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LABOR MARKET SEGMENTATION IN TURKEY

MASTER'S THESIS

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Preface

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Acronyms

BC Beveridge Curve. 23, 31, 32, 39

HLS Household Labor Force Survey. viii, xii, xiii, xvi, xx, 6–8, 61

MS Matching Skill. 2, 48–53, 56, 58, 59

WC Wage Curve. 21, 22, 29, 36, 45, 51, 57

Résumé

Le marché du travail fonctionne pour répondre à la demande de travail des entreprises et à l'offre de travail des individus. Par nature, les entreprises ont des activités, des structures organisationnelles, des tailles, des opérations et des individus très différents les uns des autres. Les différences perturbent la structure homogène et le marché offre à ses agents des conditions différentes, ce qui se traduit par des niveaux de salaire, des conditions de travail, une stabilité et des chances d'emploi différents.

Du côté de la demande du marché, les entreprises offrant des salaires plus élevés, de meilleures conditions de travail et des emplois plus stables sont qualifiées de bons emplois. Au contraire, les entreprises avec des salaires plus bas, des conditions de travail moins bonnes et des emplois plus instables sont appelées de mauvais emplois. La plupart du temps, les bons emplois exigent que les demandeurs d'emploi aient des qualifications spécifiques. D'autre part, les mauvais emplois attendent certaines qualifications ou aucune des candidats.

Du côté de l'offre du marché, les caractéristiques des travailleurs varient dans plusieurs dimensions, telles que le sexe, l'éducation et la profession. Selon les caractéristiques de l'individu, les chances d'emploi, la productivité, l'adéquation des compétences et les efforts de recherche différencient les travailleurs. Par conséquent, les individus ayant des qualifications similaires constituent des sous-groupes. La mobilité des travailleurs entre les sous-groupes peut être difficile selon l'état du marché. Par conséquent, chaque groupe opère sur des marchés différents et est exposé à des conditions de marché différentes. Les caractéristiques du marché causées par l'hétérogénéité des entreprises et des travailleurs créent la littérature sur la segmentation du marché du travail.

Compte tenu de ces informations, nous renversons les données de HLS, qui couvre 2004-2019. Le niveau d'instruction diffère selon le sexe et la région. Les données montrent que le nombre de personnes ayant au moins un diplôme de premier cycle a triplé pour la période donnée. Nous prévoyons qu'un tel changement de cette ampleur affectera inévitablement la composition du marché du travail, générant des conditions différentes sur le marché du travail. Au cours de la même période, les grandes entreprises d'au moins 50 salariés se sont multipliées. Le taux de roulement a augmenté pour le groupe moins instruit au fil des ans. À partir des données, nous concluons certaines régularités sur le marché du travail. Le salaire des personnes ayant le même niveau de scolarité augmente avec l'ancienneté et

la taille de l'entreprise employée. Ces conditions du marché du travail ont eu un effet sur les salaires et le taux de chômage. De plus, les régularités nous ramènent aux modèles théoriques.

Sur le marché du travail, les demandeurs d'emploi recherchent un emploi et les entreprises essaient de pourvoir leurs postes vacants. Même si une adéquation souhaitable est possible entre les travailleurs et les entreprises, l'embauche n'est pas toujours censée l'être puisque le marché du travail connaît des frictions. Les modèles d'appariement introduisent cette caractéristique en tant que coûts de transaction. Sur le marché du travail, les entreprises et les travailleurs sont confrontés à plusieurs obstacles au cours du processus d'embauche, tels que l'inadéquation, les échecs de coordination, les distances géographiques, etc. L'hétérogénéité du marché du travail rend également le processus d'embauche plus difficile et coûteux. L'objectif des entreprises de pourvoir le poste avec un candidat et de trouver une personne présentant les caractéristiques souhaitées est coûteux et prend généralement du temps. L'appariement ne peut avoir lieu que lorsque les entreprises trouvent le candidat recherché et conviennent d'un salaire avec le travailleur. La fonction d'appariement utilisée dans les modèles de recherche et d'appariement montre les flux entre le chômage et l'emploi et représente la technologie d'appariement et les frictions sur le marché du travail.

Nous construisons un modèle de recherche et d'appariement basé sur Mortensen et Pissarides (1994) pour élaborer sur la segmentation du marché du travail en Turquie. Afin d'examiner un autre type d'hétérogénéité, nos travaux se composent de deux parties principales, qui étudient une à une les hétérogénéités des entreprises et des travailleurs.

Dans le premier modèle, nous examinons l'hétérogénéité des entreprises par rapport à la productivité. Puisque nous ne nous intéressons qu'à l'hétérogénéité des firmes, les travailleurs sont homogènes durant cette partie. Nous distinguons les entreprises selon le niveau de productivité en tant qu'entreprises hautement productives et entreprises peu productives. Cependant, les entreprises ne choisissent pas les niveaux de productivité. Au lieu de cela, elles deviennent peu ou très productives selon la probabilité du ratio de bonnes entreprises au total. Nous supposons que le ratio d'entreprises hautement productives reste fixe pendant une période donnée. À l'équilibre, une augmentation de l'entreprise hautement productive augmente le profit attendu d'un emploi vacant, ce qui signifie que la probabilité de devenir une entreprise hautement productive est plus probable. La

nouvelle situation incite les entreprises à ouvrir plus de postes vacants, et donc plus de postes vacants diminue le taux de chômage. En attendant, exercez une pression à la hausse sur les salaires car il y a plus d'options extérieures sur le marché pour les demandeurs d'emploi.

Dans la deuxième section, nous modifions uniquement le taux de roulement dans un modèle de recherche et d'appariement standard. Comme dans le premier modèle, les travailleurs sont homogènes et le fait de devenir une entreprise à taux de roulement faible ou élevé est soumis à la densité des entreprises à taux de roulement élevé dans le modèle. Ceux-ci peuvent être perçus comme des emplois stables et instables. Dans les données, nous observons que certains groupes de travailleurs ont des taux de roulement élevés dans certains secteurs tandis que d'autres ont des taux de roulement plus faibles. La différence pour les entreprises est le taux d'arrivée d'un choc idiosyncratique qui entraîne la destruction de l'emploi. Nous constatons qu'avec la part de l'entreprise avec le taux de roulement élevé dans la hausse totale, le profit attendu diminue. En effet, la probabilité de devenir une entreprise avec un taux de roulement élevé augmente. Par conséquent, les entreprises sont moins disposées à ouvrir des postes vacants et le taux de chômage augmente. Selon la courbe des salaires, la hausse du chômage a un effet négatif sur les salaires.

Dans le troisième modèle, nous combinons les deux premiers modèles. L'entreprise peut devenir l'un des quatre états possibles : faible productivité et taux de rotation, faible productivité et taux de rotation élevé, productivité élevée et faible taux de rotation, productivité et taux de rotation élevés. Les résultats sont similaires aux deux premiers modèles. Une entreprise avec une productivité élevée et un faible taux de roulement affecte positivement les salaires et entraîne une baisse des taux de chômage.

Dans le quatrième modèle, le modèle commence à se composer de travailleurs hétérogènes et d'entreprises homogènes. Il existe deux types de travailleurs à faible et à forte productivité sur le marché du travail. L'idée peut être considérée comme une main-d'œuvre qualifiée et une main-d'œuvre non qualifiée. Le principal moteur du modèle est clair : si la composition du marché se déplace vers les travailleurs à faible ou à forte productivité, comment les conditions du marché du travail changent-elles ? On suppose que les entreprises ne connaissent pas le type de travailleur jusqu'à ce qu'une correspondance se produise. L'hypothèse est très réaliste si l'on considère toutes les caractéristiques non observables

des travailleurs. Les entreprises mettent en place un processus d'emploi pour surmonter la difficulté et utilisent des réseaux et des références. Lorsque la composition du marché change en faveur des travailleurs productifs, cela génère une externalité positive et, par conséquent, les chances d'emploi augmentent pour tous les travailleurs. C'est parce que la probabilité de l'entreprise de s'apparier avec un travailleur avec une probabilité élevée augmente et, en conséquence, le profit attendu d'un emploi vacant se multiplie. Les entreprises commencent à ouvrir davantage de postes vacants, ce qui entraîne des augmentations de salaires pour tous les types.

Dans le cinquième modèle, les travailleurs ont le même niveau de productivité mais des compétences correspondantes différentes. Les entreprises sont à nouveau homogènes pour étudier exclusivement l'effet de l'appariement des compétences. Les compétences d'appariement élevées indiquent que les travailleurs réussissent mieux à trouver un emploi et à s'y faire correspondre. Même si deux travailleurs ont des caractéristiques observables communes, leurs compétences correspondantes peuvent différer. Lorsqu'une entreprise décide d'ouvrir ou non un poste vacant, la probabilité d'obtenir une correspondance hautement qualifiée est essentielle en raison du coût du poste vacant. Si la composition évolue en faveur des travailleurs peu qualifiés, la durée moyenne du poste vacant et, par conséquent, son coût moyen pour les entreprises augmentent. Le profit attendu d'un poste vacant est un paramètre clé du nombre de postes vacants. Une autre constatation importante dans cette section est que l'efficacité augmente pour un type tandis que l'autre reste constante, générant une externalité négative pour l'autre type. Par exemple, si les faibles compétences correspondantes augmentent, le nombre de travailleurs ayant des compétences correspondantes élevées dans la composition du chômage augmente.

Dans le sixième modèle, nous combinons les deux derniers modèles. Un travailleur peut se trouver dans l'un des quatre états de caractère possibles : faible productivité et compétences de correspondance faibles, faible productivité et compétences de correspondance élevées, productivité élevée et compétences de correspondance faibles, productivité élevée et compétences de correspondance élevées. Une augmentation de l'appariement des compétences pour un groupe génère une externalité négative sur l'autre groupe en augmentant leur ratio dans le bassin de chômeurs. Une augmentation du nombre de postes vacants, ce qui signifie une augmentation de la tension sur le marché du travail, rend meilleurs les travailleurs

ayant des compétences appariées élevées puisque leur probabilité d'appariement est meilleure que les autres. De la même manière, l'augmentation du taux de destruction d'emplois affecte principalement négativement le même groupe car il y a moins d'emplois à égaler dans cette situation. L'effet est plus important sur les travailleurs dont les compétences d'appariement sont élevées que sur ceux dont l'appariement est faible.

De manière générale, l'assurance-chômage et le pouvoir de négociation ont le même effet sur tous les modèles. Une augmentation de l'assurance-chômage et du pouvoir de négociation des travailleurs entraîne une pression à la hausse sur les salaires. Cependant, il fait baisser le taux de vacance et d'emploi puisqu'il affecte le profit attendu d'un emploi vacant. Le coût d'un poste vacant affecte négativement à la fois les chances d'emploi et le salaire, car il est directement lié à la décision d'ouverture du poste vacant.

Dans la thèse, nous travaillons sur l'hétérogénéité des travailleurs et des entreprises en raison de notre inférence à partir de HLS. La condition d'hétérogénéité que nous imposons aux modèles peut expliquer les écarts salariaux et les différentes conditions du marché du travail en Turquie. Des travaux empiriques futurs pourraient vérifier si notre modèle est cohérent avec les données.

Abstract

The labor market operates to meet firms' labor demand and individuals' labor supply. By nature, the firms have different businesses, organizational structures, sizes, operations, and individuals are very different from each other. The differences disrupt the homogeneous structure, and the market offers its agents different conditions, resulting in different wage levels, working conditions, stability, and employment chance.

On the market's demand side, the firms with higher wages, better working conditions, and more stable jobs are labeled as good jobs. On the contrary, firms with lower wages, poorer working conditions, and more unstable jobs are called bad jobs. Most of the time, good jobs require job seekers to have specific qualifications. On the other hand, bad jobs expect some qualifications or none from the candidates.

On the market's supply side, workers' characteristics vary in several dimensions, such as gender, education, and occupation. Depending on the characteristic of the individual, the employment chance, productivity, matching skills, and searching efforts differentiate between workers. As a result, individuals with similar qualifications constitute subgroups. The workers' mobility between subgroups may be difficult depending on the market's condition. Therefore, each group operates in different markets and is exposed to different market conditions. The market characteristics caused by firms and workers' heterogeneity create the literature on labor market segmentation.

Considering these pieces of information, we obverse the data from HLS, which covers 2004-2019. Educational attainment differs by gender and region. The data shows that the number of people with at least an undergraduate diploma tripled for the given period. We expect that such a change of this magnitude will inevitably affect labor market composition, generating different labor market conditions. In the same period, big firms with at least 50 employees increased in number. The turnover rate has increased for the less educated group over the years. From the data, we conclude some regularities in the labor market. Individuals with the same educational attainment's wage increases with tenure and employed firm size. These labor market conditions presented an effect on wages and the unemployment rate. Moreover, the regularities bring us to the theoretical models.

In the labor market, job seekers search for a job, and firms try to fill their va-

cant positions. Even if a desirable match is possible between workers and firms, the hiring is not always supposed to be since the labor market has friction. The matching models introduce this feature as transaction costs. In the labor market, firms and workers face several barriers during the employment process, such as mismatching, coordination failures, geographical distances, etc. The labor market's heterogeneity also makes the employment process more difficult and costly. The aim of firms filling the position with a candidate and finding an individual with the desired characteristic is costly and mostly takes time. The matching can only occur when firms find the desired candidate and agree on a wage with the worker. The matching function used in the search and matching models shows the flows between unemployment and employment and represents the matching technology and friction in the labor market.

We construct a search and matching model based on Mortensen and Pissarides (1994) to elaborate on the labor market segmentation in Turkey. In order to examine a different type of heterogeneity, our works consist of two main parts, which study firm and worker heterogeneities one by one.

In the first model, we look at firm heterogeneity with respect to productivity. Since we are only interested in firm heterogeneity, workers are homogeneous during this part. We differ firms by productivity level as highly productive and low productive firms. However, firms do not choose productivity levels. Instead, they become low or high productive depending on the probability of the ratio of good firms in total. We assume that the ratio of highly productive firms remains fixed for a given period. In equilibrium, an increase in the high productive firm raises the expected profit from a vacant job, which means the probability of becoming high productive firm is more likely. The new situation induces the firms to open more vacancy, and therefore more vacancy diminishes the unemployment rate. In the meantime, put upward pressure on wages since there is more outside option in the market for job seekers.

In the second section, we only change the turnover rate in a standard search and matching model. As in the first model, workers are homogeneous, and becoming a firm with a low or high turnover rate is subject to the high turnover rate's firms' density in the model. These can be perceived as stable and unstable jobs. In the data, we observe that some worker groups have high turnover rates in some sectors while others have lower turnover rates. The difference for firms is the arrival rate of an idiosyncratic shock which results in the job's destruction. We

find that with the share of the firm with the high turnover rate in the total rise, the expected profit falls. This is because the probability of becoming a firm with the high turnover rate increase. Therefore firms are less willing to open vacancies, and the unemployment rate increases. According to the wage curve, the rise in unemployment has a negative effect on wages.

In the third model, we combine the first two models. The firm can become one of the four possible states: low productivity and turnover rate, low productivity and high turnover rate, high productivity and low turnover rate, high productivity and turnover rate. The results are similar to the first two models. A firm with high productivity and low turnover rate positively affects wages and causes a decline in unemployment rates.

In the fourth model, the model starts to consist of heterogeneous workers and homogeneous firms. There are two types of workers with low and high productivity in the labor market. The idea can be viewed as skilled labor and unskilled labor. The main driver behind the model is clear if market composition shifts to the workers with low or high productivity, how do the labor market conditions change? It is assumed that firms do not know a worker's type until a match occurs. The assumption is very realistic when we consider all workers' unobservable characteristics. Firms implement an employment process to overcome the issue and use networks and references. When the market composition changes in favor of productive workers, it generates a positive externality, and therefore the employment chance augments for all workers. It is because the firm probability of matching with a worker with high probability increases, and correspondingly the expected profit from a vacant job multiplies. The firms start to open more vacancies which cause rises in wages for all type.

In the fifth model, workers have the same level of productivity but different matching skills. Firms again are homogeneous to study the effect of the matching skill exclusively. The high matching skills indicate that workers are more successful in finding a job and matching with it. Even if two workers have common observable characteristics, their matching skills may differ. When a firm decides whether to open a vacancy, the probability of getting high-skill matching is essential due to the vacancy cost. If the composition shift in favor of workers with low matching skills, the average duration of vacancy and, therefore, its average cost to the firms increase. The expected profit from a vacant job is a key parameter of the number of vacancies. Another important finding in this section is

that the efficiency increase for one type while the other remains constant, generating a negative externality for the other type. For example, if low matching skills rise, the number of workers with high matching skills in the unemployment composition grows.

