Three Essays on Search and Matching:

Status Conscious Job Choice, Trade and Optimal Friction

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‘And miles to go before I sleep…’

--- Robert Frost

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I am the only person responsible for the errors that may have remained in the thesis.

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Content

Chapter 1

Contents

Introduction

The story of the price adjustment mechanism from a *Walrasian* world tells us that, in a market, excess supply pulls the price down and excess demand drives the price up, and hence, the market clears. However, there are situations which does not reflect the same story. This rule fails to explain the problem of unemployment which is one of the very predominant phenomenon of almost all economies. Since, unemployment is a typical problem of excess supply of labor, unemployed workers should immediately bid the wage down until the demand and supply match to each other. In reality, wages do not come down enough and unemployment exists. So, a crucial discipline in macroeconomics, namely, the theory of unemployment, has been developed to find suitable theoretical answers to that and identify the non-Walrasian features of the labor market. This particular thesis is also devoted to the discussions of labor market imperfection using the theory of search generated unemployment.

1.1. Literature Review

The most recent seminal contribution in the theory of unemployment has come in the form of *Search and Matching models*. Peter A. Diamond, Dale T. Mortensen and Christopher A. Pissarides were instrumental to develop this literature. The idea of job searches centers around the fact that "*trade in the labor market is a nontrivial economic activity because of the existence of heterogeneities, frictions and information imperfections*" (Equilibrium Unemployment Theory, Pissarides 2000). This feature of labor market came under discussion, in fact, from 1968 onwards (Phelps (1968), Alchian (1969) etc.), along with many other answers towards the strong neo classical critique (which had come through the line of rational expectation). Nonetheless the primitive versions of search theories were criticized because the wage distribution was assumed as exogenously given, and that had a key role in those models: unemployment appears in equilibrium because workers rejected low-wage jobs[1].

In the literature of search-matching unemployment, matching function relates vacancies and unemployment, and results into number of productive job matching. Rest of the searching population remains unemployed. Similarly, rest of the firms, who are looking for workers, are unable to fill up their vacancies. To bypass the role of reservation wage, Pissarides (1979, 1984) introduced matching function in his framework. The zero-profit condition[2] for new job closes the model with endogenous demand function for labor. Diamond (1982) introduced Nash bargaining for the division of the surplus from the matched job and afterwards, number of works have developed by using this wage setting rule. Mortensen, along with Pissarides, in 1994 did another important extension of this literature by endogenizing the mechanism of job destruction. Jobs face

[1] Lucas and Prescott in 1974 first developed a theoretical model to endogenize the wage distribution. However, they did not consider the problem of matching.
[2] Firms will keep entering in the market and post vacancies until the expected return from a vacant job goes to zero.

an idiosyncratic productivity shock at each period, and the productivity values are realized from a probability distribution. The model endogenously determines the reservation productivity where the job destroys. By this extension, the search unemployment model goes more close to the empirical evidence because it has been observed that in case of business cycle shocks, job destruction is more responsive than the rate of job creation. Inclusion of endogenous job destruction can explain that fluctuation within the mechanism of the theoretical model.

A large body of empirical research has developed to test the matching function. Devine and Kiefer (1993), Petrongolo and Pissarides (2001) are two key examples from a large literature. Relevance of matching function for different countries has also been studied. Statistically, among the total unemployment, the amount which can be explained by the search and matching friction, is an important topic of discussion too[3].

Presently the literature on search and matching have had a serious impact on the various fields of economics. Main reason behind the success of this modeling technique is the rigorous micro-economic foundation which was lacking in case of many previous efforts[4]. In fact, the incorporation of imperfect labor market in general equilibrium models have speeded up only after the development of this literature. Along with the literature of labor economics, application of search and matching friction has been extended to international trade theory, growth theory, and even in the recent developments of the theory of Real Business Cycle (RBC).

From the late 1980's onwards, C. Davidson, L. Martin and S. Matusz have contributed to develop the general equilibrium models with search friction in labor market, especially in the area of international trade. In 1987 Davidson et. al. introduced search frictional labor market in a two

[3] See Coles and Petrongolo (2003), Shimer (2005), Bouvet (2011).
[4]See Davidson, Martin and Matusz (1999)

sector general equilibrium model. This itself is a key theoretical contribution. They have considered varied duration of unemployment in two different sectors. Using that set up, it has been shown that in most of the cases economy does not operate along its production possibility frontier due to the effect of externality. The externality arises because: "*A job enhances both current production and the conditional probability that future production will occur. The latter following from the fact that the probability of holding a job in the future is higher for those currently employed. When output is produced in the search sector, the economy simultaneously produces jobs. Steady state welfare not only includes the value of output, but also the value of these jobs*" (Davidson, Martin and Matusz (1987)). Additionally, if the difference of factor intensity of the two sectors reduces then unemployment also falls. Davidson et. al. made another important contribution in 1994 by considering a dynamic general equilibrium model with search friction. The paper allows intergenerational transfers, and proves that steady state output maximizing allocation is not the Pareto dominant outcome. There exists another feasible allocation which can generate a higher level of steady-state employment. Although Matusz (1996) started the exercise to find the impact of trade on unemployment by introducing Shapiro-Stiglitz framework in standard trade model, but Davidson, Martin and Matusz (1999) wrote a comprehensive model on trade and search generated unemployment. In an uninhabited Ricardian setup, the paper revisits the classical trade results. From then onwards, a large number of works in the field of international trade and unemployment has emerged (Davidson and Matusz (2006, 2014), Davidson, Matusz and Shevchenko (2008), Davidson, Matusz and Nelson (2012) etc. are few examples). In recent past, Dutt, Mitra and Ranjan (2009), Mitra and Ranjan (2010) and Helpman and Itshoki (2010) also made important contributions to the literature on trade and search unemployment. (Find detail discussion on this topic in subsections1.2 and 1.3).

The effect of growth on unemployment has remained a popular topic of discussion from the conception of Okun's law. However, the inclusion of search models in growth theory has made the literature richer. Using the framework of search and matching Aghion and Howitt (1994), in their seminal work, identified the two different effects of growth: capitalization effect and creative destruction effect. The source of unemployment in their model is labor re-allocation across firms. Due to the overhead fixed cost in human capital, eventually a firm with fixed technology level would be unable to produce enough to sustain itself. Therefore, that firm has to shut down its production and leaves the workers unemployed, until they get matched with newer technology. This creative destruction may dominate the capitalization effect of growth (increase in growth creates more productive jobs) in unemployment terms. Thus, the paper has argued that the effect of growth on unemployment is ambiguous. Laing, Palivos and Wang (1995) formulated a model of growth through human capital formation (more specifically by acquiring education) where the labor market environment consists of search and matching friction. The model finds that reduction of labor market friction encourages the agents to take education, which, in turn, drives up the growth rate of the economy. Therefore, in their model, reduction in unemployment improves the rate of growth. Eriksson (1997) identified the condition under which growth correlates positively with unemployment: if the growth rate of the cost of posting vacancy is lower than the change in the rate of interest then unemployment rate and growth have a direct relation. Further the paper suggests that the government can impose (moderate) capital tax to steer growth and employment in the same direction. Mortensen and Pissarides (1998) worked in a similar line to Aghion et. al. and obtained a critical renovation cost such that increase in growth pushes the unemployment rate down when the actual cost of updating the technology is below the critical value, whereas it increases unemployment when the actual cost is above the critical value. Even the effect of growth on job creation is negative when renovation costs are sufficiently high. Impact of tax and employment protection policy on growth and unemployment (in search and matching setup) was studied in a simple model by Mortensen (2005). The paper shows that both the policies can increase unemployment. The effect on growth is ambiguous, although employment protection policy has adverse effect on the incentive to innovate. In a more recent development, Zagler (2009) also used the setup of search and matching in a sophisticated model of endogenous growth and explored the possibility of positive relation between unemployment and growth.[5]

RBC models, following the seminal work of Kydland and Prescott (1982), were able to explain the behavior of many macro variables but not so much labor market behavior till search and matching were included in the framework. Merz in 1995 discussed this issue and proposed a RBC model with the labor market involving search friction. From his model, it is obtained that the labor share of income has a countercyclical nature and job vacancy has a negative correlation with unemployment rate, and these results supports the empirical findings. Andolfatto (1996) constructed a business cycle model where labor market is not perfect and faces search friction. The major quantitative results of this paper indicate that, the labor input fluctuates more than the real wage and, similar to Merz (1995), labor's share shows countercyclical movement. Furthermore, the real wage is less flexible than labor productivity over the cycle. By calibrating a model of dynamic stochastic general equilibrium (DSGE) with a frictional labor market, Moyen and Sahuc (2005) tried to reproduce the economic behavior of EURO zone. Along with the fluctuations of real variables, they have analyzed the effect of monetary policy as well. The paper finds that the

[5] In the literature, there are some other important application of search and matching framework on the topics of growth, technological progress and wage differentiation. One can pay attention to the papers like Acemoglu (1997), Stadler and Wapler (2004), Michaelis and Birk (2006), Elsby and Shapiro (2011) etc.

classical results like the Phillips curve and the Beveridge relation[6] hold good. Moreover, they showed that labor market inflexibility has a complimentary relation with nominal rigidities. Some more recent works extend this literature by identifying the impact of fiscal policy and monetary shocks on unemployment and other macro variables using the search and matching friction (See Gertler, Sala and Trigari (2008), Mayer, Moyen and Stähler (2010), Kato and Miyamoto (2013)).

The present thesis also depends crucially on the search and matching friction of the labor market. Broadly three aspects are covered in this discussion. First, inheritance and unemployment are linked in a dynamic general equilibrium set up. Second, the effect of trade is studied in the former framework. Third, the optimal level of labor market matching is solved to maximize long run objective of the economy. A general overview of these three topics and closely related literature survey are provided in the next three subsections.

1.2. Inheritance and Unemployment Linkage

Casual observation on real world shows two contraindicative facts: most of the unemployed persons represent relatively well-off mass of a country and on the contrary, almost all underdeveloped countries register a high rate of unemployment. This acts as the primary motivation behind the current work. At micro level, people with higher wealth become more selective to accept a job. Hence, the possibility of remaining unemployed increases with higher wealth. On the other hand, in developed countries, where people have higher wealth, the overall

[6]Beveridge relation connects vacancy and unemployment, and it shows, in steady state, the relation is downward slopping and convex to the origin. See Dow and Dicks-Mireaux (1958).

unemployment problem is less severe. Therefore, a clear discordance exists between micro and macro level realities. Chapter 2 contains some empirical support to these observations.

The theoretical model, described in Chapter 2, aims to reconcile these two conflicting facts in a general equilibrium framework. This model has one organized sector and another unorganized sector producing a single good. In an economy, co-existence of an unorganized sector, where wages are flexible and market driven, with unemployment is theoretically somewhat puzzling. After an active search for the job, if an individual fails to get employed in the organized sector, then staying without earning (which is the definition of unemployment[7]) should be dominated by getting a job in the unorganized sector where obtaining a job (i.e. a strictly positive earning opportunity) is relatively easier. This situation can be commonly observed in many developing countries. The productivity of the organized sector is high but in many countries that sector is less dense compared to unorganized sector and the hiring and firing is costlier for many different attributes. C. A. Pissarides and others has elaborated this nature of labor market in length. Most of the empirical justifications use the data of the service and/or manufacturing sectors of USA, UK, France etc. where these sectors are organized (Mills (2001), Behrenz (2001), Bontemps et.al (2000), Warren (1996)). As far as the available information goes, existing literature does not satisfactorily explain this problem.

Our model, in line with the real world observation, shows that the existence of status conscious job preference (exact form of the preference function is discussed in section 3 of chapter 2) can lead to unemployment as an equilibrium solution even after incorporating the unorganized sector

[7]The "unemployed" comprise all persons above a specified age who during the reference period were "without work", "currently available for work" and "seeking work".http://www.ilo.org/public/english/bureau/stat/download/res/ecacpop.pdf

(with a free labor market entry) in an economy. Here the difference in the level of inheritance is very crucial to guarantee the existence of two classes of people, namely unemployed and unorganized sector worker. The major contribution of the paper is to explain the co-existence of both. Intuitively the argument is: people with lesser inheritance level are less capable to afford joblessness. On the other hand, wealthier individuals like to avoid working in the technologically inferior unorganized sector due to social stigma. Thus we connect the labor market with wealth distribution, and explain the wealth dynamics of a dynasty with the help of the degree of labor market efficiency.

The concept of status consciousness in economics is indeed as old as Veblen (1899) (the idea of 'conspicuous consumption'). In relatively nearer past, Grossman and Shapiro (1988), and Basu (1989) recognized the presence of a 'status good' in the preference function and captured the features of the market for such goods. Cole, Mailath and Postlewaite (1992) explained cross country heterogeneity of growth rates through status good in the preference function. Charles, Hurst and Roussanov (2009) empirical justified the conspicuous consumption. They showed the presence of conspicuous consumption among "Blacks and Hispanics" to demonstrate their economic status in comparison with "Whites". In Moav and Neeman (2010) the choice pattern of poor people discussed by assuming preference to be status conscious. The argument is, the choices made by the poor do not appear to help them escape poverty. On a similar line, Banerjee and Mullainathan (2010) argued that the consumption puzzle of the poor can be explained using 'temptation good' in the utility function. Pham (2005), in his model, introduced desire for social status and which is increasing with individual wealth level. In Marjit (2012) poverty and inequality explained in terms of the societal status where the effect of status has been captured by the relative income of the individual. These method of introducing status consciousness is more close to our approach. In our model the inheritance level indicates the social status of a representative individual. It is argued that the disutility in taking up unorganized sector job is dependent on the existing social status of the agent. This explains the presence of unemployment. Relation between occupational choice and social status is also well established in the existing literature.

> "…employment can be a factor in self-esteem and indeed in esteem by others… If a person is forced by unemployment to take a job that he thinks is not appropriate for him, or not commensurate with his training, he may continue to feel unfulfilled…"
>
> ---Amartya Sen (1975)

Unorganized sector workers in many countries face social exclusion too, along with economic and political exploitation (see, Carr and Chen (2004)). Number of empirical studies argue that family background has a definite impact on job choice of the individuals. Some examples are Udoh and Sanni (2012), Tsukahara (2007), Constant and Zimmermann (2004), Onyejiaku (1987) etc. In fact, the effect of social status in job choice discussed in the sociological literature for quite a long time. Sociologists recognize occupational type as one of the important factors to compute social status. Among different employment types, they assign least score to informal jobs to estimate social status (Hollingshead 2011). Bardley (1943), Sewell, Haller and Straus (1957), Amundson (1995), Sellers, Satcher and Comas (1999) are also important contributions from that literature. Some studies have even shown that, occupational aspiration is positively related with social status of the individual after controlling for intelligence level.

Corneo and Jeanne's 2010 paper has a very interesting formulation regarding status consciousness. More importantly, this paper questions the basis of the formation of symbolic value related to the economic activities and then defines an index which can map the "judgeable characteristics" into real numbers. Each agent tries to pass their values to their successor. Therefore, the value index is a function of the job choice and the index of the present generation. That index appears in the utility function in additive form. Then the model moves to occupational choice and growth. The present thesis takes a different route. The thesis assumes that the inheritance level of each household is the determinant of their social status. That social status generates a stigma effect against the unorganized sector jobs.

Returning to the discussion of the present modeling structure, the different characteristics of the production sector is as follows. It is assumed that organized sector has a technological superiority, but with the labor market imperfection. This imperfection is modeled by following the standard literature of search and matching friction. In this sector laborers cannot readily enter the market to supply their labor. Firms also do not get the worker freely to fill the costly vacant post. Both of them face a Pissarides-type matching function before starting production activity. That allows the scope of extracting some positive rent out of this market interaction. Both firm and workers of this sector have a bargaining power on wage negotiation. Specifically, we utilize Nash bargaining to model the factor market payments. As discussed earlier, this is also common in the literature. For modeling specification, it is assumed that unorganized sector labor market is competitive (similar to Zenou (2008).

There is quite a large literature dealing with search generated unemployment with Pissarides type matching. However, incorporating the concept of unorganized sector in this modeling set up is not really ample. Davidson and Matusz in 2006 established equilibrium unemployment in that set up along with a free entry but less productive sector. Similar differential ability based technique is used in Davidson et al. (2004) to accommodate a search frictional labor market, while economy has another sector which is frictionless. Having same result, present work keeps distance from heterogeneous ability. While skill heterogeneity was the decisive characteristic in their modeling strategy, our model works with same skill level for all workers. Another important divergence from existing literature is that it does not include inheritance with unemployment in a general equilibrium frame. A relation between inheritance (termed there as wealth) and choice of occupation was formulated in Banerjee and Newman (1993). In their model of occupational choice, a window was kept open for the least wealthy individuals to remain idle; but lacks to explain why the wealthier individuals are more probable to remain unemployed. Moreover, in their contribution 'remain idle' cannot be a feasible option in equilibrium.

Bequest motive (which has enough empirical support as well; e.g. Wilhelm, (1996); Altonji et al., (1997); Carroll, (2000)) of the agent generates an inheritance distribution in the discussed setup. Agents are willing to save a part of their wealth for the intergenerational transfer and, the inheritance of the offspring is a function of that transferred part. Hence this recursive process leads us in the direction of income dynamics. Starting from any initial income, the labor market search friction in our model randomizes the next point of the income path. That evident feature not only rescues a dynasty from getting stagnated into a particular income class but also stops the long run income path from being concentrated (or polarized) in some particular point or points (c.f. Galor and Zeira (1993)) or mutually exclusive small intervals (c.f. Grossman 2008) on the income stream. At this point our model supports Banerjee and Newman (1993).

Discussions on income dynamics cannot by pass the issue of the convergence. Galor (1996) pointed out that, debates related to the convergence of income distribution focuses on the validity of the three competing hypothesis: absolute convergence, conditional convergence and club convergence. While absolute convergence requires per capita incomes of countries to converge to one another in the long-run independently of their initial conditions, conditional convergence means that per capita incomes of the countries that are identical in their structural characteristics converge to one another in the long-run independently of their initial conditions. Club convergence needs per capita incomes of countries with identical structural characteristics to converge to one another in the long-run provided their initial conditions are similar as well.

According to the above classification our hypothetical economy can converge conditionally. By simulating our model, we find that the initial income distribution does not affect the long run income path (as in Loury (1981)) and this questions the efficacy of the celebrated big push theory. Here we differ also from Grossman (2008), Zhang (2008), Galor and Zeira (1993), Banerjee and Newman (1993) and others.

On the macro side, the comparative statics results of the model show that technological improvement can reduce aggregate unemployment with a rise in the GDP of the economy. The result imitates when the reduction in cost of posting vacancy occurs. Thus, this theoretical setup accommodates both, micro and macro level reality. The model comments about the change in the size of unorganized sector (can also be interpreted as informality) too.

Summing it up, the second chapter provides a potential channel for the existence of unemployment in equilibrium, even if the economy consists of an organized and an unorganized sector. It answers the micro and macro level paradox between unemployment and wealth. By doing so, this model also connects inheritance dynamics (wealth) with labor market friction, which is also a new contribution to the literature. This connection sets light on the long run wealth distribution and refutes the famous trap theory.

1.3. Trade and Labor Market Imperfection with Status Conscious Preference

The previous set up develops an unexplored aspect of labor market imperfection. In Chapter 3 we examine the effect of international trade in that particular set-up. Public discourses and debates have always related the opening up of the domestic economy to the creation or destruction of domestic jobs, leading to increase or decrease in unemployment. However, attempts to build formal trade models that incorporate unemployment endogenously are not a very old practice. The search and matching unemployment has opened up the rich possibilities for building general equilibrium models of trade with unemployment. It was the beginning of the 1990's, when an increasing volume of literature started to address the issues of international trade and equilibrium unemployment simultaneously in a general equilibrium set up. Chapter 3 is closely related to this genre of literature, but it sheds light on the issue of unemployment from the perspective of social status. The modeling technique of social status followed in this discussion has already been explained in the previous subsection.

The way the possibility of trade is introduced in the present model is somewhat similar to Davidson, Martin and Matusz (1999) and Helpman and Itskhoki (2010). In both these models trade opens up due to a difference in the labor market parameters among otherwise identical nations. Davidson et. al. (1999) (if large country-small country argument is not considered), a like to the single factor version of Dutt et. al. (2009), is closely related to the classic Ricardian setup and supports the result of complete specialization.

In both theoretical models and empirical investigations, the answer towards the impact of trade on unemployment is mixed. Davidson et. al. (1999), although, has judged the job creating role of trade primarily as an empirical question, but in this seminal work they have argued that capital abundant large country will face a higher unemployment rate, but trade will bring unemployment rate down for a small country. In a model of firm heterogeneity with differentiated skill levels, Davidson et. al.(2008) have come up with a different result and demonstrate that in the short-run unemployment increases due to trade, whereas in the long run there is a confounding factor, namely the entry of new firms arising out of an increase in profitability. Dutt et al. (2009) has built up an extensive model of international trade with labor market friction, where the authors have considered both Ricardian and Heckscher-Ohlin-Samuelson frameworks. A negative relation between trade and unemployment has been found in Ricardian set-up, whereas the two factor H-O-S framework yields a rise in unemployment in one country and a fall in the other. However, Mitra and Ranjan (2010) in a stylize model of offshoring with labor market friction shows that offshoring leads to an ambiguous result on aggregate unemployment in general (because there exist two opposing forces are involved on the unemployment rate in one sector whereas the other shows a clear reduction in unemployment), but reduction of unemployment is unambiguous in the presence of perfect inter sectoral labor mobility. The ambiguous result on unemployment is, although, similar to our findings but the main aim of the paper is to produce a general equilibrium model of offshoring and to find the impact of that on the labor market of the home economy.

Interestingly some contributions raise the issue of an increase in unemployment after opening up of trade in a single factor model. Helpman et. al. (2010), in their general equilibrium model with a Melitz type differentiated product, have pointed out that the opening to trade raises a country's rate of unemployment if its relative labor market frictions in the differentiated sector are low, and it reduces the rate of unemployment if its relative labor market frictions in the differentiated sector is high. King and Sähler (2014) have put forward a model of international trade with auction-based directed search unemployment. They have found that if countries differ by endowment, then after trade labor abundant country gains in employment and the reverse is the case for capital abundant country. On the other hand, if technology difference becomes the source of comparative advantage, trade drives the unemployment rate up (down) in the country whose technology is relatively superior (inferior) for producing the capital-intensive good.

A set of empirical literature, also relevant in this discussion, deals with the effect of trade on informality. Evidences do not favor a single sided conclusion. Goldberg and Pavcnik (2003) find an increase in informality after trade liberalization episodes in the 1980s and 1990s in Colombia. Again in case of Brazil they do not find any such clear evidence. Heid, Larch and Riaño (2013) use a calibrated heterogeneous firm model to study informality in Mexico during the 1990s and find that informality has slightly increased due to an increase in US off shoring. The present model allows both the organized and the unorganized sector to participate in trade and within its simple structure the model is able to comment theoretically on this issue.

In our model the preference structure of an individual is postulated as having a status dependent disutility of working in the unorganized sector. Here the inheritance level is considered as an indicator of status. Inheritance is an indicator of accumulated wealth of a whole dynasty. This inherited wealth influences the successor's occupational choice. There are two basic sectors, one designated as the organized sector and the other as unorganized. The former is characterized by search friction while the other (for simplicity) is assumed to be completely frictionless. These two sectors supply intermediate goods for production in a final good's sector. The final good is non-traded, while there can be trade in intermediaries. In this structure, stated preference pattern gives an alternative micro-explanation of the existence of the aggregate unemployment. Given this setup, we allow this economy to open up to international trade and determine the possibility of trade even with a very similar country.

