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Optimal Unemployment Insurance, Distance to Frontier, and Endogenous Growth Model

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Contents

Abstract

This study analyzes the effect of generosity of unemployment insurance (UI) on economic growth. More generous UI is claimed to cause, on the one hand, an increase in unemployment and, on the other hand, better job-match quality. Recent results suggest that positive effects likely outweigh the negative ones and thus increase the overall economic performance (Acemoglu and Shimer (2000); Marimon and Zilibotti (1999)). However, the results suffer from two sources of doubts: (i) a lack of empirical evidence; and (ii) the fact that the theoretical results were obtained for highly developed countries.

With respect to the former, this study makes use of a unique data-set provided by Scruggs et al. (2014b) and analyzes the effect of more generous UI. To connect our research to recent empirical literature (Ehrenberg and Oaxaca (1976); Centeno and Novo (2006)), we study the potential effect on TFP growth. In particular, using data on 17 relatively developed countries we extend the standard growth regression model and show that more generous UI tends to increase TFP growth. In fact, scoring one point better in the generosity index is expected to be associated with higher TFP growth by 0.5%. However, these results need to be interpreted with caution for two reasons. First, due to data limitations, the results are based purely on developed countries and thus may not be applicable in general. Second, an increase in productivity does not necessarily imply a rise in output as the loss caused by higher unemployment may offset the gain. The results seem robust against several specifications.

To address the problem of general validity of the theoretical conclusions, we develop an endogenous growth model similar to the one proposed by Acemoglu et al. (2006) and Vandenbussche et al. (2006). This model allows to incorporate different economic structure for developing and developed countries. Specifically, in line with the literature on endogenous growth model, we assume that developed countries benefit from innovation-based growth, whereas the developing ones profit rather from the so-called advantage of backwardness. As a result, both countries have different optimal institutions, including labor market institutions. In this respect, we extend the endogenous growth model literature by studying UI under different distance to the technology frontier and thus in countries with different economic environment.

The model points to two main conclusions. The effect of UI in developed countries is, under most levels of unemployment benefits, slightly negative. However, it still leaves space for an optimal level of UI under which the productivity gain may

outweigh the employment loss and thus increase the overall output as some setting of UI causes no significant loss. On the contrary, in the framework of developing countries, any level of unemployment benefits causes a significant loss in output. All in all, the model predicts that while in developed countries it seems promising to consider UI as a growth-enhancing policy, in developing countries it is most likely a harmful institution.

The contribution of this study is therefore twofold. It provides empirical evidence in favor of the positive effect of more generous UI on TFP growth. In the theoretical part it introduces a framework of endogenous growth model which shows that less developed countries suffer (more) from unemployment benefits.

1 Introduction

An importance of a social insurance has been heavily discussed topic among scholars for a long time. Moreover, the issue has become publicly discussed as some European countries are currently considering introduction of basic income pilots or are about to hold a referendum. Some economists view a social insurance, or, in particular, unemployment insurance not only as a measure of social policy, but also as a way to improve job match. In fact, some have been arguing that more generous unemployment benefits provide workers a freedom to wait and search for a better job match, which may even increase productivity and on the aggregate level the output of the economy. For example, one of the first attempts to highlight a positive effect of unemployment insurance on economic performance was made by Acemoglu and Shimer (1999). The authors constructed a general equilibrium model of search with a risk aversion and showed that for risk averse consumers, the existence of unemployment benefits is a necessary condition for the maximized output of the economy. In particular, as they argued, the presence of unemployment benefits encourages workers to search for higher wage jobs.

Similar results were obtained by Marimon and Zilibotti (1999), who strove to explain differences on European and U.S. labor markets. Specifically, they created an equilibrium search-matching model and calibrated it as: (i) a typical economy of European country with unemployment benefits; and (ii) a U.S.-type laissez faire economy with no unemployment insurance. Then they studied the impact of a technological shock (which emphasized the importance of the match between talents and vacancies) on the individual economies and concluded that the European type of economy with unemployment benefits reached a higher growth rate. In their article, Acemoglu and Shimer (2000) presented a simple static model which captures and formally expresses the notion that higher unemployment insurance allows workers to search for more productive jobs. Moreover, the authors also presented a more complex dynamic model that revealed that under a specific of calibration productivity gain caused by unemployment insurance outweighs the loss of output caused by higher unemployment.

The general conclusion is, however, not widely accepted as there are two sources of doubts: (i) a lack of empirical research, which would support or counteract their theoretical conclusions; and (ii) a fact that the theoretical models were calibrated to fit highly developed countries and therefore, do not reflect different optimal institutions in developed and developing countries. As a result, one may be skeptical to consider the results generally credible. The aim of this paper is to extend the recent literature and shed light on both sources of doubts.

The literature addressed to the empirical evidence of existence of a positive effect of more generous unemployment insurance on economic performs is narrow. In fact, to the best of our knowledge, there have been almost no empirical research devoted to this topic. However, several articles took half of the way and studied whether a greater unemployment insurance generosity may lead to better worker-job match. Most of the authors measure the job match quality by: (i) a wage of upon unemployment job; or (ii) a duration (tenure) of that job. Using the former, the results are ambiguous. While few authors in 70′ found evidence of a positive impact of generosity of unemployment benefits on post-unemployment wage (Ehrenberg and Oaxaca (1976); Burgess and Kingston (1976); Holen (1977)), some more recent studies failed to find strong (if any) relation (Blau and Robins (1986); Addison and Blackburn (2000)). Literature which have used the duration seem to provide even more mixed evidence. In particular, Centeno and Novo (2006) employed NLSY79 data-set and used tenure[1] of a job after the unemployed period as a proxy of the quality of match and showed that more generous unemployment insurance shifted the distribution of upon unemployment job duration to the right and thus increased, as the authors claimed, the quality of the match. Moreover, the impact seemed to be unequal across educational levels with the highest merit to the least educated. Likewise, Tatsiramos (2009) studied European countries and found evidence suggesting that more generous unemployment insurance tends to lead to more stable post-unemployment job. On the contrary, Van Ours and Vodopivec (2008) took advantage of natural experiment in Slovenia[2] and studied the impact of a change of unemployment insurance law on job match quality and found no detectable results.

In our study, we interpret the individual potential better vacancy-worker match as an increase in worker's productivity, which at the aggregate level leads to a rise in total factor productivity. Using a unique dataset (Scruggs et al., 2014b), we incorporate the effect of generosity of unemployment insurance into otherwise standard growth equation and find that more generous unemployment insurance is expected to have positive and significant impact on TFP growth. The results seem to be robust against several

[1] They also used the wage as proxy.

[2] In 1998, there was a reform which reduced a potential duration of unemployment for most of the workers.

specifications and used variables. Our results are very important step towards a clarification of the relationship. However, the main research interest lies in overall effect of GDP growth. That is, whether the productivity gain outweighs the loss due to a rise in unemployment and if so, under which conditions.

To investigate the second source of doubts, we employ an extension version of Schumpeterian growth model which allows to study impacts of institutions under different level of development. In particular, Acemoglu et al. (2006) created a model which assumes innovation process and adoption of well-established technology as two sources of growth. This model has become a main tool to analyze optimal institutions and policies in a family of endogenous growth models. Using the model, the authors argued that as an economy is far from the world technology frontier it is growth-enhancing to prefer long-term contracts between firms, hire experienced but low-skill managers, and run large investments. However, as the economy approach the frontier the optimal institutions need to be switched for more flexible contracts and high-skill managers who are more likely to innovate. More generally, selection and innovation are more important for more developed countries. For example, Vandenbussche et al. (2006) also used the model and assessed effects of education and human capital on growth. Specifically, assuming that innovation activity makes a relatively more intensive use of skilled labor, they showed that the closer to the world technology frontier, the more growth-enhancing high-skill labor is. In general, they claimed that economic growth cannot be explained only by stock of human capital or years of schooling, but a composition of human capital matters too. As a result, different stage of development requires different labor. Most recently, Aghion et al. (2013) employed Schumpeterian growth model to shed light on several aspects of the economic growth. In particular, the authors[3] analyzed a correlation between growth and competitive policies and how institutions affect the growth contingent on the distance to the world technology frontier. Introducing a less radical assumption of the step-by-step competition in a sector instead of overleaping one, the authors identified that: (i) escape competition effect; and (ii) Schumpeterian effect. Together these effects can explain an inverted-U shape between the market competition and the growth. The inverted-U shape, was also described and empirically confirmed using data on U.K. firms by Aghion et al. (2005).

Similarly to Acemoglu et al. (2006), Aghion et al. (2013) evaluated the magnitude of

[3] They also studied microeconomics aspects of endogenous growth as relations between growth and dynamic of firms, and long-term technological waves.

the growth and the effects of trade barriers in countries under different stages of development in the framework, where agents face a trade-off between innovation-based growth and imitation-based growth strategy. In line with the previous results, they concluded that the growth in technologically advanced countries relies more on innovation, whereas backward economies have an opportunity to grow faster as they can adopt established technology from the world technology frontier. They further argued that democracy is more growth-enhancing in more developed countries. Most of these theoretical conclusions were also supported by several pieces of evidence. For example, Aghion et al. (2013) provided evidence of the higher importance of no barriers in more technologically advanced countries as well as the increasing positive effect of democracy as countries approach the world technology frontier.

Overall, there is a large strand of literature studying optimality of institutions contingent on level of development. From this perspective, our study contributes to this strand by studying optimal generosity of unemployment insurance. Specifically, following the results from literature saying that in advanced countries the innovation process is more growth-enhancing and thus more crucial, more general unemployment insurance are more likely to have positive impact on GDP growth. On the contrary, economic growth in less developed countries is driven by less skilled intensive industries and thus also the job match is less important. Therefore, our hypothesis is that while more generous unemployment insurance has potential positive effect in developed countries, they definitely harm the economic growth in backward countries.

To assess results of our theoretical model based on studies of Acemoglu et al. (2006) and Vandenbussche et al. (2006), we undertook several exercises. We simulate the model for two representative economies developed and developing and compared their performance under 4 different settings of unemployment benefits. The model revealed that under some (optimal) level of unemployment insurance it seems possible that the presence of unemployment insurance is not harmful in developed country, however, in developing country any level of unemployment insurance causes a fall in economic growth. The results are in line with our hypothesis.

The rest of the study is organized as follows. Next section shows empirical evidence of positive impact of more generous unemployment insurance on TFP growth in developed countries. Having such results gives us a motivation to create a model which is described in the following section. Subsequently, the model is simulated and interpreted. Final section concludes this study.

2 Empirical Evidence

In this section we present empirical evidence of a positive effect of unemployment insurance on TFP growth in the developed countries. The most challenging part of the analysis is to measure the generosity of unemployment insurance which is widely known as a multi-dimentional variable. Different rules for eligibility, duration, the actual level of payments, waiting period *etc.* make the comparison among countries nearly impossible and even if the systems were set equally, the economic conditions, and informal labor market institutions prevent from a decent comparative analysis. An example of potential problems was pointed by Pallage et al. (2013) "...[w]hile duration of benefits is shorter in the United States than in most European countries, it may not imply that UI[4] programs in the United States are less generous since the duration of unemployment is also shorter" (p.2).