In the sixth model, we combine the last two models. A worker can be in one of the four possible states of character: low productivity and low matching skills, low productivity and high matching skills, high productivity and low matching skills, high productivity and high matching skills. An increase in the matching skills for a group generates a negative externality on the other group by increasing their ratio in the unemployment pool. An increase in vacancy, which means a rise in the labor market tightness, makes workers with high matching skills better since their matching probability is better than others. In the same way increase in the job destruction rate mainly negatively affects the same group since there are fewer jobs to match in this situation. The effect is more significant on the workers with high matching skills than those with low matchings.

As a general result, unemployment insurance and bargaining power have the same effect on all models. An increase in workers' unemployment insurance and bargaining power causes upward pressure on wages. However, it lowers the vacancy and employment rate since it affects the expected profit from a vacant job. The cost of a vacancy negatively affects both employment chance and wage since it directly relates to the opening vacancy decision.

In the thesis, we work on workers' and firms' heterogeneity due to our inference from HLS. The heterogeneity condition we impose on the models can explain the wage differentials and different labor market conditions in Turkey. Future empirical work may check whether our model is consistent with the data.

Özet

İşgücü piyasası, firmaların işgücü talebini ve bireylerin işgücü arzını buluşturmaktadır. Firmalar farklı iş kollarında çalışmakta, değişik organizasyon yapılarına sahip olmakta, büyüklük, faaliyet olarak farklılaşmaktadır. Bireyler de birbirlerinden oldukça farklı özelliklere sahip olmaktadırlar. Bahsedilen bu farklılıklar işgücü piyasasındaki homojen yapıyı bozmaktadır. Bu nedenle işgücü piyasası heterojen yapıdaki işgücüne farklı ücret seviyeleri, çalışma şartları, iş güvencesi ve istihdam edilme şansı sunmaktadır.

Piyasanın işgücü talebi tarafında yer alan firmalardan yüksek ücret, iyi çalışma şartları ve iş güvencesi sağlayabilenler iyi işler olarak tanımlandırılmaktadır. Öte yandan, düşük ücretli, kötü çalışma şartları ve iş güvencesi olmayanlar kötü işler olarak tanımlanmaktadır. Çoğu zaman, iyi işler istihdam edilecek boş pozisyon için adaylardan bazı vasıflara sahip olmalarını şart koşmaktadır. Bununla birlikte kötü işler ise görece daha az şart aramaktadır.

Piyasanın işgücü arzı tarafında işgücü özellikleri cinsiyet, eğitim, meslek gibi birçok yönden farklı olmaktadır. Kişinin özelliklerine bağlı olarak istihdam edilme şansı, verimlilik, eşleşme yetenekleri, arama eforu farklılaşmaktadır. Sonuç olarak, benzer özelliklere sahip bireyler homojen alt gruplar oluşturmaktadırlar. Alt gruplar arasında geçişler çoğunlukla sınırlı olmakta ve piyasanın koşullarına göre hareket kabiliyeti değişmektedir. Bu sebeplerle her bir grup farklı piyasalarda, farklı piyasa koşullarına maruz kalarak işlemektedir. Firmaların ve işçilerin heterojen yapıları işgücü piyasasında katmanlaşma literatürünü oluşturmaktadır.

Literatürdeki bu bilgilere dayanarak 2004-2019 yılları arasındaki veriyi kapsayan hanehalkı işgücü anketi analiz edilmektedir. Buna göre eğitim düzeyi hem cinsiyet bazında hem de bölge bazında farklılaşmaktadır. Dahası veriye göre en az lisans diplomasına sahip olan insan sayısı aynı dönemde 3 katına çıkmaktadır. Bu büyüklükte bir değişimin kaçınılmaz olarak işgücü piyasasını etkilemesi beklenmektedir. Aynı dönemde, en az 50 işçi istihdam eden firmaların sayısı artmaktadır. Personel değişim oranı ise en düşük eğitim grubu için artmaktadır. Bu verilerden Türkiye'de işgücü piyasası için bazı genel sonuçlara ulaşılmaktadır. Aynı eğitim grubunda olan bireylerin; hem işteki çalışma süresi, hem de istihdam edinilen firmanın büyüklüğü ücretler ile pozitif bir ilişki sergilemektedir. Bu sonuçlar, literatürde teorik çerçevede standart bir arama eşleşme modeli üzerinde gerekli değişiklikler yapılarak gösterilmeye çalışılmaktadır.

İşgücü piyasasında, işsizler çalışabilecekleri bir iş aramakta, firmalar ise boş

pozisyonlarını doldurmaya çalışmaktadır. Bir firma ve bir işsiz için istihdam için tüm şartlar uygun olsa bile piyasadaki engeller yüzünden her zaman eşleşme olamamaktadır. Eşleşme modelleri ile bu özellik işlem maliyeti olarak literatüre kazandırılmaktadır. İşgücü piyasasında hem firmalar hem de işçiler istihdam sürecinde yanlış eşleşme, eş güdüm sorunları, coğrafi uzaklık gibi engellerle karşılaşabilmektedir. Bahsedilen işgücü piyasasının heterojen yapısı da istihdam sürecini zorlaştırmakta ve maliyetini artırmaktadır. Eşleşme ancak firma uygun adayı bulduğunda ve taraflar bir ücret üzerinde anlaştığında gerçekleşmektedir. Bu modellerde kullanılan eşleşme fonksiyonu işsizlik ve istihdam arasındaki akışı göstermekte, işgücü piyasasındaki engelleri ve eşleşme etkinliğini temsil etmektedir.

Bu çalışmada, veride gözlemlenen Türkiye'de işgücü piyasasındaki katmanlaşmayı, bir standart arama ve eşleşme modeli olan Mortensen and Pissarides (1994) baz alınarak teorik bir çerçevede göstermek amaçlanmaktadır. Model farklı tipteki katmanlaşmalar üzerinde çalışabilmek amacıyla işgücü ve firma heterojenliği olmak üzere iki farklı ana kısımdan oluşmaktadır.

Birinci modelde, verimliliklerinde heterojen bir yapı varsayılarak firmalar incelenmektedir. Sadece firmalarda heterojen yapı incelenmek istendiğinden bu bölümde işgücü homojen bir yapıda bırakılmaktadır. Firmalar ise düşük ve yüksek verimli olmak üzere ikiye ayrılmaktadır. Bu modelde firmalar verimlilik seviyelerinin kendileri seçememektedirler. Verimlilik seviyesi, pozisyon ve bir aday eşleşmesi başarılı olduktan sonra toplamda yüksek verimli firmaların oranına bağlı olaslıkla belirlenmektedir. Buradaki varsayıma göre bir ekonomide belirli bir süre için yüksek verimli firma sayısı belirli bir oranda olmaktadır. Dengede, yüksek verimli firmaların sayısındaki artış, yeni boş pozisyon açacak firmaların yüksek verimli olma ihtimalini artırmaktadır. Bu yeni durum firmaları daha fazla yeni pozisyon açmaya itmektedir. Böylelikle işsizlik oranı düşmektedir. Daha fazla iş opsiyonu işçilerin seçeneklerini çoğalttığından dolayı ücretler üzerirnde yukarı yönlü baskı oluşmaktadır.

İkinci bölümde, standart arama ve eşleşme modelinde sadece firmalar için personel değişim oranı farklılaştırılmıştır. İlk modelde olduğu gibi işçiler homojen yapıda kalmaktadır. Düşük ya da yüksek personel değişim oranlı firma olmak yine modeldeki yüksek değişim oranlı firma oranına bağlı olmaktadır. Bu iki farklı değişim oranı stabil olan ve olmayan işler olarak görülebilmektedir. Veride görüleceği üzere bazı işçi grupları ve bazı sektörler yüksek değişim oranlarına sahip olmaktadırlar. Modelde bu farklılık firmalara gelen şokların gelme ihti-

malleri farklılaştırılarak sağlanmaktadır. Bu şoklar sonucunda işler tekrar boş pozisyon haline gelmekte, istihdam edilen işçi işsizlik havuzuna dönmektedir. Modelin bulgularına göre yüksek personel değişim oranlı firma sayısındaki artış yine firmlarında da yüksek dönüşümlü olma olasılığını arttırdığından dolayı firmaların boş pozisyon açma istekleri azalmaktadır. Azalan boş pozisyon sayısı da işsizlik oranını artırmakta, ücretleri düşürmektedir.

Üçüncü bölümde, ilk iki model birleştirilmektedir. Firma eğer eşleşme gerçekleşirse mümkün olan 4 firma tipinden biri haline gelmektedir. Bunlar: düşük verimli ve düşük dönüşüm oranlı, düşük verimli ve yüksek dönüşüm oranlı, yüksek verimli ve düşük dönüşüm oranlı, yüksek verimli ve yüksek dönüşüm oranlı olarak ortaya çıkmaktadır. Sonuçlar ilk iki modelinkilerle benzeşmektedir. Yüksek verimli ve düşük dönüşüm oranlı firmların oranı arttıkça ücretler artmakta, işsizlik oranları düşmektedir.

Dördüncü bölümde, modeller firmadaki heterojen yapıyı artık işçilere uygulamaktadır. İşgücü piyasaında yüksek verimli ve düşük verimli olmak üzere iki tip işçi bulunmakta, firmalar ise bu bölümde homojen kalmaktadır. Bu varsayım vasıflı ve vasıfsız işçi olarak da görülebilmektedir. Bu bölümdeki ana düşünce işçi kompozisyonundaki değişimin işgücü piyasasına etkisini incelemektir. Firmaların eşleşme tamamlanıncaya kadar işçi tipini bilmedikleri varsayılmaktadır. Varsayım işçilerin gözlemlenemeyen özellikleri de düşünüldüğü zaman çok gerçekçi olmaktadır. Firmalar gerçekte eşleşmedeki bu sorunu aşmak için istihdam süreçleri kurmakta, bağlantı ve referansları kullanmaktadırlar. İşgücü piyasasındakki kompozisyon yüksek verimli işçilerin lehine değiştiğinde, bu durum tüm işçiler üzerinde pozitif bir dışsalık yaratarak tüm işçilerin istihdam edilme şanslarını artırmaktadır. Bunun temel nedeni firmaların yüksek verimli işçiler ile eşleşme ihtimallerinin artması nedeniyle daha fazla boş pozisyon açmaları ve işsizliği azaltmaları olmaktadır. Firmaların bunu yapmasındaki neden beklenen kardaki artıştır. Bu durum aynı zamanda işçi ücretlerini de artırmaktadır.

Beşinci bölümde, işçiler aynı seviyede verimliliğe sahipken farklı eşleşme yeteneklerine sahip olmaktadırlar. İşgücünde heterojen yapıyı incelemek için firmalar bu bölümde de homojen kalmaya devam etmektedir. Yüksek eşleşme yeteneğine sahip olan işçiler daha kısa sürede iş bulmakta ve daha başarılı bir şekilde istihdam edilebilmektedirler. İki farklı işçinin gözlemlenebilir özellikleri aynı olsa bile eşleşme yetenekleri farklı olabilmektedir. Bir firma pozisyon açmak istediğinde işgücü piyasasında yüksek eşleşme yeteneği olanların oranı, boş

pozisyon açmak maliyetli bir iş olduğundan, önemli olmaktadır. Eğer piyasadaki düşük eşleşme yeteneğine sahip işçi oranı artarsa eşleşme süreçleri uzayacağından dolayı ortalama boş pozisyon maliyeti artmaktadır. Bu bölümdeki önemli bir diğer bulgu da herhangi bir tipin eşleşme yeteneğindeki artışın diğeri üzerinde negatif dışsallık yaratmasıdır. Örneğin düşük eşleşme yeteneğindeki bir artış işsizlik havuzunda yüksek eşleşme yeteneğine sahip işçilerin sayısını artırmaktadır.

Altıncı bölümde, bahsedilen son iki model birleştirilmektedir. Bir işçi: düşük verimli ve düşük eşleşme yetenekli, düşük verimli ve yüksek eşleşme yetenekli, yüksek verimli ve düşük eşleşme yetenekli, yüksek verimli ve yüksek eşleşme yetenekli dört durumun birisinde olmaktadır. Bir grup için eşleşme yeteneğindeki artış bu bölümde de diğerlerinin işsizlik havuzundaki paylarını artırarak onlar üzerinde negatif dışsallık yaratmaktadır. Dahası boş pozisyon sayındaki artış, diğer bir ifade ile işgücü piyasasındaki sıkılığın artması yüksek eşleşme yeteneği olan işçileri pozitif etkilemektedir. Çünkü istihdam edilme oranı arttıkça bu tipteki işçiler üzerindeki etkisi daha yüksek olmaktadır. Buna karşın iş yok olma oranındaki artış da benzer bir sebeple en çok bu tipteki işçileri negatif etkilemektedir.

İşsizlik geliri ve işçinin pazarlık gücü tüm modellerde aynı etkiyi göstermektedir. Bu parametrelerdeki artış ücretler üzerinde yukarı yönlü baskı oluşturmaktadır. Buna karşın boş pozisyonun beklenen karını düşürdüğünden daha az boş pozisyon açılmasına neden olarak işgücü piyasasında sıkılığı düşürmektedir. Boş pozisyonun beklenen karındaki artış ve azalışlar firmaların pozisyon açma kararlarını doğrudan etkilemektedir.

Bu tezde, firma ve işgücü yapısındaki heterojen özellik üzerinde bir çalışma yapılmaktadır. HLS'den alınan verilere göre bu heterojen yapı ücret farklılıklarını ve farklı işgücü piyasası şartlarını açıklayabilmektedir. Gelecekte yapılacak bir çalışma kurduğumuz bu modellerin veriler ile tutarlı olup olmadığını gösterebilir.

1 INTRODUCTION

The purpose of this thesis is to demonstrate how the heterogeneity in the labor market, in terms of productivity, matching skills, and turnover rate, affects agents' supply and demand decisions by establishing a theoretical model. We all know that a great variety of workers and firms exist in the labor market, which causes a heterogeneous market structure. Our question is not about the source of these heterogeneities but rather the conditions they impose on the labor market.

The main idea behind our work is that the heterogeneity we observe in the Household Labour Force Survey causes different wages, labor market conditions, employment, and unemployment chance for separate groups. This division in the labor market basically creates two different job types as good and bad, each with its own characteristic. Dual labor market theory initiated by Doeringer and Piore (2020) defines these jobs' characteristics as follows: good jobs have high wages, good working conditions, and low turnover rate. On the contrary, bad jobs have low wages, poor working conditions, and high turnover rate. In the extreme version of dual labor market theory, it is not possible for a worker to switch between good and bad jobs.

As explained above, the labor market's demand side, by means that firms, is clearly not homogeneous. On the other side of the market, the labor supply also is not homogeneous. The market composes workers with different skills, races, sex, age, matching abilities, search efforts, etc. An unemployed person can only be hired if and only if his/her qualifications meet the job's requirement he/she applied for, so the market conditions for each worker differ depending on his/her qualifications.

Although each worker and firm has its own characteristic, they form homogeneous groups with similarities. Firms can be classified according to the sector, em-

ployment size, employed worker type, productivity, etc. At the same time, the workers can be sorted by their educational attainment, age, occupation, etc. Each group exhibits particular characteristics according to its members.

Workers and firms face frictions in the labor market since several barriers exist, such as location differences, unobservable differences between workers, etc. Moreover, the employment process takes time, and opening a vacant position is costly to firms. These frictions impose different labor market conditions for each homogeneous group. One can say that each group operates in a different labor market. After all, each labor market offers a different level of wage, unemployment ratio, unemployment period, available jobs, and working conditions.

To elaborate on these heterogeneities, we construct a search and matching model based on Mortensen and Pissarides (1994), where firms and workers are segmented by their characteristics. The work consists of two main parts. In the first part, workers are homogeneous, and firms are heterogeneous with respect to their productivity levels and turnover rates. The first model, which studies productivity differences between firms, shows that productivity level itself has a positive effect on wages and increases the unemployment chance of workers for all types of firms because the increase in the expected profit induces firms to open more vacancies. The benefit is valid for both low and high-productive firms. The ratio of the high productive firm also has a positive effect on wages and employment. The second model examines the turnover rates and their effect on the labor market. When the turnover rate increases, firms are less willing to open vacancies. If the market swift to high turnover jobs, the employment ratio and wages diminish.

In the second part, on the contrary, workers are heterogeneous in terms of productivity and matching skills, while firms are homogeneous. The first model in this part finds out that the increase in the workers' productivity unsurprisingly increases labor demand and, therefore, the unemployment chance. In the following model, workers differ by matching skills. Workers are better off with greater MS. The ratio in the unemployment composition for each type is negatively influenced by the rise of their MS.

The work is organized as follows. The second section consists of related works

in the existing literature. The third section draws a brief picture of the segmentation in the labor market in Turkey. Then the models of our are presented, and interpretations of the results are made. The study finishes with an overall conclusion and an assessment of the work.