This model belongs to the tradition of Ricardian type trade models where a single factor of production is employed in two tradable goods sector. But contrary to the standard Ricardian model, here trade can take place between two countries with the same technology of production. The two trading countries differ in their frictional labor market structures. Labor market of the organized sector is considered as imperfect. Neither do firms readily get workers for their vacant posts, nor do the workers readily get employment in the organized sector. Both have to face a search process (or friction). To announce their vacancies, firms of this sector bear a positive fixed cost. In the aggregate the number of firms that can commence production by employing labor is determined by the matching function. This model shows that the differences in the fixed cost of posting vacancy between the two countries lead to a situation that permits international trade. Unlike the standard Ricardian model, incomplete specialization is the unique outcome of trade for both the countries.

In this model, as trade opens up, relative wages are equalized between the two countries. However, across sectors within a country, wages remain unequal. In fact, wage inequality increases for the organized sector good exporting country while it reduces for the unorganized sector good exporting country in the free trade equilibrium.

Our theoretical model derives some results related to the impact of trade on job creation. The total number of organized sector job created in the organized-sector-good exporting country increases under free trade compared to autarky. The reverse happens for the organized-sector-good importing country. Before trade the relative job opportunities levels in the organized and the unorganized sectors are different, the country with a higher friction in the organized labor market having a lower level of organized jobs. After trade that gap may actually increase. That is, once trade opens up, in the organized-sector-good importing country the economy becomes more informal job oriented. Since in this model there is a disutility associated with unorganized sector jobs, opening up of trade may create a loss of welfare of the unorganized sector good exporting country.

In the present model, free trade does not guarantee a decrease in unemployment in either of the countries. The aggregate level of unemployment in the free trade situation depends, among other things, on the distribution of inheritance, and there could be situations where in both countries the unemployment level rises after trade compared to autarky. The other cases can also arise, where the aggregate unemployment actually falls after trade in one of the countries, or in both the countries. In all these situations distribution of long-run wealth (inheritance) has an important role to play.

1.4. Optimal Labor Market Friction

Although we have discussed organized sector vis-à-vis unorganized sector within an economy, evidence brings another interesting story to the fore. College admission (higher education) rate has a clear counter-cyclical trend in many countries. That is, in sluggish seasons the rate of college admission increases. On the other hand, there was a serious concern in USA about the fall in the scientific edge before the recent crisis. These observations hint towards the connection between degree of labor market friction and technological improvement and hence, long run gain to the economy. The Chapter 3 vents a theoretical model on the possibility of the determination of optimal policy to achieve the long run goal through adjusting the labor market friction.

Commentaries and accounts, both in the popular press and in serious academic discussions, have come up with the opinion that steadily USA is losing its comparative advantage in advanced research[8]. Lesser number of US citizens are coming to the profession of research and development (R&D). Plenty of evidences support the fact that over the years, the percentage of US residents

[8]Galama and Hosek (2008).

getting PhD degrees is falling compared to the number of foreigners receiving the same. In 1987 the ratio of US citizens against foreign citizens who got PhD degrees from US universities was 2.33. The ratio became 1.64 in 1997. In 2007 it has reduced further to 1.18[9]. From the policy perspective, the long run loss in human capital formation is turning out to be a potential threat. Reasons behind this deterioration in research orientation of native citizens are more than one. One of the major reasons, as pointed out in the literature, is that earnings of the R&D sector workers are in general less vis-a-vis the workers in other sectors with comparable skill levels. Moreover, it takes longer time to find establishment in the R&D sector. This disparity in earnings is true not only in the US but in many other developed countries (Lassibille (2001), Marey (2002), Dupuy and Smits (2010)).

The model in Chapter 4 focuses on the fact that the number of R&D sector workers may be less (or more) than the optimum. Aiming to that direction, we take the reference of the PhD holders to provide a motivation. If the number of PhD holder of a country (like USA) falls steadily then that may correspond to a reduction in the level of research output of a country. Nonetheless, a valid empirical question regarding the percentage of the foreign PhD holders staying in USA (since the example has been made from USA's experience) and contributing to their knowledge base can be raised, when the existing literature shows a concern regarding the growth of scientific progress of USA. This intricate empirical debate is however beyond the scope of this thesis.

This present work models this situation using search and matching friction in the labor market of the production sector and shows that in view of the above phenomenon of deteriorating research orientation optimal level of friction in the labor market is desirable. Taking note of the fact that there is a strong relationship between R&D on the one hand and long run output maximization of

[9]"Stay Rates of Foreign Doctorate Recipients from U.S. Universities, 2009", Finn (2012), Table 1.

the economy on the other[10], this model suggests that the optimal level of labor market friction helps the economy to achieve its long run goal. Labor market frictions induce some of the workers to work in the R&D sector at a lower wage and this, in turn, improves the future technological progress of the economy[11]. In this model labor market friction has a dual role. On the one hand it restricts matching between workers and firms, and promotes inefficiency. On the other hand, it encourages agents to join the R&D sector which in turn develop future technology. These two roles taken together give rise to the possibility of an interior optimality. The model derives the 'optimum', finds the suitable policy which leads to this optimum and demonstrates the robustness of the analysis under balance budget of the government and stochastic fluctuations.

There are evidences which support the fact that behavior in the job market has an impact on the enrollment in higher education. A class of empirical literature suggests, college enrollment decisions are a countercyclical phenomenon (Dellas and Sakellaris (2003)). Long (2004) has estimated that college enrollment rates often increase as the unemployment rate grows and this positive effect is significant even at 5% level. Working on UK data Clark in 2009 has found that "there is a clear tendency for enrolment to be increasing when unemployment is increasing and falling when youth unemployment is falling". That trend has been evident for both boys and girls. Even in the course of recent recession (during 2010), college applications have increased significantly both in the USA and UK (Bell and Blanchflower (2011)). Long, in his very recent (2013) work on financial crisis and college enrollment, has not rejected the hypothesis that there is a positive impact of unemployment on college enrollment. Therefore, there is a scope of

[10] See Romer (1986, 1994), Grossman and Helpman (1991), Aghion and Howitt (1998) etc.

[11] At this point, the author clarifies that the model is not aiming to introduce friction in the labor market from the lack of it, but the focus is to find the optimal level of friction while knowing the fact that the labor market is frictional in most of the countries. Policy directive is to keep the friction at the optimum level, and not to introduce friction afresh.

determining an optimal level of labor market friction such that the countercyclical nature of college enrollment in turn can create desired technological advancement.

Labor market friction, which is modeled here, is of search and matching type. Introduction of search and matching model of labor market friction (Diamond-Mortensen-Pissarides model) has opened up the scope to endogenize unemployment in a general equilibrium set up. In the last two decades a number of contributions have been built upon such labor market imperfections. This application has played an influential role in growth theory, international economics, money market analysis and other areas. All these studies generally have two main objectives. The first is to find the relation between unemployment and other important macroeconomic variables. Second objective is, to check, how this inclusion makes the equilibrium outcome different from that derived under a perfectly competitive set up.

In our model, implications of labor market friction are different. The present model closely builds on a Pissarides type search-matching model of labor market imperfection, but considers the unmatched part of the workforce as a *reserved labor endowment*. Labor markets, exhibiting search-induced unemployment, are generally viewed as distorted. As a consequence of this distortion these markets are unable to produce the first best outcome. Equilibrium in such markets entails unmatched mass of workers along with unmatched employers, basically representing idle resources in the economy which could not be put into productive use due to search frictions. Here it channelizes unmatched labor to acquire education and thus contribute positively to the improvement of technology. Although that does not contribute to the present GDP, the economy gets the benefit in the long run. The model determines the appropriate level of labor market matching which leads the economy to maximize its long run objective. Furthermore, the model looks for specific government policy to attain the optimal equilibrium matching level endogenously. It has been shown that this hypothetical economy grows at a constant rate and that rate does not depend on the matching level of the economy. Therefore, by setting appropriate friction level the economy can achieve its optimal path (i.e. maximum of long run time discounted sum of the GDP values) without perturbing the growth rate of the economy. Growth rate of this hypothetical economy remains insulated from the labor market outcomes and depends on the marginal rate of technology upgrading due to investment in research activities. This model is then further extended to verify the effects of binding budget constraints of the government and the presence of random fluctuations in the output mapping of the research outcome. It is found that all major results are unaltered for both the cases. It is also shown that the growth rate varies with time only due to stochastic variations in the productivity level.

The main building block of the present model is search friction and technological innovation. There is a big literature that uses such modeling devices. Aghion and Howitt (1994) is, arguably, one of the most influential stepping stones in such modeling framework. They have constructed a model to find the effect of growth on long run unemployment. In their model search and matching friction is the source of unemployment and technological development is the only source of growth. Technological improvement in their model exerts two opposing effects on unemployment: newer technologies destroy old job matching and create new vacancies. Thus, they have argued that growth does not reduce unemployment unambiguously. Later many other growth models (Laing, Palivos and Wang (1995a), Mortensen and Pissarides (1998) and others) tried to establish the link between growth and unemployment along the same line. Meckl (2004) has an interesting model of growth which is closely built on Aghion et. al. (1994) but coupled with efficiency wage theory. They have shown that the relation between the rate of growth and the rate of unemployment is ambiguous in general, but related to the sign of inter sectoral wage differentials. In our case, job matching rate does not influence the growth rate of the economy, neither positively nor negatively. Growth depends only on the innovation technology parameter. However, the economy gets the benefit of the job-worker mismatch.

Some similar work has been done in the literature on trade unions. Palokangas (2004) has modeled an economy with two sectors: high tech and primitive sector (as outside option), where the Government strengthen the power of the labor union of production sector to boost R&D sector which in turn boosts the growth rate of the economy. A production specific R&D in the high tech sector is allowed and firms can make an optimal decision for allocating labor and fixed input between increasing output directly and increase R&D activity. Wage in the high tech sector is determined by union bargaining. With higher union wage, firms switch to invest more in R&D to improve productivity, and that leads to faster growth. In this literature, Lingens (2005) has demonstrated the ambiguous effect of unemployment which is generated due to unionization in the less skilled sector, on long run human capital formation. The unskilled laborer gains relative to the skilled (who works to provide R&D) due to unionization, which leads to the reduction of the supply of skilled labor. However, effect of the demand for skilled labor makes the employment level ambiguous. The author has shown that, if the initial values of skilled employment is high enough then the skilled demand may increase, which can offset the supply side effect. Hence, the result shows that unemployment can cause a positive effect to generate R&D in the presence of unionization.

Studies on technological innovation with labor market imperfection have been widely undertaken in the literature on wage inequality. Acemoglu (1997) has modeled an economy with frictional labor market to explain the skill, as well as, wage heterogeneity. The major finding of the paper is that, interaction between innovation and training leads to an amplification of this inefficiency and to a multiplicity of equilibria.

In this context two distinct strands of literature may be worth mentioning. In one of them it is assumed that technological innovation needs the same factor inputs as used in production activity. Others assume that a different kind of knowledge is needed to make technological innovation. One of the prominent[12] examples of the first type of work is Aghion and Howitt (1990). In their celebrated work on growth through creative destruction, they have assumed that alternative to production labor can be used in research activity directly. Our model fits in the second category where the only role of education is to form a particular skill which is necessary for research activity. If a worker has that educational attainment, then it is frictionless to join the research activity. The assumption of frictionless entry in R&D activity (as similar to Grossman and Helpman (1994)) is a simplification. Use of education as a medium of human capital accumulation or skill formation is also common in the existing literature (for example Laing, Palivos and Wang (1995b), Gupta and Dutta (2014) etc.).

1.5. Plan of the thesis

In what follows, Chapter 2 elaborates the issue of status conscious job choice and the unemployment-inheritance linkage. A brief empirical investigation is done in section 2.1 to demonstrate the micro versus macro level paradox as stated above. A different section (section 2.2) discusses the structure of the theoretical model. Short run equilibrium is explained in Section

[12] Some other recent examples, where 'skill' is formed endogenously, are the following: Beladi et al. (2011), Marjit and Acharyya (2003) etc.

2.3 while Section 2.4 deals with the long run equilibrium. Section 2.5 undertakes comparative statics exercises and section 2.6 describes the simulation results.

Chapter 3 explores the possibility of trade in the framework discussed in chapter 2. 3.1 explains the assumptions and the modeling detail. The model is solved for the autarky equilibrium in Section 3.2. Section 3.4 restructures the model in the two-country framework and explores the possibility of international arbitrage. Free trade equilibrium and the associated results are explained in Section 3.5. Since our model is heavily dependent on the wealth distribution of the economy, we take the help of a numerical exercise for a better expositional purpose. Section 3.6 summarizes all the simulation results and the propositions derived from that analysis.

The issue of optimal labor market friction is taken up in chapter 4. Section 4.1 explains the assumptions and the modeling details of the chapter. Determination of the equilibrium values of all endogenous variables are obtained in Section 4.2. The next section finds the long run optimal path for the economy and suggests an appropriate policy to achieve that path. Section 4.4 and section 4.5 are the two extensions of the basic model. The former checks the robustness of the model under the balanced budget constraint of the government. The latter shows the robustness of the results under stochastic fluctuations.

Chapter 2

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Unemployment and Inheritance Linkage: A Dynamic General Equilibrium Analysis[1]

It has been observed that high unemployment countries in the world are low GDP countries as well. Clearly lesser productive job opportunity creates lower GDP and higher unemployment. This is not something unexpected to observe. Nevertheless, the micro level observation tells a completely different story. That is, within a country, unemployment is not concentrated to the poorest section of the population. People living in the bottom of the wealth distribution do not remain jobless, rather they cannot afford to remain without earning. Therefore, there is a mismatch between micro and macro findings. In this chapter, first, some empirical results are put in front. After that a dynamic general equilibrium model is developed to capture this paradox within a theoretical setup.

[1] This chapter is based on Mazumder and Santra (2013)

2.1. Empirical Observations

Before focusing on macro level data, let us start this discussion by looking into some casual micro level empirics. American Time Use Survey (ATUS) data provides the information about "the amount of time people spend doing various activities, such as paid work, childcare, volunteering, and socializing"[2]. Using ATUS data, a significant (at 10% level) positive correlation for 4 years within 2003-2009 has been found between family income of the different individuals and the total time spent for job search, waiting and other activities, not associated with earning. In the years 2003 and 2008, the coefficient is significant even under 99% confidence interval. Therefore, this positive relation reveals that the wealthy people spend more time when they are not employed but available for work (a status which may be termed as unemployed). Later (in sub section 2.1.1.) we will focus on the household level data of India to understand the micro level relation between unemployment and wealth more clearly. Detail result of the exercise base on ATUS data is given in the following table.

Table 2.1: Correlation between Wealth and Time Use for Job search and Related Activity.

Year	Correlation coefficient	Prob > |t|
2003	0.0169	0.0106***
2004	0.0059	0.4654
2005	-0.0135	0.1053
2006	0.0142	0.0846*
2007	0.0190	0.0251**
2008	0.0271	0.0016***

[2] Source: http://www.bls.gov/tus/

2009	-0.0012	0.8883

At the macro level, however, an apparently different picture shows up. 100 countries are taken under consideration over 32 years (1980-2011)[3]. A cross section analysis is done for each year. We fit a line for unemployment against GDP, where countries are considered as the different observations[4]. This exercise shows a steady negative relationship between unemployment and GDP[5]. Coefficients of GDP for all the years are significant at 10% level and it is true for 30 years even at 5% level of significance (year 1993 and 1994 are two exceptions). Following table displays the results.

Table 2.2.: Relation between GDP and unemployment.

Year	Coefficient value	p-value	Year	Coefficient value	p-value
1980	-0.0005395***	0.004	1996	-0.0001607***	0.006
1981	-0.0005036***	0.002	1997	-0.0001758***	0.002
1982	-0.0004586***	0.008	1998	-0.0002013***	0.001
1983	-0.0004193***	0.007	1999	-0.0001987***	0.001
1984	-0.0003231***	0.022	2000	-0.0002152***	0.001
1985	-0.0002917***	0.026	2001	-0.0002194***	0.001
1986	-0.0002584***	0.025	2002	-0.0002091***	0.001
1987	-0.0002405***	0.026	2003	-0.00018***	0.001
1988	-0.0002268***	0.022	2004	-0.0001649***	0.001

[3] For the initial years, few countries are dropped due to lack of data.
[4] GMM criterion is used to abate the problem of heteroscedasticity.
[5] Source: IMF database, http://www.imf.org/external/ns/cs.aspx?id=28.

1989	-0.0001981***	0.019	2005	-0.0001486***	0.001
1990	-0.0002259***	0.003	2006	-0.0001361***	0.001
1991	-0.0001937***	0.006	2007	-0.0001237***	0.001
1992	-0.0001852***	0.013	2008	-0.0001114***	0.001
1993	-0.000131**	0.063	2009	-0.0000805***	0.017
1994	-0.0001064**	0.084	2010	-0.0000733***	0.04
1995	-0.0001287***	0.023	2011	-0.0000745***	0.033

In the next sub-section an empirical exercise has been undertaken based on household level data of National Sample Survey (NSS) of India. The increasing trend of number of unemployed in the relatively higher wealth category has been observed.

2.1.1. A Brief Empirical Analysis in The Context of Developing Country, like India

For the present purpose 59th round of the NSS data is used. NSSO in this round of survey has reported the individual level data of occupational status and the detail of the wealth of each household. In the report, wealth includes household specific information on the value of land, house, livestock holding, durable goods, investment etc. No other rounds after 59th round has covered all that information in detail. Span of survey for the 59th round was 1st January 2003 to 31st December 2003.

2.1.2. Summary statistics

Our major two variables of interest are the value of long term assets and number of unemployed. In this analysis the total asset of a household is defined as the sum total of value of lands and buildings and value of other durable assets (like television, refrigerator, furniture etc.). At the beginning of the analysis, we drop those sample households under survey who are in-capable or/and reluctant to provide information. Per unit asset of an individual is generated from the total value of the household's wealth by dividing it with the total number of the members of that particular household excluding servants (here onwards we call it as household size). Therefore,

Per unit asset = $\frac{\text{value of the total asset of a household}}{\text{household size}}$.

The analysis is restricted for the individuals of age 18 to 35. Occupational choices are made mostly within this age group. However, an individual is not likely to acquire substantial wealth by himself within that age. Mostly the wealth of such individuals' is inherited wealth. So, occupational choice is less probable to affect the wealth level. The following table gives on the descriptive stats of the per unit asset for overall India, rural India and urban India.

Table 2.3.: Descriptive statistics of per unit asset (in Rupees)

Per unit asset	Observations	Mean	Std. Dev.	Min	Max
Overall India	220667	54495.14	138212.4	0	9754667
Rural	137559	47929.33	103844.9	0	4606100
Urban	83108	65362.76	180783.8	0	9754667

Occupational choice depends not only on the per unit asset of the individuals, but on many other factors. So, to comprehend the relation between asset and the unemployment correctly we need to set controls for the other variables which can possibly affect the occupational pattern. In this analysis age, sex, education, religion and social group are the control variables.

2.1.3. A simple OLS model

This sub-section explores the relation between unemployment and asset holding. The whole range of per unit asset (taken in logarithm[6]) is divided into suitable number of quintiles classes. For each asset class, the proportion of unemployed to the total number of individuals is computed, and that becomes the dependent variable of this model. The aim is to check whether this proportion is increasing or decreasing with the asset quintile classes significantly after controlling for other factors. Correlation coefficients of these two variables for rural and urban India are 0.11 and 0.18 respectively.

Following equation describes the model:

$$y = \delta_1 + \delta_2 \ln(x) + \sum_{i=1}^{9} \delta_{3_i} \ln(E_i) + \delta_4 M + \sum_{i=1}^{6} \delta_{5_i} \ln(R_i) + \sum_{i=1}^{3} \delta_{6_i} \ln(G_i) + \epsilon$$

Where $y \equiv \ln(\frac{\text{freq of unemployed}}{\text{total freq of individuals}})$ for each asset quintile class.

$x \equiv$ asset quintile class (after clubbing the asset value of long term wealth, like TV, jewelries, land holdings etc, we divide it in 100 quintile classes).

$E_i \equiv$ frequency of individuals at the education level i per asset quintile class

(Education classes are segregated as the following: 1) not literate, 2) literate without formal schooling, 3) literate but below primary, 4) primary, 5) middle, 6) secondary, 7) higher secondary, 8) diploma/certificate course, 9) graduate).

$M \equiv$ frequency of male individuals per asset quintile class

$G_i \equiv$ frequency of individuals at the social group i per asset quintile class

(Social groups are identified as: 1) scheduled tribe, 2) scheduled cast, 3) OBC).

$R_i \equiv$ frequency of individuals of religion i per asset quintile class

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[6] Logarithmic scale is taken to control the outliers.

(Major religions of India are considered: 1) Hinduism, 2) Islam, 3) Christianity, 4) Sikhism, 5) Jainism, 6) Buddhism).

$\epsilon \equiv$ random error.

We compile the results for rural and urban India separately. R-square value is 0.3238 for the rural India. Other regression results are tabulated below (Table 4). Asset quintile class is positively and significantly related with the y variable. It is also noteworthy that higher education classes also positively and significantly related with y. This observation supports the first result too. That is, as individuals get more education, they become more selective about their job choice. Though up to below primary level this effect is not significant. Religion does not have any significant impact on y whereas gender and social groups show significant influence on y in case of rural India. Here, the intercept term is statistically significant with the sign, negative.

Table 2.4.: Regression result for rural India

y	coef. (δ_{-1})[7]	P-value	st. Error
x	0.0171 ***	0.001	0.0038
Education level per asset class: level 1	-0.0358	0.472	0.0497
E_2	0.0281	0.249	0.0025
E_3	0.0179	0.320	0.0181
E_4	0.1421***	0.001	0.0151
E_5	0 .3302***	0.001	0.0238
E_6	0.5263***	0.001	0.0221

[7] δ_{-1} denotes all other coefficients leaving δ_1, the intercept term.

E_7	0.2955***	0.001	0.0585
E_8	0.3235***	0.001	0.0301
E_9	0.2487***	0.001	0.0739
Male individuals per asset class	0.2198***	0.001	0.0219
Individuals of religion 1 per asset class	0.0306	0.657	0.0689
R_2	0.0419	0.548	0.0698
R_3	0.0692	0.333	0.0714
R_4	-0.0481	0.509	0.0729
R_5	-0.2359*	0.074	0.1322
R_6	0.0859	0.342	0.0902
Individual of social group 1 per asset class	0.0421***	0.006	0.0153
G_2	0.0669***	0.001	0.0126
G_3	0.0263***	0.007	0.0098
Constant(δ_1)	-0.1778**	0.011	0.0701

R-square value is 0.3723 is highly significant for the urban India also. Table 5 demonstrates the regression results for urban India. In case of urban India also asset class shows a positive and significant impact on y. The result for urban is also similar to rural India for education levels and social groups. However, gender has a significant role to play in this case, but religion does not have any statistically significant relation with y.

Table 2.5.: Regression result for urban India

y	Coef. (δ_{-1})	P-value	st. Error
x	0.0264 ***	0.001	0.0024
Education level per asset class: level 1	0.1080	0.387	0.0816
E_2	-0.0447	0.232	0.0373
E_3	-0.0416	0.217	0.0337
E_4	0.0450*	0.079	0.0256
E_5	0.2331***	0.001	0.03
E_6	0.5817***	0.001	0.0288
E_7	0.2623***	0.001	0.0568
E_8	0.2844***	0.001	0.0323
E_9	0.2172***	0.001	0.044
Male individual per asset class	0.2043***	0.001	0.0247
	-0.1060	0.565	0.1843

Individuals of religion 1 per asset class			
R_2	-0.0874	0.635	0.1843
R_3	-0.0726	0.697	0.1866
R_4	-0.2708	0.154	0.19
R_5	-0.2048	0.310	0.2018
R_6	-0.0691	0.717	0.1906
Individual of social group 1 per asset class	0.0721*	0.056	0.0376
G_2	0.0546**	0.011	0.0214
G_3	0.0494***	0.001	0.0120
Constant(δ_1)	-0.0501	0.788	0.1862

Hence, given this empirical result it can be argued that in the Indian economy wealth class has a statistically significant positive influence on unemployment. This is true for both rural and urban India. When we take care of state and district level effects, all the major results hold for that robustness check also (interested readers can contact authors).