As a result, a respectable comparison of the generosity of all social programs (not only unemployment insurance) is a difficult task and requires consideration of several aspects going beyond the main characteristics of social benefits. The economic literature studying methods of measuring the generosity of social programs has been rather poor and tended to use rather weak proxy variables. One of the most heavily used proxy variable for generosity is a share of GDP spent on labor market or directly on unemployment benefits. Not surprisingly, such a measure has several flaws and may lead to misleading results. For instance, when studying the evolution of the generosity of unemployment insurance in European countries in the last few decades, the proxy fails to count for a population growth and an unemployment increase, which occurred in Europe. Likewise, when comparing different countries, the figures are affected by various taxation policies as the tax burden levied on unemployment benefits differ. Overall, the share of GDP is not a good measure.

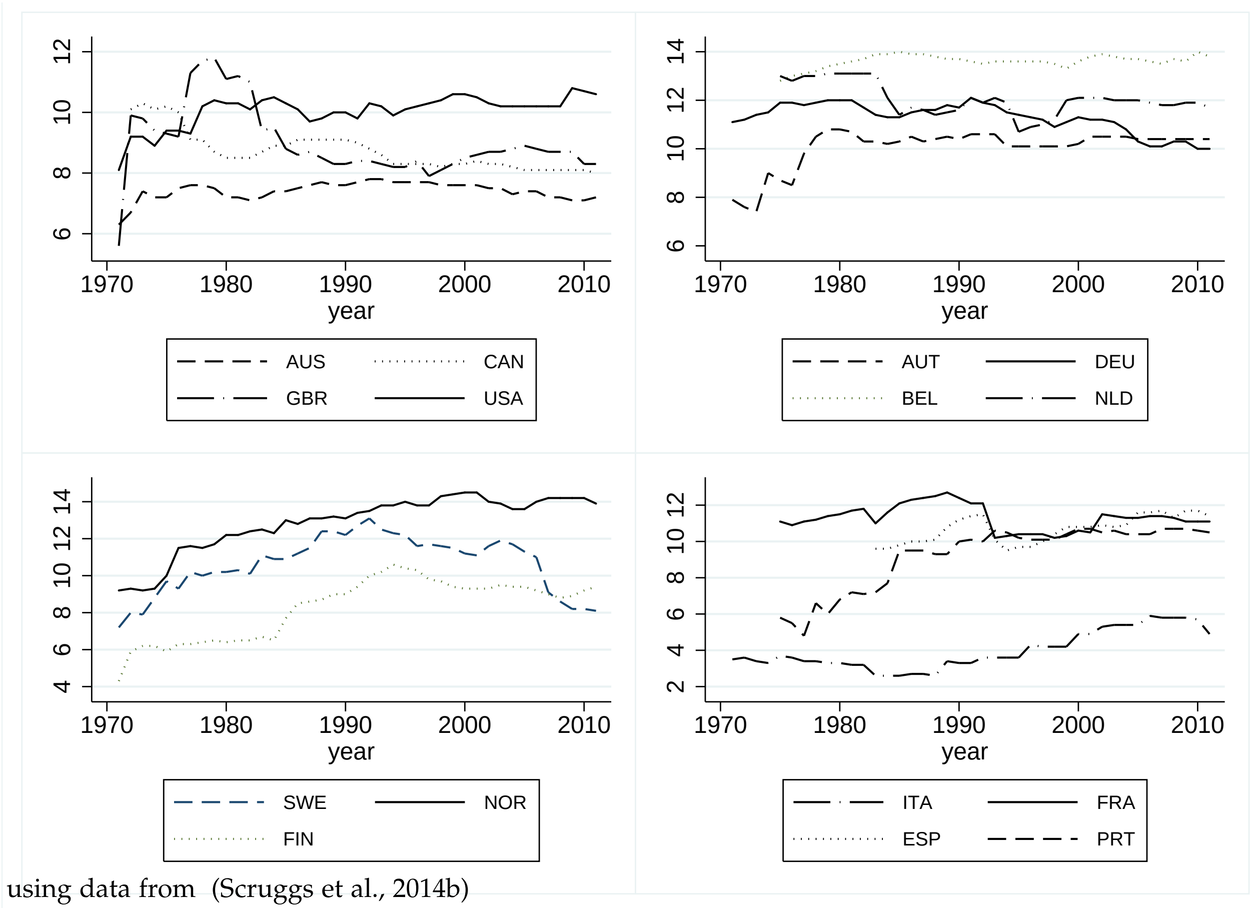
When proposing a better measure, Scruggs (2006) focused on replacement rate and coverage rate which, as he argued, are the most important features of unemployment insurance. To extend Scruggs' approach, Pallage et al. (2013) created a model consisting of two comparable economies which vary only in complexity of unemployment insurance. While in the simple model, unemployment benefits are provided for everyone and from the first day of the unemployment period, the more sophisticated model captures

[4] Unemployment insurance

more aspects e.g., the unemployment duration, the unemployment rate, the unemployment insurance duration, the actual level of unemployment benefits, taxes, and also a different financial support provided by the government. By comparing household's utilities between both models, the authors estimated an one-dimension measure of the unemployment insurance which provides the same level of utility as the multidimensional structure of the policies. However, when performing a regression of the model's output on variables that are believed to affect the generosity, although authors' acknowledgment of omitting non-linear relations and other potential flaws, only three variables (unemployment benefits, unemployment duration, and wait time) seemed significant.

To conduct our analysis, we make use of a data-set CWED 2 (Scruggs et al., 2014b), which provides systematic data on institutional features of social insurance programs in more than 30 counties since 1970'. Specifically, main variable of our interest is *Uegen* - Unemployment Generosity Index; this particular index along with two more indexes provided in the database are based on Esping Andersen's decommodification index (Esping-Andersen, 1990). The Unemployment Generosity Index, as proposed by Scruggs et al. (2014b), is a weighted average of z-scores, where the most important part is the replacement rate z-score. In addition, the sub-index is multiplied by insurance coverage, so it shows Scruggs' belief of the importance of the replacement rate and the insurance coverage rate. Figure 1 depicts several time series of evolution of the index for 4 groups of countries. Specifically, the top left graph shows Anglo-Saxon countries. With an exception for the U.S., the countries have not scored well in recent 20 years and their figures do not even reach the average value of Western European countries such as Germany, Belgium, Austria, and the Netherlands. The bottom left graph shows Nordic countries, which exhibit relatively high level of heterogeneity. While Norway's figures reach maxima from all compared countries in the last decade, Finland performs on average. The bottom right graph shows South European countries including Italy, which has the least generous unemployment insurance in the data-set. For more details, please refer to (Scruggs et al., 2014a). Moreover, in order to perform a robustness check we also employ the criticized spending on unemployment benefits as a share of GDP.

Figure 1: Generosity of Unemployment Insurance



Source: Author using data from (Scruggs et al., 2014b)

In order to explain the growth of total factor productivity, we follow literature (Gehringer et al. (2013),Isaksson (2007), and Loko and Diouf (2009)) and use variables which are widely believed to affect TFP growth. In particular, Loko and Diouf (2009) summarized the problem and divided potential determinants into 5 groups. Starting with macroeconomic factors such as inflation or a government size, he argued that TFP growth suffers from unstable environment and thus, for example, high inflation should be associated with low (if any) growth. Probably the most widely agreed variables affecting TFP in literature are variables related to a knowledge spillover e.g., trade openness and FDI. The higher the international contact is, the more likely new technology is adopted and thus the higher the growth of TFP is. Third group of factors is a sectoral composition of (a growth of) an output. In particular, many argued that economies with higher value added share of high-productivity growth sectors have higher aggregate productivity growth. Fourth aspect which may have impact on TFP is an institutional framework of a given economy. More freely thinking and acting society is more likely to innovate. Finally, Loko and Diouf (2009) discussed the importance of labor quality. Essentially, we extend the last group of arguments by adding a generosity of unemployment insurance which is supposed to improve the quality of match and thus the productivity as well. Moreover, Loko and Diouf (2009) also reckoned that higher female labor participation rate should have a positive effect on the growth of TFP, however, they, at the same time, admitted that empirical results offer rather mixed evidence. Apart from the 5 groups discussed above, Isaksson (2007) highlighted the positive effect of knowledge; patents, R&D, and information and communication technology (ICT).

Our data-set contains unbalanced panel data for 17 developed countries spanning from 1991 up to 2010. However, due to data limitation not all variables for all countries and/or all time periods are at our disposal. Table 1 shows a brief summary of the key variables and list of studied countries. In particular, for each country we report three characteristics which represent average values of the particular variable in the country for observed period. Following common notation in literature we use variable *Distance*, which is defined as a GDP *per capita* of the particular country divided by GDP *per capita* of the U.S. Therefore, the higher the figure is, the more advance the country is. Note that there are 3 countries with the average GDP *per capita* higher than the U.S., whereas the remaining countries, except for Korea, reach at least half of the U.S.'s figure. The second column depicts average score in the unemployment insurance generosity index. Once again, Korea performs the worst and along with Japan and Italy are well behind the group of front

Country	Average Distance	Average Uegen	Average TFP Growth
AUS	.76	7.55	.99
AUT	.88	10.31	1.08
CHE	1.32	13.19	.215
DEU	.84	10.93	.88
DNK	1.12	11.87	.87
ESP	.59	10.98	-.16
FIN	.84	9.55	1.59
FRA	.81	10.95	.78
GBR	.88	8.46	1.46
IRL	1.10	10.83	1.33
ITA	.75	4.745	.13
JPN	.84	5.38	.63
KOR	.43	3.47	3.13
NLD	.95	11.75	.66
NZL	.62	7.08	.40
SWE	.95	11.31	.93
USA	1	10.39	1.28

Table 1: Countries' Characteristics

running countries. On the contrary, the most generous unemployment insurance is in Switzerland. Finally, the last column summarizes the average rate of the growth of TFP in the studied period. While for most of the countries the figure is around 1, there are three extreme cases. On the one hand, Korea performs extraordinary well and reaches a figure as large as 3.13. On the other hand, Italy's growth is only 0.13 and Spain is the only country that has a negative average growth of TFP. A list of all available variables as well as their sources may be found in Appendix 8.

Based on the Table 1, Figure 2 depicts a scatter plot of the average value of the generosity of unemployment benefits and the average growth rate of TFP. It graphically depicts the extreme case of Korea.