2 LITERATURE REVIEW

The search and matching models become the standard equilibrium model of labor economics since they explain not only vacancy and unemployment relation but also helps us to understand the business cycle's effects on the labor market. The models are also prosperous and valuable in interpreting different labor market policies and regimes. Mortensen and Pissarides (1994), on which we construct our models, examines endogenous job creation and job destruction and studies the response of firms and workers facing idiosyncratic shocks. Independent of aggregate economic conditions, the shocks affect firms' vacancy policies.

After the model is initiated, the standard model is developed, criticized, and differentiated into several versions because the standard equilibrium model of the Mortensen and Pissarides (1994) remains incapable of fully explaining the cyclical behavior of labor market indicators such as unemployment ratio, vacancies, and turnover rates. Cole and Rogerson (1999) shows that the model does not represent individuals outside of the labor force. However, data reveals that a substantial flow occurs directly from the out of the labor force to the employment. According to US data, Shimer (2005) argues that the shock on productivity does not entirely reflect the volatility of unemployment and vacancy as the standard model claims. The standard model exhibits very little volatility, while data fluctuates more. To explain the difference between standard model predictions and data, Pries (2008) offers worker heterogeneity to reflect the volatility more consistently. According to the model, the unemployment pool's composition is key to volatility. The less attractive job seeker in the unemployment pool causes firms to have less incentive to hire. As Shimer (2005) points out, the fall in net productivity makes agents more vulnerable to economic downturns. Despite these findings, Pissarides (2009) assert that wage stickiness is not applied to job creation. As the standard model predicts, the continuous Nash Bargaining is relevant for new jobs, not ongo-

ing ones. To overcome the unemployment puzzle and to explain the data we observe, we add heterogeneity in the labor market. At the same time, we preserve Pissaridies' Nash Bargaining approach, but we do not consider flows outside of the labor force to unemployment. It may be a development for future works.

One of the most critical aspects of the search and matching models is that the matching function represents search frictions in the labor market. The function allows the existence of vacant jobs and unemployment simultaneously as opposed to classical models' assumption. It also defines matching technologies of the labor market. The matching efficiency depends on this technology and is affected by business cycles. Gautier and Teulings (2006) measures the frictions and finds that workers' reservation wage would be %25 more than now if there were no frictions in the labor market. Van den Berg and Van Vuuren (2010) also tests the search frictions' effect on wages. They conclude that frictions negatively affect the mean wage for the market, as the standard search and matching models predict.

The labor market consists of many people and firms with different characteristics. Individuals with similar characteristics constitute homogeneous groups in the labor market. The jobs also form groups regarding wages, duration, working conditions, etc. The literature separates and describes jobs, good and bad, according to their futures. One of the first papers describing the differences in the jobs, as duality, is Doeringer and Piore (2020). According to the study, good jobs offer higher wages, better working conditions, and lower turnover rates than bad jobs. Both jobs also offer different labor market conditions, as they operate in different countries with different rules. In these markets, some standard features are observable in workers. The earlier work of Mortensen (1986) implies that the market offers different unemployment and employment duration for different workers group. Hiebert (1999) also documents that in Canada, a worker's state in the labor market is affected by gender, ethnicity, and immigration status. This paper also uses the dual market theory to show the effects of different labor market conditions and compositions on wages and unemployment via firms' behavior.

As in our works, heterogeneity in a standard search and matching model ensures more consistency with business cycle shocks. Shimer and Smith (2001) differentiates

the matching possibility, which eventually causes the unemployment pool to be less desirable for hires. The model we construct reaches a similar conclusion. Mortensen (2010) shows that dispersed wage with on-the-job searches is possible. Although we use wage differentiation due to heterogeneities, on-the-job search is not allowed in ours. Barnichon and Figura (2015) looks into US data to determine the matching function's efficiency. The paper concludes that heterogeneity and segmentation in the labor market are essential to understanding business cycles. To fully reflect the data, we also use heterogeneity in our models. Ellingsen and Rosen (1993) presents that due to workers' heterogeneity, firms choose different levels of wage policies to attract a higher number of skilled workers. Bils et al. (2011) introduce heterogeneity in workers' assets and match quality to capture entirely cyclical fluctuations. Hagedorn and Manovskii (2008) works on the value of non-market activity and workers' bargaining power. J. W. Albrecht and Vroman (1992) uses heterogeneity among workers regarding abilities and jobs in monitoring. As in the works presented, our work consists of different heterogeneity types for workers and firms.

In the recent literature similar to our work, Acemoglu (2001) investigates the labor market policy and its effects on the composition of employment. In another study, J. Albrecht and Vroman (2002) study on skill differences between workers and skill requirements differences between jobs. The main driver is to construct a model reflecting skill changes among workers in the labor market. We study the composition effects and skill differences between workers via productivity and matching skills. The dualism and heterogeneity in the search and matching model are also helpful for studying formal and informal markets. Therefore, Malherbet et al. (2020) constructed a theoretical setup with a dual market and allowed mobility to the formal market from informal thought learning. Unemployment and employment composition affect not only the vacancy and unemployment but also the change in composition that generates externality between groups. Dolado et al. (2009) shows that a mismatch in the labor market, where highly skilled workers can be employed in unskilled jobs, has a detrimental effect on less skilled workers.

In Turkey, works about labor market segmentation analyze mostly the data HLS. Using the data, Kumaş et al. (2014) finds that firm size and job quality correlate, meaning bigger firms mainly offer higher wages and good working conditions. They also

find that the job market conditions are more favorable for middle-aged and educated men. The formal and informal jobs constitute an essential part of the labor market segmentation in Turkey. Tansel and Acar (2017) explains the transition between the informal and formal states. Their findings indicate that mobility is primarily one way to the formal sector, and most individuals stay in their initial state. The probability of being employed in an informal job is twice that of being employed in a formal one. More currently, Aldan et al. (2021) analyzes the effects of COVID-19 on a different labor market segment. The study finds that the most vulnerable part of the labor is the youngest, oldest, and less educated during the period. The results support our thoughts about the labor market segmentation. Demirci and Kirdar (2021) shows another aspect of the segmentation. Refugees generally enter the market with lower-quality jobs, which makes them more vulnerable to economic downturns.

Our motivation comes from the observation made from HLS. In the previous passage, we assert that the labor market in Turkey is segmented, and to our knowledge, no study theoretically reflects the issue.

3 LABOR SEGMENTATION IN TURKEY

The labor market in Turkey is characterized by several subgroups, such as gender, educational attainment, and region. In this section, we primarily focus on labor market differences in Turkey and draw a picture of them. The number of workers in both the state and the private sector has continuously increased between 2004 and 2019. The only exceptional year is 2008 due to the global crisis. The data we obverse is the Household Labour Force Survey (HLS), which covers 2004-2019. Figure 3.1 shows the average education difference between Nuts1 regions with the highest and lowest average (left axis) and average education (right axis).

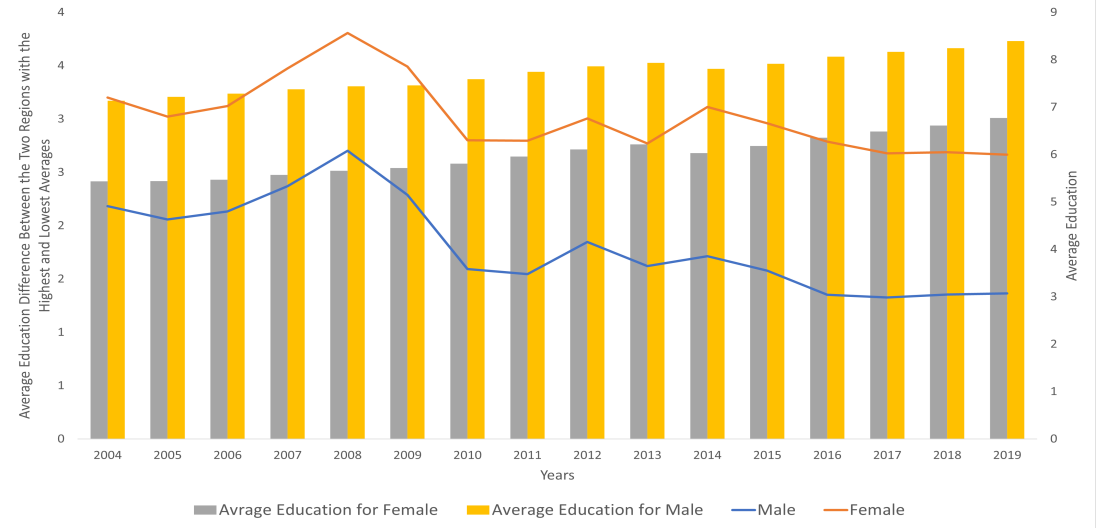

Figure 3.1: Education differences between regions by gender

Firstly, the average year of schooling differs to a large extent between men and women. However, for both gender, educational attainment shows an uptrend, more vigorously for women. The differences in year of schooling between the regions draw the attention at first sight. According to Nuts1, the difference in the average schooling between the two regions with the highest and lowest was 2.2 years for men and 3.2

years for women in 2004. The differences between regions tend to decrease in the following years as in figure 3.1. The developments mentioned may be valid for several countries. However, one feature in the labor market is very distinctive for Turkey. The number of people at least having an undergraduate degree tripled for the given period. This group constituted 7% in 2004 and 17% in 2019 of the total labor force. We expect that the change in educational attainment significantly affects the labor market as it directly changes labor composition. Since education is related to productivity (Chevalier et al., 2004; Sweetman, 2002), we construct a model that analyzes the productivity heterogeneity among workers in the labor market. For this reason, educational attainment also affects positively on wages.

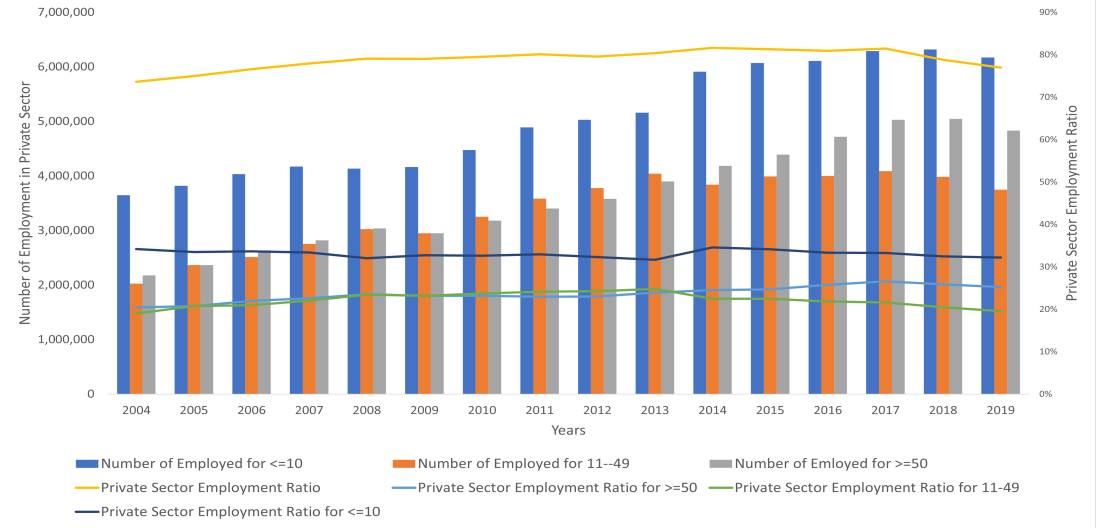

Figure 3.2: Private sector employment

On the other side of the labor market, the structure of firms varies between regions and over the years. Between 2004 and 2019, the firm operating in the private sector has substantially grown in employee number. Figure 3.2 demonstrates the number of employees (left axis) and employment rates (right axis) by firm size in the private sector. The occasion may be observable in many developing countries. However, one feature is distinctive for the Turkish labor market. The private firms, with at least 50 workers, more than doubled their employment number. The ratio of employment of these firms in total was 20% in 2004 and 25% in 2019. The rise also prevails in wages. For all sizes of private firms, wages increased, but the rise is more significant for the firms with at least 50 workers. In more detail, as the education level advance, the wage increase for all firms size. If we look at the firms' size effect on wages, we see that a worker with no

education in a firm with at least 50 workers earns more than those with primary school education in a firm with at most 10 workers. Another example, a worker with a high school diploma in a firm with at least 50 workers receives a salary more than a worker with at least a graduate diploma in a firm with at most 10 workers. Because of these observations, we expect that the transformation in the firm size influences the labor market via demand side and productivity. A firm itself may influence the productivity independent of workers' productivity which brings us to one of the other models which analyzes productivity heterogeneity in firms.

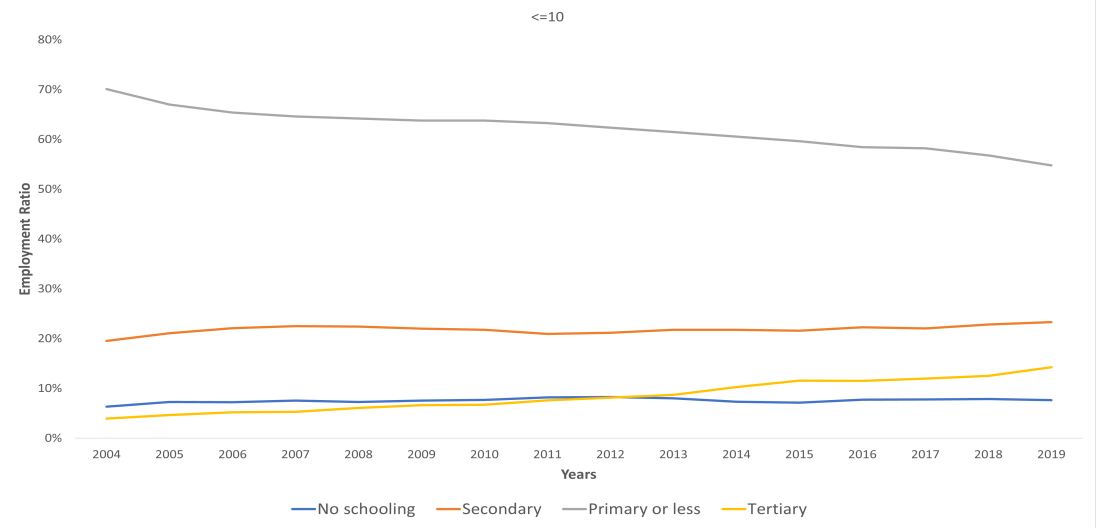

Figure 3.3: Employment ratio for the firms with at most 10 workers

The duration of jobs differs between firms and sectors depending on workers' average schooling. In 2004, the average tenure for workers with at least an undergraduate degree and at most one year of schooling was about 4.3 and 9.2 years, respectively. In 2019, the former group's tenure remained at 4.4 years, but the latter declined to 3.2 years. The fall is valid for all the firm sizes and for the workers with no schooling and primary schooling. Several arguments can explain the fall but our approach will be on the job destruction rate. Some jobs requiring lower educational attainments may become more quickly vacant.

Moreover, the employment rate has been falling for workers with primary or less education as in figures 3.3, 3.4, 3.5. In the job market, ratios in labor composition and employment chances have declined for workers with lower educational attainment. Nevertheless, we must mention that the number of people in this group grew lower than in others. Another fact is that almost half of workers with at least an undergraduate

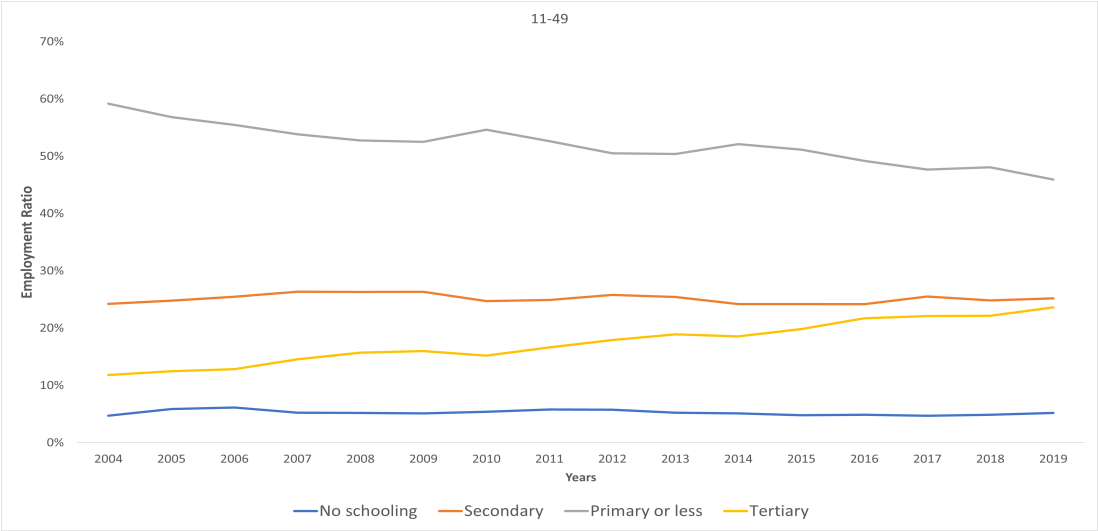

Figure 3.4: Employment ratio for the firms with at 11-49 workers

degree work in firms with at least 50. On the other hand, more than half of workers without schooling are employed in firms with at most ten workers. In the Turkish labor market, if a worker has an undergraduate degree, the probability of employment in a big firm is more likely.

