0.157)	(0.193)	(0.268)
Capital Stock	-9.107*	-11.783	32.240	-8.662**	-8.370*	-21.625*	-5.107	-11.783	-4.821
	(4.650)	(8.294)	(42.498)	(2.701)	(4.947)	(12.991)	(4.650)	(8.294)	(19.371)
Productivity	-5.719	4.647	-15.933	-4.243	-2.616	-7.173	-7.719*	4.647	9.278
	(4.584)	(5.557)	(39.290)	(3.441)	(4.687)	(9.748)	(4.584)	(5.557)	(17.900)

Notes: standard deviation in parentheses. * and ** denote statistical significance at the 10% and 5% levels, respectively.

models, we also work with three-year averages rather than with yearly data, as an alternative approach to account for business cycle effects. The empirical results are also very similar, and hence not reported. Second, in the model that includes de-mean specification of independent variables does not alter results.

3. Discussions

The results in this paper are different from findings in previous research in two directions. First, this study employs state-of-the-art econometric techniques with latest data coverage that will provide different valuable insights. The standard method in estimating the empirical unemployment determinants is least squares estimation which involves regressing unemployment on changes in capital stock (McHugh and Widdows, 1984; Stegman and Stegman, 2004; Benson, 2011). In comparison with other methodologies, such as least squares estimation and co-integration analysis, the great advantage of the cross-section augmented distributed lag (CS-DL) approach overcomes the cross-sectional dependence problem via augmenting the individual regressions using cross-section average variables. Cudik et al. (2016) showed that the CS-DL estimator is robust to error serial correlation. In particular, the CS-DL model has superior performance to other panel models when T in the range of $30 \leq T < 100$. Second, this study explores the unemployment invariance hypothesis from the different perspective – man versus woman. The motivation for our empirical investigation stems from the fact that unemployment rates are relatively high among female workers.[15] Moreover, the male labor force participation rate in OECD countries showed a systematic decline, but there was an increase for the female labor force participation rate over the last two decades (Blau and Kahn, 2013).

Our results suggest that labor force participation does not has a long-run effect on unemployment in OECD countries. This finding is robust in both male and female unemployment rates. The first likely reason for influence of labor force participation on unemployment in OECD countries is short-term. Human capital theory indicates that worker will flow from areas of relatively poor possibilities to places where employment chances are better. Lower mobility costs among employees also increase the incentives of workers to invest in particular training to a job match. Short-run workers are more likely to find a job and leave the long-run unemployment workers in the unemployed pool. Sims (2006) pointed out that the information capacity of a country includes its wiring capacity and internal human capacity. Wiring capacity indicates the availability of communication technologies that permit investors to access information. Internal human capacity indicates the capability and efficiency for an investor to use the information. International labor mobility is expected to rise as information capacity increases. Thus, the combination of the increasing information capacity and highly mobility of short-run unemployed job seekers leads to long-run invariance unemployment-labor force participation relationship among OECD countries.

The second possible explanation for the insignificant impact of labor force participation on the unemployed pool is discouraged worker effect. During the contraction period, the low skill unemployed stay in the labor force pool but not actively to search a job. They predicted that they would be unable to find an employment position because of a range of reasons, such as caring for elders, moving house and family conflict. It is also important to stress that the large worker flows out of employment are not due solely to job destruction, but because of retirement or giving birth (Dagsvik et al., 2013). This discouraged worker theory provides an explanation of the insignificant relationship between the unemployment and the magnitude of labor force

[15] In France, for example, the average male and female unemployment rate during the 1984-2017 period is 8.7 percent and 11.2 percent, respectively. Similar features are found in Belgium, Demark, Germany, Greece, Italy, Luxembourg, Netherlands, Portugal and Spain.

participation.

Tables 4 and 5 showed that that change in capital stock growth is a significant long-run determinant of male unemployment in OECD countries. One interesting finding revealed from the empirical analysis is that a significant negative relationship is arrived between change in capital stock and male rather than female unemployment rates. This result does not support the prediction of unemployment invariance theory (Layard et al., 2005). The possible reason for this result may be related to the gender inequality that female, over average, were always worse off on the labor market compared to male in terms of wag and labor force participation (Busse and Spielmann, 2006). The limited employment opportunities lead some of the female unemployed to choose to leave the labor force. For a range of reasons, including age and lack of education etc, they anticipated that they would be unable to secure a job. Labor force participation of women was found to be affected by the number of children they had and the importance they ascribed to religion and tradition (Ucal and Gunay, 2019).