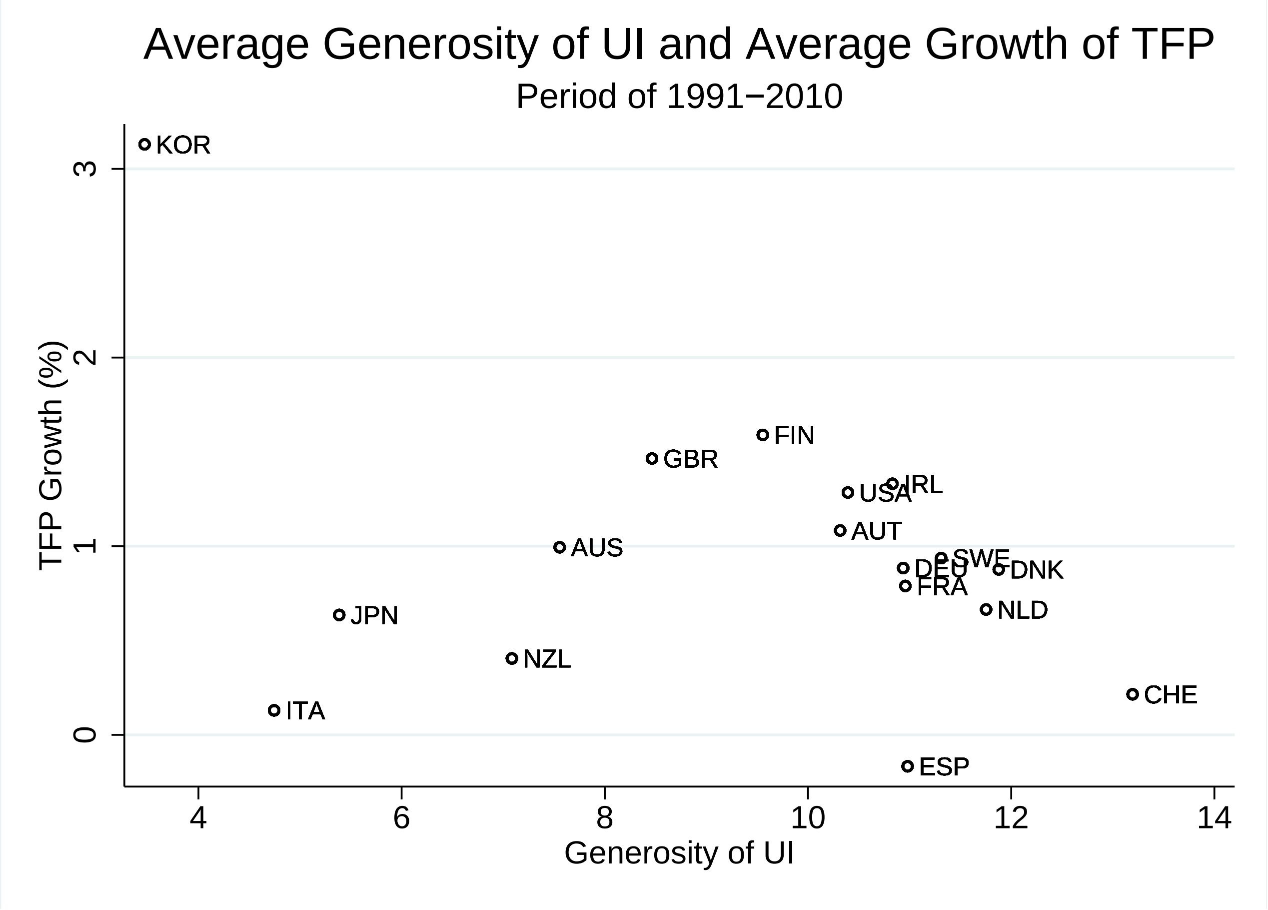


Figure 2: Generosity of UI and TFP Growth

Source: Author.

2.1 Methodology

Having a panel structure of data brings a need to identify whether the data exhibit a presence of fixed effects. On the one hand, when the fixed effects are incorrectly omitted then the coefficients are not consistent, and on the other hand, including fixed effects when it is not necessary causes inefficiency. Therefore, the proper identification of fixed effects is a key step in panel data analysis. In the literature, there are three standard models used: (i) a pooled OLS model; (ii) a random effects model; (iii) a fixed effects model.

To choose the proper model, we proceed in two steps. First, comparing results from the pooled model and the fixed effects model, we learn that the data exhibit a presence of individual heterogeneity as we reject a hypothesis of all the individual effects being jointly zero. In particular, the associated F-statistic equals to 13.2, see the last row of the Model 1 in Table 2. As a result, the pooled model can be shown to be inconsistent (Cameron et al., 2005). Second, knowing that there is an unobservable individual effect in the data, it is crucial whether the effect is correlated with the rest of explanatory variables. If the correlation is present than the random effects model is inconsistent, however, if there is no correlation between the individual heterogeneity and explanatory variables than it is more efficient than the fixed effects model. To decide, we employ Hausman test, where under the null hypothesis they both models reveal the same consistent estimates and thus the difference between them is statistically zero. In our case, Hausman test yields results that suggest rejecting the null hypothesis. For more details, please see 6. Therefore, the random effects model would result in inconsistent results. Overall, the unobservable individual effects are present and appear to be correlated with the remaining explanatory variables.

The formalized fixed effects model studying the effect of the generosity of unemployment insurance on the TFP growth looks as follows.

$$TFPGrowth_{i,t} = \alpha_i + \mathbf{X}_{i,t}\beta + Uegen_{i,t}\delta + \sum_{j=1}^{J} \phi_j \mathbb{1}[t \in j] + \varepsilon_{i,t}, \tag{1}$$

where α_i captures an individual heterogeneity for country i, $\mathbf{X}_{i,t}$ contains all used control variables, and $Uegen_{i,t}$ is the variable of our interest; and $\mathbb{1}$ is an indicator function which returns 1 if period t is a subset of time periods j, otherwise returns 0; and $\varepsilon_{i,t}$ stands for the idiosyncratic errors, which change across time as well as across countries. Even though the fixed effect allows $\mathbb{E}[\alpha_i|\mathbf{x}_i]$ to be any function of $\mathbf{x}_i$, in order to the estimator be consistent we need two more assumptions. Considering individual unobserved effect as a random variable, the first assumption can be viewed as zero conditional mean of error term for each time period t:

$$\mathbb{E}[\varepsilon_{i,t}|\mathbf{x}_i, \alpha_i] = 0.$$

The second assumption requires standard rank conditions on the matrix of time varying explanatory variables. Under these two assumptions the fixed effect estimator is consistent. For more details, please see Wooldridge et al. (2010). Moreover, in order to ensure that asymptotic inference are correct, we would need to add additional assumption about the idiosyncratic errors;

$$\mathbb{E}\left[\varepsilon_i\varepsilon_i^{'}|\mathbf{x}_i, \alpha_i\right] = \sigma_\varepsilon^2 \mathbf{I}_T,$$

along with the above mentioned assumption of zero conditional mean of idiosyncratic errors it implies that the $\varepsilon_{i,t}$ have a constant variance across time and are uncorrelated. However, when this assumption is not (completely) satisfied, it is still possible obtain an asymptotically valid inference. In particular, using clustering leads to an asymptotically valid inference regardless of a within individual auto-correlation and/or heteroscedasticity problem (Cameron and Miller, 2010). Therefore, when estimating the model, *clustered sandwich estimator* for variance is employed.

It is reasonable to suspect that the average pattern of TFP growth might have changed in time regardless of country. For example, due to a higher usage of modern technology it may tend to increase rapidly or on the contrary, during the crisis it perhaps decreased globally. To capture this effect we extend the model with time dummies; an advantage of time dummies compared to a linear trend is no imposed structure on the effect between two particular years. While the linear trend, if significant, can capture either increasing or decreasing pattern, dummies provide more variability in the patterns. Using dummies, however, brings also a disadvantage. In particular, including a dummy for every year comes at the cost of a lot of coefficients being estimated.

2.2 Results

The model pinned down by the Equation 1 shows the benchmark model. The Table 2 shows the obtained results with *TFPGrowth* as the dependent variable. Note that the difference between the models is in the way they capture the time effect. While Model A ignores the time effect completely, Model C includes dummy variables for each year except year 1991 which is taken as a benchmark. A Model B's specification is something between. Specifically, as the time period is considered a half of a decade. The period of years 1991 - 1995 is taken as a benchmark and then every 5 years is associated with one dummy. The names of the dummies are self-explaining.

All of the models use 279 observations for 17 countries with, on average, more than 16 time periods per country. The minimum is 10 observed years for one country. While both Model A and B are able to explain roughly 35% of the total variation of *TFPGrowth* (note that including time dummies increased also the *Adjusted* R^2), Model C outperforms them both. Starting with the Model A, it suggests that the generosity of unemployment insurance has a positive and significant effect on a growth of TFP. In particular, according to the model, if a country scored by 1 point better in the *Uegen* index, the estimated effect on TFP is, *ceteris paribus*, by a 0.5% higher growth. For better imagination, 1 point in the index is a difference between the average score of the U.S. and Sweden, see Table 1. Moreover, the results also confirm several facts from the literature. The value added from the financial sector has a positive and significant effect; level of investment into IT, communication, and software plays positive role in growth of productivity. Surprisingly, and against previous researches, a growth in agriculture has a positive effect. With regard to variables measuring the spillover effect; FDI has a positive and significant effect; and a positive effect of trade openness is on an edge of a 10% significance level. Remaining variables seem to be insignificant.

Model B provides similar results as Model A does. They differ only in the time dummies. Decomposing the time effect into 4 5-years periods clearly shows that in the period from 2006 up to 2010, the growth of productivity tend to be lower, in a comparison to the benchmark of early 90′. However, it is likely caused by the financial crisis which occurred in years within this period. We do not consider it being a long-lasting pattern in productivity growth. Testing joint significance of the 3 time dummies, they seem to be marginally significant (p-value = 0.10). Finally, Model C yields slightly different results; unlike in Model A and B, the growth in agriculture seems no longer significant; the

	Model A	Model B	Model C
Uegen	.584**	.603**	.52***
	(.234)	(.206)	(.147)
ValueAddedFinGrowth	.217***	.221***	.127***
	(.03)	(.03)	(.028)
Inflation	-.089	-.073	6.7e-03
	(.059)	(.076)	(.067)
IctInvestment	.083**	.087*	.092*
	(.038)	(.047)	(.052)
TradeOpenness	.023	.029*	.039***
	(.014)	(.015)	(.011)
InwardFDIShareGDP	1.5e+06*	1.2e+06	3.9e+05
	(8.0e+05)	(8.5e+05)	(6.8e+05)
ValueAddedAg	.342**	.293**	.242
	(.133)	(.132)	(.196)
GDPPwe	-.026	.039	.049
	(.024)	(.025)	(.037)
FemaleEmployment	-.087	-.063	-.026
	(.054)	(.053)	(.049)
Late90		-.705	
		(.434)	
Early00		-1.14*	
		(.636)	
Late00		-1.85**	
		(.771)	
Constant	-4.24	-7.3**	-9.81***
	(2.72)	(2.58)	(2.7)
YearEffects	No	No	Yes
Observations	279	279	279
R^2	0.353	0.373	0.541
Adjusted R^2	0.331	0.345	0.489
F	13.2	21	.

Robust standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Results

effect of level of trade openness and thus the spillover effect of technology and knowledge is strongly significant and positive as the literature suggests. Furthermore, the effect of generosity of unemployment remain significant and positive. The time effect decomposed on years demonstrates similar trend as Model B does; taking year 1991 as a benchmark, in three years in early 90′ the productivity growth was higher, whereas in years 2008 and 2009 as the crisis occurred, the growth was, on average, lower. The remaining years do not seem significantly different from 1991. The F-test confirms the joint significance of the time effect(p-value = 0.00).

2.3 Sensitivity analysis

To deliver more robust results, we conduct 6 exercises with different specifications. For clarity, it is possible to distinguish two groups of sensitivity analyses: (i) relates to specifications of the model; and (ii) verifies the conclusions using different variables (proxies) for studies phenomena.