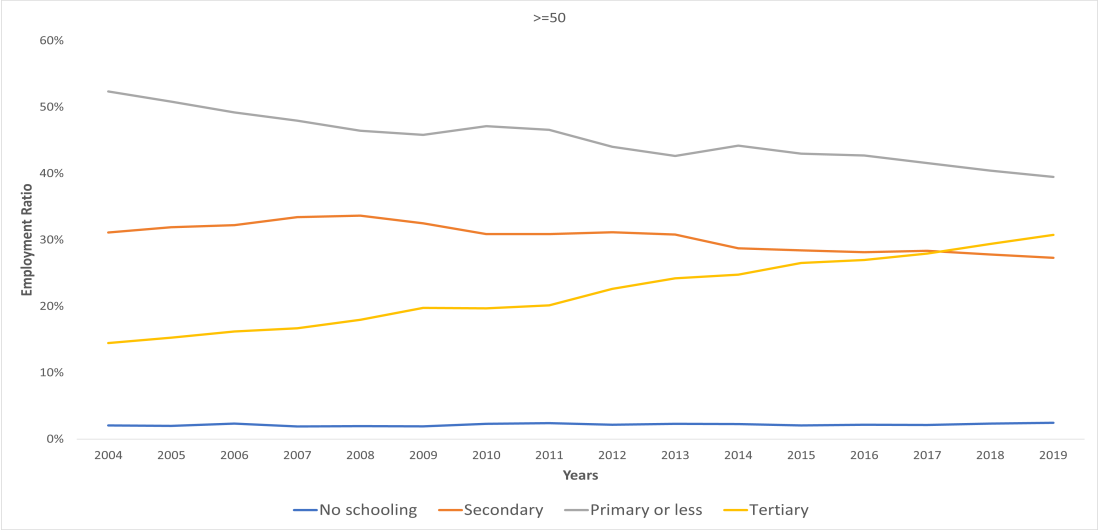

Figure 3.5: Employment ratio for the firms with at least 50 workers

The figure 3.6 shows that while the real wage of workers working less than a year does not change, those who work longer than 10 increase. The point we try to make in this section is that several dimensions segment the labor market. However, certain regularities can be found by observing data. All the differences result in a particular work group's wages and unemployment ratio.

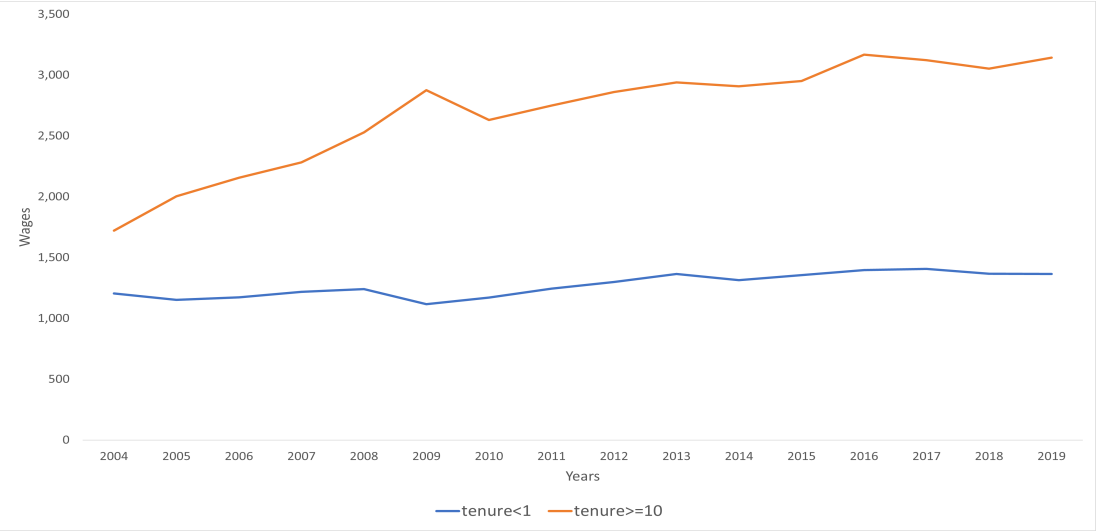

Figure 3.6: Wages and tenure over years

We conclude certain regularities for the labor market in Turkey. Wages increase primarily with the worker's tenure and firm size within the same education levels. The number of workers employed with at least an undergraduate diploma has multiplied over the years. Their ratio also has increased for the firms with all size, and the impact is greater for the firm with at least 50 employees. At the same time, the ratio of primary or less education in employment falls rapidly. The characteristics of the labor market in Turkey ultimately resulted in wages, the unemployment rate, and the tightness of the labor market.

4 THE MATCHING MODELS

In the labor market, unemployed persons and vacant jobs simultaneously exist as opposed to the competitive model's predictions. Because, even if job requirements and unemployed person demands meet, matching is not always happening. The Matching Model explains this phenomenon by introducing transaction costs to the labor market models. The key idea is that there are frictions in the labor market such as mismatching, coordination failures, geographic distance (Pissarides, 2000).

Mismatching is a measure that shows the heterogeneity in the labor market by several criteria (Pissarides, 2000). More heterogeneity causes the hiring process becomes more costly and time-consuming. Firms use more time to get the right candidate for their vacant position. On the other hand, workers also are trying to get the right job for themselves. Because of the coordination failure, some of these vacant jobs receive many applications while others get none. Thus, vacancies that would normally be filled remain vacant, and job seekers that would normally be employed remain unemployed. Other than mentioned issues, search intensity and reservation wages also can be counted as one of the frictions.

The matching model is based on a matching function representing the sum of outcomes between vacant jobs and job searching (Cahuc et al., 2014). At every instant, some of the vacant jobs are filled by those searching for a job, while some of these filled jobs are being destroyed. This matching process takes place between firms and workers according to the prevailing matching technology (Pissarides, 2000). It is assumed that agents in the market do not behave coordinately with each other. Every agent aims to maximize its objective function subject to the matching and separation technologies.

4.1 Assumptions of the Models

The following assumptions are valid for all the models worked on in our thesis. Time is continuous, and the population is normalized to 1. All agents are risk neutral, infinitely lived and their discounting rate for the future is r. The jobs are destroyed by exogenous shock at a rate of p. There are frictions in the labor market, and it is characterized by the matching function.

A firm can have only one vacant or one filled position at a time. Only vacant positions can be subject to the trade. Some of these vacant jobs can receive many applications, while others can get none. In the case of many applicants, the firm randomly chooses one of them. The rest of the applicants return to the unemployment pool and continue searching for a job. A person can be either employed or unemployed at a time. Only unemployed workers can search for a job. On-the-job search is not allowed in our model, and search is undirected. So every firm has the same probability of matching. Since free entry conditions are in use, the expected profits for all vacancies must be zero. Wages are determined by a bargaining process between a firm and a worker, and the outcome depends on the worker's bargaining power.

In the standard model, there is no heterogeneity among workers and firms. In the following sections, we argue that the heterogeneity in the labor market can explain the differences in the labor market that we observe in the data. We construct a search and matching model that the labor market segmented by productivity and turnover rate for firms, productivity, and matching skills for workers.

4.2 The Matching Process

The matching function represents the aggregate level relation between firms and workers. We take as a base model Mortensen and Pissarides (1994). The matching function $M(V, U)$ represents the instantaneous flow of hires at a given date. V and U denote, respectively, the number of vacant jobs and workers searching for a job. The matching function is assumed to be strictly increasing. It means that the number of hires increases with the number of vacancies and job applicants. For a successful match, there must be at least one vacant and one job seeker, $M(V, 0) = M(0, U) = 0$. We also assume that the matching function concave and homogeneous degree of 1.

These are empirically tested and supported assumptions Pissarides (2000). The futures of the matching function allow us to write the probability of filling a vacant job per unit of time as $\frac{M(V,U)}{V} = M(1, U/V) = m(\theta)$. The tightness of the labor market is given by $\theta = V/U$. Vacant jobs are filled at a rate that diminishes with the labor market tightness, as shown in $m'(\theta) = -\frac{U^2}{V^2} M'_u(1, U/V) < 0$. Similarly, the exit rate from unemployment (hazard rate) is defined as $\frac{M(V,U)}{V} = \theta m(\theta)$. The exit rate from unemployment is an increasing function of the labor market tightness and it is defined as $m(\theta) + \theta m'(\theta) = M_V(V, U) > 0$.

5 FIRM HETEROGENEITY

5.1 Productivity

In this section, we establish a model that explains labor market segmentation using firms' productivity differences. We consider an economy with two types of firms: high productive and low productive. $i = l$ and $i = h$ denote firms with low and high productivity. ϕ and $(1-\phi)$ are, respectively, the ratio of low and high productive firms in total. Labor is assumed to be homogeneous and the sole factor of production.

In this model, we are not interested in the process of choosing productivity levels as Acemoglu (2001). The main idea behind that the firm's productivity level is mainly proportional to the initial capital requirement. Investing is not about choosing the capital level for most people. It is about whether to open a firm since, most of the time, capital is given. We aim to explain the segmentation observed in data with productivity differences between firms.

A match occurs when a firm and a job seeker meet and agree on negotiated wage. Once a vacant job is filled, it becomes low productive with probability ϕ or high productive with probability $1-\phi$. After a successful match, a low type firm produces y^l, and a high type firm produces y^h. The former pays w^l, and the latter pays w^h. It is reasonable to assume that $w^h > w^l > z$ and $y^h > y^l$. The production continues until a shock arrives, and the job is destroyed with the probability of p. As a result, the worker returns to unemployment, and the firm's position becomes vacant.

This section will be written in detail to guide the following models.

5.1.1 Labor Market Flows

The population is denoted by N and normalized to unity. At every instant, jobs are destroyed with the probability of q, and vacancies are filled via matching technology $M(V, U)$. L and U denote respectively the number of employed and unemployed workers. The total population is represented by $N = L + U$. Therefore, at every instant, the amount of qL person flows into unemployment. On the other side, $\theta m(\theta)U$ of a person find a job, leave unemployment status and become employed. The inflow and outflow of unemployment can be written as follow,

$$\dot{U} = qL - \theta m(\theta)U \tag{1}$$

$\dot{U}$ signifies the variation in the stock of unemployed persons. It is known that the variations are equal to zero in the steady state. The steady-state unemployment ratio can be found using the equation 1.

$$u = \frac{q}{q + \theta m(\theta)} \tag{2}$$

The equation 2 shows an important result of the model. There is a unique unemployment rate for given values of q and θ. In our model, q is an exogenous parameter, but θ is an endogenous parameter which means its value is determined in the model. The equation 2, which is called Beveridge Curve, describes a convex and downward sloping curve that shows the relation between vacancy (v) and unemployment rate (u). The position of the curve, considering the origin, represents the efficiency of the matching technology. Efficiency is greater when the curve is closer to the origin.

5.1.2 The Behaviour of Firms

Superscript i represents the type of a firm. All returns and costs will be instantaneous unless otherwise stated. Let Π_e^i be the profit expected from a filled job. The return of the filled job is $r\Pi_e^i$. When a job is filled, the firm produces an amount of real output y^i and pays its worker a wage w^i. This filled job can be destroyed and change its state to a vacant job with the probability of p. Thus, the profit expected from a filled job,

$$r\Pi_e^i = y^i - w^i + q(\Pi_v - \Pi_e^i) \tag{3}$$

Π_v be the profit expected from a vacant job. The return of the vacant job is $r\Pi_v$. Since the hiring process includes costly actions such as advertising, interviewing, consulting, etc., a vacancy costs h per unit of time. A vacant position changes its state according to a Poisson process with a rate $m(\theta)$. At this point, the firm does not decide to become h type or l type. It becomes a low or high productive firm depending on the probability of ϕ and $(1-\phi)$. As explained before, we are not interested in choosing the initial capital level for an investment. Mostly, investing depends on not choosing the capital level. It is about investing or not. Furthermore, it is reasonable to assume that an economy structurally can have a certain percentage of the high productive firm for a given time. Thus, the profit expected from a vacant job,

$$r\Pi_v = -h + m(\theta)\Big(\phi\Pi_e^l + (1-\phi)\Pi_e^h - \Pi_v\Big) \tag{4}$$

New firms enter the market until all profits are exploited. It means that firms open a new vacancy as long as they expect a profit from it. The free entry condition can be written as $\Pi_v = 0$. By imposing the free entry condition on the equation 3 and 4, we reach to the labor demand equation.

$$\frac{h}{m(\theta)} = \frac{\phi(y^l - w^l) + (1-\phi)(y^h - w^h)}{r+q} \tag{5}$$

It is essential to know that the left side of the equation 5 shows the average cost of the vacant job. $1/m(\theta)$ shows the average duration of the vacancies. The right side represents the profit expected from a filled job. At free equilibrium, the average cost of a vacancy must be equal to the profit expected from a filled job. It is clearly seen in the equation 5 that the profit expected from a filled job decreases with an increase in wages. Firms respond to it by decreasing the average cost of vacancies which is ensured by opening fewer vacancies.

5.1.3 The Behaviour of Workers

Let V_e^i and V_u be the expected utility of an employee and an unemployed. All workers are supposed to be homogeneous in this section. The expected utility of an employed,

$$rV_e^i = w^i + q(V_u - V_e^i) \tag{6}$$

When a worker is employed, he/she starts to earn a wage depending on the type of the firm. The job may become vacant at every instant due to a shock with the probability of q. In case of a shock, the worker becomes unemployed and returns to searching for a job. The expected utility of an unemployed,

$$rV_u = z + \theta m(\theta)\Big(\phi V_e^l + (1-\phi)V_e^h - V_u\Big) \tag{7}$$

In our model, unemployed persons are constantly searching for a job. During this process, he/she gains an amount of z, which is basically understood as unemployment insurance. There are no differences in job search efforts in our models. An unemployed apply for a job and is randomly selected from applicants to become employed with a rate $\theta m(\theta)$. If a successful match happens, the job becomes l type with a probability ϕ or h type with a probability $1-\phi$. The condition $w^i > z$ is assumed to hold to ensure labor supply (Pissarides, 2000).

5.1.4 Wage Bargaining

In the labor market, firms and workers match according to matching technology given by $M(V,U)$. The firm and the job seeker negotiate over the wage depending on workers' bargaining power γ, which takes a value between $[0,1]$. A Nash bargaining process determines the wage for a firm l type and h type.

$$Max_{w^i} = (V_e^i - V_u)^{1-\gamma}(\Pi_e^i - \Pi_v)^{\gamma} \tag{8}$$

As a result of the maximization problem of the equation 8, the total surplus, the share of employee and employer, is defined as,

$$S^i = (V_e^i - V_u) + (\Pi_e^i - \Pi_v) \tag{9}$$

$$\text{Employee rent} : V_e^i - V_u = S^i\gamma \tag{10}$$

$$\text{Employer rent} : \Pi_e^i - \Pi_v = S^i(1-\gamma) \tag{11}$$

Using the equations 3 and 6, total surplus for each type as a single equation,

$$S^i = \frac{y^i - r(V_u + \Pi_v)}{r+q} \tag{12}$$

In order to find negotiated wage, we use the equations 3, 6, 12.

$$w^i = \gamma y^i + (1-\gamma) r V_u \tag{13}$$

The interpretation of the equation 13 is that when a worker has all bargaining power γ, he/she gets all of the production (y). On the contrary case, the worker gains equal to the rV_u, which is equal to the expected utility of the unemployed. For the value of $0 < \gamma < 1$, both parties get a share of the production as much as their bargaining power.