Thus, empirically we cannot rule out the presence of a negative relation between unemployment and wealth in the macro sense, and the reverse is the relation for the micro level. That is, as total wealth of a country increases unemployment falls. That induces an apparent paradox between micro and macro level relationships between the two variables. Following sections develop a theoretical model which explains the empirical findings and provides some interesting results.

The plan for the rest of the chapter is as follows. Section 2.2 discusses the structure of the theoretical model. After that short run equilibrium is explained in Section 2.3 whereas Section 2.4 deals with the long run equilibrium. Section 2.5 examines comparative statics and section 2.6 describes all the simulation results. The last section, namely section 2.7, summarizes the whole model and draws some concluding remarks.

2.2. The Model

We model an economy where a single good is produced using labor as the only factor of production. The modelling mechanism allows for intertemporal dynamics through intergenerational transfer of wealth.

2.2.1. Preferences and time

Consider a discrete time framework where at the beginning of each period a new batch of population joins the economy. They live for two periods. Let the total mass of each generation be normalized to unity (thus in our economy there is no population growth). So, a new and an old (call them as 'young' and 'old' respectively) group of people live simultaneously at each time period and therefore at any instance, total population mass is two. In that sense, this is a model with *overlapping generations*.

Individuals consume the single manufactured good, produced using labor. Each individual is identically endowed with one unit of labor inelastically in each period (for simplicity we have assumed away other factors of production, like capital and also set the discount rate as zero).

Let us name the young age of an agent as period 1 and period 2 as her old age. Individuals receive some wealth as inheritance (X) from her previous generation. They cannot save and hence completely exhausts their income earned plus the inheritance (of her lifetime) to purchase the produced good. Realization of utility (through consumption of the purchased goods and leaving a bequest) occurs at the end of her lifespan. Specifically, the preference structure of an individual born at time t, is assumed as:

$$U_t = \frac{1}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} c_{t+1}{}^{1-\alpha} b_{t+1}^{\alpha} - D_t k X_t - D_{t+1} k X_t \text{ with } \alpha \in (0,1) \text{ and } k > 0 \tag{1}$$

The above function reveals that an individual born at time t gets positive utility (U) from consumption (c) and bequest (b). The indicator D takes the value either equal to 1 or 0, depending on the type of employment that the individual receives at the subscripted time. D equals to 1 if the individual joins unorganized sector, otherwise it takes the value 0. The construction of the utility function demonstrates that the individual gets a disutility from working in the unorganized sector. The disutility level has an increasing relation with X. Here, inheritance appears in the utility function as a symbol of social status. Everyone in this economy cares about their societal position and thus, each of them has the stigma associated with the unorganized job. However, the social cost of choosing an unorganized job is higher for the individuals who have higher level of inheritance.

2.2.2. Production

One good is produced in the economy, but there are two sectors that engage in this productive activity. One sector, termed as the organized sector, utilizes a technology where one unit of labor produces ‘p’ units of the consumable. The other sector: the unorganized sector, produces ‘a’ units of the good with one unit of labor. Each firm of both the sectors uses a single worker at a time. The technological superiority of the organized sector is assumed by taking $p > a$. This technological dominance of the organized sector is also reflected in the preference structure of the individual's. The utility function of a representative individual, exhibits disutility from working in the unorganized sector. This disutility is a positive function of her inheritance level, which reflects her social status.

The unorganized sector is perfectly competitive in both, product and factor markets, while the organized sector has the same only in its product market.

2.2.3. Decision problem

Any individual in this economy faces a series of choice problems in her life span. At each point where she has to take a single decision, she gets three different possible options of action. They are the following:

I. Organized sector job.

II. Unorganized sector job.

III. Wait.

Initially at period one when she is about to enter the labor market she chooses one among the three. If second or third is selected, then no more decisions are to be taken in that period. The first option, although, creates another choice problem. If she opts for the organized sector job, then she has to pass through the search process which is a random 'lottery' to her. After the 'lottery' she may get an organized job (call it as 'lucky' situation) or may remain jobless (call it as 'unlucky' situation). Here she has to reveal state contingent decisions. Hence, she faces a choice problem again, and takes a call between the three for different states. In case of 'unlucky' situation the option of 'organized job' does not remain as a feasible one. At the beginning of period two, when she becomes old, she has to follow the same path of the decision problem again.

All the decisions are taken by the individual at the beginning of her young age. Every agent can expect rationally. Decisions are taken so as to maximize the expected indirect utility. Uncertainty in the indirect utility arises because of the search-matching mechanism in organized sector.

2.2.4. Factor market

At every point of time, each individual in our economy is endowed with an indivisible unit of labor, which she can supply either to the organized or to the unorganized sector. Factor market of the organized sector is not perfect and consists of search frictions. So, at any point of time, a pool of job seekers searches for jobs in the organized sector and at the same time, there are infinitely lived firms in this sector, looking for workers to commence production. Both the number of firms and individuals, who are looking for productive matching, are endogenously determined within the model. This "trade in the labor market"[8] is uncoordinated. So, this may well be the case that some of the vacant posts fail to get a worker, on the other hand some workers remain jobless after an active search. Here we use a Pissarides type matching function to capture this scenario. This gives the number of jobs formed at any moment in time as a function of the number of workers looking for jobs and the number of firms looking for workers. The matching function is increasing in its each argument, and is concave and homogeneous of degree one. The particular functional form assumed is the following:

$$m_t = [u_t^{\zeta} + v_t^{\zeta}]^{\frac{1}{\zeta}}$$

Where, m_t be the proportion of the population who are matched, u_t be the proportion of searching population in the total population at time t and v_t be the ratio of total number of vacancy and total population at time t. This form of matching function was supported in Stevens (2007).

[8] C. Pissarides (2000), Equilibrium Unemployment theory

For simplicity, let us assume $\zeta = -1$.

Hence, $\frac{m_t}{u_t} = \frac{v_t}{u_t+v_t} \equiv \rho_t$(say) and $\frac{m_t}{v_t} = \frac{u_t}{u_t+v_t} \equiv \pi_t$ (say).

One additional property of this matching function is, therefore,

$$\rho_t + \pi_t = 1. \tag{2}$$

That is, the probability of getting a job (ρ_t) and the probability of getting a worker for a vacant job (π_t) adds up to 1.

Let ϕ_t be the proportion of the young in the searching population. Then $\phi_t\rho_t$ represents the proportion of young agents getting an organized sector job at time t. On the other hand $(1-\phi_t)\rho_t$ becomes the proportion of old individuals who secure their job in the organized sector at time t. Similarly, $\phi_t\pi_t$ is the matching probability of a young worker with a vacant post, likewise a vacant post finds an old worker with the probability $(1-\phi_t)\pi_t$.

Contrary to the existing search-matching literature where a job and an employee are separated by a random shock, job destruction in our case occurs automatically when an employed worker completes her lifespan. That is, once the organized sector job is formed, it cannot be destroyed by any exogenous force, within the life span of the laborer. To an organized sector firm $(1-\pi_t)$ is the probability of not having a successful match with a worker.

A job seeker in the organized sector may remain jobless with probability $(1-\rho_t)$. So, $(1-\rho_t)\phi_t$ gives the proportion of young unemployed persons and $(1-\rho_t)(1-\phi_t)$ is the proportion of old in the unemployed mass.

An individual does not receive any wage if she remains unemployed. Alternatively, she may opt for a job in the unorganized sector, in which she instantaneously receives employment and earns a positive wage (note that factor market in the unorganized sector is frictionless).

2.2.5. The organized sector firms

To post a vacancy organized sector firm has to bear a strictly positive fixed cost. Notice, in this model, we assume cost explicitly only for firms, and no explicit cost is assumed for the workers. The idea behind this assumption is that workers have free time while unemployed and they may spend that time in some activity which gives them benefit (family time, home production etc.), and in addition some odd income may also come in that period. However, they also have searching cost too. (See Pissarides (2000), chapter 1). On the other hand, firms face only losses for a vacant post. They have to incur cost to keep the work place ready for the next match and for active search to fill the vacant post. No per period gain is associated with a vacant post. This is how literature somewhat justify the assumption.

From our earlier discussion, it is evident that there may arise three cases after a vacancy is posted in the organized sector. Other than the possibility of not getting a worker, two more events may occur. A vacant post can be matched either with a young worker or with an old worker. The difference between the last two situations is the following: young worker can work for two consecutive periods, whereas an old worker can supply her labor for only one period.

We use J_{yt} to denote the expected infinite income stream from a filled job having a young worker at time 't' and J_{ot} to denote the analogous value for an old worker. V_t, on the other hand is used to denote the expected infinite income stream from a vacancy. New firms enter the market as long as V_t remains positive.

Let w_{sy} be the wage of the young worker employed in the organized sector. w_{so} is the wage paid to an old worker in the same sector.

Now we can write the following relations:

$$J_{yt} = 2(p - w_{sy}) + V_{t+2} \qquad (3)$$

$$J_{ot} = (p - w_{so}) + V_{t+1} \tag{4}$$

$$V_t = -d + \pi_{t+1}\left[\phi_{t+1}J_{yt+1} + (1 - \phi_{t+1})J_{ot+1}\right] + (1 - \pi_{t+1})V_{t+1} \tag{5}$$

Where, 'd' is the cost of posting a vacancy.

Explanation of these equations is the following. A firm receives a positive return of $(p - w_{sy})$ per period whenever the vacant firm gets a worker. Therefore, when a young worker is matched with a firm at time t the firm receives positive return for two consecutive periods with certainty. But after these two periods the post becomes empty and the firm has to post a vacancy to resume the production again. Therefore, from period $\overline{t + 2}$ onwards V_{t+2} is the return to the firm. Similarly we get the equation for J_{ot}.

A vacant firm pays strictly positive fixed cost d to post a vacancy at each period. If the firm matches with a worker then firm either gets J_{yt} or J_{ot} according to the worker's remaining life span, and on the other hand if the firm fails to match with any worker then the firm has to start with a vacant post at period $\overline{t + 1}$ again; hence will receive V_{t+1} from the next period onward.

Free entry guarantees that in equilibrium $V_t = 0$, for all t. That is, at the margin, firms would be indifferent between posting and not-posting the vacancy. If V_t remains positive (negative), firms would enter (leave) the market. Hence, both the J's become time independent.

$$J_y = 2(p - w_{sy}) \tag{6}$$

$$J_o = (p - w_{so}) \tag{7}$$

Now the equation (5) can be rewritten as,

$$\pi_t = \frac{d}{\phi_t J_y + (1 - \phi_t)J_o} \tag{8}$$

2.2.6. Wages

The factor market of the unorganized sector is perfect. So, a laborer receives her value marginal product as wage, and CRS production technology levels the marginal product and average product of laborer. Unorganized sector wage is, what she produces.

That is, $w_n = a$ (9)

Hence, w_n is time independent.

Costly labor market friction in the organized sector creates the opportunity to extract some positive rent out of this market interaction. Both the firms and laborers have some strictly positive degree of bargaining power in the organized sector, and firm owner and laborer share the total value of production through Nash bargaining. If $\beta(< 1)$ denotes the bargaining power of laborers, then the wages are determined by the following equations:

$$w_{sy} = \arg\max_{w_{sy}} \ (2w_{sy})^{\beta}(\overline{2p - w_{sy}})^{1-\beta} \tag{10}$$

$$w_{so} = \arg\max_{w_{so}} \ (w_{so})^{\beta}(p - w_{so})^{1-\beta} \tag{11}$$

Solving above two equations,

$$w_{sy} = w_{so} \equiv w_s = \beta p. \tag{12}$$

Here we strengthen our assumption as $\beta p > a$ to make w_s higher than w_n, since the assumption that an organized sector is more productive than the unorganized one does not suffice to guarantee the stated wage differential. Note that, agents, in equilibrium, always choose to search for the organized sector job and that does not depend on their wealth level. Wealth level plays the crucial role only to segregate the unorganized sector labor pool and the unemployed mass. It is explained in more detail in section 2.3.

Unorganized sector wage, as an outside option in the bargaining process, is not included. First, the two wages of organized sector become unequal and dependent on time, Moreover, it will make the analysis difficult in the sense of explaining the result. Since not every individual joins the unorganized sector, and the people who take up the job are differentiated by their inheritance level. Therefore, the that will guarantee higher wage in the organized sector on the basis of the worker's inheritance level. This is something unrealistic. However, inclusion of the outside option will widen the wage gap between the two sectors and that will push the analysis more towards the derived result. Including the outside options do not contribute significantly towards our analysis, but make it more cumbersome.

2.3.Short-run Equilibrium

Following sub-sections discuss, first, the occupational choice problem of the agent and, after that we move to the factor market solutions and finally the inheritance distribution and its dynamics are elaborated in length.

The equilibrium short run[9] solutions of our designed economy is the focus of this section.

2.3.1. Optimal occupational choice

Every individual optimally chooses to search for a job in the organized sector with any level of X. This is because, the wage of this sector is strictly higher than the return from the unorganized sector or from unemployment, and moreover, workers' pay nothing for the job-search. If she fails to get a job in period one she goes for search in period two. However, if she becomes 'lucky' in the first period, there is no more extra incentive to go for search in the second period again. This is the unique solution at the beginning of the first period's decision problem.

[9] Given the information of (t-1), all the endogenous variables can be determined at period t. This is how we define as the short run solution in the model. Latter, a discussion follows to explain the time independent solution of the model which is characterized as the long run steady state solution.

Decisions vary from one individual to the other for the following two situations. Agents, who face an 'unlucky' situation, opt for the unorganized sector job if she has $X_t \leq \frac{w_n}{k}$. This decision remains the same, if she is 'unlucky' in both the two periods. On the contrary if her inheritance, X_t , is greater than $\frac{w_n}{k}$ then she never chooses to work in unorganized sector: even if she faces an unlucky situation in both the periods. As stated earlier, agents have a disutility to work in the unorganized sector due to her status, which is represented by her inheritance. Although the unorganized sector job gives an income gain, social stigma outweighs that gain for the individuals with higher X (read it as 'higher social status'). To follow the result formally, interested readers are requested to consult the Appendix 1.

Therefore, the following two strategies prevail in equilibrium:

i. Search for organized job is chosen, at the beginning and then, if becomes 'lucky', 'work for organized sector' is chosen; if 'unlucky' be the case then wait is chosen.

ii. Search for organized job is chosen, at the beginning and then, if becomes 'lucky', 'work for organized sector' is chosen; if 'unlucky' be the case then unorganized job is chosen.

The actual form of the expected indirect utility functions (EIU) for (i) and (ii) are as follows. (For derivations see the appendix 2).

$$\mathrm{EIU(i)} = X + \rho_t(2w_s) + (1-\rho_t)\rho_{t+1}(w_s) \tag{12}$$

$$\mathrm{EIU(ii)} = X - \big((1-\rho_t) + (1-\rho_t)(1-\rho_{t+1})\big)kX + (2\rho_t + (1-\rho_t)\rho_{t+1})(w_s) + \big((1-\rho_t) + (1-\rho_t)(1-\rho_{t+1})\big)(w_n). \tag{13}$$

Comparing equation (12) and (13), it is clear that, (ii) is the dominant strategy for $X \leq \frac{w_n}{k}$, and (i) otherwise.

In the figure below (figure 2.1.) we plot the optimal expected indirect utility path, with the needed parametric restrictions, denoted by the thick line.

Therefore, at the end of any period, people who have more inheritance than $\frac{w_n}{k}$, remain unemployed in this economy. This result explains the micro-level empirical finding elaborated in section (2.1). Note that this solution is true for any non-zero and non-unitary probability values generated from the organized sector. In the following section we solve for the equilibrium short-run probability values.

Therefore, at the end of any period, people who have more inheritance than $\frac{w_n}{k}$, remain unemployed in this economy. This result explains the micro-level empirical finding elaborated in section (1.1) and (1.2). Note that this solution is true for any non-zero and non-unitary probability values generated from the organized sector. In the following section we solve for the equilibrium short-run probability values.

2.3.2. Factor market solutions

At any point in time, populations from two consecutive generations are economically active. So, in our economy total population adds up to 2 at any instance. The whole young population and the old individuals who became 'unlucky' in their young age, participate in the search process of a particular period.

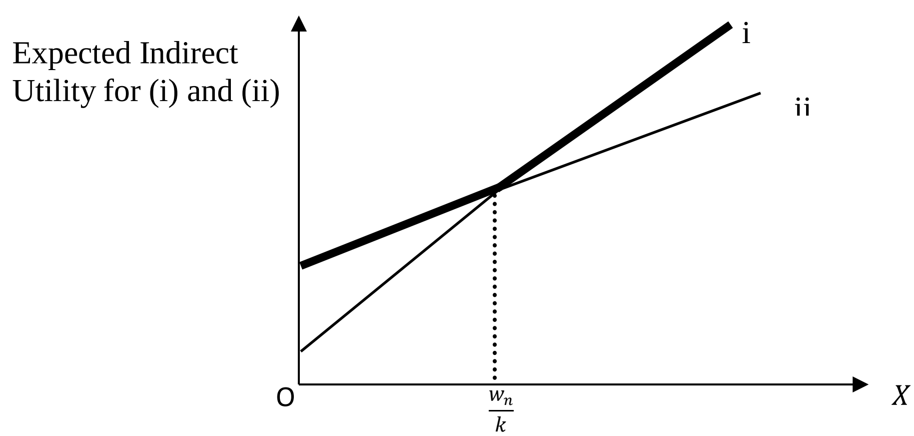

Figure 2.1.: Expected Indirect Utility of the Agent

Then, if S_t is the total number of job-seekers at time period t, $S_t = 1 + (1 - \rho_{t-1}\phi_{t-1} S_{t-1})$. As stated earlier ϕ_t is defined as the proportion of the young among the searching population at time t. Since the young population proportion (recollect, they all are searchers too) is equal to one, therefore, $\phi_t S_t = 1$. The left hand side of the equation is the young pool of searchers.

Hence, $S_t = 1 + (1 - \rho_{t-1})$.

Thus, $\phi_t = \frac{1}{2-\rho_{t-1}}$. (14)

As all the previous period values of each variable are known to the economy at period t, from equation 14, ϕ_t can be determined for each t. Once ϕ_t is known then using equation 8 and equation 2 one can easily solve π_t and ρ_t for each t, as the wages are already determined.

The next sub-section discusses how these probabilities affect the inheritance distribution of the economy.

2.3.3. Inheritance distribution

Inheritance distribution of the economy actually summarizes all the optimal decisions of the individuals. Unemployment, as defined by the International Labour Organization, is the situation when people are without jobs and they have actively sought work for a given time period. In our model unemployed mass (according to this definition) lies above a certain level of X. We may consider X^c (eventually which is equal to $\frac{w_n}{k}$) as a critical inheritance level, people below which is termed as 'poor'; otherwise 'rich'. Optimal decision of the individual who has lesser X than X^c, shows that she chooses to work in the unorganized sector when she does not get the organized sector job. Where, in an 'unlucky' state individual with $X > X^c$ does not choose to go for an unorganized job, but to wait. Hence, the poorer individuals at any point of time are working in this economy, and not remain unemployed. People with the higher level of inheritance remain without any job if they become unlucky after an active search for a job in the organized sector.

Here we consider the different individuals from the different sections of the population, and find that where their dynasty may move in the next generation given their respective X and the probability values. Following are the system of dynamic equations to explain the intergenerational movement.

Let us call $\frac{w_n}{k}$ as X^c.

If $X_t \leq X^c$,

$X_{t+2} = \alpha(X_t + 2w_s)$, with probability ρ_t (15)

$X_{t+2} = \alpha(X_t + w_n + w_s)$, with probability $(1 - \rho_t)\rho_{t+1}$ (16)

$X_{t+2} = \alpha(X_t + 2w_n)$, with probability $(1 - \rho_t)(1 - \rho_{t+1})$ (17)

If $X_t > X^c$,

$X_{t+2} = \alpha(X_t + 2w_s)$, with probability ρ_t

$X_{t+2} = \alpha(X_t + w_s)$, with probability $(1 - \rho_t)\rho_{t+1}$ (18)

$X_{t+2} = \alpha(X_t)$, with probability $(1 - \rho_t)(1 - \rho_{t+1})$ (19)

These equations are generated from an inherent assumption: $X_{t+1} = f(b_t)$ and from the outcome of the maximization of the utility function (equation 1). Here, for simplicity we assume that $X_{t+1} = b_t$. Because of the assumed Cobb-Douglas structure of the utility function (given in equation 1), optimization exercise yields that the bequest level is equal to the α proportion of the total wealth of the individual.

Other details of the equation are straightforward to see. If the agent receives the opportunity of working in the organized sector at the beginning of period 1, her wealth equates with $(X_t + 2w_s)$ for all X_t at the end of period 2. So, it explains equation (15). In case of the other equations inheritance level plays a key role. First, we consider $X \leq X^c$. Individual works in the unorganized sector if the 'unlucky' state is realized. It is true for both young and old age. That is, total wealth can be either $(X_t + w_n + w_s)$ or $(X_t + 2w_n)$ with probability $(1 - \rho_t)\rho_{t+1}$ or $(1 - \rho_t)(1 - \rho_{t+1})$ respectively. Again, if $X_t > X^c$, optimal decision dictates the agent to wait when she does not get employment in the organized sector after an active search. Hence, if she fails to be 'lucky' in the period 1 but receives an organized sector job in next period, then the total wealth of the individual is $(X_t + w_s)$ and if she faces 'unlucky' state in both the periods, her wealth remains as X_t.

The numbering of the bold lines is done according to the equation number. Figure 2.2 depicts the above equations.

There may arise a situation where all the three lines cut the $45°$ line within $[0, X^c]$. In that case, all individuals in the long run would have inheritance less than X^c and then no one in the population remains unemployed after a certain finite time period. That creates an uninteresting situation in the long run for the present purpose. We get the above figure by imposing suitable parametric restrictions (Appendix 3) such that we can concentrate on the case where unemployment prevails in the economy. More discussion on the inheritance dynamics is kept at section 2.4.1.

From figure 2.2 we can have the following observation. An individual who herself initially starts as poor may bring her next generation to the richer section. The reverse is also true. Therefore, always a dynasty faces a positive probability of changing the economic status between some arbitrary finite number of generations. Hence, the economic mobility depends mostly on the labor market efficiency in this model. The corresponding transition probabilities are displayed below:

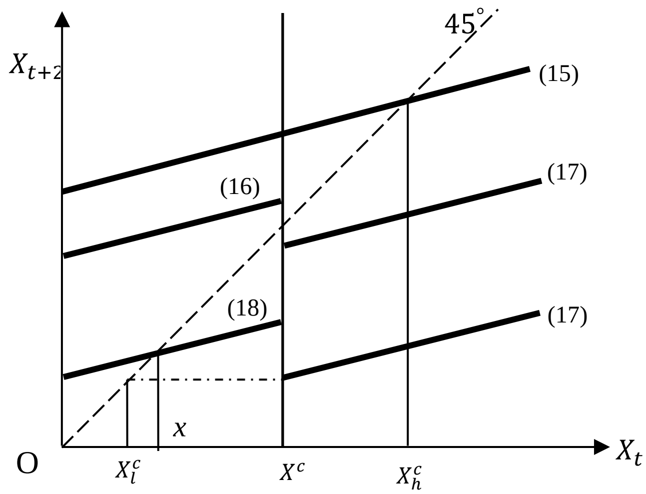

Figure 2.2.: Inheritance Dynamics

$$P(X_{t+2} > X^c | X_t > X^c)$$

$$= \begin{cases} \rho_t, & \text{if } X_t < \left(\frac{w_n}{\alpha k} - w_s\right) \\ \rho_t + (1-\rho_t)\rho_{t+1}, & \text{if } \left(\frac{w_n}{\alpha k} - w_s\right) < X_t < \frac{w_n}{\alpha k} \\ 1, & \text{otherwise} \end{cases} \qquad (20)$$

$$P(X_{t+2} > X^c | X_t < X^c)$$

$$= \begin{cases} \rho_t, & \text{if } X_t < \left(\frac{w_n}{\alpha k} - w_s - w_n\right) \\ \rho_t + (1-\rho_t)\rho_{t+1}, & \text{otherwise} \end{cases} \qquad (21)$$

2.4. Long run equilibrium

In this section, we consider the model with time dynamics. First, we discuss the movement of the inheritance distribution with time, given any initial distribution and there after the dynamics of probability values will be considered.