It seems reasonable to consider an option that the model is likely dynamic; saying that a growth of productivity in a given country is affected by a growth in the same country previous year. To check this option, we include a growth of the previous year among the explanatory variables. However, this, under a presence of fixed effects, cannot be estimated consistently by OLS. Hence we employ procedure proposed by Arellano and Bond (1991), where they derived a consistent generalized method of moments estimator. One may also argue that the idiosyncratic error suffers from auto-correlation. Therefore, we run the model with a lagged value of individual error terms. Finally, we average observations for 5 years into one observation. For instance, for the growth of TFP we obtain average 5 years growth. It dramatically reduces the number of observations, but the resulting model suppresses the effect of business cycles. Table 3 presents the results.

First column, denoted as a Model D, represents results when the lagged value of the dependent variable is included. The fact that the lagged value is insignificant leads to rejecting the dynamic model and preferring the static model. The middle column, Model E, shows output from the model where error terms are assumed to follow AR(1) process. What the table fails to show, is a value of modified Bhargava et al. Durbin-Watson statistics, which is 1.67. Unfortunately, no standard statistical software has implemented

	Model D	Model E	Model F
L.TFPGrowth	-.067		
	(.06)		
Uegen (5years)	.868***	.596***	.409*
	(.181)	(.156)	(.202)
ValueAddedFinGrowth (5years)	.243***	.218***	.149**
	(.032)	(.033)	(.07)
Inflation (5years)	-.092	-.098	-8.7e-03
	(.072)	(.076)	(.105)
IctInvestment (5years)	.08*	.06	.074
	(.044)	(.048)	(.054)
TradeOpenness (5years)	.018	.03*	.033**
	(.015)	(.016)	(.015)
InwardFDIShareGDP (5years)	9.7e+05	1.5e+06*	1.0e+06*
	(7.8e+05)	(8.9e+05)	(5.4e+05)
ValueAddedAg (5years)	.505**	.599**	.546
	(.231)	(.238)	(.382)
GDPPwe (5years)	-.013	-.023	-.059*
	(.026)	(.027)	(0.03)
FemaleEmployment (5years)	-.087	-.069	.036
	(.063)	(.056)	(0.65)
Constant	-7.26**	-5.99***	-8.14**
	(3.37)	(2.05)	(3.62)
Observations	242	262	62
R^2			0.568
Adjusted R^2		0.246	0.493
F		12.2	12.7

Robust standard errors in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Sensitivity Analysis I

critical values and to the best of our knowledge, the only published critical values are those in (Bhargava et al., 1982). Furthermore, the authors stated values for circumstances (number of time periods and individuals) which are not comparable with ours. Therefore, we can say nothing about significance of the lagged value of error term, however, comparing the Model E with the Model A, the results do not differ significantly. As a result, we can conclude that there is no significant problem caused from potential autocorrelation. This is likely due to the usage of the clustering method when estimating the Model A. Finally, Model F provides results for 5-years average observations. Note that there are only 62 observations - roughly 20% of the initial data-set. Furthermore, comparing to previous models, this model is able to explain more of the total variation of the TFP growth, as $R^2 = 0.57$. Similarly to Model C, which also captures time effect and eliminates impact of fluctuation, the trade openness is believed to have positive and significant effect. At regard to the generosity of unemployment insurance, the effect remain significant, even though only at a 10% significant level.

To dissipate potential concerns about used variables, we analyze three models which check a robustness of our results against different choice of variables. In particular, we substitute $TFPGrowth$ by $LabProdG$, which is nothing but a growth of GDP per worked hour; and $Uegen$ by the criticized share of GDP spent on unemployment benefits $PubExpUb$. Table 4 presents results for three models with no time effect[5]. Along with the Table 2, these results show all possible combinations of $TFPGrowth$ and $PubExpUb$ as the dependent variables and $Uegen$ and $LabProdG$ as variables of the main interest on the right-hand side.

As Model G in the Table 4 shows, alternative measure of unemployment generosity barely affect our the results; all significant variables from Model A remain significant and moreover, trade openness reaches a 10% significant level; also the R^2 remains unchanged. Comparing to previous models, a change of the dependent variable causes a fall of R^2; otherwise the results are similar. Finally, when both $Uegen$ and $TFPGrowth$ are substituted the positive effect generosity of unemployment insurance on the productivity growth is still present. Overall, the obtained results bring additional pieces of evidence in favor of our hypothesis; more generous unemployment insurance have a positive impact on the productivity growth.

[5]Including the time effect causes no important differences in studied variables

	Model G TFPGrowth	Model H LabProdG	Model I LabProdG
PubExpUb	.916***		1.2***
	(.231)		(.284)
ValueAddedFinGrowth	.246***	.106**	.143***
	(.029)	(.038)	(.031)
Inflation	-7.6e-03	-.111	6.4e-03
	(.075)	(.077)	(.096)
IctInvestment	.103**	.081*	.106**
	(.036)	(.043)	(.04)
TradeOpenness	.027*	.02	.025
	(.014)	(.017)	(.016)
InwardFDIShareGDP	1.8e+06**	1.5e+06	1.9e+06*
	(7.8e+05)	(8.8e+05)	(9.2e+05)
ValueAddedAg	.125	.365**	.076
	(.158)	(.162)	(.212)
GDPPwe	-.041	-.059*	-.074**
	(.026)	(.03)	(.032)
FemaleEmployment	5.8e-03	-.016	.09**
	(.044)	(.05)	(.039)
Uegen		.606**	
		(.235)	
Constant	-4.31	-5.28*	-6.24**
	(2.49)	(2.83)	(2.44)
Observations	279	279	279
R^2	0.353	0.214	0.245
Adjusted R^2	0.331	0.188	0.220
F	52.6	10.9	26.5

Robust standard errors in parentheses.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 4: Sensitivity Analysis II

Overall, the empirical study shows that in the developed countries more generous unemployment insurance have a positive effect on productivity. In particular, it seems that more generous unemployment insurance by 1 point in the index results in a roughly 0.5% productivity gain. This conclusion appears to be robust against different specifications. Note that it does not necessary imply higher economic growth as more generous unemployment insurance is likely to cause higher unemployment rate which may outweigh the positive productivity gain.

3 Model

The aim of the model introduced in this chapter is to formally analyze the different effects of the generosity of unemployment insurance under various level of development. The model is based on two most important notions: (i) while in the less developed countries the economic growth relies mostly on imitation process which requires less precious match between labor and vacancy, in the more advanced economies the quality of a match is crucial; (ii) having more generous unemployment insurance, and thus higher workers' outside options, the workers can afford to wait for a better match. To capture these ideas we create two-rounds matching model in a framework of an endogenous growth model.

At the beginning of every period, there are two interview rounds in which firms meet workers, they bargain about wage and after that the worker either accepts the job offer or reject. We assume there is a unity of industries ν ($\nu \sim U[0,1]$) and in each of them, only one firm can hire a worker. It can be viewed as that only the most efficient firm in the industry can produce. The mechanisms works as follows; if any of the firms in industry ν hires a worker during the first round of interviews than there is no more interviews in that particular industry during the second round of interviews. Otherwise, firms in the sector have one more opportunity to hire a worker. If a firm does not hire a worker at all, its production in that time period is nothing. When a worker is hired and before the production process takes place, there is an innovation and imitation phase, during which the hired workers attempt to improve a current level of technology in the particular industry. Only after the innovation and imitation process is over, regardless of being successful or not, the production occurs. The level of technology used in a particular industry affects neither the ability to produce the intermediate goods nor the cost of the production, but it affects how effectively and costly the intermediate good is aggregated into a final good; the higher the level of technology used to produce a final good from the intermediate good, the higher the value of the intermediate production. The framework of the model is applicable to a range of countries, such that some of them are more developed and some of them less. Nevertheless, in every country there are the same industries and differ only in the level of employed technology.

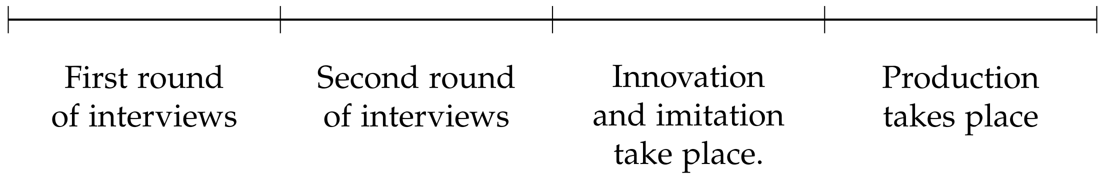


Figure 3: Timing of Economy

3.1 Production

In every country, there is a competitive market for final good y that can be seen as aggregated output of all goods from all industries ν. The final good production is characterized by Cobb-Douglass production function

$$y_t = \psi \int_0^1 A_{t,\nu}^{1-\alpha} (x_{t,\nu})^\alpha d\nu, \tag{2}$$

where $A_{t,\nu}$ captures the technology used in final production of product ν at time t and $x_{t,\nu}$ is number of goods from sector ν. From the competitiveness of final good market follows that price for each intermediate good must equal to its marginal profit

$$p_{t,\nu} = \frac{\partial y_t}{\partial x_{t,\nu}} = \psi \alpha A_{t,\nu}^{1-\alpha} x_{t,\nu}^{\alpha-1}. \tag{3}$$

Taking the price as given, intermediate monopoly firm maximizes its profit, using a final good as capital in one-to-one technology. Although the production itself does not depend on labor input, the dynamic of the level of technology under which the firm operates relies on human capital of hired workers. In addition, we impose an assumption that with no labor the firm produces nothing.

$$\begin{aligned} \max_{x_{t,\nu}} \quad & p_{t,\nu} x_{t,\nu} - x_{t,\nu} \\ \text{subject to} \quad & p_{t,\nu} = \psi \alpha A_{t,\nu}^{1-\alpha} x_{t,\nu}^{\alpha-1} \end{aligned} \tag{4}$$

Solving the firm's problem yields the optimal production

$$x_{t,\nu}^* = \psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}. \tag{5}$$

Using the optimal level of production, one can find the value function of the maximization problem $\pi^*_{t,\nu}$

$$\pi^*_{t,\nu} = \begin{cases} \psi^{\frac{1}{1-\alpha}}(1-\alpha)\alpha^{\frac{1+\alpha}{1-\alpha}} A_{t,\nu} = \delta A_{t,\nu} & \text{if } l > 0 \\ 0 & \text{if } l = 0 \end{cases} \tag{6}$$

The Equation 6 shows both the optimal profit for a firm with no labor and for a firm with hired labor. For more detailed elaboration of the optimal profit with labor, please see Appendix 5.

3.2 Technology

Technology and its dynamics is a key feature of the model as the economic growth depends purely on a growth of the technology. The growth of the technology is so called endogenous, as it is driven by firms' incentives to improve their monopoly rents. Proposition 3.1 expresses the notion formally.

Proposition 3.1. *Assuming firm's problem as defined in Equation 4; more advanced technology under which the industry ν operates leads to higher profit. As a result, firms have an incentive to invest into technological progress.*

The proof can be found in Appendix 5.

To project the growth of technology into the economic growth, we need to impose three assumptions. Following recent literature related to endogenous growth models (among others (Acemoglu et al., 2006), (Vandenbussche et al., 2006), and (Aghion et al., 2013)) we incorporate the following assumptions.

Assumption 3.1. A technological growth is driven by innovation and imitation and cannot be negative.

Assumption 3.2. While the process of imitation requires little or no specificity, in order to innovate the specificity (match) is more important.

Assumption 3.3. The closer to the frontier, the innovation process is more likely to be successful and *vise verse*.

Assumption 3.4. The growth caused by imitation activity is independent of the workers.