At this point, the relation between wage and labor market tightness θ can be defined by using the equations 7, 10, 11. At the free entry equilibrium, the value of unemployment,

$$rV_u = \frac{z(r+q) + \theta m(\theta)\gamma\Big(\phi y^l + (1-\phi)y^h\Big)}{\theta m(\theta)\gamma + r + q} \tag{14}$$

Substituting this in to the 13 we get,

$$w^l = \gamma y^l + \frac{z(1-\gamma)(r+q)}{\theta m(\theta)\gamma + r + q} + \frac{\gamma\theta m(\theta)(1-\gamma)\big(\phi y^l + (1-\phi)y^h\big)}{\theta m(\theta)\gamma + r + q} \tag{15}$$

$$w^h = \gamma y^h + \frac{z(1-\gamma)(r+q)}{\theta m(\theta)\gamma + r + q} + \frac{\gamma\theta m(\theta)(1-\gamma)\big(\phi y^l + (1-\phi)y^h\big)}{\theta m(\theta)\gamma + r + q} \tag{16}$$

The equation 15 and 16 is referred as the wage curve (WC). Note that these equations replace the labor supply curve of the competitive models. In both equation, wages (w^i and w^l) and the labor market tightness (θ) are endogenous parameters. The rest is set exogenously.

$$\frac{\partial w^h}{\partial \theta} = \frac{\partial w^l}{\partial \theta} > 0$$

It can be deduced from equations 15 and 16 that the wage levels for both type and labor market tightness have a positive relationship. An increase in the number of vacancies makes it easier for unemployed persons to find a job. We defined the exit rate from unemployment as $\theta m(\theta)$, which is an increasing function of θ. Apart from that as θ increases the value of unemployment (7) also increases. So, job seekers are more likely to find a job and have less fear of staying unemployed. This situation strengthens the worker's hand and increases his/her bargaining power.

5.1.5 Labor Market Equilibrium

In the matching model, the relation between labor demand (5), the wage curves (16,15), and the Beveridge Curve (2) conclude the equilibrium values of the unemployment rate (u), wages (w), and labor market tightness (θ). The labor demand equation and the wage curves determine the equilibrium value of the w^l, w^h, and θ. The Beveridge Curve and the equilibrium value of θ set the equilibrium value of the unemployment rate (u). The intersection of the labor demand curve (5) and the wage curves (16,15) gives us the following equation which reveals the unique value of θ^*,

$$\frac{h}{m(\theta)} = \frac{(1-\gamma)\big(\phi y^l + (1-\phi)y^h - z\big)}{\theta m(\theta)\gamma + r + q} \tag{17}$$

When the negotiated wage is considered, the left side of the equation 17 shows the average cost of vacancy. Since $m(\theta)$ decreases with θ, the average cost of vacancy rises with labor market tightness. Also, $1/m(\theta)$ represents the average duration of a vacant position. An augment in θ also causes an increase in the average cost of a vacancy. Firms must compensate for the rise in vacancy costs by opening fewer vacancies which end up in lower labor market tightness. On the other hand, the right side of the equation

presents the profit expected from a filled job. It can be deduced that it decreases with $\theta m(\theta)$. The rise in vacancy makes unemployment more valuable for job seekers since more outside options are available.

In the following section, we will analyze the effects of parameters on wages, unemployment rate, and labor market tightness.

5.1.6 Comparative Statics

Unemployment Benefit: z

The unemployment benefit z expresses all the gain from unemployment insurance if there is one, leisure activities, contemporary wages, etc. For simplicity, we treat it as a fixed amount. The unemployment benefits (z) is present at the wage curves equations (16,15) and the equation 17. Although it is not present in the unemployment equation 2, it indirectly affects the unemployment rate through labor market tightness.

$$\frac{dw^h}{dz} = \frac{dw^l}{dz} > 0, \quad \frac{d\theta}{dz} < 0, \quad \frac{du}{dz} > 0$$

For a given value of θ, an increase in the z augments the value of the unemployment and therefore puts upward pressure on wages through negotiation. As a result of a shift to the left on the WC, the labor market tightness θ falls. The reason is that the firms respond to the decrease in the expected profit from a filled job by reducing the cost of vacancies. The only way to realize that is by opening fewer positions. The unemployment benefit does not influence the unemployment rate directly. However, it has an indirect effect through θ, which affects the value of unemployment via $\theta m(\theta)$. The higher value of θ implies that workers leave more quickly the unemployment status. Since the unemployment rate and θ have negative relation, a rise in z broadens the unemployment rate.

Bargaining Power: γ

The bargaining power of the employee impacts the bargaining process of wages. As bargaining power is close to 1, the wage rises to the point where it equals the total surplus.

$$\frac{d\theta}{d\gamma} < 0, \quad \frac{du}{d\gamma} > 0$$

For this model, the effects of the bargaining power on wages are too cumbersome to evaluate. Nevertheless, from the standard model and economic theory, the employee's bargaining power positively affects wages. On the other hand, as in the unemployment benefit z, γ lowers the expected profit from a filled job. According to the equation 17 the average cost of vacancies must fall. Hence firms compensate for it by opening fewer vacancies which causes to fall in θ. γ indirectly affects the unemployment rate via θ. Since the outcome is lower tightness in the labor market, the unemployment rate tends to increase.

The Cost of Vacancy: h

In every instant, a vacant position costs an amount of h to the firm. An augmentation in the cost of vacancy reduces the profit expected from a vacant job. Also, it causes an increase in the average cost of vacancy in the labor demand equation 5. The only chance for the firm is to open fewer vacancies to reduce the cost.

$$\frac{d\theta}{dh} < 0, \quad \frac{du}{\partial h} > 0$$

Since there is now less vacancy in the labor market, θ decreases, and at this moment unemployment rate goes up. The cost of vacancy indirectly affects wages by lowering the bargaining power and outside options due to lower θ.

The Job Destruction Rate and The Interest Rate: r & q

The job destruction rate primarily affects the expected profit from a filled job. An increase in the q causes filled positions to be more likely to be destroyed than before. The outcome is less vacancy and, therefore, lower θ. Less vacancy in the labor market makes firms' bargaining power stronger and puts downward pressure on wages. Furthermore, the q is about the efficiency of the matching process (Cahuc et al., 2014). The increase in the q lowers the efficiency. For this reason, the job destruction rate directly affects the unemployment rate by moving BC to the right, where it is less efficient.

$$\frac{dw^h}{dq} = \frac{dw^l}{dq} < 0, \quad \frac{d\theta}{dq} < 0 \quad \frac{du}{dq} > 0$$

$$\frac{dw^h}{dr} = \frac{dw^l}{dr} < 0, \quad \frac{d\theta}{dr} < 0, \quad \frac{du}{dr} > 0$$

The interest rate induces a decline in the surplus from a filled job. The same logic about wages and labor market tightness for q implies for r too. The difference is that the interest rate indirectly affects unemployment through θ.

Productivity: y^l & y^h

$$\frac{dw^h}{dy^l} = \frac{dw^l}{dy^l} > 0, \quad \frac{d\theta}{dy^l} < 0, \quad \frac{du}{dy^l} < 0$$
$$\frac{dw^h}{dy^h} = \frac{dw^l}{dy^h} > 0, \quad \frac{d\theta}{dy^h} < 0, \quad \frac{du}{dy^h} < 0$$

The increased productivity for both types of firms enhances the profit expected from a filled job. An increase in the right side of the equation 17 must be compensated from the left side, which indicates the average vacancy cost. As we know, opening more vacancies increases θ, which lowers the $m(\theta)$ and unemployment rate via θ.

Interpretations are valid except in only one case when γ equals 1. In the case of workers gathering all the surplus from productivity increase, there is no augmentation in the profit expected for firms. For this reason, labor demand remains unchanged.

The Ratio of Low Productive Firm: ϕ

As we mentioned for the model, the firms' productivity level is determined with a rate of ϕ for lower productivity and $1 - \phi$ for higher productivity. The identification process is realized after a successful match. Therefore firms do not know the level of productivity they will have. The randomness directly impacts the firm's decision on whether to open a vacancy or not. As ϕ rises, becoming a low-productive firm is more likely to happen. Consequently, the profit expected from a filled job drops, which results in a fall in θ and a rise in the unemployment rate.

$$\frac{dw^h}{d\phi} = \frac{dw^l}{d\phi} < 0, \quad \frac{d\theta}{d\phi} < 0, \quad \frac{du}{d\phi} > 0$$

The table 5.1 summarizes all the results from comparative statics.

Table 5.1: Comparative statics for the model 1

	z	γ	h	q	r	ϕ	y^h	y^l
w^h	+	+	-	-	-	-	+	+
w^l	+	+	-	-	-	-	+	+
θ	-	-	-	-	-	-	+	+
u	+	+	+	+	+	+	-	-

5.2 Turnover Rate

In this section, we construct a model that explains labor market segmentation using firms' turnover rate differences. We again consider an economy with two types of firms: firms with low and high turnover rates. $j = l$ and $j = h$ denote firms with low and high turnover rates. σ and $(1 - \sigma)$ are, respectively, the total ratio of low and high turnover rate firms in total. Labor is assumed to be homogeneous and the sole factor of production.

The data shows that the turnover rate is higher for some jobs and lower for others. In this model, we aim to explain that turnover rates impact several parameters, such as unemployment rate, wages, etc., in the labor market.

In our model, a match occurs when a firm and a job seeker meet and agree on negotiated wage. Once a vacant job is filled, it becomes a firm with a low turnover rate with probability σ or a firm with a high turnover rate with probability $1 - \sigma$. There are no productivity or wage differences between firms. It is reasonable to assume that there is homogeneity in production and wages since we only want to analyze turnover rate effects on wages, labor market tightness, and unemployment rate. The production continues until a shock arrives, and the job is destroyed with the probability of p^l for a low type and p^h for a high type. With this, the worker becomes unemployed, and the firm's position becomes vacant. It is assumed to be $q^h > q^l$.

The model and solutions are the same as the first model in the following sections. To save space and time, we only show the necessary explanations. For detailed comments, readers can refer to the first model.

5.2.1 Labor Market Flows

The population is denoted by N and normalized to unity. At every instant, jobs are destroyed with the probability of q^l for a low type firm and q^h for a high type firm. Vacancies are filled via matching technology $M(V, U)$. L and U denote respectively the number of employed and unemployed workers. $N = L + U$ represents the total population. Therefore, at every instant, the amount of $(q^l + q^h)L$ person flows into unemployment. On the other side, $\theta m(\theta)U$ of a person find a job, leave unemployment status and become employed. The inflow and outflow of unemployment can be written

as follow,

$$\dot{U} = \dot{N} + (q^l + q^h)L - \theta m(\theta)U \tag{18}$$

$\dot{U}$ defines the change in the stock of unemployed persons. Note that the changes are equal to zero in the steady state. We reach the steady state unemployment ratio by using the equation 18.

$$u = \frac{q^h + q^l}{q^h + q^l + \theta m(\theta)} \tag{19}$$

5.2.2 The Behaviour of Firms

Superscript j represents the type of a firm. When a job is filled, the firm produces a real output y and pays its worker a wage w. This filled job can be destroyed and change its state to a vacant job with the probability of p^j depending on the firm's type. Thus, the profit expected from a filled job,

$$r\Pi_e^j = y - w + q^j(\Pi_v - \Pi_e^j) \tag{20}$$

Π_v^j defines the profit expected from a vacant job. Since the hiring process is costly, a vacancy costs h per unit of time. A vacant position changes its state according to a Poisson process with a rate $m(\theta)$. At this point, the firm does not decide to become h type or l type. It becomes a low or high turnover rate firm depending on the probability of σ and $(1 - \sigma)$. Thus, the profit expected from a vacant job,

$$r\Pi_v = -h + m(\theta)\Big(\sigma\Pi_e^l + (1-\sigma)\Pi_e^h - \Pi_v\Big) \tag{21}$$

By imposing the free entry condition on the equation 20 and 21, we reach to the labor demand equation.

$$\frac{h}{m(\theta)} = \frac{(y-w)\Big(\sigma(r+q^h) + (1-\sigma)(r+q^l)\Big)}{(r+q^l)(r+q^h)} \tag{22}$$

5.2.3 The Behaviour of Workers

Let V_e^j and V_u be, respectively, the expected utility of an employee and an unemployed. The expected utility of an employed,

$$rV_e^j = w + q^j(V_u - V_e^j) \tag{23}$$

When a worker is employed, he/she earns a wage of w. At every instant, a job may become vacant with a probability of q^j depending on the firm's type. Consequently, the worker becomes unemployed and returns to searching for a job. The expected utility of an unemployed,

$$rV_u = z + \theta m(\theta)\big(\sigma V_e^l + (1-\sigma)V_e^h - V_u\big) \tag{24}$$

Unemployed persons constantly search for a job. During this process, he/she gains an amount of z. An unemployed apply for a job and be randomly selected from applicants to become employed with a rate of $\theta m(\theta)$. If a successful match happens, the job becomes l type with a probability σ or h type with a probability $1-\sigma$. The condition $w > z$ is assumed to hold.

5.2.4 Wage Bargaining

In the labor market, matching technology is given by $M(V,U)$. Firms and workers negotiate over the wage depending on workers' bargaining power γ, which takes a value between $[0,1]$. The wage for a firm l type and h type is the outcome of a Nash bargaining process.

The total surplus, the share of employee and employer, is defined as,

$$S^j = (V_e^j - V_u) + (\Pi_e^j - \Pi_v) \tag{25}$$

$$\text{Employee rent} : V_e^j - V_u = S^j\gamma \tag{26}$$

$$\text{Employer rent} : \Pi_e^j - \Pi_v = S^j(1-\gamma) \tag{27}$$

We find total surplus for each type as a single equation by using the equations 20, 23, 26, and 27,

$$S^j = \frac{y - r(V_u + \Pi_v)}{r + q^j} \tag{28}$$

In order to find negotiated wage, we use the equations 20, 23, 28.

$$w = \gamma y + (1 - \gamma) r V_u \tag{29}$$

At this point, the relation between wage and labor market tightness θ can be defined by using the equations 24, 26, 27. At the free entry equilibrium, the value of unemployment,

$$rV_u = \frac{z(r + q^l)(r + q^h) + \theta m(\theta)\gamma y\Big(\sigma(r + q^h) + (1 - \sigma)(r + q^l)\Big)}{(r + q^l)(r + q^h) + \theta m(\theta)\gamma[\sigma(r + q^h) + (1 - \sigma)(r + q^l)]} \tag{30}$$

Substituting this in to the 29 we get the WC.

$$w = \frac{z(1 - \gamma)(r + q^l)(r + q^h)}{(r + q^l)(r + q^h) + \theta m(\theta)\gamma[\sigma(r + q^h) + (1 - \sigma)(r + q^l)]} + \tag{31}$$

$$\gamma y\left(\frac{(r + q^l)(r + q^h) + \theta m(\theta)[\sigma(r + q^h) + (1 - \sigma)(r + q^l)]}{(r + q^l)(r + q^h) + \theta m(\theta)\gamma[\sigma(r + q^h) + (1 - \sigma)(r + q^l)]}\right) \tag{32}$$

$$\frac{\partial w}{\partial \theta} > 0$$

The wage level and labor market tightness have a positive relationship. An increase in labor market tightness reduces the unemployment rate. A rise in the labor market tightness increases the chance of getting employed. Since job seekers have more outside options than before, the expected utility of unemployment is higher. These effects together have a positive impact on wages.

5.2.5 Labor Market Equilibrium

In the matching model, the relation between labor demand (22), the wage curve (32), and the Beveridge Curve (19) determine the equilibrium values of the unemployment rate (u), wages (w), and labor market tightness (θ). The labor demand equation and the wage curves determine the equilibrium value of the w, and θ. The Beveridge Curve and the equilibrium value of θ set the equilibrium value of the unemployment rate (u). The intersection of the labor demand curve (22) and the wage curves (32) gives us the following equation which reveals the unique value of θ^*,

$$\frac{h}{m(\theta)} = \frac{(1-\gamma)(y-z)[\sigma(r+q^h)+(1-\sigma)(r+q^l)]}{(r+q^l)(r+q^h)+\theta m(\theta)\gamma[\sigma(r+q^h)+(1-\sigma)(r+q^l)]} \tag{33}$$

When the negotiated wage is considered, the left side of the equation 33 shows the average cost of vacancy. Since $m(\theta)$ decreases with θ, the average cost of vacancy also decreases with labor market tightness. On the other hand, the right side of the equation presents the profit expected from a filled job. It can be deduced that it decreases with $\theta m(\theta)$. The rise in vacancy makes unemployment more valuable for job seekers since more outside options are available.

In the following sections, we will analyze the effects of parameters on wages, unemployment rate, and labor market tightness.

5.2.6 Comparative Statics

Since there is not much difference between our first two models, some of the effects of the parameters will be the same. To save time and space, we will only show them in the summary table 5.2.