2.4.1. Inheritance dynamics

For each generation, there is a distribution of inheritance (X) over the entire population. Let the distribution function be $F_t(X_t)$, where $X_t \in (0, \overline{X})$ and $\overline{X}$ is the exogenous large finite upper bound of inheritance (the construction of which is shown in fig 2). That is $F_t(X_t)$ proportion of people have less than or equal to X_t amount of inheritance at period t. To analyze the evolution of the inheritance of the dynasty over time from an initial time period, we set up a starting point where the economy is populated by a given pool of old and young individuals with their respective inheritance levels.

Note that, in our model if the probability values remain strictly positive and non-unitary, then the inheritance distribution[10] of the population can never become polarized. It cannot be the case that every individual become either 'rich' or 'poor' after a finite time. This remains true for any initial population distribution. This is a very significant departure from Galor and Zeira (1993). Factor market friction in the organized sector develops this interesting phenomenon. The probabilistic nature of this factor market halts any unidirectional movement over X and opens up the more realistic possibility, that is, X of a particular dynasty can move both way with time.

From Figure 2.2, let us we concentrate on X_l^c and X_h^c. It is not difficult to prove that after a finite time, inheritance of all individual come within the interval $[X_l^c, X_h^c]$, provided probability values remain strictly positive and non-unitary (the next sub-section shows that in the long-run equilibrium also probability values satisfies these restriction endogenously). Note that, in Figure 2.2 all lines cut the 45° line from below. Hence, if the model was a deterministic one, then 'x' or X_h^c would be a long run stable equilibrium. That is, the process might end up at x or X_h^c after infinite time interval. Because of the stochastic nature of the model under discussion, no X_{t+2} can remain

[10] X is a good proxy of wealth since, X is a function of b and b depends on the wealth.

infinitely on the same inheritance path on which X_t lies. There is always a positive probability of switching the path. Therefore, given a X_t either below X_l^c or above X_h^c, this dynamic process brings X_{t+n} within the stated interval after some arbitrary time periods. Once all X_ts come within the interval $[X_l^c, X_h^c]$, it is impossible to get out of that interval; although the population will never converge at a particular inheritance level. For certain parametric restriction simulation result (shown in section 2.6) displays that long-run distribution of 'X' converges to a bounded and continuous wealth distribution.

2.4.2. Factor market dynamics

In this subsection, again we return to the factor market. Here we consider the factor market behavior with time. We have seen earlier that factor market variable of the unorganized sector is time independent, so we concentrate on the factor market of the organized sector.

Let us reframe the equation (8) using equation (2).

$$\rho_t = 1 - \frac{d}{\phi_t J_y + (1-\phi_t) J_o} \tag{22}$$

Using (14) and (19) we get a difference equation of ϕ_t.

$$\phi_t = \frac{1}{\left(1 + \frac{d}{\phi_{t-1} J_y + (1-\phi_{t-1}) J_o}\right)} \tag{23}$$

Above stated dynamic relations yields following results:

$\frac{\delta\phi_t}{\delta\phi_{t-1}} > 0,\ \frac{\delta^2\phi_t}{\delta\phi_{t-1}^2} < 0.$

$0 < \phi_t|(\phi_{t-1} = 0) < 1,\ 0 < \phi_t|(\phi_{t-1} = 1) < 1$ and $\phi_t|(\phi_{t-1} = 0) < \phi_t|(\phi_{t-1} = 1)$ (see Appendix 4). Now we put the above results in figure.

So, from Figure 2.3 it is clear that in the long run ϕ_t converges to an interior stable equilibrium, A.

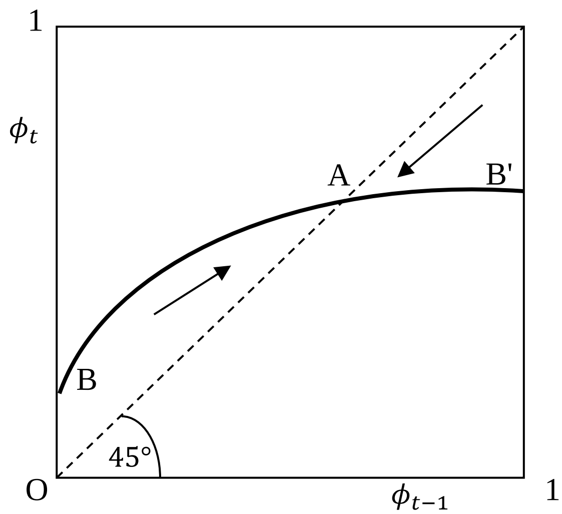

Figure 2.3.: Dynamics of the Proportion of Young Agent

Therefore, the long run probability values remain strictly positive and non-unitary (from equation 22). In the long run, ϕ_t becomes time independent. As we solve for ϕ and all other endogenous variables of the imperfect factor market, ρ, π. Hence, S can be determined. This proves the existence of unemployment in the long-run equilibrium.

2.5. Comparative Static Results

In this section we find out how the economy changes with the change of two different parameters: one is the production parameter and other is from factor market. Actually, we focus on the parametric change of the organized sector because this is the sector which makes our model interesting and plays a very crucial role in this hypothetical economy.

2.5.1. Effect of change in production technology

Suppose productivity of the organized sector (i.e. p) jumps up due to some exogenous technological upgradation. So, a filled job pays more and hence increases the incentive of posting vacancies. That is, V_t becomes positive. Therefore, more new firms enter and post vacancies till V_t

remains positive. That increase in the number of the vacancy increases the probability (i.e. ρ_t) of getting a job in the organized sector in short-run. Mathematically, it is clear that an increase in p leads to a rise in the denominator of the RHS of the equation 8. Hence, π_t falls for a rise in the productivity of the organized sector and that implies an increase in ρ_t from equation 2.

Another interesting thing to notice is the following. Since the probability of being 'lucky' rises, it actually decreases the proportion of searchers within the searching population who are old. (Remember that the old searchers are those who failed to get an organized job in their younger age).

In Figure 2.3, BB' curve shifts up with a rise in p and accordingly A, the steady state point of ϕ, also moves in an upward direction. From equation (23) it is evident that ϕ and ρ changes in the same direction. Therefore, if p increases, the long-run steady state value of ϕ and ρ also increases, and π falls. In the steady state, this in turn shrinks the size of unorganized sector as well. This is because probability of job match in the organized sector rises and for any X, $G(X)$ falls with the increase in p, which lefts lesser proportion of people for the unorganized sector job.

As ρ_t changes in the positive direction with p, the total number of unemployment at time t (i.e. short-run[11]) of the economy declines. On the other hand GDP at time t rises through both the increase in productivity and the increment in the probability of getting matched in the organized sector. Although the total production of the unorganized sector falls because of shortage in the supply of labor, the higher productivity of the organized sector outweighs that loss. Therefore, a more advanced technology in the organized sector implies a higher GDP coupled with a lower unemployment and this has accorded with our empirical findings documented earlier.

[11] This claim is true for short-run. Since change in p changes the probability of the job match, and hence the transition probabilities (probability of switching the income class: rich to poor and the reverse) also change, that perturbs the whole inheritance distribution. Therefore, long-run change in unemployment or GDP can be shown by simulation results, which has been demonstrated at section 2.6.

Mathematical proofs are in the Appendix 5.

2.5.2. Effect of change in cost of posting a vacancy

If the cost of posting a vacancy (i.e. d) falls, it makes vacancy posting lucrative. It increases the number of vacancies. If d falls, as the previous one, BB' moves in an upward direction and similar effects as described in the previous subsection, take place. So, as d falls total unemployment decreases and GDP increases (Appendix 6) at time t (in short-run).

This sub-section shows the economy wide importance of factor market efficiency in the long run income distribution. Here, we are summarizing what we obtain from the simulation study (see next section for detailed results in tabular form) for a change in d with appropriate parameter values for a very large iteration:

i. Country with higher cost of posting vacancy faces a greater level of long-run unemployment and a lesser level of long-run GDP.
ii. If the cost of vacancy is high enough, then in the long run economy wise inheritance distribution becomes biased towards lower income and the vice-versa.

If the factor market is not efficient enough (i.e. high ‘d’) then the distribution of income resembles Pareto distribution. Results show that even if initially a country starts with a very high average income, then also the average income of the country may drop down because of factor market inefficiency. On the other hand, an initially poor country can become a high average income country by improving their factor market.

Additionally, for a higher value of d, since the probability of job match falls and for any X, G(X) rises, the proportion of people works for unorganized sector also increases. That is, if the organized sector's labor market of an economy is less efficient then the size of the unorganized sector of that economy would be larger in the steady state.

Countries like USA[12] or Norway[13], representative of lesser labor market friction, show that the long run income distribution is skewed towards the higher income quintiles. On the other hand, for countries like Brazil or India income distribution is skewed to the left tail.

2.5.3. Effect of change in status consciousness

From equations (22) and (23) it clear that in the steady state probability of job match for the worker (ρ) does not depend on the status consciousness of the individuals (which is captured by the value of k). However, the distribution of the inheritance gets affected. As k rises, the cut off inheritance (X^c) goes up, and equations (20) and (21) shows, that drives up the proportion of people who stays above or moves up with respect to the X^c. This brings down the participation and size of the unorganized sector.

Due to higher vale of k, therefore, chance of getting job in the organized sector remains unaltered but the number of people who does not want to join unorganized sector increases. As a result, the overall unemployment rises and GDP falls. Both of these two results from the fact that the size of the unorganized economy shrinks when status consciousness is high in the economy.

2.6. Simulation Results

This section elaborates the numerical exercise done in this work. Since the long-run wealth distribution in our model is theoretically intractable, though it has a serious influence on the

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12 *Economic inequality through the prisms of income and consumption*, David S. Johnson, Timothy M. Smeeding, and Barbara Boyle Torrey (http://www.bls.gov/opub/mlr/2005/04/art2full.pdf)

13 http://www.regjeringen.no/en/dep/hod/documents/regpubl/stmeld/2006-2007/Report-No-20-2006-2007-to-the-Storting/2/2/1.html?id=466524

findings, this section has a separate importance. Following table displays the hypothetical parametric assumptions.

Table 2.6.: Parameter values

Parameters	Description	Value
α	Proportion of income spent for bequest	0.40
d	Cost of posting a vacancy (Low)	0.25
d^h	Cost of posting a vacancy (High)	0.54
β	Bargaining power of an organized sector worker	0.55
p	Marginal productivity of labor in organized sector (Low)	1
p^h	Marginal productivity of labor in organized sector (High)	1.5
k	Disutility parameter from social stigma	0.5
a	Marginal productivity of labor in unorganized sector	0.22

Number of individuals under observation are 10000. Number of iteration is, T=1000.

Following are the results reported for the parametric restrictions given in the table above.

Result 1: The distribution of inheritance converges in the long run. That steady state distribution does not depend on the initial wealth distribution.

Following table depicts Kolmogorov-Smirnov[14] test statistic for the convergence test of the long-run inheritance distribution.

Table 2.7.: Convergence of inheritance distribution

Initial wealth distribution	'T' vis-à-vis '(T-1)'	'T' vis-à-vis '(T-100)'
Normal	0.0094 (0.7671)	0.0158 (0.1633)
Uniform	0.0169 (0.1138)	0.0126 (0.4032)
Single valued (all the values are same but below the cut-off level)	0.0260 (0.8840)	0.0270 (0.8547)
Single valued (all the values are same but above the cut-off level)	0.0055 (0.9981)	0.0154 (0.1850)

[14] Non-technically, Kolmogorov-Smirnov test statistics is used to compare between a sample with some reference distribution, or to compare between two samples.

Following table shows the convergence in the long run starting from different initial wealth distributions given the other parametric values. Results narrates that initial condition has no significant role for the long run distribution of inheritance.

Table 2.8.: Convergence test starting from two different initial distribution of inheritance

Two different initial distributions	Kolmogorov-Smirnov test statistic
Normal vis-à-vis Uniform	0.0164 (0.1345)
Normal vis-à-vis Single valued (below the cut-off)	0.0267 (0.5306)
Normal vis-à-vis Single valued (above cut-off)	0.0086 (0.8519)
Uniform vis-à-vis Single valued (below the cut-off)	0.0358 (0.1907)
Uniform vis-à-vis Single valued (above the cut-off)	0.0108 (0.6020)
Single valued: below cut-off vis-à-vis above the cut-off	0.0296 (0.3981)

Result 2: The long-run steady state GDP increases and the long-run steady state unemployment decreases for an increase in the productivity of the organized sector.

Following two figures (figure 2.4 and figure 2.5) display the above result. We compute the whole model for a higher value of p ($\equiv p^h$) and compare the GDP and the unemployment values for the two different situations. This exercise is done with the uniform initial wealth distribution.

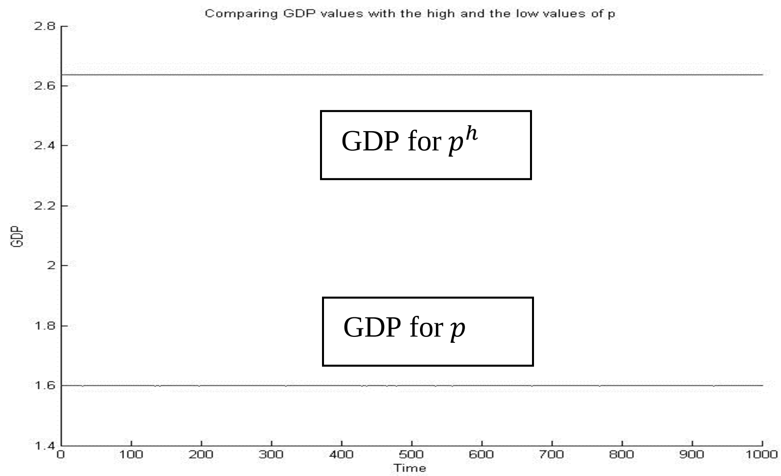


Figure 2.4.: GDP values for High and Low values of ‘p’

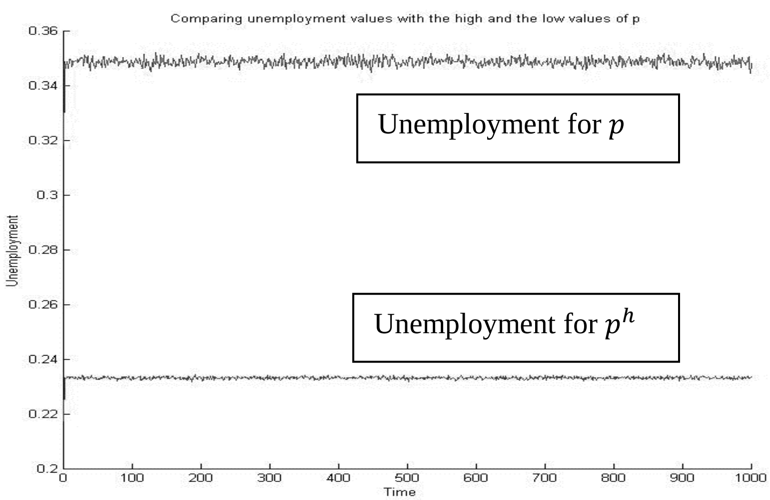


Figure 2.5.: Aggregate Unemployment for High and Low Values of ‘p’

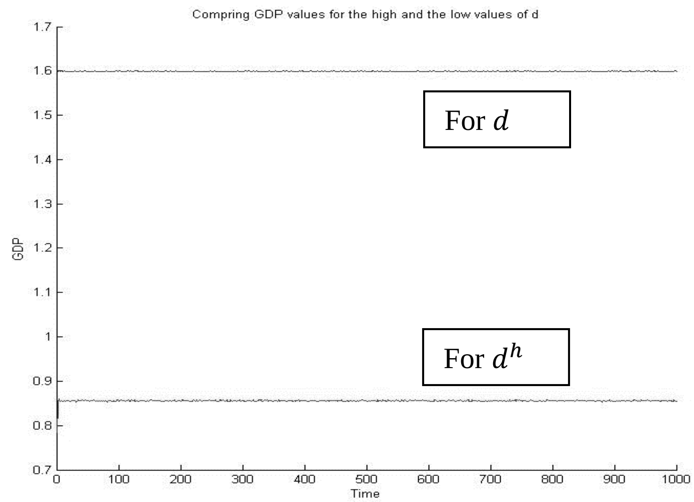


Figure 2.6.: GDP Values for High and Low Values of ‘d’

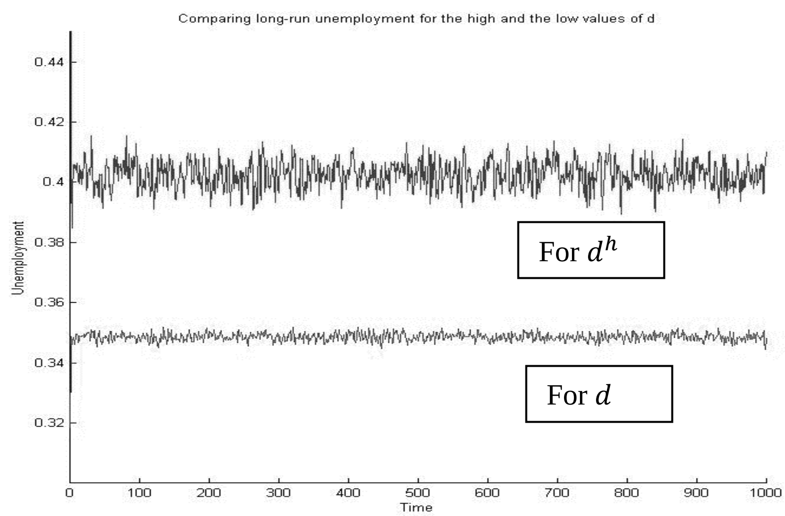
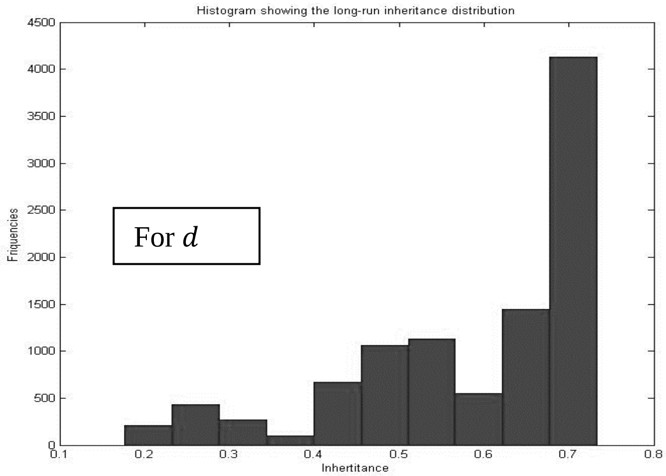


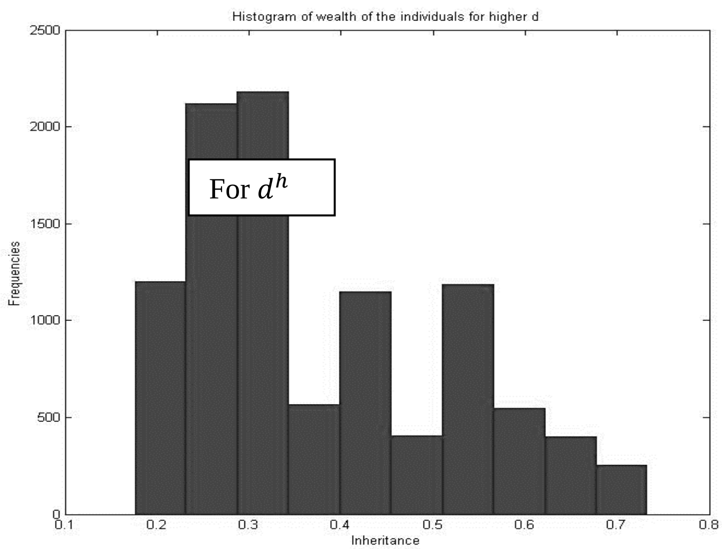
Figure 2.7.: Unemployment Values for High and Low values of ‘d’

Result 4: If cost of vacancy is high enough, then in the long run economy wise inheritance distribution becomes biased towards lower income and the vice-versa.

Next two histograms depict the long-run inheritance distribution of the individuals for the two different level of cost of posting vacancies (for d and d^h respectively).



<u>Figure 2.8.: Simulated Inheritance Distribution for Low ‘d’</u>



<u>Figure 2.9.: Simulated Inheritance Distribution for high ‘d’</u>

2.7. Conclusion

The Walrasian general equilibrium framework has established the fact that "… factors of production are always fully employed in the full-information, frictionless markets" (Davidson, et al., 1988). To account for the presence of unemployment, economists have sometimes relaxed the assumptions of ‘frictionless markets’ or have avoided ‘full information’ situation. Keeping all these contributions in mind, we think that an explicit relation between inheritance and unemployment; generated due to labor market friction, needs to be established.

This model churns out a relationship between unemployment and inheritance, and postulates that, individuals who inherit relatively more remain unemployed. It showcases the existence of unemployment together with the persistence of a perfect and an imperfect labor market in the equilibrium both in long and short run without restricting ‘on the job search’ (c.f. Davidson, Martin, & Matusz, 1988). A cutoff inheritance level is determined under which no one chooses to continue without positive earnings. This result explains the micro-level empirical findings too.

This model offers a dynamic structure such that the descendent of any agent can move either below or above the cutoff level of inheritance with positive probability given her present level of inheritance. That is, we refute the importance of the initial and thus, we discord with the concept of equilibrium trap which suggests that if a country begins with a very low (or high) income can never change their situation in the long run. The present work guarantees an inheritance (and thus, income) distribution spread out both below and above the cutoff in the long run. The long run income distribution is moderated only by the productivity parameters or the factor market parameters and not due to initial inheritance distribution.

The model also describes the macro level result obtained in the empirical exercise. Most of the countries with higher GDP have lower level of unemployment. We have shown that higher productivity and/ or lesser labor market friction can yield higher GDP coupled with lesser unemployment.

A possible alley of extension of this work can accommodate unemployment for targeted income groups (for example the middle class) as well as study the consequences of trade on unemployment in this framework.

Appendix

Appendix 1

Here the optimal decisions of the agents are solved. Since in the discussed model, cost of searching is equal to zero, each individual likes to search for an organized sector job at each period. An agent can receive a higher wage from organized sector, only if she faces the search process. But she does not lose anything if she goes for search. Therefore, she can take a chance in the search process of the organized sector to get a higher wage without cost. Hence, it is optimal for any agent to search in the organized sector. The choice problem between opting for a search or not is actually a comparison between the weighted average with strictly positive weights and the minimum value, where all values are not identical. Hence, opting for search becomes a dominant strategy.