Note that assumption 3.4 further develops the assumption 3.2 as the imitation activity no longer needs workers. It somewhat simplifies the model, however, the interpretation may be that the workers, who are studied in this model, are high-skilled and, at the same time, there are also present (implicitly) low-skilled workers who generate imitation growth. Having stated all the technology-oriented assumptions, the law of motion of technology which embodies the properties looks as follows.

$$A_{t,\nu} = A_{t-1,\nu} + (1-\lambda)\phi(\bar{A}_{t-1} - A_{t-1}) + \lambda \eta_t A_{t-1}, \tag{7}$$

where η represents the match of the worker and the industry saying that probability of innovation increases with a better match, $\bar{A}_{t-1}$ is the technology frontier at time $t-1$ and A_{t-1} represents a technology level in a particular country, defined as the average level of technology through the industries.

$$A_t = \int_0^1 A_{t,\nu} \mathrm{d}\nu. \tag{8}$$

3.3 Consumer

Consumers are assumed to live for one period and being endowed with an endowment *end* and a particular skill H which is assumed to be distributed uniformly on interval (0,1) i.e., $H \sim U[0,1]$. At the beginning of the period, she can interview up to 2 firms/industries and discuss their job offers[6]. The meetings go sequentially so first, she learns about the first job offer and either accepts or rejects. In case of the rejection, she meets the second firm/industry and learns the second job offer. However, the vacancy in the second firm may be already taken by a worker who accepted the job during the first round of interviews. If also the second job offer is rejected, then she becomes unemployed with unemployment benefits UB. Formally, she solves the following decision

[6]In future studies, the number of interviews may capture a labor market flexibility and thus allows us to study the importance of the flexibility on different labor markets.

problem.

$$
\begin{aligned}
V_2(\eta_2, UB) &= pu(end - \tau + UB) + \\
&\quad + (1-p) \max_{acc,rej} \left\{ u(end - \tau + w^{II}(\eta_2, \beta, UB)), u(end - \tau + UB) \right\} \qquad (9) \\
V_1(\eta_1, UB) &= \max_{acc,rej} \left\{ u(end - \tau + w^{I}(\eta_1, \beta, UB)), \mathbb{E}\left[V_2(\eta, UB)\right] \right\} \qquad (10)
\end{aligned}
$$

where p stands for probability that the second firm (industry) hired somebody else during the first round of interviews. We assume a utility function u, which satisfies typical properties i.e., being increasing, concave, and satisfying Inada condition; τ stands for a lump-sum tax, used to found the UB. Potential wages in the first and the second round of interviews differ as the negotiators have different outside options and thus different bargaining power. The wage setting process as well as taxation shall be described later.

The probability p that a firm hires a worker during the first round is, however, set endogenously as follows. There is a level of a match $\bar{\eta}_1$ that satisfies $\mathbb{E}\left[V_2(\eta, UB)\right] = u(end - \tau + w^I(\bar{\eta}_1, \beta, UB))$ i.e., if the match is revealed to be $\bar{\eta}_1$, the worker is indifferent between accepting and rejecting the offer. In addition, since the $\frac{\partial w^I(\eta,\beta,UB)}{\partial \eta} > 0$[7], for all $\eta > \bar{\eta}_1$ the worker will accept the first job offer.

$$
p = Prob(\eta > \bar{\eta}_1) = 1 - Prob(\eta < \bar{\eta}_1) = 1 - F_\eta(\bar{\eta}_1). \qquad (11)
$$

During the second round of interviews, she will accept the offered job only if

$$
u(end - \tau + w^{II}(\eta_2, \beta, UB)) > u(end - \tau + UB).
$$

Since the utility function is assumed to be increasing and has an inverse function, it leads to

$$
w^{II}(\eta_2, \beta, UB) > UB.
$$

Using this relation we can define $\bar{\eta}_2$ implicitly as follows

$$
w^{II}(\bar{\eta}_2, \beta, UB) = UB. \qquad (12)
$$

Proposition 3.3 argues that $w^{II}(\eta, \beta, UB)$ is increasing in the value of η, and therefore the worker will accept the job offer from the second firm (industry) if the match $\eta_2 > \bar{\eta}_2$.

[7] See Proposition 3.3

Similarly to p let us define q as probability of $\eta > \bar{\eta}_2$, and hence

$$q = Prob(\eta > \bar{\eta}_2) = 1 - Prob(\eta < \bar{\eta}_2) = 1 - F_\eta(\bar{\eta}_2). \tag{13}$$

Using the notation of defined probabilities, let us elaborate on the expected value of the value function of workers before the second round of interviews. It is necessary to consider the expected value of the value function, because at the time of the first interview the worker does not know her second match. In particular, not only the quality of the match between the firm and the worker is unknown, but also the industry. Therefore the level of technology from previous period is also only expected. In particular, the expectation of previous technology level equals to the aggregate level of technology in particular country.

Lemma 3.1. *Suppose the industries are distributed uniformly, $\nu \sim U[0,1]$, then the expected value over ν of the previous technology level equals to A_{t_1}*

$$\mathbb{E}\left[A_{t-1,\nu}\right] = \int_0^1 A_{t-1,\nu} \mathrm{d}\nu = A_{t-1}$$

The proof follows from the Equation 8. With probability p, her potential interviewer in the second round has already hired a different worker during the first round, and thus she will have no opportunity to meet any firm during the second round and remain unemployed. With a complementary probability $1 - p$ she begins a bargaining process over the job offer with the other firm. Once the bargain begins, the probability q to be hired depends on the level of match η_2 and if it successes the worker enjoys $w^{II}(\eta, \beta, UB)$; otherwise she gets unemployment benefits.

$$\begin{aligned}
&\mathbb{E}\left[V_2(\eta, \beta, UB)\right] = \\
&= \mathbb{E}\left[pu(end - \tau + UB) + (1-p)(qu(end - \tau + w^{II}(\eta, \beta, UB)) + \right. \\
&\qquad \left. + (1-q)(u(end - \tau + UB)))\right] = \\
&= (1 - q + pq)u(end - \tau + UB) + q(1-p)\mathbb{E}\left[u(end - \tau + w(\eta))|\eta > \bar{\eta}_2\right] = \\
&= (1 - F_\eta(\bar{\eta}_1) + F_\eta(\bar{\eta}_1)(F_\eta(\bar{\eta}_2)))u(end - \tau + UB) + \\
&\qquad + F_\eta(\bar{\eta}_1)\mathbb{E}\left[u(end - \tau + w^{II}(\eta, \beta, UB)\right]
\end{aligned} \tag{14}$$

Similarly to $\bar{\eta}_2$, we can implicitly express the value of $\bar{\eta}_1$ as conditions under which the worker is indifferent to accept the offer in the first stage of interviews or reject it.

$$u(As - \tau + w^I(\bar{\eta}_1, \beta, UB)) = \mathbb{E}\left[V_2(\eta, \beta, UB)\right] \tag{15}$$

3.4 Matching and Bargaining

The contact between a worker and a firm is not affected by any information asymmetry. Both parties know the value of their match η before the contract is signed. Unlike Marimon and Zilibotti (1999), we do not consider a linear function as appropriate measure to capture a quality of the match. In order to incorporate more curvature and follow the parsimony rule, we assume that the match function $\eta(d)$, where d stands for a distance between the industry ν and the skill of the worker H and n capture the relative advantage of a very good match against a relatively poor one[8], looks as follows

$$\eta(d) = \exp(-dn). \tag{16}$$

Lemma 3.2. *Under assumptions of both human capital H and industries ν being distributed according to $U \sim [0,1]$, then the distance d, defined as $d = |H - \nu|$ has the following cumulative distribution function*

$$F_d(x) = \begin{cases} 1 & \text{if } x \geq 1 \\ 1 - (1-x)^2 & \text{if } x \in (0,1) \\ 0 & \text{if } x \leq 0 \end{cases}$$

and a corresponding probability density function

$$f_d(x) = \begin{cases} 0 & \text{if } x \geq 1 \\ 2(1-x) & \text{if } x \in (0,1) \\ 0 & \text{if } x \leq 0. \end{cases}$$

The proof can be found in Appendix 5.

Proposition 3.2. *Suppose the matching function defined by Equation 16 and the conclusion of*

[8] The higher the n is, the less weighty the difference between a good match and poor one.

Lemma 3.2, then the cumulative distribution function is

$$F_\eta(x) = \int_{\exp(-n)}^{x} \frac{2(1+\frac{1}{n}\log(\eta))}{n\eta}\mathrm{d}\eta = 1 + \frac{2\log(x)}{n} + \frac{\log^2(x)}{n^2}$$

The proof can be found in Appendix 5

The solution of the bargaining over a wage problem requires to think of two stages, during the first round of interviews both sides - a firm in the industry and a worker - have different outside options than during the second round. Let us start with the second round and define $w_t^{II}(\eta, \beta, UB)$ as a wage from the second interview rounds with a match η, a worker's bargaining power β, and UB a level of unemployment benefits. Since the second round is the last one, the outside option of a firm in case it did not hire a worker is zero production and zero profit (see Equation 6). Therefore, a firm can agree on a wage $w_t^{II}(\eta, \beta, UB)$ as big as its gross profit $\delta A_{t,\nu}$. Likewise, it is terminal stage for the worker as she cannot meet any other firm and thus her outside option is a utility level from receiving UB: $u(end - \tau + UB)$. Assuming that the worker has a bargaining power β, than the possible wage from the second round of interviews is defined as[9]

$$w_t^{II}(\eta, \beta, UB) = \beta\left[\delta A_{\nu,t} - UB\right]. \tag{17}$$

The bargaining process is more complicated during the first round of interview as the outside options are less clear. The worker has no incentive to accept a wage than would make her worse than what she can expect from the second round of interviews, mathematically

$$u(end - \tau + w_t^{I}(\eta_1, \beta, UB)) \geq \mathbb{E}\left[V_{2,t}(\eta, \beta, UB)\right].$$

The firm, however, will not agree on a wage that would make the net profit lower than if it finds a worker in next round of interviews (expectation as the match η is unknown), namely

$$\delta A_{t,\nu} - w_t^{I}(\eta_1, \beta, UB) \geq F_\eta(\bar{\eta}_1)(\mathbb{E}\left[\delta A_{t,\nu} - w_t^{II}(\eta, \beta, UB)\right]).$$

Combining these two conditions and assuming that β is the worker's bargaining power, the wage $w_t^{I}(\eta, \beta, UB)$ looks as follows

[9] Note that the bargaining power here is considered to be exogenously given.

$$
\begin{aligned}
w_t^I(\eta_1, \beta, UB) &= u^{-1}(\mathbb{E}\left[V_{2,t}(\eta, \beta, UB)\right]) - end + \tau \\
&+ \beta \left\{ \delta A_{t,\nu} - F_\eta(\bar{\eta}_1)(\mathbb{E}\left[\delta A_{t,\nu} - w_t^{II}(\eta, \beta, UB)\right]) - \right. \\
&\left. \quad u^{-1}(\mathbb{E}\left[V_{2,t}(\eta, \beta, UB)\right]) + end - \tau \right\}
\end{aligned} \tag{18}
$$

Note that from the perspective of the worker, the value of the required level of match is uncertain at the time of the first round of bargaining. It is because the technological level of the firm/industry which she will meet during the second round of bargaining is unknown and she can only formulate her expectation over w_t^{II}. The Lemma 3.3 derives the value of $\bar{\eta}_2$.