The Job Destruction Rate q^l

The rise in the job destruction rate for a firm with a low turnover rate, q^l, harms the profit expected from a filled job. The fall must be compensated by lowering the average vacancy cost, possibly by creating fewer vacancies. For this reason, the labor market tightness, θ, falls. The outside option for workers now becomes more scarce than before. Therefore, their chance of becoming employed is reduced. Following

these developments, the firm has more power in the wage bargaining process, which pushes the wage downwards.

$$\frac{dw}{dq^l} < 0, \quad \frac{d\theta}{dq^l} < 0, \quad \frac{du}{dq^l} > 0$$

Less labor market tightness and more destruction rate raise the unemployment rate directly and indirectly. The rise in the q^l shifts BC to the less efficient position. The labor market has more unemployed even for the same level of θ. The indirect effect comes from θ, which falls because of the less job creation and less efficient market.

The Job Destruction Rate q^h

The job destruction rate for a firm with a high turnover rate, q^h, also harms the profit expected from a filled job. The same logic for the relation between q^h, θ, wage, and the unemployment rate is valid for this section too. An increase in the probability of job destruction of whatever type of firm lowers the wages and the labor market tightness while increasing the unemployment rate.

$$\frac{dw}{dq^h} < 0, \quad \frac{d\theta}{dh} < 0, \quad \frac{du}{dq^h} > 0$$

Less labor market tightness and more destruction rate raise the unemployment rate directly and indirectly. The rise in the q^h shifts BC to the less efficient position. The labor market has more unemployed even for the same level of θ. The indirect effect comes from θ, which falls because of the less job creation and less efficient market. Lastly, the reason that q^l and q^h have the same effect on endogenous parameters is that the labor supply side is not segmented.

The Ratio of Firm with a Low Turnover Rate: σ

$$\frac{dw}{d\sigma} > 0, \quad \frac{d\theta}{d\sigma} > 0, \quad \frac{du}{d\sigma} < 0$$

As we mentioned for the model, the firms' turnover rate level is determined with a rate of σ for lower productivity and $1 - \sigma$ for higher productivity. Whether the firm

has a low turnover rate or a high turnover rate is determined after a successful match. Therefore, when opening a vacancy, firms do not know their turnover rate level. This setup impacts firms' decisions on the opening vacancy. An increase in the σ enhances the probability of becoming a firm with a low turnover rate and expands the possible employment duration. Hereat, the profit expected from a filled job rises, meaning more vacancies will be created. The increase in the vacancy number moves along the BC where the unemployment rate is lower.

$$\frac{dw}{dz} > 0, \quad \frac{dw}{d\gamma} > 0, \quad \frac{dw}{dh} < 0, \quad \frac{dw}{dy} > 0$$

$$\frac{d\theta}{dz} < 0, \quad \frac{d\theta}{d\gamma} < 0, \quad \frac{d\theta}{dh} < 0, \quad \frac{d\theta}{dy} > 0$$

$$\frac{du}{dz} > 0, \quad \frac{du}{d\gamma} > 0, \quad \frac{du}{dh} > 0, \quad \frac{du}{dy} < 0$$

For this section, the effects of the r on wages and labor market tightness are too cumbersome to evaluate. The table 5.2 summarizes all the results from comparative statics.

Table 5.2: Comparative statics for the model 2

	z	γ	h	q^l	q^h	σ	y
w	+	+	-	-	-	+	+
θ	-	-	-	-	-	+	+
u	+	+	+	+	+	-	-

5.3 Productivity & Turnover Rate Differentiation

In this section, we create a model that combines the first two. We analyze segmentation in the labor market using firms' productivity and turnover rate differences. The economy consists of four different types of firms. $i = l$ and $i = h$ denote firms with low and high productivity. ϕ and $(1 - \phi)$ are the ratio of low and high productive firms of the total. $j = l$ and $j = h$ denote firms with low and high turnover rates. σ and $(1 - \sigma)$ are the total ratios of low and high turnover rate firms. To be clear, for example, a firm becomes low productive with a low turnover rate with the possibility of $\phi\sigma$. Labor is assumed to be homogeneous and the sole factor of production.

Once a firm and a job seeker agree on a wage, a vacant job becomes filled. After the match, the firm can be one of the four possible states. It becomes probability of: $\phi\sigma$ a low productive and low turnover rate, $(1 - \phi)\sigma$ a high productive and low turnover rate, $\phi(1 - \sigma)$ a low productive and high turnover rate, $(1 - \phi)(1 - \sigma)$ high productive and high turnover rate firm.

The model differentiates wages, productivity, and job destruction rates. After a successful match, a low type firm produces y^l, and a high type firm produces y^h. The former pays w^l, and the latter pays w^h. The production continues until a shock arrives, and the job is destroyed with the probability of p^l for low turnover rate types and p^h for high turnover types. With this, the worker return to the state of unemployed, and the firm's position becomes vacant. It is reasonable to assume that $w^h > w^l > z$, $y^h > y^l$ and $q^h > q^l$.

The model and solutions are the same as the first model in the following sections. To save space and time, we only show the necessary explanations. For detailed comments, readers can refer to the first model.

5.3.1 Labor Market Flows

The population is denoted by N and normalized to unity. At every instant, jobs are destroyed with the probability of q^l or q^h depending on the type of the firm. The labor market matches through a matching technology $M(V, U)$. L and U denote respectively the number of employed and unemployed workers. $N = L + U$ represents the total population. Therefore, at every instant, the amount of $(q^l + q^h)L$ job is destroyed, and

workers become unemployed. Conversely, $\theta m(\theta)U$ matches with a job. The inflow and outflow of unemployment can be written as follow,

$$\dot{U} = \dot{N} + (q^l + q^h)L - \theta m(\theta)U \tag{34}$$

$\dot{U}$ denotes the changes in the stock of unemployed persons. As it is known, changes are null in the steady state. We find the steady state unemployment ratio by using the equation 34,

$$u = \frac{q^h + q^l}{q^h + q^l + \theta m(\theta)} \tag{35}$$

5.3.2 The Behaviour of Firms

Superscript i, j represents the type of a firm. $\Pi_e^{i,j}$ is the profit expected from a filled job. After a match, the firm starts to produce an actual output y^i and pays the worker a wage w^i. Since the wage and the production depend on a productivity level, they are denoted by i. The job turnover rates are related to the job destruction rate, and they are denoted by j. After a filled job is destroyed, it changes state to a vacant job with a probability of p^j depending on its type. Thus, the profit expected from a filled job,

$$r\Pi_e^{i,j} = y^i - w^i + q^j(\Pi_v - \Pi_e^{i,j}) \tag{36}$$

$\Pi_v^{i,j}$ is the profit expected from a vacant job. We know that hiring is a costly process that costs h per unit of time. A vacant position changes its state according to a Poisson process with the rate $m(\theta)$. At this point, the firm is not capable of deciding the type. Again it depends on the probability of types. Thus, the profit expected from a vacant job,

$$r\Pi_v = -h + m(\theta)\Big(\phi\sigma\Pi_e^{l,l} + \phi(1-\sigma)\Pi_e^{l,h} + (1-\phi)\sigma\Pi_e^{h,l} + (1-\phi)(1-\sigma)\Pi_e^{h,h} - \Pi_v\Big) \tag{37}$$

We find to the labor demand equation by imposing the free entry condition, $\Pi_v = 0$, on the equation 36 and 37,

$$\frac{h}{m(\theta)} = \frac{\Big[\sigma(r+q^h)+(1-\sigma)(r+q^l)\Big]\Big[\phi(y^l-w^l)+(1-\phi)(y^h-w^h)\Big]}{(r+q^l)(r+q^h)} \tag{38}$$

5.3.3 The Behaviour of Workers

$V_e^{i,j}$ and V_u show the expected utility of an employee and an unemployed. The expected utility of an employed,

$$rV_e^{i,j} = w^i + q^j(V_u - V_e^{i,j}) \tag{39}$$

When a job seeker is employed, he/she earns a wage of w. A job may be destroyed at every instant with a probability of q^j depending on the firm's type. If it happens, the worker becomes unemployed and returns to searching for a job. The expected utility of an unemployed,

$$rV^u = z+\theta m(\theta)\Big[\phi\sigma V_e^{l,l}+(1-\phi)\sigma V_e^{h,l}+\phi(1-\sigma)V_e^{l,h}+(1-\phi)(1-\sigma)V_e^{h,h}-V_u\Big] \tag{40}$$

Unemployed persons search for a job with the same effort. The job seeker enjoys an amount of z, considered unemployment insurance during the unemployment period. When an application is made for a job, the worker is randomly selected among other candidates. After a hiring process, the job becomes l, l type with a probability $\phi\sigma$; l, h type with a probability $\phi(1-\sigma)$; h, l type with a probability $(1-\phi)\sigma$; and h, h type with a probability $(1-\phi)(1-\sigma)$. The condition $w^i > z$ is assumed to hold **Pissaridies 2000**.

5.3.4 Wage Bargaining

The matching technology is given in the labor market by $M(V, U)$. Firms and workers negotiate over the wage depending on workers' bargaining power γ, which takes a value between $[0, 1]$. The wages are the outcome of a Nash bargaining process.

The total surplus, the share of employee and employer, is defined as,

$$S^{i,j} = (V_e^{i,j} - V_u) + (\Pi_e^{i,j} - \Pi_v) \tag{41}$$

$$\text{Employee rent} : V_e^{i,j} - V_u = S^{i,j}\gamma \tag{42}$$

$$\text{Employer rent} : \Pi_e^{i,j} - \Pi_v = S^{i,j}(1-\gamma) \tag{43}$$

Using the equations 36 and 39, we reach to total surplus for each type as a single equation,

$$S^{i,j} = \frac{y^i - r(V_u + \Pi_v)}{r + q^j} \tag{44}$$

In order to find negotiated wage, we use the equations 36, 39, 44.

$$w^i = \gamma y^i + (1-\gamma) r V_u \tag{45}$$

The equation 45 shows that the bargaining power γ determines the surplus sharing between worker and firm. At this point, the relation between wage and labor market tightness θ can be defined by using the equations 40, 42, 27. At the free entry equilibrium, the value of unemployment,

$$rV_u = \frac{z(r+q^l)(r+q^h) + \theta m(\theta)\gamma[\phi y^l + (1-\phi)y^h][\sigma(r+q^h) + (1-\sigma)(r+q^l)]}{(r+q^l)(r+q^h) + \theta m(\theta)\gamma[\sigma(r+q^h) + (1-\sigma)(r+q^l)]} \tag{46}$$

Substituting this in to the 45 we get,

$$w^i = \gamma y^i + \frac{z(1-\gamma)(r+q^l)(r+q^h)}{(r+q^l)(r+q^h) + \theta m(\theta)\gamma[\sigma(r+q^h) + (1-\sigma)(r+q^l)]} + \tag{47}$$

$$\frac{\theta m(\theta)\gamma(1-\gamma)[\phi y^l + (1-\phi)y^h][\sigma(r+q^h) + (1-\sigma)(r+q^l)]}{(r+q^l)(r+q^h) + \theta m(\theta)\gamma[\sigma(r+q^h) + (1-\sigma)(r+q^l)]} \tag{48}$$

The equation 48 is named as the wage curve (WC).

$$\frac{\partial w^i}{\partial \theta} > 0$$

The wage levels and labor market tightness have a positive relationship. An increase in labor market tightness reduces the unemployment rate. As we mentioned several times, a rise in the labor market tightness makes the employment process more likely to happen. As job seekers have more outside options, their bargaining power improves. These effects together have a positive impact on wages.

5.3.5 Labor Market Equilibrium

The relation between labor demand (38), the wage curve (48), and the Beveridge Curve (35) define the equilibrium values of the unemployment rate (u), wages (w), and labor market tightness (θ). The labor demand equation and the wage curves determine the equilibrium value of the w^l, w^h, and θ. The Beveridge Curve and the equilibrium value of θ identify a unique unemployment rate. The intersection of the labor demand curve (38) and the wage curves (48) gives us the following equation which reveals the unique value of θ^*,

$$\frac{h}{m(\theta)} = \frac{(1-\gamma)[\phi y^l + (1-\phi)y^h - z][\sigma(r+q^h) + (1-\sigma)(r+q^l)]}{(r+q^l)(r+q^h) + \theta m(\theta)\gamma[\sigma(r+q^h) + (1-\sigma)(r+q^l)]} \tag{49}$$

The left side of the equation 49 shows the average cost of vacancy. Since $m(\theta)$ decreases with θ, the average cost of vacancy increases with labor market tightness. On the other hand, the right side of the equation presents the profit expected from a filled job. It can be deduced that it increases with θ. The rise in the number of vacancies makes unemployment more valuable for job seekers since more outside options are available.

In the following sections, we will analyze the effects of parameters on wages, unemployment rate, and labor market tightness.

5.3.6 Comparative Statics

Since we construct our models based on a standard model of Mortensen and Pissarides (1994), we comment only on the essential parameters of this specific model. Others will be shown in the summary table 5.3.

The Job Destruction Rate: q^l

The increase in the job destruction rate for a firm with a low turnover rate, q^l, harms the profit expected from a filled job. The fall must be compensated by lowering the average vacancy cost, possibly by creating fewer vacancies. For this reason, the labor market tightness, θ, falls. The outside option for workers now becomes more scarce than before. Therefore, their chance of becoming employed is reduced. Following these developments, the firm has more power in the wage bargaining process, which pushes the wage downwards.

$$\frac{dw^i}{dq^l} < 0, \quad \frac{d\theta}{dq^l} < 0, \quad \frac{du}{dq^l} > 0$$

Less labor market tightness and more destruction rate raise the unemployment rate directly and indirectly. The rise in the q^l shifts BC to the less efficient position. The labor market has more unemployed even for the same level of θ. The indirect effect comes from θ, which falls because of the less job creation and less efficient market.

The Job Destruction Rate q^h

The increase in the job destruction rate for a firm with a high turnover rate, q^h, also harms the profit expected from a filled job. The same logic for the relation between q^h, θ, wage, and the unemployment rate is valid for this section too. An increase in the probability of job destruction of whatever type of firm lowers the wages and the labor market tightness while increasing the unemployment rate.

$$\frac{dw^i}{dq^h} < 0, \quad \frac{d\theta}{dq^h} < 0, \quad \frac{du}{dq^h} > 0$$

Less labor market tightness and more destruction rate raise the unemployment rate directly and indirectly. The rise in the q^l shifts BC to the less efficient position. The labor market has more unemployed even for the same level of θ. The indirect effect comes from θ, which falls because of the less job creation and less efficient market. Lastly, the reason that q^l and q^h have the same effect on endogenous parameters is that the labor supply side is not segmented.

The Ratio of Firm with a Low Turnover Rate: σ

$$\frac{dw^i}{d\sigma} > 0, \quad \frac{d\theta}{d\sigma} > 0, \quad \frac{du}{d\sigma} < 0$$

As we mentioned for the model, the firms' turnover rate level is determined with a rate of σ for lower productivity and $1-\sigma$ for higher productivity. Whether the firm has a low turnover rate or a high turnover rate is determined after a successful match. Therefore, when opening a vacancy, firms do not know the level of the turnover rate they will have. This setup has an impact on firms' decisions about opening a vacancy. An increase in the σ increases the probability of becoming a firm with a low turnover rate and expands the possible employment duration. Hereat, the profit expected from a filled job rises, meaning more vacancies will be created. The increase in the vacancy number makes a move along the BC where the unemployment rate is lower.

The Ratio of Low Productive Firm: ϕ

$$\frac{dw^i}{d\phi} < 0, \quad \frac{d\theta}{d\phi} < 0, \quad \frac{du}{d\phi} > 0$$

As we mentioned for the model, the firms' productivity level is determined with a rate of ϕ for lower productivity and $1-\phi$ for higher productivity. The identification process is realized after a successful match. Therefore firms do not know the level of productivity they will have. The randomness directly impacts the firm's decision on whether to open a vacancy or not. As ϕ rises, becoming a low-productive firm is more likely to happen. Consequently, the profit expected from a filled job drops, which causes a fall in θ and an increase in the unemployment rate.

$$\frac{\partial w^i}{\partial z} > 0, \quad \frac{dw^i}{dh} < 0, \quad \frac{dw^i}{dy^l} > 0, \quad \frac{dw^i}{dy^h} > 0$$

$$\frac{d\theta}{dz} < 0, \quad \frac{d\theta}{dh} < 0, \quad \frac{d\theta}{dy^l} > 0, \quad \frac{d\theta}{dy^h} > 0,$$

$$\frac{du}{dz} > 0, \quad \frac{du}{dh} > 0, \quad \frac{du}{dy^l} < 0, \quad \frac{du}{dy^h} < 0$$

For this section, the effects of the γ and r on wages and labor market tightness are

too cumbersome to evaluate. The table 5.3 summarizes all the results from comparative statics.