In summary, a favorable finding is that physical capital formation is able to reduce unemployment. However, an unfavorable evidence is capital stock change only create job opportunity for men rather than women. The possible explanation for the heterogeneous behavior of male and female response to capital formation results from establishments making different hiring decisions with respect to full-time and part-time workers. The segmented labor market model assumes that the labor market is characterized by primary and secondary workers because of the heterogenous nature of workers, with respect to skills, experience, competence and preference (Blanchard and Diamond, 1990; Leontaridi, 1998). Primary workers have long job tenures and rarely move into and out of employment. By contrast, secondary workers frequently move between jobs and exhibit instability. In addition, it is reasonable to expect that employers often adjust the number of secondary employees during contractions and expansions, but convert some primary workers to part-time status over the cycle. Female with young age is at risk of pregnancy. Becker et al. (2019) studied around 9000 applications with different marital status and the age of children. Married women with older children have more part-time employment opportunity than women with very young kids. Married women with childless feature, who is likely to be pregnant have less part-time job chance than single women. These evidences are not found in full-time jobs because female part-time job seekers imply the potential requirement for external childcare.

V. *Conclusion*

This study presented enhanced evidence regarding the unemployment invariance hypothesis in OECD counties that have been neglected in the research published to date. Some interesting patterns emerged while we investigated the roles played by the labor force participation and change in capital stock in driving the long-term evolution of unemployment dynamics. Based on the state-of-art panel approach this study found that both male and female unemployment dynamics are not significantly associated with labor force participation in OECD counties. One crucial policy implication of this result is that policy makers should be very cautious about the change the labor force participation such as the introduction of the early retirement scheme. Because the uncorrelation is found between unemployment and labor force participation rates, the policy implication is that government policy changes (cut working hours or encourage early

retirement) the size of the labor force have no impact on unemployment in the long-term. For example, decreasing in working hours have been debated in OECD economies for decades (Hunt, 1998; 1999; Contensou and Vranceanu, 2000; Skuterud, 2007; Neumann et al., 2013).[16] Trade unions in Europe have pushed hard for shorter working hours, emphasizing that working bours reductions would create jobs, reduce unemployment and enhance the quality of family life. Based on Layard et al. (2005), if government employs working hours reduction to cut unemployment, inflation will increase more than it would otherwise. Moreover, government realizes that inflation increasing is unacceptable and then permits unemployment to move back its long-term level. As a result, Layard et al. (2005) argues that the non-acceleration-inflation rate of unemployment (NAIRU) depends on long run institutional change (such as benefit system or wage-bargaining arrangement). In particular, Layard et al. (2005) consider that the NAIRU is positive related with duration of unemployment and union coverage, and negative corelated with coordinated bargaining by unions and employers.

This study present new empirical evidence obtained from using capital stock change that does not lend support to the 'unemployment invariance hypothesis'. The capital stock growth is a crucial determinant in male unemployment. In particular, the empirical result revealed that capital stock growth has a significantly negative impact on male unemployment, reflecting the fact that an increase in capital stock improves the labor market matching process because an increase makes it is easier to open vacancies and fill the available vacancies. Consequently, the government should focus on a long-run economic policy that aims to provide better institutions by improving capital formation related legislation which might help improve job creation performance and labor market efficiency. If the aim is to achieve balanced gender equity development across the OECD countries, then a female-friendly policy (for example, the promotion of gender equality business policy) in the reduce gender inequality to achieve equality merits a high priority.