The following table shows different pay-offs for different strategies under alternative states of the world. States and strategies are noted in rows and columns respectively. Notations used in the table are likewise: ‘L’ and ‘U’ indicate lucky and unlucky situations; ‘O’, ‘N’ and ‘W’ are for organized job, unorganized job and wait, respectively.

Pay-off matrix of each period:

	O	N	W
L	w_s	$w_n - kX$	0
U	not applicable	$w_n - kX$	0

Optimal solutions are illustrated below

for, $X \leq w_n/k$		for, $X > w_n/k$	
if L then	O	if L then	O
if U then	N	if U then	W

Since the agent faces the same pay-off matrix in second period, optimal decisions also remain also unchanged.

Recollect that, in our model, after being lucky the job cannot be destroyed, therefore, if an agent receives the state L in period one then realization of any state in period two makes no difference to her pay-off. Hence, if she is lucky in period one then she continues as organized sector worker in both the periods of her life.

Appendix 2

Expected indirect utility representations (EIU) of the optimal decisions for a representative individual are written below.

If $X \leq \frac{w_n}{k}$ then

$$EIU|_{X \leq \frac{w_n}{k}}$$

$$= (\rho_t)(2w_s) + (1 - \rho_t)(w_n - kX) + (1 - \rho_t)(\rho_{t+1})w_s + (1 - \rho_t)(1 - \rho_{t+1})(w_n - kX) + X$$

$= [(\rho_t)(2w_s) + (1-\rho_t)w_n + (1-\rho_t)(\rho_{t+1})w_s + (1-\rho_t)(1-\rho_{t+1})w_n] + [1-(1-\rho_t) - (1-\rho_t)(1-\rho_{t+1})]X$

$$= [\rho_t + (1-\rho_t)(\rho_{t+1})]w_s + [(1-\rho_t) + (1-\rho_t)(1-\rho_{t+1})]w_n + [1-(1-\rho_t) - (1-\rho_t)(1-\rho_{t+1})]X \quad (24)$$

$\mathrm{EIU}|_{X>\frac{w_n}{k}}$

$$= (\rho_t)(2w_s) + (1-\rho_t)(\rho_{t+1})w_s + X \quad (25)$$

Appendix 3

Parameter restrictions for the figure 2.2 are listed below:

i) $\frac{w_n}{(w_n+w_s)} < \frac{\alpha k}{1-\alpha} < \frac{w_n}{w_s}$

ii) $\frac{w_n}{2\alpha k} < w_s < \left(\frac{1}{\alpha k} - 1\right) w_n$

iii) $\frac{\alpha}{1-\alpha} < \frac{1}{2k}$

Where $w_n = a$ and $w_s = \beta p$.

Appendix 4

$$\frac{\partial \phi_t}{\partial \phi_{t-1}} = \frac{d(J_y - J_o)}{\left(d + \phi_{t-1}J_y + (1-\phi_{t-1})J_o\right)^2}$$

$$\frac{\partial^2 \phi_t}{\partial \phi_{t-1}^2} = (-2) \times \frac{d(J_y - J_o)^2}{\left(d + \phi_{t-1}J_y + (1-\phi_{t-1})J_o\right)^3}$$

$\phi_t|(\phi_{t-1} = 0) = \frac{1}{1+\frac{1}{J_o}} < 1$ and positive.

$\phi_t|(\phi_{t-1} = 1) = \frac{1}{1+\frac{1}{J_y}} < 1$ and positive.

Appendix 5

$$\frac{\partial \phi_t}{\partial p} = \frac{d}{\left(d+\phi_t J_y+(1-\phi_t)J_o\right)^2} \times \left(\phi_{t-1}\frac{\partial J_y}{\partial p} + (1-\phi_{t-1})\frac{\partial J_o}{\partial p}\right) > 0, \text{ for all } 0 < \phi_{t-1} < 1.$$

and $\frac{\partial \rho_t}{\partial \phi_t} > 0$

Where, $\frac{\partial J_y(p)}{\partial p} > 0,\ \frac{\partial J_o(p)}{\partial p} > 0.$

Total Unemployment

$$\equiv TU_t = (1 - F_{t-1}(X^c))\,(1-\rho_{t-1})(1-\rho_t) + \left(1 - F_t(X^c)\right)(1-\rho_t). \tag{26}$$

$\frac{\partial TU_t}{\partial p} < 0$

$$GDP_t = [F_{t-1}(X^c)\,(1-\rho_{t-1})(1-\rho_t) + F_t(X^c)(1-\rho_t)]a + [\rho_{t-1}\phi_{t-1}S_{t-1} + \rho_t S_t]p. \tag{27}$$

$$\frac{\partial GDP_t}{\partial p} = \rho_{t-1}(1-\rho_t) + 2\rho_t + [(p - F_t(X^c)a) + (1-\rho_{t-1})(p - F_{t-1}(X^c)a)]\frac{\partial \rho_t}{\partial p} > 0.$$

Appendix 6

$$\frac{\partial \phi_t}{\partial d} = -\frac{1}{\left(1+\frac{d}{\phi_{t-1}J_y+(1-\phi_{t-1})J_o}\right)^2} \times \frac{1}{\phi_{t-1}J_y+(1-\phi_{t-1})J_o} < 0. \tag{28}$$

$\frac{\partial TU_t}{\partial d} > 0.$

$$\frac{\partial GDP_t}{\partial d} = [(p - F_t(X^c)a) + (1-\rho_{t-1})(p - F_{t-1}(X^c)a)]\frac{\partial \rho_t}{\partial d} < 0. \tag{29}$$

Chapter 3

Contents

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Trade and Labor Market Imperfection:

A Model with Status Conscious Preference[1]

In the previous chapter, the theoretical model shows that an economy with status conscious individuals can yield unemployment in equilibrium even if it consists of two types of labor markets, one exhibits search friction, while the other is perfectly competitive. On the basis of that theoretical set up, present chapter develops a model of trade. More explicitly this chapter comprehends, if such (as described above) a single factor economy, with one non-traded final good and two traded intermediate goods, opens up to trade then the difference in the degree of the labor market imperfection becomes a source of comparative advantage between two otherwise identical countries. Moreover, we questions the classical trade theoretical results with our findings in the given set up. Complete specialization is impossible in such an uninhibited set up. Moreover, trade does not equalize wages within the country, neither does it guarantee the reduction of

[1] This chapter is based on Mazumder (2015).

unemployment. Subsequent sections elucidate the theoretical set up in detail and characterize completely the equilibrium for both autarky and free trade situation. After that the trade results are explained and simulation results are summarized.

3.1. The Model

This section is set to describe a three-goods and one factor general equilibrium model in a discrete time framework. The following sub-sections elaborate the different minutiae of this model.

3.1.1. Basic Structure

In our hypothetical economy there are infinitely lived firms and single period lived individuals. At the beginning of a period, a new generation joins the economy and the previous generation ceases to exit. The total mass of each generation is normalized to unity (thus in our economy there is no population growth). An individual, i, receives some inheritance $(X_t(i))$ from her previous generation. $G_t(X)$ proportion of people who has less than or equal to X amount of inheritance. Thus $G_t(X)$ is the endogenously determined distribution of inheritance over the entire population. Every individual derives utility (U) from consumption (c) and bequest (b) kept for her next generation. Both of these economic activities are done by using only one non-perishable final good, F. The final good is produced by two intermediate goods, namely m and n. m is assumed to be an organized sector product, whereas n is assumed to be produced in the unorganized sector. Although this unorganized sector is economically productive, and hence remunerative, working in this sector is against the social status. Social stigma brings a disutility with the choice of working in the unorganized sector.

In this model, firms, in the two intermediate goods sectors and one final good sector, work like infinitely lived institutions. Only labor is employed to produce intermediate goods. Each individual supplies one unit of labor inelastically to the economy. Organized sector firms, at the beginning of each period, face a search and matching friction to get productive workers. They post costly vacancies at each period, but the return from that particular period depends on whether the firm can successfully match with a laborer or not. Since, firms stay in the economy for infinitely large number of periods, losses from unlucky situations are compensated by gains from lucky situations. This friction can arise due to many reasons. Following Pissarides (2000), worker and firm are uncoordinated, hence the process of their matching is time consuming and costly. In addition to that, in many countries organized sector is less in size and dispersed, that makes the worker firm match more uncertain. Due to different administrative and economic reasons, the job firing is also not instantaneous. Thus, the organized labor market does not become frictionless.

The unorganized sector of the economy consists of a frictionless labor market. Firms in this sector behave like standard competitive sector firms with free entry and exit (it can also be thought of as a worker's self-entrepreneurial sector). The final good is produced with the two intermediate goods in a perfectly competitive set up.

3.1.2. Time sequence

We first explicate the sequence of events within a period. As mentioned earlier, workers (as well as consumers) live for a single period. A representative individual, born at the very beginning of a period is endowed with the inheritance which had been kept as bequest by her predecessor. Given her inheritance level she takes her occupational decision by maximizing expected utility (in the next subsection the particulars of this decision making process have been discussed in more detail).

From this optimization exercise of a representative individual, number of organized sector job-searcher in the equilibrium is determined. Vacancies are posted by the organized sector firms to get worker. Since the individuals live for a single period, at the start of a period each organized sector firm is vacant. A firm of this sector pays the cost of posting a vacancy before the initiation of search. Thus, a matching takes place between the vacant firms and the job seekers.

Matched firm-worker pairs start production immediately. Unmatched searchers either gets employed in the unorganized sector to produce or remain unemployed. Unmatched firms of the organized sector, on the other hand, are compelled to wait for that period without receiving any positive return. Unsuccessful firms of a period may join the search activity in the next period by again paying the cost of posting vacancy.

Before the end of the period matched firms and workers of the organized sector share the surplus through bargaining for operational profits and wages respectively, and unorganized sector workers get their competitive wage. At the end of the individuals' life span they consume and keep bequest for their successor, and receive utility. A particular period ends with the death of the representative individual.

3.1.3. Utility

An individual, i, born at time period t, is assumed to have a simple Cobb-Douglas type preference structure with a disutility term:

$$U_i = \frac{1}{\alpha^{\alpha}(1-\alpha)^{1-\alpha}} c^{1-\alpha} b^{\alpha} - DkX_i \text{ with } \alpha \in (0,1) \text{ and } k > 0. \quad (1)$$

Notations are as specified before. In this model individuals do not have the option of monetary savings. Hence they exhaust all the monetary income, which they earn by supplying labor, to purchase the final good and to make bequests. D acts as a decision dummy. It takes the value unity if the individual works in the unorganized sector, otherwise it assumes the value zero. Clearly the individual gets a disutility from working in the unorganized sector. The disutility level increases in a proportion, k with the level of X. Here inheritance (which is actually a good indicator of the wealth of a particular dynasty) appears in the utility function as a symbol of social status. This assumption implies that everyone in this economy is conscious about their societal position and thus, each of them has the stigma associated with the unorganized job. However, the social cost of choosing an unorganized job is increasing with the level of inheritance to the individuals.

Individual optimally chooses c, b and D to maximize her utility given her wealth. She does the optimization sequentially. At the first stage she maximizes her utility by choosing optimal c and b given any D. After that optimal D is decided. Hence, the determination of D leads to the occupational decision choice. This optimization exercise is done by the individual at the beginning of the period, by maximizing her expected utility. Section 3.2 explains the equilibrium decisions in length.

3.1.4. Organized sector

It is presumed that perfect competition is present in the product market of m good but not in the factor market. The latter consists of a search friction. Each firm of this sector can post only a single vacancy for a period. The existence of uncoordinated search process (or, search friction) prevents firm and labor (remember, at the beginning of a period individuals are also looking for jobs) to be matched instantaneously and with certainty. Job search is a time consuming, uncertain and costly process. So it may well be the case that, on the one hand, some of the vacant posts fail to get filled up by a worker, while on the other hand some worker remains jobless after an active search. To capture this real feature Pissarides type matching modeling device has been introduced in this model. More specifically we assume that

$M_t \equiv M(u_t, v_t)$.

where, M_t is the proportion of the population who are matched at time t, u_t is the proportion of searching population in the total population at time t and v_t is the ratio of total number of vacancy and total population at time t. It is assumed that M is homogenous of degree one, increasing in each argument and concave.

Hence, $\frac{M_t}{u_t} = M(1, \theta_t)$ and $\frac{M_t}{v_t} = M(\theta_t^{-1}, 1)$.

Where, $\theta \equiv \frac{v}{u}$. That means that in a particular period an organized sector's firm may not get a worker with a positive probability $(1 - M(\theta_t^{-1}, 1))$. At period t, a job seeker in this sector remains jobless with probability $(1 - M(1, \theta_t))$.

Once a firm and a worker are matched then the production of good m takes place. Firms of this sector utilize a production technology where one unit of labor produces a_m units of the m good. In this sector, market imperfection prevails in the distribution of surplus also. Costly search friction generates a positive rent. Both firms and workers have a bargaining power and the revenue is shared through Nash Bargaining. The next two subsections describe the cost and benefit of the firms and the workers respectively.

3.1.5. Firms

To post a single vacancy in this sector, a firm has to incur a positive cost (d) in terms of the final good. However, that does not guarantee a worker to the vacant firm. After posting the vacancy that firm ensures the position in matching process as a vacant firm. As a result of search, if a particular firm gets a worker then that firm can commence production, otherwise the firm receives nothing.

Although a firm can produce for a single period at a time (since a worker is a single period lived individual), but stays infinitely in the economy. Let V_t be the life time expected return from a vacant post to an organized sector firm[2] and J_t be the gain from a filled post to a firm at time t.

$$V_t = -p_{Ft}d + M(\theta_t^{-1}, 1)J_t + V_{t+1}$$

$$J_t = (p_{mt}a_m - w_{mt}) \tag{2}$$

Where, p_m and p_F are the price of m and F respectively, and w_{mt} is per period wage of this sector at time t.

Free entry condition guarantees that new firms enter the market as long as V_t remainspositive and leaves if V_t becomes negative. Hence in equilibrium, we fix V_t at zero. That implies the following:

$$M(\theta_t^{-1}, 1) = \frac{p_{Ft}d}{J_t} \tag{3}$$

Notice, an increase in cost of posting vacancy, $p_{Ft}d$, leads to an exit of firms to avoid the negative return from a vacant firm. That decreases the number of vacancies in the matching process. Interestingly, that action makes the situation easier for the existing firms. Probability of getting a worker to a particular vacant firm rises (since, matching function is concave) after the departure of some firms and that brings return from vacancy back to zero. Exit of a firm in this frictional labor market creates a positive externality for the rest of the firms. This is the ‘congestion

[2] Just to keep the model less notation heavy, it is assumed that discount factor is equal to unity. The main results remain unperturbed with the inclusion of fractional discount factor.

externality'[3] of the matching framework which the agents do not endogenize while decisions are taken. This holds equally for the job seekers as well.

3.1.6. Workers

Similar to a firm, an individual who wants to supply her labor in m sector, faces a random matching process before getting employed. Once a worker successfully matches with a firm, she can deliver her single unit of labor and receive the wage in return. On the other hand if she is unsuccessful and fail to get a vacant firm she will receive nothing from the organized sector. Unlike firms, for simplicity, there is no search cost for a worker.

As stated earlier, both the agents of this sector have some positive bargaining power. Total revenue from production is distributed among firm and worker by Nash Bargaining.

Outside option is not considered for the agents in the bargaining process. This model derives the main results using the labor market friction and wage differential between organized and unorganized sector. In equilibrium, the wage difference in favor of the organized sector is guaranteed from the existence of the search friction and the demand structure for the intermediate goods (see section 3). Inclusion of the uniform outside option does not change the results of our analysis significantly. More importantly it does not jeopardize the properties of the equilibrium, but make the algebra little cumbersome (see Appendix 6). It is assumed that the information of the wealth of each agent is not common to the firm. So, the bargaining take place only on the basis of the wage and productivity of a job match in the economy. This assumption helps to avoid the

[3]Hosios (1990)

unrealistic situation of differential wage rate on the basis of heterogeneous wealth having the skill level unaltered.

Hence, we, here, confine our discussion without considering the outside option for the agents.

$$w_{mt} = \arg\max_{w_{mt}} (w_{mt})^{\beta}(J_t - V_t)^{1-\beta}$$

i.e. $w_{mt} = \arg\max_{w_{mt}} (w_{mt})^{\beta}(p_{mt}a_m - w_{mt})^{1-\beta}$. (This step follows from the free entry condition).

That is,

$$w_{mt} = \beta p_{mt}a_m. \quad (4)$$

Hence from equation (2)

$$J_t = (1-\beta)p_{mt}a_m. \quad (5)$$

So initially (ex-ante) expected gain to a worker from this sector is $M(1, \theta_t)w_{mt}$.

3.1.7. Unorganized sector

Good n, the other intermediate good, is produced and marketed in a perfectly competitive setup. Frictionless factor market of this sector guarantees full employment. An individual, who chooses to work in the n-sector can be matched instantaneously with a job. The same also holds for a firm looking for a worker and they can immediately start producing. To commence production, a firm need only labor. Production technology is assumed to follow constant return to scale (CRS): a single unit of labor can produce a_n units of the n good.

In this sector, unrestricted entry of firms with no bargaining power equates factor payment with the value of its marginal product. Therefore per period wage of unorganized sector (w_{nt}) is$p_{nt}a_n$, where price of n isp_{nt} at period t, and firms are making zero profit.

Therefore,

$$w_{nt} = p_{nt}a_n. \tag{6}$$

3.1.8. Final good's sector

Final good (F) sector uses the two intermediate goods as factors (m and n) from a frictionless market. The production function of F good is given by,

$$F_t = m_t^{\gamma} n_t^{1-\gamma} \tag{7}$$

This non-perishable good is sold in a perfectly competitive market. So, F sector firms make zero profit in each period. The intermediate goods prices are determined by equating demand and supply.

3.2. Equilibrium in Autarky

The individuals' optimization decision is solved in the subsequent subsections and the prices of m, n and F is determined under autarky, endogenously.

3.2.1. Optimal decisions of the individual

Since ex-ante (at the beginning of her life span) the level of income is uncertain to an individual, she takes her decision by the optimizing her expected indirect utility function.

There exists an uncertainty in the organized sector's labor market. So, the expected wage rate ($M(1, \theta_t)\beta p_{mt} a_m$, which is derived in equation 4) of this sector should be greater than or equal to the unorganized sector wage rate ($p_{nt} a_n$, from equation 6). If this does not hold then, in equilibrium, labor will not be supplied to m-good sector and hence, the m-good cannot be produced. Due to the Cobb-Douglas type production function of the final good, each intermediate good is essential and therefore, demand pulls the price of good m and wage rate prevailing in that sector rises, such that individuals optimally select to supply their labor in the organized sector. This in turn implies, organized sector job is more lucrative than the unorganized sector job to all individuals. Since search is not costly for the workers and does not preclude the opportunity to work in the unorganized sector, in equilibrium each worker participates in the search process of the organized sector.

Thus we have the following proposition:

Proposition 1: In equilibrium wage of the organized sector is higher than the unorganized sector and each individual searches for the organized sector job.

Therefore,

$$u_t = 1. \tag{8}$$

In the second stage, those who remain unmatched after the search process, decides whether to join unorganized sector or to continue as an unemployed person. An individual, in this model, with a very high level of inheritance has a proportionally higher level of disutility for working in the unorganized sector. Compared to the gain from the wage of the unorganized sector, this disutility is smaller for the individuals who have lesser inheritance. Appendix 1 proves that there exists a critical level of inheritance (X^c) which is $\frac{w_{nt}}{kp_{Ft}}$, that makes the marginally unmatched worker indifferent between taking up an unorganized sector job and remaining unemployed. If the agent has $X \leq \frac{w_{nt}}{kp_{Ft}}$ then she opts for the unorganized job after being 'unlucky'. On the other hand, if her inheritance, X, is greater than $\frac{w_{nt}}{kp_{Ft}}$ then she chooses to remain as unemployed. Intuition behind this is, higher status in the society gives more disutility for working in the unorganized sector.

Proposition 2: Individual with higher inheritance remains unemployed. $\frac{w_{nt}}{kp_{Ft}}$ is the cut-off level of inheritance, below which remain unemployed is suboptimal.

Individuals face an ex-anti income uncertainty due to friction in the labor market of organized sector, and that leads to the problem of occupational choice where individuals take decision on the basis of their expected wealth. However, at the end of an individual's life span there is no uncertainty related to her wage income. So, she can determine her consumption and bequest level given her total wealth. Her wealth includes the wage she earned and the inheritance she received. Since utility can be derived only in terms of the final good, individuals transform their wages into F-good.

Maximizing (1) with respect to the budget constraint, $c_t + b_t = \frac{w_{it}}{p_{Ft}} + X_t$, optimal consumption and bequest level can be written as follows. Where, $i \in \{m, n\}$.

$$c_t = (1-\alpha)(\frac{w_{it}}{p_{Ft}} + X_t)$$

and, $b_t = \alpha(\frac{w_{it}}{p_{Ft}} + X_t)$.

3.2.2. Intermediate goods market

Both the intermediate goods are produced using CRS technology, and hence, the aggregate production of each good equals the total number of laborers working in that particular sector multiplied by the marginal productivity (in this single factor case which is also the average productivity) of labor.

Total supply of good-m, at period t, denoted by S_{mt}, is therefore $M_t a_m$, where M_t is the total number of individuals who are matched with an organized sector job at period t. From the rest of the population (i.e. $1 - M_t$) workers with inheritance level belowX_t^c, i.e. $G_t(X_t^c)$,works in the n good sector at period t. Since at any particular period matching and remaining below $X^c$are two independent events, total labor supply for the unorganized sector is, therefore, equal to$(1 - M_t)G_t(X_t^c)$. Hence,$(1 - M_t)G_t(X_t^c)a_n$ is the total supply of good n for the t^{th} period. This is denoted by S_{nt}. So, the relative supply of m and n is,

$$\frac{S_{mt}}{S_{nt}} = \frac{M_t a_m}{(1-M_t)G_t(X_t^c)a_n} \qquad (9)$$

Proposition 3: Relative supply of the intermediate goods depends on the distribution of inheritance.

Relative supply of the intermediate goods depends crucially on how many number of individuals goes to work in the unorganized sector. That number is determined by the distribution of the wealth of the economy. Note, people with sufficiently high inheritance level do not choose to join unorganized sector job even after not getting a job in the organized sector. Therefore, if the economy is skewed towards the higher income class then, ceteris paribus, the supply of good-n is relatively low in that economy than an economy which is skewed towards the lower income class.

Demand for the intermediate goods is generated from the final good sector. Producers of the F good minimize their cost of production by choosing m and n optimally in accordance with the prices of these two intermediate goods. The producers minimize $p_{mt}m + p_{nt}n$, which is the total cost subject to the technology constraint given in equation (7). That yields the following relative equation:

$$\frac{D_{mt}}{D_{nt}} = \frac{\gamma}{1-\gamma}\left(\frac{p_{nt}}{p_{mt}}\right) \tag{10}$$

Where, D_i is denoted as demand of the i^{th} good, ($i = \{m, n\}$).

3.2.3. Market Equilibrium

The equilibrium of the product market is characterized by equalizing relative demand relative supply. Using the equations (9) and (10) the following can be obtained:

$$\frac{p_{nt}}{p_{mt}} = \frac{1-\gamma}{\gamma}\frac{M_t}{(1-M_t)G_t(X_t^c)}\frac{a_m}{a_n}. \tag{11}$$

From equation (3) and equation (5), a relation between relative price and matching function can be derived:

$$M(\theta_t^{-1}, 1) = \frac{1}{1-\beta}\frac{d}{a_m}\frac{p_{Ft}}{p_{mt}}. \tag{12}$$

On the other hand zero profit condition in the product market of F good implies the equality between the total costs of production and the total revenue from production.