Table 5.3: Comparative statics for the model 3

	z	h	q^l	q^h	σ	y^l	y^h	ϕ
w^h	+	-	-	-	+	+	+	-
w^l	+	-	-	-	+	+	+	-
θ	-	-	-	-	+	+	+	-
u	+	+	+	+	-	-	-	+

6 WORKERS HETEROGENEITY

In this work section, we turn our attention to the workers. Contrary to the previous models, we examine workers' heterogeneity in the labor market. For this purpose, we create three different models, including productivity and matching heterogeneity between workers. In the following two models, we analyze productivity and matching heterogeneity one by one. In the final model, we combine them and examine them together.

6.1 Productivity

In the first model, we set up a model with workers with different productivity levels. The economy consists of two different types of workers. $k = l$ and $k = h$ denote workers with low and high productivity. β and $(1 - \beta)$ are the ratios of low and high productive workers in the total. Firms are assumed to be homogeneous, and labor is the sole factor of production.

Firms do not know workers' types before hiring. Once a firm opens a vacant position, the decision is made by the possibility of encountering a worker with l or h type, which is equal to the β and $(1 - \beta)$. This assumption is reasonable considering all the networks and references used in the employment process.

When a firm and a job seeker agree on a wage, the firm's productivity depends on ending up with which type of worker. A low type firm produces y^l and pays w^l while a high type firm produces y^h and pays w^h. The production continues until a shock arrives, and the job is destroyed with the probability of p. In case of a shock, the worker becomes unemployed, and the firm's position becomes vacant. It is assumed that $w^h > w^l > z$, $y^h > y^l$.

The model and solutions are the same as the first model in the following sections. To save space and time, we only show the necessary explanations. For detailed comments, readers can refer to the first model.

6.1.1 Labor Market Flows

The population is denoted by N and normalized to unity. At every instant, jobs are destroyed with the probability of q. L^k and U^k denote respectively the number of employed and unemployed workers by type. $N = L^l + L^h + U^l + U^h$ represents the total population. Therefore, at every instant, the amount of $(q)L^k$ job is destroyed, and workers become unemployed. Conversely, $\theta m(\theta)U^k$ matches with a job. The inflow and outflow of unemployment can be written as follow,

$$\dot{U}^k = \dot{N} + (q)L^k - \theta m(\theta)U^k \tag{50}$$

$\dot{U}^k$ denotes the changes in the stock of unemployed persons for each type. As it is known, there is no change in the steady state. We find the steady state unemployment ratio for each type by using the equation 50,

$$u^k = \frac{q}{q + \theta m(\theta)} \tag{51}$$

Since there is heterogeneity in labor supply. The ratio of workers in the unemployment pool needs to be defined. λ is the ratio of low productive worker rate, $1 - \lambda$ is the ratio of high productive worker rate in the unemployment pool. Since λ is $U_l/U_l + U_h$, we can write it as,

$$\lambda = \frac{\frac{q\beta}{q+\theta m(\theta)}}{\frac{q}{q+\theta m(\theta)} + \frac{q}{q+\theta m(\theta)}} \tag{52}$$

where $\lambda = \beta$. Thus, there are no differences between workers' and unemployment pool composition as their matching efficiency is the same. We differentiate it in the next two models.

6.1.2 The Behaviour of Firms

Superscript k represents the type of worker. Π_e^k is the profit expected from a filled job. When a job is filled, the firm produces a real output y^k and pays its worker a wage w^k depending on the employed worker's type. The filled job can be destroyed with the probability of p. Thus, the profit expected from a filled job,

$$r\Pi_e^k = y^k - w^k + q(\Pi_v - \Pi_e^k) \tag{53}$$

Π_v be the profit expected from a vacant job. A vacancy costs h per unit time to the firm. A vacant position becomes filled according to a Poisson process with a rate $m(\theta)$. After a successful match, the firm becomes a low productive type with a probability β, a high productive type with a probability $1-\beta$. Thus, the profit expected from a vacant job given by,

$$r\Pi_v = -h + m(\theta)(\beta\Pi_e^l + (1-\beta)\Pi_e^h - \Pi_v) \tag{54}$$

According to the free entry condition, $\Pi_v = 0$, all profits must be exploited by new entrants. We write the labor demand equation by using 53 and 54,

$$\frac{h}{m(\theta)} = \frac{\beta(y^l - w^l) + (1-\beta)(y^h - w^h)}{r+q} \tag{55}$$

6.1.3 The Behaviour of Workers

Let V_e^k and V_u^k be the expected utility of an employee and an unemployed. The expected utility of an employed,

$$rV_e^k = w^k + q(V_u^k - V_e^k) \tag{56}$$

The filled job yield a return of w^l to the low productive, w^h to the high productive worker. At every instant, the job has become a vacant position with the probability of q due to a shock. Hence the worker may return to the state of unemployment and start searching for a job. The expected utility of an unemployed given by,

$$rV_u^k = z + \theta m(\theta)(V_e^k - V_u^k) \tag{57}$$

Job seekers receive an unemployment benefit of z during their unemployment period. A job seeker can be hired with the rate of $m(\theta)$. There is no hazard rate difference between the low and high workers. However, the expected utility of a job seeker differs between them, as denoted by k. The condition $w^h > w^l > z$ is assumed to hold to ensure labor supply.

6.1.4 Wage Bargaining

The bargaining process between a firm and a job seeker depends on the worker's bargaining power γ, whose values are between $[0, 1]$. γ is the same for both types of workers. Nevertheless, productivity differences result in differences in wages. The total surplus, the share of employee and employer, is defined as,

$$(S^k) = (V_e^k - V_u^k) + (\Pi_e^k - \Pi_v) \tag{58}$$

$$\text{Employee rent} = V_e^k - V_u^k = S^k\gamma \tag{59}$$

$$\text{Employer rent} = \Pi_e^k - \Pi_v = S^k(1-\gamma) \tag{60}$$

$$\tag{61}$$

Using the equations 53 and 56, 58 we find total surplus for each type as a single equation.

$$S^k = \frac{y^k - r(V_u^k + \Pi_v)}{r+q} \tag{62}$$

We use the equations 53, 56, 58 for finding the negotiated wage.

$$w^k = \gamma y^k + (1-\gamma) r V_u^k \tag{63}$$

At the free entry, the equilibrium value of unemployment can be written by using the equations 57, 59, 60.

$$rV_u^k = \frac{z(r+q) + \theta m(\theta)\gamma y^k}{\theta m(\theta)\gamma + r + q} \tag{64}$$

Substituting this into the wage equation 63 we get the WC,

$$w^l = \frac{z(1-\gamma)(r+q)}{\theta m(\theta)\gamma + r + q} + \frac{\gamma y^l\big(\theta m(\theta) + r + q\big)}{\theta m(\theta)\gamma + r + q} \tag{65}$$

$$w^h = \frac{z(1-\gamma)(r+q)}{\theta m(\theta)\gamma + r + q} + \frac{\gamma y^h\big(\theta m(\theta) + r + q\big)}{\theta m(\theta)\gamma + r + q} \tag{66}$$

6.1.5 Labor Market Equilibrium

In the matching model, the relation between labor demand (55), the wage curves (65,66), and the Beveridge Curve (51) define the equilibrium values of the unemployment rate (u^l, u^h), wages (w^l, w^h), and labor market tightness (θ).

The labor demand equation and the wage curves determine the equilibrium value of the w^l, w^h, and θ. The Beveridge Curve and the equilibrium value of θ specify the equilibrium value of the unemployment rate (u). The intersection of the labor demand curve (55) and the wage curves (65,66) gives us the following equation which reveals the unique value of θ^*,

$$\frac{h}{m(\theta)} = \frac{(1-\gamma)\big[\beta(y^l - z) + (1-\beta)(y^h - z)\big]}{\theta m(\theta)\gamma + r + q} \tag{67}$$

6.1.6 Comparative Statics

The Ratio of Worker With Low Productivity: β

An increase in the ratio of workers with low productivity causes a decrease in the expected profit from a filled job. We mentioned that firms hire a worker without knowing their type. As the number of low-productive workers increases, the firm can hire more likely an l-type worker and produce y^l. According to the equation, 67 firms must respond to it by lowering their vacancy costs which is possible by opening fewer vacancies. Fewer vacant position means lower market tightness. Therefore job seekers have fewer outside options, which puts downward pressure on wages.

$$\frac{dw^h}{d\beta} < 0, \quad \frac{dw^l}{d\beta} < 0 \quad \frac{d\theta}{d\beta} < 0, \quad \frac{du^h}{d\beta} > 0, \quad \frac{du^l}{d\beta} > 0$$

β has an indirect effect on unemployment rates. Since it lowers the labor market tightness, the unemployment rate rises due to the fewer vacant positions.

The Level of Low Productivity: y^l

We need to consider the equation 67 to decide the effect of productivity of the l-type. An increase in the productivity of l-type workers induces a rise in the expected profit from the filled job. The labor demand reacts to it by opening more vacancies. So, the labor market tightness improves the favor of job seekers. Since their possible unemployment duration reduces, their bargaining power increases. The effects are valid for both types since they are in the same labor market. For the l-type of worker, another effect is in use. Since the rise y results in a growth in total surplus, it also generates a positive effect.

$$\frac{dw^l}{dy^l} > 0, \quad \frac{dw^h}{dy^l} > 0, \quad \frac{d\theta}{dy^l} > 0, \quad \frac{du^l}{dy^l} < 0, \quad \frac{du^h}{dy^l} < 0$$

The effects mentioned lead to higher labor market tightness which indirectly causes a decrease in the unemployment rate for both types.

The Level of High Productivity: y^h

The same logic for y^l applies to y^h too. The difference is total surplus effect is now valid for the h-type worker instead of the l-type.

$$\frac{dw^l}{dy^h} > 0, \quad \frac{dw^h}{dy^h} > 0, \quad \frac{d\theta}{dy^h} > 0, \quad \frac{du^l}{dy^h} < 0, \quad \frac{du^h}{dy^h} < 0$$

Others Parameters: z, γ, h, q, r

The effects of other parameters on the wages, the labor market tightness, and the unemployment rate are the same of previous models. The logic written in the first section apply for here too.

$$\frac{dw^k}{dz} > 0, \quad \frac{dw^k}{d\gamma} > 0, \quad \frac{dw^k}{dh} < 0, \quad \frac{dw^k}{dq} < 0, \quad \frac{dw^k}{dr} < 0,$$

$$\frac{d\theta}{dz} < 0, \quad \frac{d\theta}{d\gamma} < 0, \quad \frac{d\theta}{dh} < 0, \quad \frac{d\theta}{dq} < 0, \quad \frac{d\theta}{dr} < 0,$$

$$\frac{du}{dz} > 0, \quad \frac{du}{d\gamma} > 0, \quad \frac{du}{dh} > 0, \quad \frac{du}{dq} > 0, \quad \frac{du}{dr} > 0,$$

The table 6.1 summarizes all the results from comparative statics.

Table 6.1: Comparative statics for the model 4

	z	γ	h	q	r	β	y^l	y^h
w^h	+	+	-	-	-	-	+	+
w^l	+	+	-	-	-	-	+	+
θ	-	-	-	-	-	-	+	+
u^h	+	+	+	+	+	+	-	-
u^l	+	+	+	+	+	+	-	-

6.2 Matching Skills

As a second model, we construct a model including workers with different matching skills. The economy consists of two different types of workers. $m = l$ and $m = h$ denote workers with low and high MS. κ and $(1 - \kappa)$ are the ratios of l-type and h-type in the total. α^m represents a coefficient that determines the matching efficiency of a person. Firms are assumed to be homogeneous, and labor is the sole factor of production.

Firms, again, do not know workers' types before hiring. However, the h-type workers match faster owing to their MS. Once a firm opens a vacant position, the decision is made by the possibility of encountering a worker with l or h type, which is equal to the κ and $(1 - \kappa)$. Even though workers have the same productivity, background, and education, they can be different in matching skills, which refers to the ability to search and match with a job. This assumption must be familiar to all of us.

The firm produces y and pays w^l or w^h depending on the type of hired worker. Firms enjoy the existence of h-type as they lower the duration of the vacant position. The production continues until a shock arrives, and the job is destroyed with the probability of p. In case of a shock, the worker becomes unemployed, and the firm's position becomes vacant. It is assumed that $w^h > w^l > z$.

The model and solutions are the same as the first model in the following sections. To save space and time, we only show the necessary explanations. For detailed comments, readers can refer to the first model.

6.2.1 Labor Market Flows

The population is denoted by N and normalized to unity. At every instant, jobs are destroyed with the probability of q. L^m and U^m denote respectively the number of employed and unemployed workers by type. $N = L^l + L^h + U^l + U^h$ represents the total population. Therefore, at every instant, the amount of $(q)L^m$ job is destroyed, and workers become unemployed. Conversely, $\theta m(\theta)U^m$ matches with a job. The inflow and outflow of unemployment can be written as follow,

$$\dot{U}^m = \dot{N} + (q)L^m - \theta m(\theta)U^m a^m \tag{68}$$

$\dot{U}^m$ signifies the changes in the stock of unemployed persons for each type. We find the steady state unemployment ratio for each type by using the equation 68,

$$u^m = \frac{q}{q + \theta m(\theta)a^m} \tag{69}$$

The heterogeneity in the labor market must be defined. τ is the ratio of low MS worker rate, $1 - \tau$ is the ratio of high MS worker rate in unemployment pool. Let's define τ as an equation,

$$\tau = \frac{\kappa\big(q + \theta m(\theta)a^h\big)}{[\kappa\big(q + \theta m(\theta)a^h\big)] + [(1-\kappa)\big(q + \theta m(\theta)a^l\big)]} \tag{70}$$

$$\frac{\partial \tau}{\partial \theta} > 0, \quad \frac{\partial \tau}{q} < 0$$

The differentiation gives us a critical result. When the labor tightness increases, the low MS type worker ratio in the unemployment pool also rises. The logic behind that is clear, a higher θ increases the employment possibility for both types. However, the possibility increases more for the h-type than the l-type. As a result, the ratio of l-type rises in the unemployment composition, even if their number reduces.

On the other hand, an increase in the q raises the possibility of destroying jobs. In this case, employed persons are more likely to lose their jobs. Since h-type workers are more likely to be employed, the effect has more significance on them.

6.2.2 The Behaviour of Firms

Superscript m represents the type of worker. Π_e^m shows the profit expected from a filled job. As a result of filling a job, the firm produces a real output y and pays its worker a wage w^k depending on the employed worker's type. The filled job can be destroyed with the probability of p. Thus, the profit expected from a filled job given by,

$$r\Pi_e^m = y - w^m + q(\Pi_v - \Pi_e^m) \tag{71}$$

Π_v is the profit expected from a vacant job. h represents the cost of a vacant position per unit of time to the firm. A vacant position becomes filled according to a Poisson process with the rate $m(\theta)$. In case of a match, the firm becomes a low type with the probability κ, a high type with the probability $1-\kappa$. Thus, the profit expected from a vacant job given by,

$$r\Pi_v = -h + m(\theta)\Big(a^l\kappa\Pi_e^l + a^h(1-\kappa)\Pi_e^h - \Pi_v(\kappa a^l + (1-\kappa)a^h)\Big) \tag{72}$$

The free entry condition imposes that new entrants must exploit all the profit. To reach to the labor demand equation, we use 71 and 72,

$$\frac{h}{m(\theta)} = \frac{a^l\kappa(y-w^l) + a^h(1-\kappa)(y-w^h)}{r+q} \tag{73}$$

6.2.3 The Behaviour of Workers

Let V_e^m and V_u^m be the expected utility of an employee and an unemployed.

$$rV_e^m = w^m + q(V_u^m - V_e^m) \tag{74}$$

An employee is paid w^l or w^h by a firm depending on his/her MS. The position may become vacant every instant due to a shock with the probability of q. The employee becomes unemployed and starts searching for a job.

$$rV_u^m = z + \theta m(\theta)a^m(V_e^m - V_u^m) \tag{75}$$

Job seekers receive an unemployment benefit of z during their unemployment period. An unemployed can find a job at the rate of $a^m m(\theta)$. The hazard rate differentiates between the low-type and high-type workers.