Lemma 3.3. *Under the definitions 7, 12, and 17, the quality of the match under which the worker is indifferent between accepting the job offer with a wage w^{II} and choosing her outside option of being unemployed with UB is*

$$
\bar{\eta}_2 = \frac{1}{\lambda}\left[\frac{1+\beta}{\beta}\frac{UB}{\delta A_{t-1}} - \frac{A_{t-1,\nu}}{A_{t-1}} - \phi(1-\lambda)(a_{t-1}-1)\right],
$$

where $a_{t-1} = \frac{\bar{A}_{t-1}}{A_{t-1}}$ is interpreted as an inverse distance to the frontier.

The proof can be found in Appendix 5.

Having found the value of $\bar{\eta}_2$, to find the expectation worker anticipates is enough to find $\mathbb{E}\left[\bar{\eta}_2\right]$

$$
\mathbb{E}\left[\bar{\eta}_2\right] = \frac{1}{\lambda}\left[\frac{1+\beta}{\beta}\frac{UB}{\delta A_{t-1}} - 1 - \phi(1-\lambda)(a_{t-1}-1)\right], \tag{19}
$$

which follows from Lemma 3.1.

The Lemma 3.3 also reveal a key aspect of the model. The expected level of a match in the second round of negotiation depends positively on a level of unemployment benefits. This is the canal, which ensures that unemployment insurance increases the expected value in the first round of negotiation and provide workers with higher outside option.

Having introduced the matching and bargaining process and having set the wages, let us derive properties of wages.

Proposition 3.3. *Suppose the introduced framework and take both UB and β as given, then both wages $w^I(\eta, \beta, UB)$ and $w^{II}(\eta, \beta, UB)$ increase with better match η at the same rate.*

The proof can be found in Appendix 5.

3.5 Government

In the model, government is responsible for redistribution of its income collected as lump-sum taxes as an unemployment benefits to people who stay with no job. In order to impose a time consistent policy, we assume that the government's budget need not to be balanced in every period. Specifically, we simple assume that sum of the unemployment benefits distributed among unemployed in time t has to equal to a tax collection in time $t + 1$. It means, that government can run a debt in every period, but in the subsequent period it must be redeemed.

$$\sum_H UB_{H,t} = \sum_H \tau_{t+1,H} \tag{20}$$

Furthermore, this assumption enriches the information set of consumers when taking their decisions as they *ex ante* know the taxation. From economic point of view, it also seems reasonable as in most of the countries today's debt of governments will be redeemed by future generations.

3.6 Economic Growth

Having defined all key parts of the model, we can analyze the economic growth under introduced framework. Let g denote an economic growth based on a standard definition; a percentage increase in output is

$$g = \frac{y_t - y_{t-1}}{y_{t-1}}. \tag{21}$$

Proposition 3.4. *Under the assumed framework, the growth rate defined by Equation 21 equals*

$$g = (1 - \lambda)\phi(a_{t-1} - 1) + \lambda \int_0^1 \eta_{t,\nu} \mathrm{d}\nu,$$

where $a_{t-1} = \frac{\bar{A}_t - 1}{A_{t-1}}$ is interpreted as an inverse distance to the frontier.

The proof can be found in Appendix 5.

According to the proposition 3.4, the growth rate is sum of effect following from imitation activity and innovation respectively. It further reveals that highly developed countries ($a_t \to 1$) grow mainly through innovation.

4 Simulation of Model

In order to solve the model, we need to incorporate and specify few more features. In particular, we impose a constant relative risk aversion (CRRA) form of utility function

$$u(c) = \begin{cases} \frac{c^{1-\sigma}-1}{1-\sigma} & \text{if } \sigma \neq 1 \\ \log(c) & \text{if } \sigma = 1. \end{cases} \tag{22}$$

It is also necessary to specify the path of development of UBs in time. It is understandable that if UBs were fixed at a particular level, their importance would diminish as we suppose a growth model in which all others sources of income increase as the economy grows. Therefore, we assume that the unemployment benefits evolve with respect to the economic growth in previous period

$$UB_t = UB_{t-1}(1 + g_{t-1}), \tag{23}$$

where g is defined by Equation 21. The theoretical model, namely one of the implication of Proposition 3.4 precisely defines the growth of the frontier economy, however, it is not useable when solving the model with only two representative countries. Hence, we assume an exogenous growth rate of the frontier economy at 5% per period of time. For simplicity, where it is possible and causes no confusion, we omit time indexes.

To calibrate our model, we choose few parameters so they follow literature, however, the remaining parameters are set to match some styled economics facts. Specifically, β that captures the bargain power of labor is set to 0.62 as is suggested by Karabarbounis and Neiman (2012). To pick a proper value of elasticity of intertemporal substitution, it is difficult to follow literature as the estimated values differ significantly. We decided to follow a suggestion from (Havránek, 2013) and use σ = 3. Two variables alter with the level of development of the economy a_t - initial endowment of consumers *end* and weight on a growth by innovation λ. The dependence of the former on the level of development follows from (Isaksen et al., 2014), where the authors used OECD data to analyze the households' savings and concluded that households in more developed countries tend to have, on average, higher savings (financial assets). The latter simply implies that countries which may easily benefit from imitation process will do so and highly developed countries will focus on innovation based growth. This further extends the assumption 3.3, in a sense that governments in particular countries are aware of the situation and can adjust their policies. The parameter λ is set to 0.2 for developed countries and 0.4 for developing countries. Note that we do not require the policies to be optimal.

The parameter n, which affects the distribution of the vacancy-job match, is set relatively high to 6. As a result, the difference between a very good match and rather poor one is not so weighty as if n was lower. The value of ϕ capturing a speed of the growth driven by imitation is set to 0.05, ψ which normalizes the product of economy is set to 2.25. Finally, α measuring the importance of input relative to the technology in production function is set to 0.7. Therefore, the input is more important than the technology in a production.

To assess the results we consider two representative countries. On the one hand, one of the countries, henceforth the developed country, is highly developed, its technology is close to the frontier, consumers have relatively high level of savings, and institutions are set in favor of innovation. On the other hand, the other country, henceforth the developing country is rather backward, its technology level is low, policies are oriented toward imitation and households barely owe assets as valued as 2 or 3 times of their disposable incomes.

To solve the model we conduct an exercise studying the cumulative growth rate in 5 sequential periods of time under different setting of unemployment insurance. Apart from economy with no unemployment insurance which is considered being a baseline and it is further used as a benchmark for a growth in economies under different unemployment benefits settings. We choose reasonable rates of unemployment benefits which satisfy two required conditions: (i) the level of unemployment insurance is reasonable in comparison to the average wage of the economy; and (ii) the same levels of generosity (low, medium, and high) are comparable between the two representative economies. The latter appears to be rather difficult as the two representative economies differ in their performances and outcomes. Moreover, the unemployment benefits in absolute numbers have to differ. In the developed economy, we set low, medium, and high level of unemployment benefits to 10%, 25%, and 50% of an average wage, respectively. To find corresponding values in a framework of the developing economy, we equalize the ratio of unemployment benefits to the economy's outcome. Therefore, for a given period of time it must hold

$$\frac{UB_a}{y_a} = \frac{UB_b}{y_b},$$

where a stands for the developed (advanced) economy and b for the developing (backward) economy. Using Equation 2 and the fact that both economies are equal in terms of inputs (industries), the expression can be simplified as follows

$$\frac{UB_a}{UB_b} = \frac{\int_0^1 (A_\nu^a)^{(1-\alpha)} \mathrm{d}\nu}{\int_0^1 (A_\nu^b)^{(1-\alpha)} \mathrm{d}\nu}.$$

In our case, if the two unemployment benefits should be comparable between the economies, the ratio must be approximately $\frac{7}{5}$ [10]. Therefore, if the high unemployment benefits in the developed economy are equal to 1 (representing a 50% of the average wage in the developed country), the level of high unemployment benefits in the developing economy must be $\frac{5}{7}$, which is, however, close to the economy's average wage.

We simulate both economies under each level of unemployment benefits 30-times and Table 5 presents the average values. The first column summarizes the average value of a sum of growth rates over 5 periods of time for every setting. The economy with no unemployment insurance is a benchmark. The second column captures the percentage difference in the cumulative growth between the baseline economy with no unemployment insurance and the particular economy. The third column shows the *t-ratio*[11], which measures the significance of the difference in cumulative growth. Finally, last column displays unemployment rate under the specific setting. The top of the table is devoted to the developed economy, whereas the bottom summarizes the developing country.

To assess the importance of the results for our hypothesis, it is crucial to compare how the increasing generosity of unemployment insurance affects the cumulative growth in the developed and the developing economy. In general, in both economies there is negative impact of unemployment insurance on cumulative growth, however, the magnitude

[10]These results were obtained numerically. The distribution of the technology level across the industries A_ν follows uniform distribution with a mean of A_t^i for a country i and time t.

[11]For more details, please see Appendix 5

varies significantly. In the developed economy, the effect of introducing the low level of unemployment benefits on the cumulative growth rate is on an edge of statistical significance ($|t\text{-}ratio| = 1.58$). On the contrary, in the developing country, there is no doubt that non-zero unemployment benefits cause a loss in economic output. Moreover, in the case of medium level of unemployment insurance, the developed economy also suffers a less significant decrease in the cumulative growth rate.

Surprisingly, the developing economy performs better in the case of high level of unemployment insurance. However, it is due to an imperfection of the model. In particular, under such extreme conditions of unreasonably generous unemployment benefits and, in turn, high unemployment in both economies, the growth via imitation activity outweighs the effect of innovation. As a result, the model is no longer able to capture the consequences of a quality of match on the growth. Instead, it compares a growth caused by imitation activity and here the developing country benefits from its backwardness and overperforms the developed economy. Overall, these results, even though they may look startlingly, only reflect extreme circumstances under which the model loses its power to explain the studied phenomena. Note that we present these results only with a purpose to describe the model's behavior under unreasonably generous unemployment benefits and we do not consider them to be plausible.

The results show few clear patterns. For example, for both economies it is true that more generous unemployment insurance causes higher unemployment rate. This confirms the moral hazard problem argument. However, the effect between countries is unequal; the unemployment rate in the developed country for a given level of the generosity of unemployment benefits is always lower than the one in the developing country. In addition, for low and medium level of unemployment benefits, the loss in developed country is lower in comparison with the developing country. The explanation is as follows. While in both countries there is a decrease of output caused by lower employment, in the developed country, the loss is partially offset by better match and more likely successful innovation activity and consequently by higher growth of technology. The developing country cannot gain much technology growth from better match, because its institutional framework is imitation-oriented.

Apart from the main results, there are several outcomes worth commenting. First, the results confirm that developing countries tend to grow faster as they benefit from their backwardness. Comparing the developed and developing economies under no unemployment insurance policy, the 5 periods of time cumulative growth in developing country is almost 144% of the growth during the same period in the developed country. Second, no unemployment insurance policy implies weak (if any) consumers' outside options, which, in turn, imply zero rate of unemployment as the model allows everyone to find a job. This is a truth for both modeled economies, the developed country and the developing country. Third, in case of high level of unemployment insurance in developing country, the unemployment rate is 100%. This is again an extreme result, which is caused by the specification of the model. It is driven by two separated causes: (i) unemployment benefits, under such circumstances, stands for roughly 85% of an average wage[12]; and (ii) due to the construction of the model, the economy is able to grow via imitation activity which does not require labor. Finally, probably the most contra-logical result, the unemployment rate in the developing country under high unemployment benefits policy reaches 100% and yet, the growth rate is decently high. As discussed above, the results suffer from inability of the model to cope with the extreme conditions imposed by such high unemployment benefits and we think of the results as being caused be the imperfections of the model.