That is, $p_{Ft}F_t = p_{mt}m_t + p_{nt}n_t$. Equations (10) and (7) can be used to show (Appendix 2):

$$\frac{p_{Ft}}{p_{mt}} = A\left(\frac{p_{nt}}{p_{mt}}\right)^{1-\gamma} \tag{13}$$

Where $A \equiv \left(\left(\frac{\gamma}{1-\gamma}\right)^{1-\gamma} + \left(\frac{\gamma}{1-\gamma}\right)^{-\gamma}\right)$ is a constant parameter.

Again, critical inheritance level X_t^c can be written as following:

$$X_t^c = \frac{a_n}{k}\frac{p_{nt}}{p_{mt}}\frac{p_{mt}}{p_{Ft}}.$$

And hence using (13),

$$X_t^c = \frac{a_n}{Ak}\left(\frac{p_{nt}}{p_{mt}}\right)^{\gamma}. \tag{14}$$

Equation (12) can also be transformed into a function of the ($\frac{p_n}{p_m}$) and that takes the following form:

$$M(\theta_t^{-1}, 1) = \frac{A}{1-\beta}\frac{d}{a_m}\left(\frac{p_{nt}}{p_{mt}}\right)^{1-\gamma}. \tag{15}$$

Using Equation (11), (14) and (15), $\frac{p_{nt}}{p_{mt}}$ can be solved in short run[4]. Following is the analytical description. The determination of inheritance is generated from an inherent assumption: $X_{t+1} = f(b_t)$, that is, inheritance of any period can be generated only from the bequest, kept in the previous period (bequest motive has enough empirical support as well; e.g. Wilhelm (1996); Altonji et al. (1997); Carroll (2000)). Here, for simplicity, it is assumed that $X_{t+1} = b_t$. Therefore, G_t, the distribution of inheritance, is determined from period $(t-1)$'s bequest activity of the agents (detailed discussion about G_t is kept for the next subsection). By replacing the expression of X_t^c from equation (14) to equation (11), the equation (11) can be written in terms of M_t and $\frac{p_{nt}}{p_{mt}}$. Again, equation (15) expresses M_t as a function of $\frac{p_{nt}}{p_{mt}}$, where M_t is a function of only v_t in equilibrium (since, $u_t = 1$ in equilibrium and hence, $\theta = v$). Since, G_t, the known inheritance distribution at period t, is a rising function of $\frac{p_{nt}}{p_{mt}}$ and M_t is decreasing function of $\frac{p_{nt}}{p_{mt}}$ (from equation (15)), therefore RHS of equation (11) is a monotonically falling function of $\frac{p_{nt}}{p_{mt}}$. The LHS of equation (11) is a 45° line in terms of $\frac{p_{nt}}{p_{mt}}$. Hence, for any period t, $\frac{p_{nt}}{p_{mt}}$ can be solved. Now all the endogenous variables are determined, and by this, characterization of the model is complete for short run.

3.2.4. Dynamics of inheritance distribution function (G)

This subsection is devoted to explain the dynamic path of different dynasties with respect to their wealth levels. In other words, given the inheritance level in period t we study the behavior of the inheritance of the dynasty in period $t+1$. As it is mentioned above, inheritance of $(t+1)^{th}$ period

[4] Given the information of $(t-1)$, all the endogenous variables can be determined at period t. This is defined as the short run solution in this model. Latter, a discussion follows to explain the time independent solution of the model which is characterized as the long run steady state solution.

is determined by the bequest activity of previous period (b_t). From subsection 3.2.1. we have seen the bequest level, b_t, is equal to the α proportion of the total wealth of the individual which is, again, a function of X_t. Hence, a dynamic path of the inheritance can be determined. The corresponding stochastic dynamic equations are stated below.

If$X_t \leq X^c$,

$$X_{t+1} = \alpha\left(X_t + \frac{w_{mt}}{p_{Ft}}\right), \text{ with probability } M(1, \theta_t) \qquad \text{(I)}$$

$$X_{t+1} = \alpha\left(X_t + \frac{w_{nt}}{p_{Ft}}\right), \text{ with probability } (1 - M(1, \theta_t)) \qquad \text{(II)}$$

If $X_t > X^c$,

$$X_{t+1} = \alpha\left(X_t + \frac{w_{mt}}{p_{Ft}}\right), \text{ with probability } M(1, \theta_t) \qquad \text{(I)}$$

$$X_{t+1} = \alpha(X_t), \text{ with probability } (1 - M(1, \theta_t)) \qquad \text{(III)}$$

The difference equation (I) shows that if the agent receives the opportunity of working in the organized sector, her wealth is $\left(X_t + \frac{w_{mt}}{p_{Ft}}\right)$ for all X_t at the end of her life. Cases (II) and (III) depicts situations when the inheritance level plays a key role. First let us consider $X \leq X^c$. Individual works in unorganized sector if she remains unmatched after the search. So, total wealth is $(X_t + \frac{w_{nt}}{p_{Ft}})$ with probability $(1 - M_t)$. Again, if $X_t > X^c$, optimal decision dictates the agent to stay as unemployed (jobless) when she does not get employment in the organized sector after an active search. Hence her wealth remains X_t and this is shown by (III).

Note that, the distribution of inheritance is altered by the price ratios from the three aspects. The wage income of the individuals, probability of matching with the vacant organized sector firms and the cut off level of inheritance, all these three are the function of the price ratios.

The equations are depicted in the following figure (Figure 2.1.).

The bold lines I, II, III represent the difference equations I, II and III respectively. The above figure (Figure 2.1) is drawn by imposing suitable parametric restrictions such that we can concentrate on the case where in long run unemployment prevails in the economy.

Let us call them 'poor' whose inheritance level is in between $(0, X^c)$ and 'rich' whose inheritance

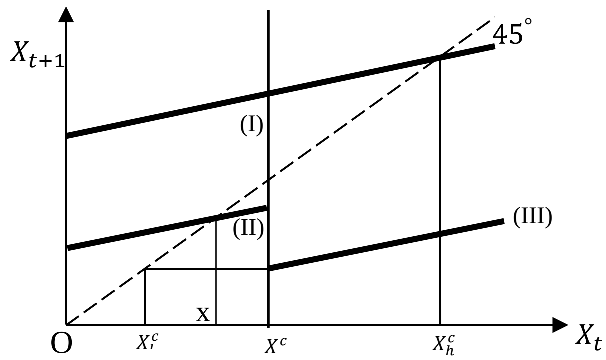

Figure 2.1.: Inheritance Dynamics

level is above X^c. From Figure 2.1 one can obtain the following observation. An individual who herself initially starts as poor may bring her next generation to the richer section with positive probability if she gets an organized sector job. If she does not get the unorganized sector job (according to this parametric restriction), her next generation will not find herself in the richer class. In the reverse case, a rich agent may put her next generation into the poorer section, if she fails to match with an organized sector firm. This tells us that people always face a positive probability (until the probability value of getting matched or unmatched in the organized sector hits zero or one) of changing her social status. Hence in this model, the economic mobility from rich (higher status) to poor (lower status) depends mostly on the degree of labor market inefficiency of the organized sector.

$$P(X_{t+1} > X^c | X_t > X^c) \quad = \begin{cases} M(1, \theta_t), & \text{if} X^c < X_t < \left(\frac{w_{nt}}{p_{Ft}\alpha k}\right) \\ 1 & \text{if,} \quad X_t > \frac{w_{nt}}{p_{Ft}\alpha k} \end{cases}$$

$$P(X_{t+1} > X^c | X_t < X^c) \quad = \begin{cases} M(1, \theta_t), & \text{if} \quad \left(\frac{w_{nt}}{p_{Ft}\alpha k}\right) - \frac{w_{mt}}{p_{Ft}} < X_t < X^c \\ 0, & \text{if,} \quad X_t > \frac{w_{nt}}{p_{Ft}\alpha k} \end{cases}$$

Proposition 4: Long run distribution of inheritance cannot be polarized and it remains bounded.

These above stated equations are the determinants of the dynamics of wealth distribution. Due to such stochastic nature, wealth distribution can never be polarized. However, in this model income distribution cannot go out of bound in long run too. It is not difficult to prove[5] that after a finite time, inheritance of all individual come within the interval $[X_l^c, X_h^c]$ (shown in Figure 2.1), provided probability value of getting organized sector job remains strictly positive and non-unitary.

Starting from any initial income, the labor market search friction in our model randomizes the next point of the inheritance path. That evident feature not only rescues a dynasty from getting stagnated into a particular income class but also stops the long run income path from being concentrated (or polarized) in some particular point or points (c.f. Galor and Zeira (1993)) or mutually exclusive small intervals (c.f. Grossman (2008)) on the income stream.

[5] From figure 2.1, the idea behind the proof can be identified intuitively. Any particular value of X which is greater than X_h^c, can be on line II or line III in the next period. It would get maximum after infinitely many iteration, if at every successive period it lies on line II, and then also it will converge at X_h^c. Similar argument holds for any value of X less than x. The truncation of line III allows the distribution to move up to X_l^c.

Discussions on income dynamics, invariably, questions about the convergence issue. Galor, (1996) pointed out that, debates related to the convergence of income distribution focuses on the validity of the three competing hypothesis: absolute convergence, conditional convergence and club convergence. Definition of the absolute convergence is the following: per capita incomes of countries converge to one another in the long-run independently of their initial conditions. Whereas conditional convergence means that per capita incomes of the countries that are identical in their structural characteristics converge to one another in the long-run independently of their initial conditions. Club convergence claims per capita incomes of the countries with identical structural characteristics to converge to one another in the long-run provided that their initial conditions are similar as well.

According to the above classification our hypothetical economy can converge conditionally. Because of its dynamic stochastic nature, the steady state distribution cannot be figured out analytically. By simulating the model, the convergence of the inheritance distribution is examined and it is shown that the initial income distribution is isolated from the long run income path (as in Loury (1981)). Simulation results show that for certain parametric specification the inheritance distribution converges in the long run. All the simulation results are described in section 3.6.

3.3. Long Run Equilibrium

Long run equilibrium is defined as a steady state solution where all the endogenous variables are solved time independently. The previous section has demonstrated the dynamics of the inheritance distribution and the corresponding transitional probability values. This exercise constructs a dynamic path, because the only source of time dynamics in this model is the inheritance distribution. The simulation results (displayed in section 3.6) guarantees that at least for some parametric specifications wealth distribution converges in the long run. So, G_t can be replaced by the long run wealth distribution, G. (As a function of $\frac{p_{nt}}{p_{mt}}$, the direction of the change in the distribution function remains the same corresponding to the change in $\frac{p_{nt}}{p_{mt}}$ both in the short run and in the long run.) Therefore, now the model can be solved for the long run time independent steady state. The technique for solving the long run equilibrium of the model is, otherwise, not much different with the short run solution. The economy is described in the long run steady state, using equations (11), (14) and (15), by dropping the time subscript. Thus,

$$\frac{p_n}{p_m} = \frac{1-\gamma}{\gamma}\frac{M}{(1-M)}\frac{a_m}{a_n}\frac{1}{G\left(\frac{a_n}{Ak}*\left(\frac{p_n}{p_m}\right)^{\gamma}\right)} \quad (16)$$

and, $M(\theta^{-1}, 1) = \frac{A}{1-\beta}\frac{d}{a_m}\left(\frac{p_n}{p_m}\right)^{1-\gamma}$ (17)

Clearly, right hand side (RHS) of the equation (16) is a continuous and monotonically decreasing function of $\frac{p_n}{p_m}$, this is because from equation (17) it is evident that increase in $\frac{p_n}{p_m}$ actually brings the equilibrium vacancy posting down and therefore M falls and $G(.)$ increases with an increase in $\frac{p_n}{p_m}$. At the steady state, equation (16), therefore, solves for an equilibrium value of the relative price of the intermediate goods (appendix 3 contains some more details). Now the model has been solved in autarky for both short run (shown in subsection 3.2.) and for long run as well.

Proposition 5: Unique equilibrium exists in autarky.

It is to be noted that, both in the short run and the steady state equilibrium price ratio, $\frac{p_n}{p_m}$, depends not only on the production parameters but also on the distribution of wealth and labor market parameters. If an economy consists of more rich people, then correspondingly higher status effect drives the economy to produce less unorganized sector good by supplying fewer labor towards this sector. That leads to a higher price level of the unorganized sector good. Again, if a labor market demands higher cost for posting a vacancy in organized sector then lesser firms can afford to post vacancy (since return from a vacant firm falls) and therefore, production of organized sector falls. Therefore, in the long run, price level may also vary due to such labor market differences.

3.3.1. Aggregate equilibrium unemployment in autarky

The aggregate steady state level of equilibrium unemployment in autarky in our model is

$$\mathrm{TU} = (1 - \mathrm{M})(1 - \mathrm{G}(\mathrm{X}^{c})). \tag{18}$$

$$\text{or, } \mathrm{TU} = \left(1 - \mathrm{M}\left(\left(\frac{p_n}{p_m}\right)^{1-\gamma}\right)\right)\left(1 - \mathrm{G}\left(\frac{a_n}{Ak} * \left(\frac{p_n}{p_m}\right)^{\gamma}\right)\right)$$

The first term shows the number of unmatched individual and the second term is the proportion of the population lies above X^{c}. Therefore, the aggregate equilibrium unemployment in this model depends on the distribution of inheritance. Although G is a positive function of $\frac{p_n}{p_m}$, but M has a negative relation with $\frac{p_n}{p_m}$. So, the change in TU with respect to the change in $\frac{p_n}{p_m}$ is ambiguous and depends on the price elasticity of the distribution function of wealth and of the matching function.

Proposition 6: Aggregate unemployment depends on the distribution of inheritance and labor market inefficiency.

3.4. Two Country Framework

In this section the scope of opening up to trade is explored. The main objective behind this investigation, is to check, which are the possible changes may come into the classical trade results if the two almost identical countries interact with each other through trade in this framework. Importantly, this model can also address the impact of trade on unemployment. For these purpose, first we need to characterize this model into two country set up (which is the focus of this section) and then we enter into the trade part (kept in section 3.5).

Let us assume that there are only two countries in the world, home (h) and foreign (f). Both the countries have the same technology of production, factor endowment level and preference structure. The lone difference among the two countries is in the degree of labor market imperfection in the organized sector. Even between these two otherwise identical countries relative price ratios of tradable goods may differ. Firms located in h are paying less, in real terms, to post a vacancy than in the firms of f (so, $d^f > d^h$). This means, commencing production of good m is more difficult (costly) in foreign than in home. Therefore, number of vacancies posted in f, v_t^f,for each $\frac{p_{nt}^f}{p_{mt}^f}$ is less than that of h (from equation (17)). Since the preference structure of the individuals in h and f are same, the number of job seekers in the organized sector labor market also remains same: $u^h = u^f = 1$. Consequently for each $\frac{p_{nt}^f}{p_{mt}^f}$, lesser number of successful matches are realized in 'f' in equilibrium due to the increasing nature of the matching function. Right hand side of the equation (16) in the case of foreign country, remains smaller for all $\frac{p^f_{nt}}{p^f_{mt}}$ compared to h.

For the foreign country (16) and (17) are the following

$$\frac{p^f_n}{p^f_m} = \frac{1-\gamma}{\gamma}\frac{M^f}{(1-M^f)}\frac{a_m}{a_n}\frac{1}{G^f\left(\frac{a_n}{Ak}\left(\frac{p^f_n}{p^f_m}\right)^{\gamma}\right)}, \tag{19}$$

where $M^f \equiv M(1, v^f)$, since $u^f = 1$ as in the case of home, in equilibrium. Above discussion proves $M > M^f$.

$$M\left(\theta^{f^{-1}}, 1\right) = \frac{A}{1-\beta}\frac{d^f}{a_m}\left(\frac{p^f_n}{p^f_m}\right)^{1-\gamma}. \tag{20}$$

Since $d^f > d^h$, for any price ratio of the intermediate goods ($\frac{p^f_n}{p^f_m}$), LHS of equation (20) is higher than LHS of equation (17). That implies $v^f < v^h$ in autarky and hence $M^f < M^h$ for each $\frac{p_n}{p_m}$. Note that the wealth distribution function contains a superscript 'f'. Simulation exercise shows that the steady state wealth distribution changes for the change in the real cost of posting vacancy (that is d). Typically for most of the values of X, $G^h(.) \leq G^f(.)$ (this is discussed in detail latter in Section 3.6). Given $M^f < M^h$ and $G^h(.) \leq G^f(.)$, for each value of ($\frac{p^f_n}{p^f_m}$), RHS of equation (19) is lesser than RHS of equation (16).

Thus, the above analysis proves that, in equilibrium, $\frac{p^h_n}{p^h_m} > \frac{p^f_n}{p^f_m}$. Since the two countries have identical market setup in the final good sector, equation (13) hold, for the foreign country as well. That leads to the similar directional result for the price of final good: $\frac{p^h_F}{p^h_m} > \frac{p^f_F}{p^f_m}$.

Proposition 7: Trade can open up between two otherwise similar countries due to the difference in the degree of labor market imperfection. As trade opens up, home and foreign will export m and n good respectively.

3.5. Trade Equilibrium and results

Previous section has demonstrated the possibility trade may open up among identical nations. If home and foreign agree to trade freely then the intermediate goods can be exchanged among themselves successfully. Let us allow the two economies to participate in trade. Since the relative price of good n is higher in home country than foreign, good n is exported from foreign to home and good m is exported from home to foreign in this free trade environment. This arbitrage equalizes the price ratios of the intermediate goods of the two the countries.

The equilibrium price is determined where the world demand is equated with the world supply of the intermediate goods. It is pretty straightforward to verify that world relative supply of the intermediate goods is the following:

$$\frac{S_m^W}{S_n^W} = \frac{(M^{T^h} + M^{T^f})a_m}{\left(\left(1-M^{T^h}\right)G^{T^h}\left(\frac{a_n}{Ak} * \left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right) + \left(1-M^{T^f}\right)G^{T^f}\left(\frac{a_n}{Ak} * \left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right)\right)a_n},$$

and the world relative demand is:

$$\frac{D_m^W}{D_n^W} = \frac{\gamma}{1-\gamma}\left(\frac{p_n^T}{p_m^T}\right).$$

Where $M^{T^j} \equiv M\left(1, v^{T^j}\right)$, since $u^{T^j} = 1$ (let $j = \{h, f\}$) and superscript T is used as a notation for trade. As final good sector is a non-traded goods equation (13) still holds for both the country.

Producer of good F takes the price ratio of the intermediate goods as externally given. (This analysis assumes steady state).

Using the following three equations equilibrium $\frac{p_n^T}{p_m^T}$ in free trade situation can be solved

$$\left(\frac{p_n^T}{p_m^T}\right) = \frac{1-\gamma}{\gamma}\frac{(M^{T^h}+M^{T^f})a_m}{\left(\left(1-M^{T^h}\right)G^{T^h}\left(\frac{a_n}{Ak}*\left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right)+\left(1-M^{T^f}\right)G^{T^f}\left(\frac{a_n}{Ak}*\left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right)\right)a_n} \quad (21)$$

Correspondingly labor market equations of the organized sectors of the two countries become the following:

$$M\left(\theta^{T^{f^{-1}}},1\right) = \frac{A}{1-\beta}\frac{d^f}{a_m}\left(\frac{p_n^T}{p_m^T}\right)^{1-\gamma} \quad (22)$$

$$M\left(\theta^{T^{h^{-1}}},1\right) = \frac{A}{1-\beta}\frac{d^h}{a_m}\left(\frac{p_n^T}{p_m^T}\right)^{1-\gamma} \quad (23)$$

Hence, a free trade equilibrium price level can be solved from equations (21), (22) and (23). From equation (13) it can be seen that, price ratio of the final good and the m-good ($\frac{p_F^T}{p_m^T}$) of two countries are also equalized in the free trade regime.

Proposition 8: Unique equilibrium exists in free trade situation.

Given a unique price level exists in the free trade situation, from equations (22) and (23) it can be written that:

$$\frac{M\left(\theta^{T^{f^{-1}}},1\right)}{d^f} - \frac{M\left(\theta^{T^{h^{-1}}},1\right)}{d^h} = 0.$$

$\mathrm{M}\left(\theta^{\mathrm{T^f}^{-1}}, 1\right) > M\left(\theta^{\mathrm{T^h}^{-1}}, 1\right)$, (since $d^f > d^h$).

Since $u^j = 1$, to hold the above equation following condition must be satisfied,

$$v^{T^h} > v^{T^f}. \tag{24}$$

Therefore, after trade vacancy posting by the organized sector firms, and hence the production of the m-good (since M is an increasing function of it arguments), remain higher in the home country in comparison with the foreign.

Equation (21) can be re-written as follows

$$\left(\frac{p_n^T}{p_m^T}\right) = \frac{1-\gamma}{\gamma} * \frac{a_m}{a_n} * \left(\frac{M^{T^h}}{\left(1-M^{T^h}\right)} * \frac{1}{G^{T^h}\left(\frac{a_n}{Ak} * \left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right)} * (1-\Theta) + \frac{\left(M^{T^f}\right)}{\left(1-M^{T^f}\right)} * \frac{1}{G^{T^f}\left(\frac{a_n}{Ak} * \left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right)} * \Theta \right) \tag{25}$$

Where, $\Theta \equiv \frac{\left(1-M^{T^f}\right)G^{T^f}\left(\frac{a_n}{Ak} * \left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right)}{\left(\left(1-M^{T^h}\right)G^{T^h}\left(\frac{a_n}{Ak} * \left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right) + \left(1-M^{T^f}\right)G^{T^f}\left(\frac{a_n}{Ak} * \left(\frac{p_n^T}{p_m^T}\right)^{\gamma}\right)\right)} < 1.$

If the two countries stop trading, the possible trade price ratio will belong within the two instantaneous autarky price ratios. Equation (25) explains that. $\frac{p_n^T}{p_m^T}$ is determined by taking the weighted average of the two instantaneous (assuming, wealth distribution does not change instantaneously) autarky price ratios (after they stop trading). That means, opening up always leads to a successful arbitrage. Note that, there is a superscript T on the wealth distribution function, G, as well. The wealth distribution function itself can change in free trade situation, since probabilities of getting a job in organized sector is varying with the change in price ratios. Given that a general wealth distribution function is considered and the model is a stochastic difference equation model, it is not possible to comment analytically about the steady state distribution function. Still the simulation exercise shows, at least for some parametric specifications, equation (25) can produce an equilibrium $\frac{p_n^T}{p_m^T}$ such that $\frac{p_n^f}{p_m^f} < \frac{p_n^T}{p_m^T} < \frac{p_n^h}{p_m^h}$ holds in the steady state also.

Proposition 9: If $\frac{p_n^f}{p_m^f} < \frac{p_n^T}{p_m^T} < \frac{p_n^h}{p_m^h}$ then $v^{T^f} < v^f$ and $v^h < v^{T^h}$in equilibrium after trade.

If $\frac{p_n^f}{p_m^f} < \frac{p_n^T}{p_m^T} < \frac{p_n^h}{p_m^h}$ holds, then the comparison exercise between equation (17), equation (22), equation (20) and equation (23) can show that $v^{T^f} < v^f$ and $v^{T^h} > v^h$ (see appendix 4). Therefore, after trade the number of vacancies of two countries are not equalized and hence, probability of getting a worker (job) by a vacant firm (job searcher) are also not equalized in the two countries. The probability actually falls for the home country after the opening up of trade, and reverse is the case for the individual searchers.

Following subsections briefly describe some more impact of free trade.