6.2.4 Wage Bargaining

The bargaining process between a firm and a job seeker depends on the worker's bargaining power γ, whose values are between $[0, 1]$. γ is the same for both types of workers. Nevertheless, MS differences result in differences in wages. The total surplus, the share of employee and employer, is defined as,

$$(S^m) = (V_e^m - V_u^m) + (\Pi_e^m - \Pi_v) \tag{76}$$

$$\text{Employee rent} = V_e^m - V_u^m = S^m\gamma \tag{77}$$

$$\text{Employer rent} = \Pi_e^m - \Pi_v = S^m(1-\gamma) \tag{78}$$

$$\tag{79}$$

Using the equations 71 and 74, 76 we find total surplus for each type as a single equation.

$$S^m = \frac{y - r(V_u^m + \Pi_v)}{r+q} \tag{80}$$

We use the equations 71, 74, 76 for finding the negotiated wage.

$$w^m = \gamma y + (1-\gamma) r V_u^m \tag{81}$$

At the free entry, the equilibrium value of unemployment can be written by using the equations 75, 77, 78.

$$rV_u^m = \frac{z(r+q) + \theta m(\theta) a^m \gamma y}{\theta m(\theta)\gamma a^m + r + q} \tag{82}$$

Substituting this into the wage equation 81 we get the WC for both type of workers,

$$w^l = \frac{z(r+q)(1-\gamma)}{\theta m(\theta)\gamma a^l + r + q} + \frac{\gamma y[\theta m(\theta) a^l + r + q]}{\theta m(\theta)\gamma a^l + r + q} \tag{83}$$

$$w^h = \frac{z(r+q)(1-\gamma)}{\theta m(\theta)\gamma a^h + r + q} + \frac{\gamma y[\theta m(\theta)a^h + r + q]}{\theta m(\theta)\gamma a^h + r + q} \tag{84}$$

6.2.5 Labor Market Equilibrium

In the matching model, the relation between labor demand (73), the wage curves (83,84), and the Beveridge Curve (69) define the equilibrium values of the unemployment rate (u^l, u^h), wages (w^l, w^h), and labor market tightness (θ).

The labor demand equation and the wage curves determine the equilibrium value of the w^l, w^h, and θ. The Beveridge Curve and the equilibrium value of θ define the equilibrium value of the unemployment rate (u). The intersection of the labor demand curve (73) and the wage curves (83,84) gives us the following equation which reveals the unique value of θ^*,

$$\frac{h}{m(\theta)} = (1-\gamma)(y-z)\left(\frac{a^l\kappa}{\theta m(\theta)\gamma a^l + r + q} + \frac{a^h(1-\kappa)}{\theta m(\theta)\gamma a^h + r + q}\right) \tag{85}$$

6.2.6 Comparative Statics

The Ratio of Worker With Low MS: κ

According to the equation 85, an increase in the worker ratio with low MS reduces the expected profit from a vacant job. Since a vacant job duration extends due to the l-type workers, the cost of vacancies augments. The firms compensate for it by creating fewer vacant jobs. Thus, the labor market tightness and the probability of getting a job for a job seeker fall. These all effects put downward pressure on the wages of both types.

$$\frac{dw^l}{d\kappa} < 0, \quad \frac{dw^h}{d\kappa} < 0, \quad \frac{d\theta}{d\kappa} < 0, \quad \frac{du^l}{d\kappa} > 0, \quad \frac{du^h}{d\kappa} > 0, \quad \frac{d\tau}{d\kappa} > 0$$

As the labor market tightness diminishes, the unemployment ratio for both type increases.

The Low Matching Skill: a^l

An improvement in the low matching skill, a^l, increases the value of unemployment and the expected profit from a filled job. The firm is now eager to open more vacancies. Because of the more outside option for job seekers, their bargaining power strengthens, and wages tend to rise.

$$\frac{dw^l}{da^l} > 0, \quad \frac{dw^h}{da^l} > 0, \quad \frac{d\theta}{da^l} > 0, \quad \frac{du^l}{da^l} < 0, \quad \frac{du^h}{da^l} < 0, \quad \frac{d\tau}{da^l} < 0$$

Since labor market tightness increases with new jobs opening, the unemployment rate diminishes. Besides that, the unemployment composition changes. Given a value of a^h, an improvement in the l-type MS increases their chance of getting employed. Thus, in the unemployment pool, their ratio diminishes.

The High Matching Skill: a^h

The overall effect on the labor market tightness, the wages, and the unemployment rate remain the same with an improvement in the low matching skill. However, this time the composition shifted in favor of h-type job seekers. Since they are more likely to be employed, their ratio diminishes in the unemployment pool.

$$\frac{dw^m}{da^h} > 0, \quad \frac{d\theta}{da^h} > 0, \quad \frac{du}{da^h} < 0, \quad \frac{d\tau}{da^h} > 0$$

Others Parameters: z, γ, h, q, r, y

The effects of other parameters on the wages, the labor market tightness, and the unemployment rate are the same of previous models. The logic written in the first section apply for here too.

$$\frac{dw^m}{dz} > 0, \quad \frac{dw^m}{d\gamma} > 0, \quad \frac{dw^m}{dq} < 0, \quad \frac{dw^m}{dr} < 0, \quad \frac{dw^m}{dh} < 0, \quad \frac{dw^m}{dy} > 0$$

$$\frac{d\theta}{dz} < 0, \quad \frac{d\theta}{d\gamma} < 0, \quad \frac{d\theta}{dh} < 0, \quad \frac{d\theta}{dq} < 0, \quad \frac{d\theta}{dr} < 0, \quad \frac{d\theta}{dy} > 0$$

$$\frac{du}{dz} > 0, \quad \frac{du}{d\gamma > 0}, \quad \frac{du}{dh} > 0, \quad \frac{du}{dq} > 0, \quad \frac{du}{dr} > 0, \quad \frac{du}{dy} < 0$$

$$\frac{\partial \tau}{\partial \theta} > 0, \quad \frac{\partial \tau}{\partial a^l} < 0, \quad \frac{\partial \tau}{\partial a^h} > 0, \quad \frac{\partial \tau}{\partial \kappa} > 0, \quad \frac{\partial \tau}{\partial q} < 0$$

The table 6.2 summarizes all the results from comparative statics.

Table 6.2: Comparative statics for the model 5

	z	γ	h	q	r	κ	y	a^h	a^l
w^h	+	+	-	-	-	-	+	+	+
w^l	+	+	-	-	-	-	+	+	+
θ	-	-	-	-	-	-	+	+	+
u^h	+	+	+	+	+	+	-	-	-
u^l	+	+	+	+	+	+	-	-	-
τ				-		+		+	-

6.3 Productivity & Matching Skills Differentiation

The final model combines productivity and matching skills heterogeneities in workers. The economy consists of four different types of workers. Superscript k denotes the worker's productivity, and m signifies the matching efficiency. β is the ratio of low productive workers in total. κ is the ratio of workers with low matching efficiency. A worker can be one of the four states of this combination. α^m represents a coefficient that determines the matching efficiency of a person. Firms are assumed to be homogeneous, and labor is the sole factor of production.

The firm produces y^l or y^h and pays $w^{k,m}$ depending on the type of hired worker. The production continues until a shock arrives, and the job is destroyed with the probability of p. In case of a shock, the worker becomes unemployed, and the firm's position becomes vacant.

The model and solutions are the same as the referring models. To save space and time, we only show the necessary explanations. For detailed comments, readers can refer to the previous models.

6.3.1 Labor Market Flows

The population is denoted by N and normalized to unity. At every instant, jobs are destroyed with the probability of q. $L^{k,m}$ and $U^{k,m}$ denote respectively the number of employed and unemployed workers by type. Total population represented by,

$$N = L^{l,l} + L^{l,h} + L^{h,l} + L^{h,h} + U^{l,l} + U^{l,h} + U^{h,l} + U^{h,h} \tag{86}$$

Therefore, at every instant, the amount of $(q)L^{k,m}$ job is destroyed, and workers become unemployed. Conversely, $\theta m(\theta)U^{k,m}$ matches with a job. The inflow and outflow of unemployment can be written as follow,

$$u^{k,m} = \frac{q}{q + \theta m(\theta) a^m} \tag{87}$$

6.3.2 The Behaviour of Firms

Superscript k, m represents the type of worker. $\Pi_e^{k,m}$ is the profit expected from a filled job. After a match, the firm starts to produce an actual output y^k and pays the worker a wage $w^{k,m}$. Since productivity depends on a productivity level, it is denoted by k. Wage levels are determined by production and MS, and it is denoted by m. After a filled job is destroyed, it changes state to a vacant job with a probability of p^j depending on its type. Thus, the profit expected from a filled job,

$$r\Pi_e^{k,m} = y^k - w^{k,m} + q(\Pi_v - \Pi_e^{k,m}) \tag{88}$$

Π_v is the profit expected from a vacant job. h represents the cost of a vacant position per unit of time to the firm. A vacant position becomes filled according to a Poisson process with the rate $m(\theta)$. Thus, the profit expected from a vacant job given by,

$$r\Pi_v = -h + m(\theta)\Big[\alpha^l\kappa\beta\Pi_e^{l,l} + \alpha^l\kappa(1-\beta)\Pi_e^{h,l} + \alpha^h(1-\kappa)\beta\Pi_e^{l,h} + \tag{89}$$

$$\alpha^h(1-\kappa)(1-\beta)\Pi_e^{h,h} - \Pi_v((1-\kappa)\alpha^h + \kappa\alpha^l)\Big] \tag{90}$$

By implementing the free entry conditions, we reach the labor demand,

$$\frac{h}{m(\theta)} = \frac{\kappa\alpha^l\big[\beta(y^l - w^{l,l}) + (1-\beta)(y^h - w^{h,l})\big]}{r+q} \tag{91}$$

$$+\frac{(1-\kappa)\alpha^h\big[\beta(y^l - w^{l,h}) + (1-\beta)(y^h - w^{h,h})}{r+q} \tag{92}$$

6.3.3 The Behaviour of Workers

Let $V_e^{k,m}$ and $V_u^{k,m}$ be the expected utility of an employee and an unemployed.

$$rV_e^{k,m} = w^{k,m} + q(V_u^{k,m} - V_e^{k,m}) \tag{93}$$

An employee is paid $w^{k,m}$ by a firm depending on his/her MS and productivity. The position may become vacant at every instant due to a shock with a probability of

q. The employee becomes unemployed and starts searching for a job.

$$rV_u^{k,m} = z + \theta m(\theta)\alpha^m(V_e^{k,m} - V_u^{k,m}) \tag{94}$$

Job seekers receive an unemployment benefit of z during their unemployment period. An unemployed can find a job at a rate of $a^m m(\theta)$. The hazard rate differentiates between the low-type and high-type, as in the previous section.

6.3.4 Wage Bargaining

The wage bargaining process is the same with previous sections,

$$w^{k,m} = \gamma y^k + (1-\gamma) rV_u^{k,m} \tag{95}$$

$$rV_u^{k,m} = \frac{z(r+q) + \theta m(\theta) a^m \gamma y^k}{\theta m(\theta)\gamma a^m + r + q} \tag{96}$$

We get the WC for all types,

$$w^{k,m} = \frac{(1-\gamma)z(r+q)}{\theta m(\theta)a^m\gamma + r + q} + \frac{\gamma y^k\left(\theta m(\theta)\alpha^m + r + q\right)}{\theta m(\theta)a^m\gamma + r + q} \tag{97}$$

6.3.5 Labor Market Equilibrium

In the matching model, the relation between labor demand (92), the wage curves (**??**), and the Beveridge Curve (87) define the equilibrium values of the unemployment rates ($u^{k,m}$), wages ($w^{k,m}$), and labor market tightness (θ).

The labor demand equation and the wage curves determine the equilibrium value of the wages and θ. The Beveridge Curve and the equilibrium value of θ define the equilibrium value of the unemployment rates. The intersection of the labor demand curve (92) and the wage curves (97) gives us the following equation which reveals the unique value of θ^*,

$$\frac{h}{m(\theta)} = \frac{(1-\gamma)[\phi y^l + (1-\phi)y^h - z][\sigma(r+q^h) + (1-\sigma)(r+q^l)]}{(r+q^l)(r+q^h) + \theta m(\theta)\gamma[\sigma(r+q^h) + (1-\sigma)(r+q^l)]} \tag{98}$$

6.3.6 Comparative Statics

Parameters: z, γ, h, q, r, κ, β, y^l, y^h, a^l, a^h

The effect of parameters has given in the last previous model. Since the final model combine them we just give the summary table 6.3.

$$\frac{dw^{k,m}}{dz} > 0, \quad \frac{dw^{k,m}}{d\gamma} > 0, \quad \frac{dw^{k,m}}{dh} < 0$$

$$\frac{dw^{k,m}}{dq} < 0, \quad \frac{dw^{k,m}}{dr} < 0, \quad \frac{dw^{k,m}}{d\kappa} < 0, \frac{dw^{k,m}}{d\beta} < 0$$

$$\frac{d\theta}{dz} < 0, \quad \frac{d\theta}{d\gamma} < 0, \quad \frac{d\theta}{dh} < 0$$

$$\frac{d\theta}{dq} < 0, \quad \frac{d\theta}{dr} < 0, \quad \frac{d\theta}{d\kappa} < 0, \frac{d\theta}{d\beta} < 0$$

$$\frac{du^{k,m}}{dz} > 0, \quad \frac{du^{k,m}}{d\gamma} > 0, \quad \frac{du^{k,m}}{dh} > 0$$

$$\frac{du^{k,m}}{dq} > 0, \quad \frac{du^{k,m}}{dr} > 0, \quad \frac{du^{k,m}}{d\kappa} > 0, \quad \frac{du^{k,m}}{d\beta} > 0$$

The Unemployment Pool Composition

The unemployment pool composition is affected by changes in labor market conditions. The increasing matching efficiency causes a negative externality in the other groups. MS is the critical factor in getting out of employment. In the unemployment pool: τ is the ratio of low ms workers, $1-\tau$ is the ratio of high ms workers, λ is the ratio of low productive workers, $1-\lambda$ is the ratio of high productive workers.

Table 6.3: Comparative statics for the model 6

	z	γ	h	q	r	κ	β	y^l	y^h	a^l	a^h
$w^{l,l}$	+	+	-	-	-	-	-	+	+	+	+
$w^{l,h}$	+	+	-	-	-	-	-	+	+	+	+
$w^{h,l}$	+	+	-	-	-	-	-	+	+	+	+
$w^{h,h}$	+	+	-	-	-	-	-	+	+	+	+
θ	-	-	-	-	-	-	-	+	+	+	+
$u^{k,m}$	+	+	+	+	+	+	+	-	-	-	-

Changes in the labor market tightness affect the different types of workers. An increase in the θ negatively influences $\lambda\tau$ and $(1-\lambda)\tau$ by increasing their ratio in the unemployment pool. Because, both groups consist of low MS workers with lower unemployment chances than workers with high MS. The positive effect is more significant for those with high matching skills. On the contrary, the job destruction rate q has a more negative effect on those with high matching skills. Since they are more likely employed in a job, a rise in the q influence them to a greater extent.

Parameters β and κ represent the ratio of workers with low productivity and the ratio of workers with low MS in the population. Normally, in case of an increase in their ratio also affects their ratio in the unemployment pool. a^l and a^h are coefficients that determine the matching efficiency of a person. The rise in the matching efficiency of a particular group influences them positively but negatively affects other MS groups. In case of an increase in the lower MS group's matching efficiency, augment their employment ratio and diminish their number in the unemployment pool. However, in this case, even if the higher MS group's matching efficiency remains the same, the number of workers with higher MS augments in the unemployment pool.

The table 6.4 summarizes the effects of parameters.

$$\frac{d\lambda\tau}{dq} < 0, \quad \frac{d\lambda(1-\tau)}{dq} > 0, \quad \frac{d(1-\lambda)\tau}{dq} < 0, \quad \frac{d(1-\lambda)(1-\tau)}{dq} > 0$$

Table 6.4: Comparative statics for the model 6

	θ	β	κ	q	a^l	a^h
$\lambda\tau$	+	+	+	-	-	+
$\lambda(1-\tau)$	-	+	-	+	+	-
$(1-\lambda)\tau$	+	-	+	-	-	+
$(1-\lambda)(1-\tau)$	-	-	-	+	+	-

7 CONCLUSION

We construct a search and matching model to examine the labor market heterogeneities. The primary motivation behind this theoretical work is that the data HLS shows the subdivided structure in the labor market. We aim to reflect this pattern using a theoretical framework. To achieve the goal, we construct six models that study worker and firm heterogeneity in different sections.

The models differentiate labor and firm productivity, turnover rate, and matching skills. We insist on this issue because labor market dynamics shows particular characteristic for some groups. Some workers and jobs have high turnover rates, while some offers more stable working conditions. Moreover, the education level of the region is one of the critical factors in employment chance and wage level.

The labor market in Turkey is constantly changing. One major difference in the last 20 years is the number of people with at least an undergraduate degree. This significant change creates a structural change in the labor market. The level of educational attainment changes the firms' behavior, unemployment pool compositions, and other people in the workforce, like in our models. We argue in the theoretical framework that an increase in the productivity of workers and firms induces the labor market to offer higher wages and employment chances. In general, matching skills positively affect employment, but it may cause a negative externality in the other groups. The turnover rate drives firms to open fewer vacancies which cause a rise in the unemployment rate.

Additional future work with different characteristics of workers and firms may broaden the scope of the theoretical framework. Additionally, an empirical test of whether our model reflects Turkey's real labor market conditions will be beneficial for economic literature.

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