A number of literatures studied the determinants of income inequality. Two channels have been discussed through which capital leads to wealth and income inequality (e.g. Piketty, 2014; Piketty and Saez, 2014; Alvaredo et al., 2017; Piketty et al., 2019). Higher return for the wealthy than the average income changes is considered as the first channel. The second channel is considered as the phenomenon that the return rate of capital earning is a rising linkage with the initial wealth, or the savings rate is a rising relationship with initial wealth, or both. The empirical result in this study implies the potential third channel between capital formation and income inequality through heterogenous male and female searching and matching processes in the labor market. This study only provides a partial evidence on the labor market inequality channel.[17] Working this possibility out in detail is beyond the scope of this paper; hence we leave this interesting topic for future research.[18]

[16] In Canada, for example, the province of Quebec decreased the standard workweek from 44 to 40 hours during the 1997-2000 period with the purpose of job creation. Skuterud (2007) found that the weekly hours worked reduction policy cannot increase employment at either the provincial level or within industries.

[17] More recently, Feng and Tang (2019) studied the effect of labor market, human capital and marriage factors in urban China's income inequality, but they do not address the issue of physical capital.

[18] There is much need for additional research to identify and quantify the potential forces that drove the labor market inequality in the OECD countries. We see our econometric exploration in Section 4 as a useful start, but it is important to provide further results based on other plausible instruments and identification strategies.

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Appendix

Table A1. The Long-run Effects of Labor Force Participation and Capital Accumulation on Unemployment Based on the Cross-Sectional Augmented Distribution Lag (CS-DL) Model (Three-year Averages), 1986-2017

	Aggregate Unemployment Rate			Male Unemployment Rate			Female Unemployment Rate		
Panel A: Pooled estimates									
Model (Lags)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)
Labor Force Participation	-0.178	0.230	-0.206	-0.142	0.140	0.009	-0.017	0.168	-0.525
	(0.188)	(0.154)	(0.335)	(0.164)	(0.393)	(0.345)	(0.113)	(0.175)	(0.475)
Capital Stock	-7.046	-15.747**	-17.992	-14.252**	-10.267**	21.702*	-5.163	-19.643	-21.442
	(7.057)	(5.816)	(20.608)	(6.038)	(5.078)	(11.155)	(6.065)	(14.966)	(18.999)
Panel B: Mean Group estimates									
Model (Lags)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)
Labor Force Participation	0.017	0.306	-0.018	0.168	0.833*	0.468	-0.019	-0.223	0.216
	(0.204)	(0.270)	(0.236)	(0.199)	(0.427)	(0.290)	(0.161)	(0.229)	(0.169)
Capital Stock	-13.057**	-13.801	-4.685	-19.681**	-25.437*	-24.607*	-7.123	-18.043	-21.750
	(6.092)	(11.396)	(9.137)	(7.140)	(14.117)	(13.701)	(5.710)	(15.860)	(20.775)

Table A2. The Long-run Effects of Labor Force Participation and Capital Accumulation on Unemployment Based on the Cross-Sectional Augmented Distribution Lag (CS-DL) Model (De-mean), 1984-2017

	Aggregate Unemployment Rate			Male Unemployment Rate			Female Unemployment Rate		
Panel A: Pooled estimates									
Model (Lags)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)
Labor Force Participation	-0.326	-0.214	0.051	-0.021	0.072	0.270	-0.144	-0.111	-0.052
	(0.242)	(0.260)	(0.319)	(0.112)	(0.098)	(0.224)	(0.155)	(0.205)	(0.343)
Capital Stock	-7.277	-12.379*	-17.927*	-14.739**	-21.285**	-27.476**	-3.098	-6.124	-13.361
	(5.084)	(7.394)	(10.502)	(3.931)	(7.731)	(12.902)	(3.053)	(5.974)	(12.302)
Panel B: Mean Group estimates									
Model (Lags)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)	(1,1)	(2,2)	(3,3)
Labor Force Participation	0.072	0.193	0.531**	0.052	0.174	0.652*	-0.051	-0.020	0.150
	(0.169)	(0.187)	(0.220)	(0.162)	(0.224)	(0.339)	(0.130)	(0.164)	(0.186)
Capital Stock	-10.505**	-15.637*	-28.374**	-19.761**	-30.795**	-33.465*	-6.510	-10.743	-15.989
	(5.291)	(8.822)	(12.917)	(6.945)	(12.471)	(18.076)	(4.944)	(8.253)	(11.944)