3.5.1. Factor price equalization

After trade, the relative wage of the organized sector and the unorganized sector in the home become equalized with the foreign. This is because, wages depend on prices, productivity parameters and bargaining strength of the labor. Price ratios are identical in free trade regime and other parameters are same for both the countries. Real wages (in terms of final good) of the two countries are also equalized after opening up to trade. Nonetheless the wage differential exists between the two sectors within a country. If the wage of m-good sector merges with the n-good sector's wage then in the equilibrium production of m-good will drop down drastically (since getting job in m-good sector is probabilistic, job seekers will opt for frictionless n-good sector for supply their labor which indicates shortage of labor supply in m-good sector and that will be true for both the countries) and as a result price adjustment pulls back the wage of the m-good sector above. This wage difference increases for the home country and decreases for the foreign country after trade. Intuitively the reason behind this finding is the following: after trade m-good sector (relative to n-good sector) gains in h (vis-à-vis f) which increases $\frac{w_m^{T^h}}{w_n^{T^h}}$ and $\frac{w_m^{T^f}}{w_n^{T^f}}$ falls compared to autarky, and wage in the m-good sector is higher than in the n-good sector's wage in both the countries. These two arguments taken together, the difference in wage gap of the two sectors in the two different countries can be explained after the trade opening up. Appendix 5 describes the result mathematically. This is clearly a departure from the classical Ricardian type results.

Proposition 10: Relative wages of the two sectors are equalized between home and foreign ($\frac{w_m^{T^h}}{w_n^{T^h}} = \frac{w_m^{T^f}}{w_n^{T^f}} \equiv \frac{w_m^T}{w_n^T}$). After trade wage inequality increases in the home country and falls in the foreign.

3.5.2. Specialization

Although structurally the present model is very similar to the classical Ricardian setup, complete specialization cannot be a solution in the free trade equilibrium. If foreign country specializes in good-n that means working in the unorganized sector become more lucrative. That is, $\frac{w_n^{T^f}}{p_F^{T^f}} > \frac{w_m^{T^f}}{p_F^{T^f}}$.

The problem is, equalization of two countries factor price-ratio tells that, real wages are same in both the countries and hence, this inequality is true for the home as well (see appendix 5 for mathematical clarification). Therefore in both the countries all the individuals should opt for joining in n-good sector and they get jobs readily in that sector (as we know that the factor market of the n-good sector is friction less). That leads to a situation where the production of m-good cannot take place worldwide and which is impossible to sustain in the equilibrium. On the other hand persistence of labor market friction in m-good sector guarantees the production of n-good in both the countries[6]. So, in the free trade situation also incomplete specialization prevails for both home and foreign country.

Proposition 11: After trade complete specialization cannot occur in the equilibrium.

3.5.2. Impact on the aggregate unemployment and on the unorganized sector

The aggregate unemployment after trade is $\mathrm{TU}^{\mathrm{T}^{\mathrm{j}}} = \left(1 - \mathrm{M}^{\mathrm{T}^{\mathrm{j}}}\right) * \left(1 - \mathrm{G}^{\mathrm{T}^{\mathrm{j}}}\left(\mathrm{X}^{\mathrm{T}^{\mathrm{c}}}\right)\right)$. Clearly this expression depends on the distribution of wealth. Even if the directional change in $\left(1 - \mathrm{M}^{\mathrm{T}^{\mathrm{j}}}\right)$ after trade compared to no trade regime is traced, then also, the wealth distribution may change that direction altogether. That is, trade cannot guarantee fall in unemployment. In subsection 3.3.1 the impact of the change in price on TU is discussed. Change in the distribution function for the change in the price ratio has an important role to determine the effect of trade on aggregate unemployment.

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[6] $\left(1 - \mathrm{M}^{\mathrm{T}^{\mathrm{j}}}\right) * \mathrm{G}^{\mathrm{T}^{\mathrm{j}}}\left(\mathrm{X}^{\mathrm{T}^{\mathrm{c}}}\right)$is the labor supplied towards the production of *n*-good at country-j. Equation (22) and (23) shows that $\mathrm{M}^{\mathrm{T}^{\mathrm{j}}}$is non-unitary and from section (3.5*)* it can be seen that $\mathrm{G}^{\mathrm{T}^{\mathrm{j}}}\left(\mathrm{X}^{\mathrm{T}^{\mathrm{c}}}\right)$ is strictly positive.

Due to its analytical intractability it is left here without commenting much in detail. In the next section simulation results put some light in this regard.

Similarly, the impact of trade on the participation in the unorganized sector is also ambiguous, because the size of the unorganized sector depends on $\left(1 - M^{T^j}\right) * G^{T^j}\left(X^{T^c}\right)$. However, as discussed earlier the real return from the unorganized sector increases for foreign country after trade opens up. Since, $\left(1 - M^{T^f}\right)$ rises and the terms of trade is also favorable towards unorganized sector in the foreign land, if the distributional impact is not much large then trade may increase the contribution of the unorganized sector to GDP in foreign (reverse may happen in home).

Proposition 12: Impact of trade on aggregate unemployment and on the participation in the unorganized sector are ambiguous.

3.6. Simulation Results

This section has a separate importance specifically for this model. Since the distribution of the wealth plays a crucial role here, an analytical intractability arises in the issues mainly related to convergence (implies, the questions associated to the long run stability of the endogenous variables). However numerical exercise not only gives support to the theoretical findings of this model, additionally it brings out some very interesting results. Following table displays the hypothetical parametric assumptions.

Here, following Petrongolo and Pissarides (2001), it is assumed that matching function is of Cobb-Douglas type. The functional form is,

$$M_t = m v_t^{\theta} u_t^{1-\theta}. \tag{26}$$

Table 3.1.: Parameter values

Parameters	Description	Value
α	Proportion of income spent for bequest	0.45
m	Matching efficiency	0.4
d	Cost of posting a vacancy for home country	0.05
d^f	Cost of posting a vacancy for foreign country	0.2
β	Bargaining power of an organized sector worker	0.8
γ	Elasticity of production with respect to m-good	0.65
a_m	Marginal productivity of labor in m-good sector	1
a_n	Marginal productivity of labor in n-good sector	0.2
k	Disutility parameter from social stigma	0.65
θ	Matching elasticity	0.75

Number of individuals under observation are 10000. Number of iteration is, ‘Time’=1000.

Result 1: The distribution of inheritance and the price ratios converge in the long run. That steady state values do not depend on the initial wealth distribution.

Following figures depict the convergence of autarky price ratios ($\frac{p_n}{p_m}$ and $\frac{p_F}{p_m}$) for the home country.

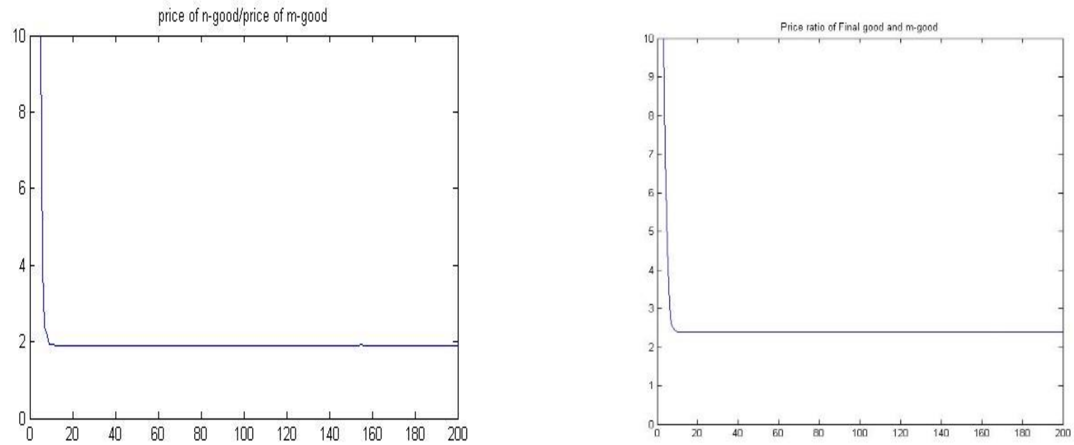

Figure 3.2.: Autarky Price Ratios ($\frac{p_n}{p_m}$ and $\frac{p_F}{p_m}$) for the Home Country

The long run distribution of inheritance is displayed in the following histogram.

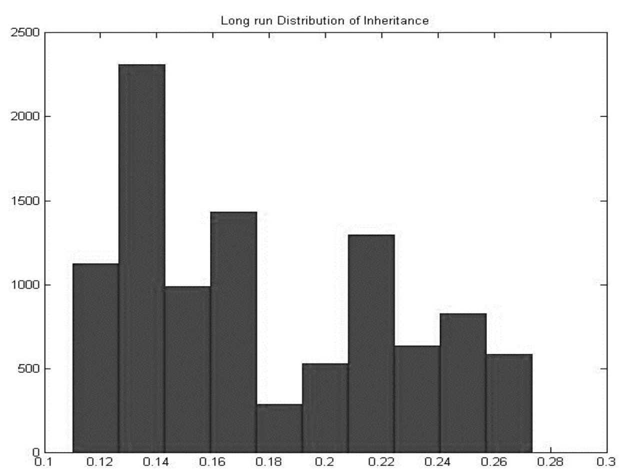

Figure 3.3: Simulated Inheritance Distribution

Following table depicts Kolmogorov-Smirnov test[7] statistic for the convergence test of the long run inheritance distribution.

Following table shows the convergence in the long run starting from two different initial wealth distributions given the other parametric values. Results narrates that initial condition has no significant role for the long run distribution of inheritance.

Table 3.2.: Convergence of inheritance distribution

Initial wealth distribution	'Time'vis-à-vis '(Time-1)'	'Time' vis-à-vis '(Time-100)'
Normal	0.0101	0.0150
	(0.8049)	(0.3269)
Uniform	0.0074	0.0138
	(0.9811)	(0.4336)
Single valued	0.0115	0.0119
(all the values are same	(0.6630)	(0.6230)
but below the cut-off level)		
Single valued	0.0110	0.0111
(all the values are same	(0.7162)	(0.7030)
but above the cut-off level)		

[7] Kolmogorov-Smirnov test is done between the two randomly taken samples of size 8000 considering the end distributions as the population.

Table 2.3.: Convergence test starting from two different initial distribution of inheritance

Two different initial distributions	Kolmogorov-Smirnov test statistic
Normal vis-à-vis Uniform	0.0115 (0.6630)
Normal vis-à-vis Single valued (below the cut-off)	0.0132 (0.8421)
Normal vis-à-vis Single valued (above cut-off)	0.0104 (0.7804)
Uniform vis-à-vis Single valued (below the cut-off)	0.0146 (0.3569)
Uniform vis-à-vis Single valued (above the cut-off)	0.0111 (0.7030)
Single valued: below cut-off vis-à-vis above the cut-off	0.0068 (0.9931)

Result 2: Long run empirical distribution function of inheritance for home country is dominated by foreign country.

Here we would like to mention about the issue of first-order stochastic dominance. Long run empirical inheritance distribution of the foreign country does not stochastically dominate (first order) the same for home country. Nevertheless, for most of the observed values of the long run empirical distribution function of the foreign is ling above the home empirical distribution function in autarky. Random sample of size 8000 is drawn from each of the long run wealth distribution (home and foreign). Steady state empirical distribution functions are constructed for the stated two samples and the plots are given in the figure below.

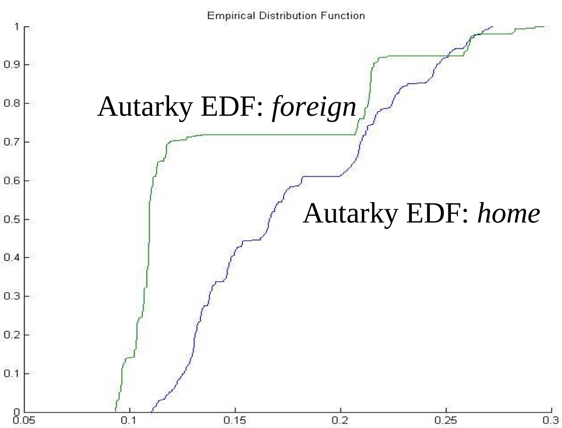

Figure 3.4.: Empirical Distribution Function at Autarky

After trade the two empirical distribution functions indicates the following pattern (Figure 3.5).

Result 3: $\frac{p_n^f}{p_m^f}$lies below than $\frac{p_n^h}{p_m^h}$.

Result 4: $\frac{p_n^T}{p_m^T}$ can lie in between$\frac{p_n^h}{p_m^h}$and $\frac{p_n^f}{p_m^f}$. This comparison is done starting from the autarky steady state values[8].

[8]For some parametric restriction it may be the case that $\frac{p_n^T}{p_m^T}$ goes out of the bound of steady-state autarky price ratios. However that does not mean that trade becomes ungainful. At every instance (taking inheritance distribution as

Following figure (Figure 3.6) supports the above two results.

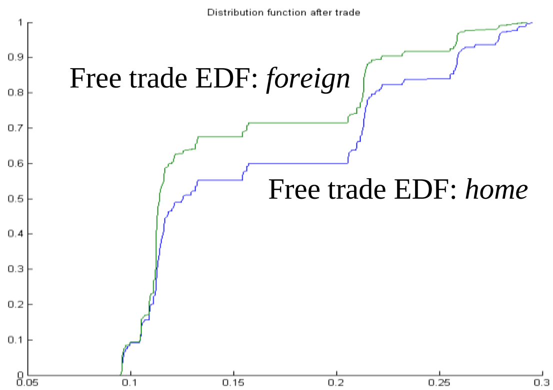

Figure 3.5.: Empirical Distribution Function at Free Trade

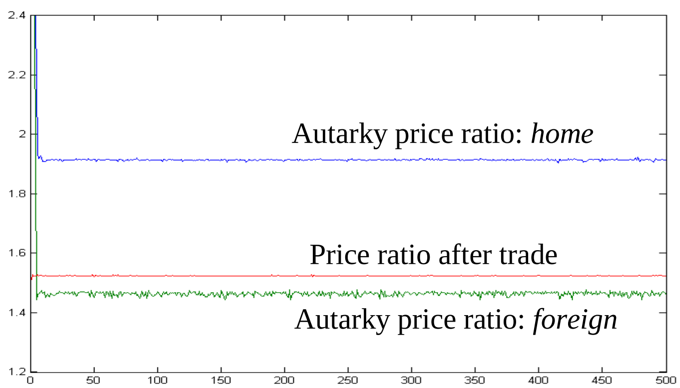

Figure 3.6.: Price Ratios in Autarky and Free-Trade

Result 5: Given this parametric specification, unemployment rate increases in home country but falls in case of foreign[9].

given) of time trade price ratio remain in between the autarky price levels of two countries. Trade open up leads to successful arbitrage. So, no-trade is always inferior than free-trade to the sellers of both the countries.

[9]For some different parametric specification unemployment in both the countries can actually rise in a free-trade steady-state compared to the steady-state level in autarky. This is observed through simulation study that if the steady state price-ratio in a free trade situation comes below the steady-state level of *foreign* autarky price ratio then unemployment can rise in both the countries.

Following figures display the above result.

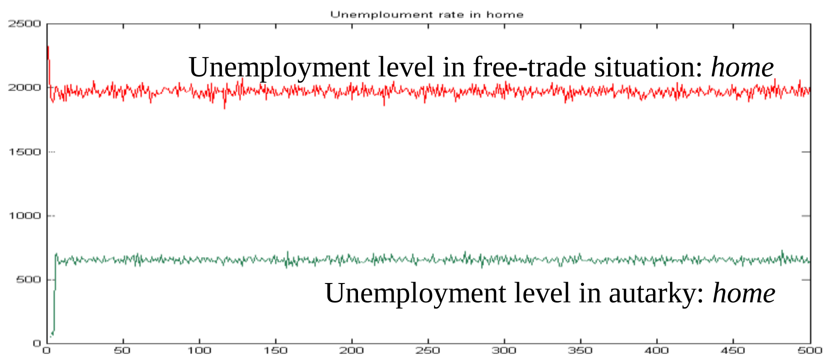

Figure 3.7.: Unemployment level at Autarky and Free Trade in *home*

Figure 3.8.: Unemployment level at Autarky and Free Trade in *foreign*

3.7. Conclusion.

The three-good general equilibrium model under the discussion assumes a societal status conscious preference, and captures the link between the inheritance level, the labor market friction and unemployment. After solving the model in autarky we allow the economy to enter into the international trade and explore the possible free trade results. Here in the trade situation, the comparative advantage between the two almost similar countries are originating from the difference in the degree of the labor market inefficiency. Although it is a single factor model with two tradable goods, but the findings in the trade situation are quite different from the Ricardian results. Even if the trade takes place between the two very similar countries (with same market size and same production technology), this modeling strategy shows that complete specialization cannot be an equilibrium outcome. As a result, the wage inequality prevails after trade irrespective of the country. In one country it falls and in the other it rises after opening up.

A very frequent question that is asked in the context of unemployment is, whether free trade has pacified the problem or not. Previously it was argued that both of the countries in the Ricardian setup gains in employment terms after trade, and only labor abundant countries gain when trade happens due to endowment differences. Given the present model, free trade is not the sufficient condition for the unambiguous reduction in unemployment in any of the two countries. The wealth distribution of a country, as well as the extent of the status consciousness can play a key role in this regard.

The model can be extended even further to check the possibility of trade due to the difference in the status consciousness between two countries. However, that does not add much insight. Sketchily, the country with higher status consciousness will import unorganized sector good and the country with lesser status consciousness will export unorganized sector good. One can check other trade results associated with that. The results will be similar to our findings.

Appendix

Appendix 1

Here the optimal decisions of the agents are solved. Since in the discussed model, cost of searching is equal to zero, each individual likes to search for an organized sector job at each period. An agent can receive a higher wage from organized sector, only if she faces the search process. But she does not lose anything if she goes for search. Therefore, she can take a chance in the search process of the organized sector to get a higher wage without cost. Hence, it is optimal for any agent to search in the organized sector. The choice problem between opting for a search or not is actually a comparison between weighted average with strictly positive weights and the minimum value, where all values are not identical. Hence, opting for search becomes a dominant strategy.

The following table shows different pay-offs for different strategies under alternative states of the world. States and strategies are noted in rows and columns respectively. Notations used in the table are likewise: 'L' and 'U' indicate lucky and unlucky situations; 'O', 'N' and 'W' are for organized job, unorganized job and wait, respectively.

Pay-off matrix of each period:

	O	N	W
L	$\frac{w_{mt}}{p_{Ft}}$	$\frac{w_{nt}}{p_{Ft}} - kX_t(i)$	0
U	not applicable	$\frac{w_{nt}}{p_{Ft}} - kX_t(i)$	0

Optimal solutions are illustrated below

for, $X_t(i) \leq \frac{w_{nt}}{kp_{Ft}}$		for, $X_t(i) > \frac{w_{nt}}{kp_{Ft}}$	
if L then	O	if L then	O
if U then	N	if U then	W

Therefore $\frac{w_{nt}}{kp_{Ft}}$ becomes the critical level of the inheritance.

Appendix 2

Problem of the firm in the final good sector:

Min $p_{mt}m_t + p_{nt}n_t$

s.t $m_t^{\gamma}n_t^{1-\gamma} = F_t$

This minimization exercise yields

$\frac{m_t}{n_t} = \frac{\gamma}{1-\gamma}\frac{p_{nt}}{p_{mt}}$.

And, $F_t = m_t^{\gamma}n_t^{1-\gamma}$

Hence,$F_t = \left(\frac{p_{mt}}{p_{nt}}\frac{1-\gamma}{\gamma}\right)^{1-\gamma} m_t$ (27)

and, $F_t = \left(\frac{p_{mt}}{p_{nt}}\frac{1-\gamma}{\gamma}\right)^{-\gamma} n_t$ (28)

Since firms are facing perfect competition in product market, zero profit condition for the final good market is also satisfied. So,

$p_{Ft}F_t = p_{mt}m_t + p_{nt}n_t$

or, $\frac{p_{Ft}}{p_{mt}}F_t = \left[\left(\frac{p_{nt}}{p_{mt}}\frac{\gamma}{1-\gamma}\right)^{1-\gamma} + \frac{p_{nt}}{p_{mt}}\left(\frac{p_{nt}}{p_{mt}}\frac{\gamma}{1-\gamma}\right)^{-\gamma}\right] F_t$

or, $\frac{p_{Ft}}{p_{mt}} = \left(\frac{p_{nt}}{p_{mt}}\right)^{1-\gamma}\left(\left(\frac{\gamma}{1-\gamma}\right)^{1-\gamma} + \left(\frac{\gamma}{1-\gamma}\right)^{-\gamma}\right)$

or, $\frac{p_{Ft}}{p_{mt}} = A\left(\frac{p_{nt}}{p_{mt}}\right)^{1-\gamma}$

Where, $A \equiv \left(\left(\frac{\gamma}{1-\gamma}\right)^{1-\gamma} + \left(\frac{\gamma}{1-\gamma}\right)^{-\gamma}\right)$

Appendix 3

Equation 16 and Equation 17 respectively are the following two equations.

$$\frac{p_n}{p_m} G\left(\frac{a_n}{Ak}\left(\frac{p_n}{p_m}\right)^{\gamma}\right) = \frac{1-\gamma}{\gamma} \frac{1}{\left(\frac{1}{M} - 1\right)} \frac{a_m}{a_n}$$

$$M(\theta^{-1}, 1) = \frac{A}{1-\beta} \frac{d}{a_m} \left(\frac{p_n}{p_m}\right)^{1-\gamma}$$

The second equation shows that M is a function of $\left(\frac{p_n}{p_m}\right)$. Notice, if for some $\frac{p_n}{p_m}$, M hits 1, then RHS of equation 16 becomes infinity. Let us call that critical price ratio as $\left(\frac{p_n}{p_m}\right)^c$. For all other higher values of $\frac{p_n}{p_m}$, RHS of the equation 16 is monotonically falling.

LHS of equation 16 is a multiplicative function of two monotonically increasing functions of $\left(\frac{p_n}{p_m}\right)$. The first term is a linearly increasing with slope 1. The second term is the distribution function and values within the parenthesis is an increasing function of $\left(\frac{p_n}{p_m}\right)$ with the slope lesser than one. Since these two terms are in multiplicative form, LHS takes the value zero when $\left(\frac{p_n}{p_m}\right) = 0$.

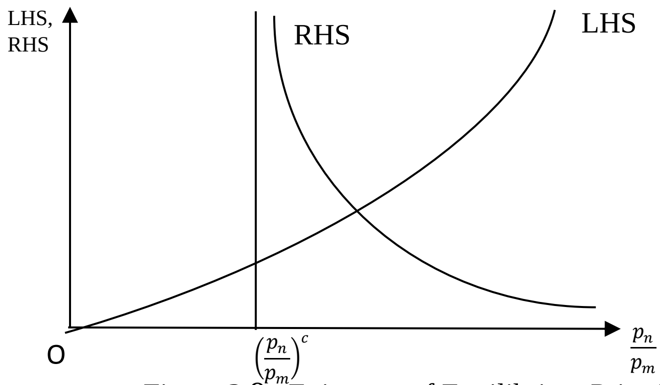

Figure 3.9.: Existence of Equilibrium Price Ratio

Appendix 4

Using equation (17) and equation (23) for $\frac{p_m^h}{p_n^h} < \frac{p_n^T}{p_m^T} < \frac{p_m^f}{p_n^f}$,

$$\frac{M\left(\theta^{h^{-1}},1\right)}{M\left(\theta^{T^{h^{-1}}},1\right)} = \left(\frac{\frac{p_n^h}{p_m^h}}{\frac{p_n^T}{p_m^T}}\right)^{1-\gamma} > 1$$

$$M\left(\theta^{h^{-1}},1\right) > M\left(\theta^{T^{h^{-1}}},1\right)$$

$$v^h < v^{T^h}$$

Similarly, using equation (20) and equation (22) for $\frac{p_m^h}{p_n^h} < \frac{p_n^T}{p_m^T} < \frac{p_m^f}{p_n^f}$, one can show:

$$v^f > v^{T^f}.$$

Appendix 5

From equation (4) and equation (6) we get,

$$\frac{w_m^h}{w_n^h} = \frac{\beta a_m}{a_n}\frac{p_m^h}{p_n^h} \tag{29}$$

$$\frac{w_m^f}{w_n^f} = \frac{\beta a_m}{a_n}\frac{p_m^f}{p_n^f}\ . \tag{30}$$

After trade, price ratios of good m and good n are equalized to $\frac{p_m^T}{p_n^T}$. Therefore,

$$\frac{{w_m^T}^h}{{w_n^T}^h} = \frac{{w_m^T}^f}{{w_n^T}^f} \equiv \frac{w_m^T}{w_n^T}. \tag{31}$$

Sub-section (3.i) has argued that in this modeling set up wage of the organized sector always remain higher than the unorganized sector wage.