All in all, the results tend to support our hypotheses. In particular, one of the hypotheses is confirmed clearly; more generous unemployment insurance in the developing country seems to harm the economic growth. However, the results regarding the developed country leave a space for discussion; while our hypothesis claims that the overall effect of more generous unemployment insurance on economic growth is ambiguous, the results suggest negative impact. Nevertheless, the loss, at least for the low unemployment benefits, is on an edge of significance and thus we cannot completely reject the claim that there may be an optimal level unemployment insurance which causes no negative (or even causes positive) impact on the economic growth as, for example, Acemoglu and Shimer (1999) argued. The hypothesis about an existence of non-linear effect is necessarily a consequence of the first one and the second one.

[12]Note that the reason for such high unemployment benefits is discussed above.

	Developed country			
	Cumulative Growth (5 Periods)	Change against No UBs	T-ratio (28 df)	Unemployment Rate
No UBs (Baseline)	60.10 %			0 %
Low UBs	59.62 %	- 0.75 %	-1.58	1.57 %
Medium UBs	52.08 %	- 13.30 %	-30.06	17.5 %
High UBs	36.23 %	- 39.69 %	-77.22	48.15 %
	Developing country			
No UBs (Baseline)	86.64 %			0 %
Low UBs	84.56 %	- 2.40 %	-10.80	8.42 %
Medium UBs	73.61 %	- 15.04 %	-66.42	60.56 %
High UBs	65.06 %	- 24.91 %	-85.36	100 %

Source: Author.

Table 5: Solution

5 Conclusion

This study devotes to a problem of the optimal level of the generosity of unemployment insurance and the effect on economic growth rate. Specifically, we continue in a research conducted by Acemoglu and Shimer (1999), Acemoglu and Shimer (2000), and Marimon and Zilibotti (1999) suggesting that more general unemployment insurance may have positive effect on economic performance. We focus on two sources of doubts which may pretend from considering their results more credible: (i) theoretical focus on developed countries; and (ii) a lack of empirical evidence.

The theoretical part combines two strands of literature. On the one hand, it follows a broad research on endogenous growth model (Schumpeterian growth model) and, on the other hand, it significantly extends studies on potential positive impact of unemployment insurance on economic performance. In particular, our theoretical model embodies a mechanism which describes how greater generosity of unemployment insurance results in higher outside option for unemployed workers and thus allows them to wait for a better quality match. The better quality match is, in turn, likely to be associated with a higher productivity of the workers. At the aggregate level, higher productivity leads to higher growth of TFP of the economy. Unlike most of the scholars (Marimon and Zilibotti (1999), Acemoglu and Shimer (2000)), we study the productivity gain in a framework of endogenous growth model, which allows us to distinguish between developed and developing economies. Similarly to Vandenbussche et al. (2006) and Aghion et al. (2013) we impose the difference between developed and developing country policy into assumptions about the sources of their growth; while the developing economy benefits from the advantage of backwardness and the developed country growth relies on innovation success. Specifically, we calibrate two representative economies; one corresponds to the developed economy with technology close to the technology frontier; the other one symbolizes a backward economy where the growth depends, in a large scale, on imitation of already well-established technology.

Solving the model brings results that indicate two main conclusions. First, they confirm a stylized fact that the developing countries (e.g., China, India) tend to grow faster than already developed economies. Given a comparable (the same in terms of the ratio to the economy's outcome) unemployment insurance policy, the representative developing country always grows faster than the developed economy. Second, more generous unemployment insurance along with the given development-dependence (optimal) policies seem to be more harmful for the economic growth in the backward countries than in the developed countries. Unlike the recent literature (e.g., Acemoglu and Shimer (2000)), our theoretical model fails to reveal evidence that some particular level of unemployment benefits may have a positive impact on the economic growth. However, a low level of unemployment insurance in the developed economy caused nearly negligible loss of cumulative growth, which may be caused by the specification of the model or particular calibration values. Therefore, based on our results it is difficult to argue in favor of or against beneficial effect of the (some level of) unemployment insurance on the economic growth in advanced countries. However, in all likelihood the unemployment insurance in the developing country affects the economic growth negatively. These conclusions are relevant to our hypotheses; specifically they support the hypothesis that in the developing country the effect of unemployment benefits is negative, whereas the effect in developed countries is, under appropriately chosen level of unemployment benefits, insignificant.

To bring empirical evidence, we analyze a relationship between generosity of unemployment insurance and TFP growth. In particular, due to the unavailability of data concerning the developing countries, the focus is solely on the developed countries environment. Furthermore, to connect our research to recent empirical literature, we study the potential effect of unemployment insurance on productivity growth while omitting the economic growth. In particular, we extend studies of Van Ours and Vodopivec (2008) and Centeno and Novo (2006) on the potential effect of more generous unemployment insurance on a better quality match in post-unemployment job by shifting the focus on the resulting productivity gain. We collect a data-set of variables that are thought to affect the TFP growth for 17 developed countries covering period of 20 years and use it to study the effect of unemployment insurance generosity on the productivity growth. In addition, instead of the commonly used share of GDP spent on unemployment benefits as a proxy for generosity of unemployment insurance, which have been criticized (Pallage et al., 2013), we employ an index of unemployment insurance generosity created by Scruggs et al. (2014a). The obtained results reveal auspicious conclusion; unemployment insurance generosity is likely to enhance the productivity growth. In particular, an increase in the index by 1 point is expected to cause a faster TFP growth by slightly more than 0.5%. This conclusion is robust against different specifications of models and/or used variables.

With respect to our aims, the empirical exercise finds a solid evidence in favor of the existence of a positive effect of unemployment insurance on the productivity growth. Potential policy implications, however, need to be deduced with a caution. While the productivity gain is growth-enhancing, it is ambiguous whether it can outweigh higher unemployment caused by moral hazard problem associated with the unemployment insurance. Hence, the productivity gain does not necessarily implies higher economic growth, not even in the developed countries, where the productivity is of higher importance. Unfortunately, there is no empirical results toward the developing countries.

All in all, this study contributes to literature in two different aspects. First, using the theoretical framework of endogenous growth model, this thesis studies the effect of unemployment benefits on TFP growth in developing countries, which has been a neglected topic as most of the authors focus solely on developed countries. Second, in the empirical part we extend recent studies on the effect of unemployment insurance on post-unemployed match and shows that the potential better match positively affects the productivity growth. Furthermore, we manage to provide evidence supporting our hypotheses; the theoretical model suggests that unemployment insurance is more harmful to economic growth in the developing countries, whereas the effect in the developed countries is either neutral or only slightly negative and thus the effect is necessarily nonlinear. Based on the data-set, we find empirical evidence in favor of a positive effect on TFP growth in the developed countries.

Natural extension of this strand of literature is to provide empirical evidence whether productivity gain caused by more generous unemployment insurance outweighs the negative impact of increasing unemployment. Moreover, the potential interaction of unemployment insurance with other institutions remain a neglected question in empirical literature. The question could for example be, whether it is the productivity gain more likely to occur in export oriented or consumption oriented countries; or how the level of development of counties affects the productivity gain. Furthermore, the core of the theoretical model can be relatively easily employed to explain effects of different labor market institutions under different distance to frontier. For instance, allowing workers to participate in more interview rounds i.e., letting the labor market be more flexible is also likely to have an impact conditioned on the level of development. More flexible labor market will possibly lead to a better job match.

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Appendix

Problem 4 Suppose a firm's problem defined by 4. Plugging the constraint into the (gross) profit function leads to new objective function of only one control variable - $x_{t,\nu}$

$$\pi(x_{t,\nu}) = \psi\alpha A_{t,\nu}^{1-\alpha} x_{t,\nu}^{\alpha} - x_{t,\nu}.$$

The first order condition looks as

$$\psi\alpha^2 A_{t,\nu}^{1-\alpha} x_{t,\nu}^{\alpha-1} - 1 = 0.$$

Rearranging leads to

$$\psi\alpha^2 A_{t,\nu}^{1-\alpha} = x_{t,\nu}^{1-\alpha},$$

$$x_{t,\nu} = \psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}.$$

To claim that $\psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}$ is optimal solution, one needs to verify the second order condition

$$\pi_{t,\nu}^{''}(x_{t,\nu}) = (\alpha - 1)\psi\alpha^2 A_{t,\nu}^{1-\alpha} x_{t,\nu}^{\alpha-2}$$

The objective function is concave as long as $(\alpha - 1)\psi\alpha^2 < 0$, which is assumed as $\psi > 0$ and $0 < \alpha < 1$. Having the policy function of the problem, one can calculate the value function π^*

$$\pi_{t,\nu}^* = p(x_{t,\nu}^*)x_{t,\nu}^* - x_{t,\nu}^* = x_{t,\nu}^*(p(x_{t,\nu}^*) - 1),$$

$$\pi_{t,\nu}^* = \psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}(\psi\alpha A_{t,\nu}^{1-\alpha}(\psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu})^{\alpha-1} - 1),$$

$$\pi_{t,\nu}^* = \psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}(\alpha^{\frac{\alpha-1}{1-\alpha}} - 1),$$

$$\pi_{t,\nu}^* = \psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}(\frac{1-\alpha}{\alpha}),$$

$$\pi_{t,\nu}^* = \psi^{\frac{1}{1-\alpha}} \alpha^{\frac{1+\alpha}{1-\alpha}} A_{t,\nu}(1-\alpha).$$

Proof of Proposition 3.1

Proof. To show that the firm's problem given by equation 4 persuades them to invest into a growth of technology in order to rise their profits, it is enough to consider part of the equation 6 with positive labor and show it is increasing in a technology level.

Mathematically,

$$\frac{\partial \pi^*_{t,\nu}}{\partial A_{t,\nu}} = \frac{\partial \left(\psi^{\frac{1}{1-\alpha}} (1-\alpha) \alpha^{\frac{1+\alpha}{1-\alpha}} A_{t,\nu} \right)}{\partial A_{t,\nu}} = \psi^{\frac{1}{1-\alpha}} (1-\alpha) \alpha^{\frac{1+\alpha}{1-\alpha}} = \delta,$$

where the last step follows from definition 6, furthermore δ is positive as assumed. □

Proof of Lemma 3.2

Proof. Suppose, ν and H are both distributed according $U[0,1]$ and d is defined as

$$d = |H - \nu| .$$

Then, the cumulative distribution function $F_d(x)$ is

$$F_d(x) = Prob(d \leq x) = Prob(|H - \nu| \leq x) = 1 - (1-x)^2$$

To see this, consider a square with a length of its side equal to 1 and suppose that axes represent human capital H and industry ν, respectively. Note that its area equals 1 as well. Furthermore, the diagonal is a set of points where $\nu = H$ and thus the distance, d, is 0. As the the distance x increases, the area which satisfies the condition of being away from the diagonal less than x increases as well. For given x, there are two right-angled triangles lying at the most distant angles from the diagonal, each with an area $\frac{(1-x)^2}{2}$. The area of our interest is a complement of the sum of these right-angled triangles in the square. See figure 4.

$$1 - (1-x)^2$$

To find probability density function for $x \in (0,1)$, it is enough to take a derivative of cumulative distribution function.

$$f_d(x) = \frac{\partial F_d(x)}{\partial x} = 2(1-x)$$

The rest of the lemma follows from properties of cdf and pdf. □

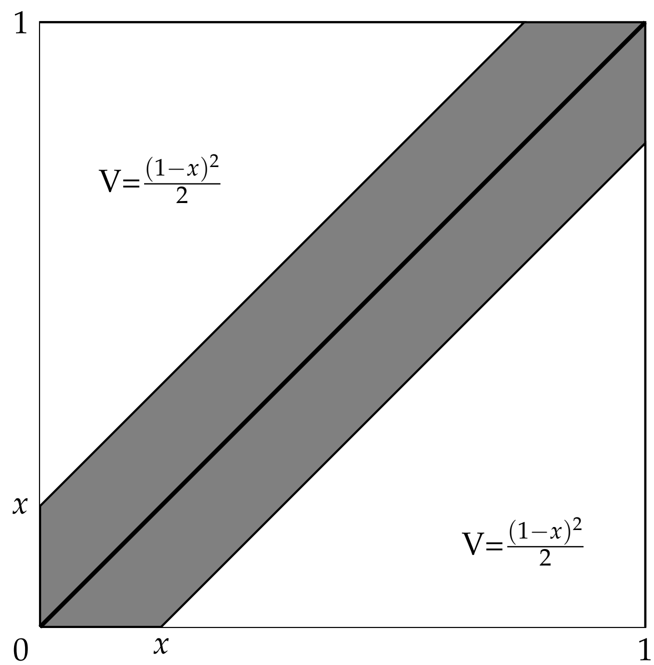

Figure 4: Area of a distance lower than x.

Proof of Proposition 3.2

Proof. Suppose that the distance, d, has a pdf $2(1-d)$ for $d \in (0,1)$ and $\eta(d) = \exp(-ad)$. Using the lemma 3.2

$$F_d(x) = \int_0^x 2(1-t)\mathrm{d}t.$$

One way to find $F_\eta(x)$ is to apply the transformation formula

$$\int_{\eta(1)}^{\eta(0)} f\left(d(\eta)\right) \left|\frac{\mathrm{d}d}{\mathrm{d}\eta}\right| \mathrm{d}\eta.$$

A bit of algebra shows that

$$d(\eta) = -\frac{1}{a}\log(\eta)$$

and

$$\frac{\mathrm{d}d}{\mathrm{d}\eta} = -(a\eta)^{-1}.$$

Plugging $d(\eta)$ into pdf of d yields

$$f(d(\eta)) = 2(1 + \frac{1}{a}\log(\eta)).$$

One also needs to calculate the new boundaries $\eta(1) = \exp(-a)$ and $\eta(0) = 1$. Having found everything what is needed, one can plug it back to the formula and obtain

$$F_\eta(x) = \int_{\exp(-a)}^{x} \frac{2}{a\eta}\left(1 + \frac{1}{a}\log(\eta)\right) \mathrm{d}\eta.$$

The integral can be split into two.

$$F_\eta(x) = \frac{2}{a}\int_{\exp(-a)}^{x} \frac{1}{\eta}\mathrm{d}\eta + \frac{2}{a^2}\int_{\exp(-a)}^{x} \frac{\log(\eta)}{\eta}\mathrm{d}\eta.$$

Solving for the integrals leads to

$$F_\eta(x) = \frac{2}{a}\left(\log(x) + a\right) + \frac{2}{a^2}\left(\frac{\log^2(x)}{2} - \frac{a^2}{2}\right),$$

$$F_\eta(x) = 1 + \frac{2\log(x)}{a} + \frac{\log^2(x)}{a^2}.$$

□

Proof of Lemma 3.3

Proof. Suppose that the level of match $\bar{\eta}_2$ is defined by 12 and substituting for $w^{II}(\bar{\eta}_2, \beta, UB)$ from equation 17 we obtain

$$UB = \beta\left[\delta A_{t,\nu} - UB\right],$$

where $A_{t,\nu}$ is a function of $\bar{\eta}_2$. Plugging for $A_{t,\nu}$ from equation 7 evaluated at $\bar{\eta}_2$

$$UB = \beta\left[\delta\left(A_{t-1,\nu} + (1-\lambda)\phi(\bar{A}_{t-1} - A_{t-1}) + \lambda\bar{\eta}_2 A_{t-1}\right) - UB\right]$$

$$\bar{\eta}_2 = \frac{(1+\beta)UB - \beta\delta A_{t-1,\nu} - \beta\delta\phi(1-\lambda)(\bar{A}_{t-1} - A_{t-1})}{\beta\lambda\delta A_{t-1}}$$

$$\bar{\eta}_2 = \frac{1+\beta}{\beta\delta\lambda A_{t-1}}UB - \frac{A_{t-1,\nu}}{\lambda A_{t-1}} - \frac{\phi(1-\lambda)}{\lambda}\frac{\bar{A}_{t-1} - A_{t-1}}{A_{t-1}}$$

$$\bar{\eta}_2 = \frac{1}{\lambda}\left[\frac{1+\beta}{\beta}\frac{UB}{\delta A_{t-1}} - \frac{A_{t-1,\nu}}{A_{t-1}} - \phi(1-\lambda)(a_{t-1} - 1)\right]$$

□

Proof of Proposition 3.3

Proof. To show the stated relation, it is enough to take a derivative of expression for both wages. In particular, for $i \in \{1,2\}$

$$\frac{\partial w_t^i(\eta_i, \beta, UB)}{\partial \eta_i} = \beta\delta\lambda A_{t-1}.$$

To see this for w_t^{II}, it is enough to realize that neither β, δ, nor UB is a function of the quality of a match. Moreover, current level of technology for a given industry is, according to definition 7, a sum of 3 elements and only the last one contains η_t. The same hold for w_t^I, where it is perhaps more complicated as the expression looks more difficult, however, all terms in expectations cannot appear in the results. □

Proof of Proposition 3.4

Proof. Starting with the definition 21 and plugging 2 for y_t

$$g = \frac{\psi \int_0^1 A_{t,\nu}^{1-\alpha} x_{t,\nu}^{\alpha} \mathrm{d}\nu - \psi \int_0^1 A_{t-1,\nu}^{1-\alpha} x_{t-1,\nu}^{\alpha} \mathrm{d}\nu}{\psi \int_0^1 A_{t-1,\nu}^{1-\alpha} x_{t-1,\nu}^{\alpha} \mathrm{d}\nu},$$

using the optimal output of intermediate firms /industries $x_{t,\nu}^*$ defined by 5 yields

$$g = \frac{\int_0^1 A_{t,\nu}^{1-\alpha} \left(\psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}\right)^{\alpha} \mathrm{d}\nu - \int_0^1 A_{t-1,\nu}^{1-\alpha} \left(\psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}\right)^{\alpha} \mathrm{d}\nu}{\int_0^1 A_{t-1,\nu}^{1-\alpha} \left(\psi^{\frac{1}{1-\alpha}} \alpha^{\frac{2}{1-\alpha}} A_{t,\nu}\right)^{\alpha} \mathrm{d}\nu}$$

$$g = \frac{\int_0^1 A_{t,\nu} \mathrm{d}\nu - \int_0^1 A_{t-1,\nu} \mathrm{d}\nu}{\int_0^1 A_{t-1,\nu} \mathrm{d}\nu}.$$

Using the definition 7 and 8, we can plug for $A_{t,\nu}$

$$g = \frac{\int_0^1 A_{t-1,\nu} + (1-\lambda)\phi(\bar{A}_{t-1} - A_{t-1}) + \lambda A_{t-1} \int_0^1 \eta_\nu \mathrm{d}\nu}{A_{t-1}},$$

$$g = (1-\lambda)\phi(a_{t-1} - 1) + \lambda \int_0^1 \eta_\nu \mathrm{d}\nu.$$

□

Definition of T-ratio from Table 5 The presented *t-ratio* measures a significance of the difference between means of two random variables. Under the null hypothesis, both series have the same mean, and thus the difference between them equals to zero. From the standard definition of the *t-ratio*

$$t - ratio = \frac{\bar{X} - \bar{Y}}{\sqrt{\frac{s_x^2}{n_x} + \frac{s_y^2}{n_y}}},$$

where n_x and n_y stand for number of observations and s_x^2 and s_y^2 are sample variances. Mathematically, for $i \in \{x, y\}$

$$s_i^2 = \frac{1}{n_i - 1} \sum_{j=1}^{n_i} (I_j - \bar{I})^2.$$

In our case, both n_x, n_y equal 20 and one of the series is always the 20 simulations of the economy with no unemployment insurance. Rejecting the null hypothesis follows standard rules and critical values.

	—- Coefficients —-			
	(b)	(B)	$(b-B)$	$sqrt(diag(V_b - V_B))$
	fixed	random	Difference	S.E.
Uegen	5837574	-.0433345	.6270919	.115156
ValueAddedFinGrowth	.2170376	.2104976	.0065399	.
Inflation	-.0893044	-.1051543	.01585	.020571
IctInvestment	.0825005	.0805764	.001924	.0286342
TradeOppeness	.0232069	.0093943	.0138126	.012251
InwardFDIShareGDP	1513899	-283719.3	1797619	377692.3
ValueAddedAg	.3415296	-.0735461	.4150756	.176499
GDPPwe	-.0263281	-.0356317	.0093036	.0149806
FemaleEmployment	-.0870769	-.019261	-.0678159	.0369919

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: H_0: difference in coefficients not systematic

$\chi^2(1) = (b-B)'[(V_b - V_B)^{-1}](b-B)$ = 22.65

$Prob > \chi^2$ = 0.0000

Table 6: Hausman Test

Variable	Description	Source
Uegen	Index of Unemployment Generosity	CWED 2
TFPGrowth	Growth of (Multifactoral) Total Factor Productivity	OECD
GDPPwe	GDP per Worked Hours	OECD
GDPPCReal	Real GDP *per capita* (Constant 2005 USD)	World Bank
TradeOpenness	Sum of Import and Export over GDP	World Bank
FemaleEmployment	Employment Rates: Women	OECD
Inflation	Inflation	World Bank
InwardFDIShareGdp	Inward FDI Stock (USD) Divided by Nominal GDP	OECD & Own Calculation
ValueAddedAg	Value Added in Agriculture, Forestry, and Fishing Contribution to VA Growth (percentage)	OECD
GDPNominal	Nominal GDP (USD)	World Bank
IctInvestment	Investment into IT, Communication, and Software (Percentage of all Investment)	OECD
ValueAddedFinGr	Value Added in Financial Sector Growth (Change) of Contribution to VA Growth (Percentage)	OECD
Distance	Ratio of *GDPPwe* and *GDPPwe* of USA	Own Calculations
Infrastructure	Percentage of GDP spent on Infrastructure	World Bank
PubExpUb	Share of GDP Spent on Unemployment Benefits	OECD
PubExpUbDistance	Product of *PubExpUb* and *Distance*	Own Calculation
LabProdG	Labor productivity growth (growth of *GDPPwe*)	OECD

Table 8: Dataset