Therefore, $\frac{w_m^h}{w_n^h} > 1$.

Now $\frac{p_n^f}{p_m^f} < \frac{p_n^T}{p_m^T} < \frac{p_n^h}{p_m^h}$ can be re-written as $\frac{p_m^h}{p_n^h} < \frac{p_n^T}{p_m^T} < \frac{p_m^f}{p_n^f}$

$$\frac{\beta a_m}{a_n}\frac{p_m^h}{p_n^h} < \frac{\beta a_m}{a_n}\frac{p_n^T}{p_m^T} < \frac{\beta a_m}{a_n}\frac{p_m^f}{p_n^f}$$

or, $\frac{w_m^h}{w_n^h} < \frac{w_m^T}{w_n^T} < \frac{w_m^f}{w_n^f}$

or, $1 < \frac{w_m^h}{w_n^h} < \frac{w_m^T}{w_n^T} < \frac{w_m^f}{w_n^f}$, (since, $\frac{w_m^h}{w_n^h} > 1$).

Hence the organized and unorganized wage gap reduces in foreign and increases in home after trade.

From equation (13) one can write, after trade, ${p_F^T}^h = {p_F^T}^f \equiv p_F^T = A * p_m^T \left(\frac{p_n^T}{p_m^T}\right)^{1-\gamma}$.

Therefore, sector specific real wages (wage of sector m (or, n)/price of the final good) are also equalized between the two countries.

Appendix 6

Outside option is not considered while the organized sector wage is determined in sub-section 2.iv.b. Here it is discussed, how the inclusion of uniform outside option does not change the analysis in any substantial manner. Equations (16) and (17), in this model, characterize the equilibrium and generate the major results. The heterogeneity in the wage rate of the two sectors and the search frictional labor market play the key role for the above stated equations. The present assumptions of the model are sufficient to generate these conditions. Uniform outside option further jacks up the wage of the organized sector over the unorganized sector.

The unorganized wage remains as, $w_n = p_n a_n$ (at the steady state).

$w_m = \beta p_m a_m + (1-\beta) p_n a_n$, when unorganized wage is considered as the outside option for the organized sector worker. Therefore, w_m is still greater than w_n.

Now, $J = (1-\beta)(p_m a_m - p_n a_n)$. (32)

Which implies, the equation (17) becomes

$$M(\theta^{-1}, 1) = \frac{A}{1-\beta} \frac{d}{(a_m - a_n \frac{p_n}{p_m})} \left(\frac{p_n}{p_m}\right)^{1-\gamma}. \quad (33)$$

Notice, the equation shows that M, the overall job matching level, is negatively related with $\frac{p_n}{p_m}$ which is the needed condition for the negative slope of the RHS of equation (16). Hence, the uniqueness of the equilibrium is ensured (proposition 4). Along with the proposition 4, this negative slope of RHS of equation (16) guarantees proposition 7 as well.

Other results of the model depend on the direction of the relative wage. Since,

$w_m > w_n$

and $\frac{w_m}{w_n} = \beta \frac{a_m}{a_n} \frac{p_m}{p_n} + (1 - \beta)$ (34)

(the first part of the RHS is same as before, second part comes as an additive constant which same for different countries),

therefore, proposition (9), proposition (10) and proposition (11) hold.

The information of the wealth is assumed as private to the agents and not known to the firms. Wage bargaining is done only on the basis of the productivity from the job match. This assumption makes the wage rate fixed for a particular sector and does not allow to vary on the basis of wealth having the same skill level.

Chapter 4

Contents

Figure Contents

A Model of Optimal Labor Market Friction

Friction, according to the existing literature, generates unproductive labor force in the economy and hence, is a source of inefficiency. Extending the literature further, this chapter considers, both positive and negative impact of labor market friction on the economy. In many developed countries, it has been observed that college enrollment rate is counter-cyclical in nature. That finding instigates our analysis in the following direction. Frictional labor market, although, reduces the per period GDP by keeping a part of labor force jobless, but a positive role can also be traced in R&D formation. So, an economy can achieve its long run goal by setting an optimal level of friction in the labor market. This chapter develops a theoretical model to find the optimal level of friction and designs policy to realize that optimal job matching rate. The model ascribes that optimality condition can be attained without perturbing the growth rate of the economy. The robustness of the results is tested under Government's balanced budget constraint and under stochastic fluctuation in productivity level.

4.1. The Basic Model

In this section, we build our benchmark model. The following sub-sections describe the details of this basic model, which is embedded in a discrete time framework.

4.1.1. Basic Structure and Time Sequence

The hypothetical economy comprises of individuals who live for two periods, infinitely lived firms and a benevolent government. Individuals are endowed with two unit of labor from which each unit can be supplied in each of the time periods inelastically. They receive utility from consumption which takes place at the end of their life span. Firms employ labor, as the only factor input, to produce a single good which is consumed by the agents of the economy. Product markets are perfectly competitive. However, we model the labor market with search friction. That is, firm posts a vacancy and entails that it can be filled with a job searcher with certain probability of matching (for details see subsection 4.1.3). Government provides an education system and carries R&D activity by educated work-force (which is produced by the education system) to improve the available technology of production in the economy[1].

Population mass of each generation is normalized to unity. Two generations are present in the economy at any particular time period: the old generation is already present from the last period and a new generation joins the economy at the beginning of the present time period. Old generation leaves the economy after living two consecutive time periods.

[1] Literature burdens with the conflicting views about the effectiveness of public funding versus private funding towards enhancing overall productivity of the economy (See, David, Hall and Toole (2000), Hall and Reenen (2000), Feldman and Lichtenberg (1998) etc). We are taking the side of public expenditure of R&D, since here we are interested in overall technological improvement of the economy. There are countries where still public funding is higher than private funding in research (See Albu (2011)).

At the beginning, young individuals have two options: either they can search for jobs or they may take education which is provided by the Government. Individuals who decide to search for job, create the pool of job seeking workers. At the beginning of each period, vacant firms search for productive workers to undertake production. The pool of job seeking workers and the vacant firms interacts through a Pissaridies type random matching function. Vacant firms who get matched with the productive workers can commence production. Other vacant firms (who have failed to find workers) remain idle until the next matching process takes place. In case of unmatched workers, the option of public education is still available. Firms employ worker for consecutive two time periods and one worker-firm match sustains until the worker is alive. This can also be interpreted as job firing with rate one after two periods and within two the period the rate is zero.

Government does R&D activity only with the help of educated workers. Therefore, individuals who have taken education at the first period can join R&D activity at the second period, and receives wage for one period. Technology available for production at any particular period t is developed as an end product of $(t-1)^{th}$ period's R&D activity. The workers who develop that new technology joined the economy and received their education at $(t-2)^{th}$ period.

4.1.2. Technological progress

Technology grows endogenously in this model. The progress of technology depends on the labor endowment allotted to the research activity. Impact of investing in research activity increases on an increasing rate of time. Available technology at period t is denoted as A_t. Dynamics of technological progress is as follows:

$$A_{t+n+1} = A_{t+n} + \psi^{t+n}\Omega_{t+n}. \qquad (1)$$

where, n is any natural number and $\psi > 1$. Ω indicates the amount of labor invested towards R&D at any period. ψ can be interpreted as the marginal contribution of labor investment towards the technological change. Here it is assumed that technology of a particular period depends on the previous period's technology level and the marginal progress of technology is increasing with time.

In this basic structure of the model, although it is assumed that mapping between improvement in research activity and the production activity is not uncertain, and one-to-one. That is, improvement in research is certain, and if R&D improves then the increase in productivity of the economy is guaranteed. Section 4.5 extends the model by introducing randomness in production level using the new technology.

4.1.3. Firms

Firms, at the beginning of any point of time, can be of two types: filled or vacant. Filled firms pay per period wage to the already hired laborers at the beginning of each period. This is the only cost for a filled firm. Per period productivity of each worker, employed at t, is A_t which remains unchanged for the two successive time periods. Vacant firms need to incur a positive cost of posting a vacancy for hiring a worker. We assume this vacancy posting cost is proportional[2] to the productivity of a worker at that period. That is, vacancy posting cost at period tis dA_t, say. After posting the vacancy a vacant firm faces a random matching function to get a worker and undertake production. The matching function which is considered here, follows the properties of typical Pissarides type matching function, and the specific form is assumed as the following:

$$M_t = \frac{\gamma u_t v_t}{u_t + v_t} \tag{2}$$

[2]This assumption is commonly used in literature. See Pissaridies (chapter 1, 2000).

Where, $0 < \gamma < 1$. $u_t$is the number of individuals searching for the job and v_t is the number of vacancies posted at t^{th} period. γcan be interpreted as the degree of overall matching efficiency of the labor market. This particular form (Stevens (2007)) of the matching function also satisfies the following properties: it is increasing in each of its argument, homogenous of degree one and is concave.

Probability of a successful matching at period t for a firm is,

$$M(\theta^{-1}, 1) \equiv \frac{M_t}{v_t} = \frac{\gamma}{1+\theta_t} \quad (3)$$

Where $\theta(\equiv \frac{v}{u})$ is conventionally termed as market tightness. Note that, probability of a successful matching for a firm is a negative function of market tightness.

Let V_t be the life time expected return from a vacant post from the period t onwards. There are two components in V_t: cost of posting a vacancy and expected return from that vacancy. Since, firms are infinitely lived and return from the vacancy is compared in lifetime basis, V_t is represented in recursive form. Hence,

$$V_t = -dA_t + M(\theta_t^{-1}, 1)(2(A_t - w_t) + V_{t+2}) + \left(1 - M(\theta_t^{-1}, 1)\right)V_{t+1} \quad (4)$$

$w_t$is the per period wage which is determined at the beginning of period t and prevail the same contract for the next two periods. The justification behind this assumption is, the technical knowhow for each matching taking place at the beginning of period t, is A_t andas we have explained earlier that firms can adopt technology only before commencing the production activity.

Perfectly competitive goods market allows firms to entry and to exist, freely. In equilibrium this implies, V_t to be zero, for all t. That is, the marginal firm would be indifferent between posting and not-posting the vacancy. If V_t remains positive (negative), firms would enter (leave) the market. Thus using equation (4), we get:

$$M(\theta_t^{-1}, 1) = \frac{dA_t}{2(A_t - w_t)} \quad (5)$$

4.1.4. Workers

In this model a representative individual receives utility only from the consumption of the good. Further it is assumed that she consumes at the end of her life span. She does not have any bequest motive or no credit market exists to smooth the consumption over two periods. Utility depends linearly on consumption[3].

$$U_{t-1}(C_t) = C_t,$$

where U is the utility of the representative agent and C is her consumption. The subscript of U says the time when she entered the economy and the subscript of C is the time of consumption activity.

Therefore, only the income which she earns in her whole life time does matter in utilitarian terms, and now onwards we use wage earned as an alternative for her utility.

Individuals, who are born and look for the job at period t, face the same matching function as described in equation (2). The probability of getting an employment by one job seeker is, hence, the following:

$$M(1, \theta) \equiv \frac{M_t}{u_t} = \frac{\gamma}{\theta_t^{-1} + 1}. \quad (6)$$

A successful matching offers w_t as per period wage to the ‘lucky’ searcher. If one fails to get employed, as described earlier, she may join the government provided schooling or may remain unemployed. In either case, she does not receive any wage at period t. However, if she decides to

[3] Introduction of effort cost can also generate similar results to which this model is particularly focusing.

take education (costless, for computational ease) then she has the option to join research activity and earn a positive wage, R_{t+1} (say), at period $(t+1)$. It is a simplifying assumption that there exists no friction when she joins R&D activity. On the other hand, if she remains unemployed, she gets nothing. Clearly in this model remaining unemployed is a dominated strategy for any individual.

Author clarifies in Appendix 2 that the costless education and frictionless R&D sector are not very restrictive assumptions for the present purpose. A simple extension of the basic model can imitate similar outcomes.

4.1.5. Wages

Both, the firm and the worker has a positive bargaining power. Costly friction (neither firm nor worker can be matched to each other without passing through expensive search process) creates this possibility of rent seeking. They settle a wage rate through Nash bargaining. The total output produced is shared among them according to their bargaining power and the opportunity cost of forming this matching. Hence,

$$w_t = \underset{w_t}{\arg\max} \big(2(A_t - w_t)\big)^{\beta} \, (2w_t - R_{t+1})^{1-\beta}.$$

$0 < \beta < 1$ can be explained as the bargaining power of the firm. First parenthesis contains firm's share of output. Firm's opportunity cost of not entering into a productive matching is zero (as mentioned earlier, $V_t = 0$ for all t at equilibrium). Whereas worker's opportunity cost of accepting this match for the two consecutive periods is R_{t+1}, the wage rate given by the government for

R&D activity at period $(t+1)$. Thus, worker's output share net from her opportunity cost is comprised in the second parenthesis of the above equation. After simplification,

$$w_t = (1-\beta)A_t + \frac{\beta}{2}R_{t+1}. \quad (7)$$

Equation 7 shows that the worker's return from a job match ($2w_t$) is a weighted average of the total return from a productive firm-worker matching ($2A_t$) and the worker's return from working in R&D sector (R_{t+1}). That is, $2w_t$ lies in between $2A_t$ and R_{t+1}. In this model, the determination of R_{t+1}, the Government provided R&D wage rate is not modeled. For any arbitrary R_{t+1}, it can be higher, lower or equal to $2A_t$.

If $R_{t+1} > 2A_t$, then $2w_t > 2A_t$ as well (see equation 7). In one hand, all the individual will find it optimal to work in R&D and no one will search for job to produce good, on the other hand, it is straight forward to see that number of vacancy posting will be zero (since, (from equation 4) return from posting a vacancy will be negative even if the firm becomes lucky to get a worker). Hence, the model will end there, since utility comes only from consuming the produced good.

If $R_{t+1} = 2A_t$, then one can solve the equilibrium number of worker needed for R&D activity to get A_t which equals to $\frac{R_{t+1}}{2}$ (assuming there does not exists any informational asymmetry) from this equation[4]. However, that does not stop from equilibrium vacancy posting to become zero (see equation 5). Therefore, production will not take place.

Hence, $R_{t+1} < 2A_t$ (which implies $2w_t > R_{t+1}$ and $2A_t > 2w_t$ too) is the only interesting case. In this case equilibrium number of vacancy posting is positive (see equation 5). From this point onwards the model focuses only on this case. This, in turn, would imply that, in equilibrium, it is

[4] Note that, $A_t = A_{t-1} + \psi^{t-1}\Omega_{t-1}$.

optimal for every individual to first search for a job in the consumer good sector. Labor market friction, however, keeps the supply for R&D sector worker positive.

Without loss of generality, following particular R_{t+1} (which is less than $2A_t$) is assumed for keeping the model simple and interesting: Government set the wage of the R&D sector, R_{t+1}, as proportional to the expected wage what the agent would get from the firm at period t if she get matched. That is,

$$R_{t+1} = sM_t w_t \tag{8}$$

where, $0 < s < 1$ is the proportionality parameter. As it is discussed in the introduction, often it has been seen that the return from working in R&D sector is lower than working production sector at a comparable skill level. In our model individual who works in R&D sector, settles late (only for a single period) and receives lesser wage too. This makes the framework of the model closer to the real world.

4.2. Equilibrium

This section proceeds to solve the model for a unique equilibrium and determines the value of all the endogenous variables.

First we determine the equilibrium wage rate substituting equation (8) in to equation (7),

$$w_t = \frac{1-\beta}{1-\frac{\beta}{2}sM(1,\theta_t)} A_t. \tag{9}$$

Therefore, the wage rate depends positively on the technology level of the economy and the probability of getting a job, while the bargaining power of the firm affects wage rate negatively.

As we have argued in the previous section, for each individual the return from a job in the production sector is strictly higher than the return from R&D sector employment. That characteristic is captured in the equations (8) and (9). Therefore, each individual chooses to search for the job at the beginning of her life span, as an equilibrium decision. Return from a job is strictly higher than the return from working as researcher at her old age. If she fails to get a job, then she would take the state provided education and join the R&D sector in the next period. Hence, in equilibrium

$$u_t = 1. \tag{10}$$

and,

$$\Omega_t = 1 - M_{t-1}. \text{ (Since, from equation (10), } M(1, \theta_t) = M_t\text{)} \tag{11}$$

From the matching function (equation (2)), assumed in this model, it can be shown that summation of the two probability values (i.e. $M(1, \theta_t)$ and $M(\theta_t^{-1}, 1)$, probability of getting a job and probability of getting a worker) is constant and same with the level of overall labor market efficiency parameter.

$$\text{Therefore, } M(\theta_t^{-1}, 1) + M(1, \theta_t) = \gamma. \tag{12}$$

Using equations (5), (10) and (12), therefore, a relation between wage rate and per-period matching of the economy can be established:

$$M_t = \gamma - \frac{dA_t}{2(A_t - w_t)}. \tag{13}$$

Substituting the value of w_t from equation (9) in equation (13) $M_t$can be expressed in terms of exogenous parameters.

$$M_t + \frac{d}{2\beta}\frac{1-\frac{\beta s M_t}{2}}{1-\frac{sM_t}{2}} = \gamma. \quad (14)$$

Left hand side (LHS) of the equation (14) is a positively sloped monotonic function with respect to M_t and right hand side (RHS) is independent of M_t.Therefore in M_t plane, LHS and RHS can intersect each other for suitable parametric restriction[5]. Hence, equation (14) solves for the time independent equilibrium value of overall employment level of the economy. Henceforth this market determined equilibrium value of M_t is denoted as M^* (where, $0 < M^* < 1$).This solves the model.

Clearly, technological progress has no impact on M^*, but government spending on research activity has a negative influence on it. The intuition is as follows. A higher return from the R&D sector, increases the outside option of the individual when he bargains with the firm. If the individual gets a higher return from research activity then it increases the outside option for her, when she bargains with the firm. This in turn reduces the return of the firm from a productive matching, and that implies, V_t becomes negative (recollect equation 4). V_t reaches the break-even point only if v falls, and hence, M^* goes down. Equilibrium level of matching (M^*) also depends on d, β and γ[6], but here we are focusing on the governments' policy parameter (for more discussion, see Section 4).

For the present purpose we rewriteM^* as:

$$M^* = M^*(s;\ d, \beta, \gamma). \quad (15)$$

[5] Necessary parametric restriction is $d < 2\gamma\beta$.
[6] Effect of other three parameters on M^* are the following: $\frac{\partial M^*}{\partial d} < 0$, $\frac{\partial M^*}{\partial \beta} > 0$ and $\frac{\partial M^*}{\partial \gamma} > 0$.

where, $\frac{\partial M^*}{\partial s} = -\frac{M^*}{s+\frac{2 \ 2\beta}{1-\beta \, d}\left(1-\frac{sM^*}{2}\right)^2} < 0$ and $M^*(0; d, \beta, \gamma) = \gamma - \frac{d}{2\beta}$ (let us assume parametric values such that $\left(\gamma - \frac{d}{2\beta}\right) > 0$).

4.3. Long Term Gain Vis-à-vis Short Term Loss

In this section we model the impact of introducing a social planner (government may play this role as well) who is concerned about the long run goal. GDP at a particular time point, t, is strictly increasing with M^*. That is, if the labor market friction reaches its minimum then per-period GDP reaches its maximum. In this model GDP at period t is the following:

$$GDP_t = (A_t + A_{t-1})M^*. \tag{16}$$

Given all available information, GDP_t takes the maximum value for $M^* = 1$.

However, the long run present discounted sum of GDP values from time period t is denoted as Γ_t and is equal to:

$$\Gamma_t = \sum_{n=0}^{\infty} \delta^n M(A_{t+n-1} + A_{t+n}). \tag{17}$$

where, the discount rate is $\delta \in (0,1)$.

Individual lives only for two periods. She cumulates her income from all these two periods and consumes at the end of her lifespan. This is a single non-perishable good economy. Therefore, she does not get the scope to discount the future. However, Government stays for the infinite period and maximizes the present value of the infinite income stream.

Incorporating equation (11) we can rewrite equation (1) for the time independent M as follows.

$$A_{t+n+1} = A_{t+n} + \psi^{t+n}(1 - M). \quad (18)$$

We reduce the equation (17) further by using equation (18) and assuming $\delta\psi < 1$ the following can be derived:

$$\Gamma_t = \frac{M}{1-\delta}\left(2A_{t-1} + (1 - M)(1 + \delta)\left(\frac{\psi^{t-1}}{1-\psi\delta}\right)\right). \quad (19)$$

In this section we are focusing on the social planner's point of view. As the social planner is concerned about the long run benefit of the economy, we are assuming equation (19) as her objective function. Fromtonwards, an optimal path for the economy is to be chosen by obtaining an appropriate overall matching level of the economy, M^{**}. Therefore to maximize Γ_t, we set $\frac{\partial \Gamma_t}{\partial M} = 0$ (from equation (19)) and solve for M^{**}[7].

$$M^{**} = \frac{1}{2} + \frac{A_{t-1}}{\psi^{t-1}}\left(\frac{1-\psi\delta}{1+\delta}\right). \quad (20)$$

And it can also be shown that[8] (using equation (18)),

$$\frac{A_t}{\psi^t} = \frac{1-M}{\psi-1}. \quad (21)$$

Suitable substitution of equation (21) into equation (20) solves for M^{**} which maximizes Γ_t. The typical expression of this optimal matching level is,

$$M^{**} = \frac{1}{2}\left(1 + \frac{1-\psi\delta}{\psi-\delta}\right) < 1. \quad (22)$$

Therefore, there exists an optimal level of matching which maximizes economy's long run welfare. Although GDP_t reaches the maximum for $M^* = 1$, but $M^{**} \in (0,1)$ since, $\psi > 1$. That is, to

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[7] At M^{**} second order condition is also satisfied

[8] Assumption: if $n \to \infty$, then $A_{t-n} \to 0$.

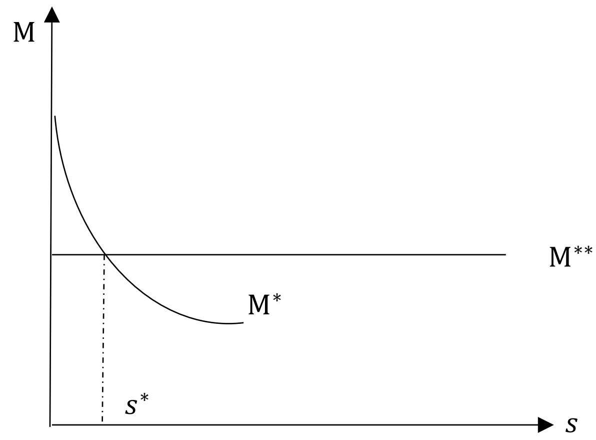

Figure 4.1.: Market Determined Rate of Job Match Vis-À-Vis Optimal Job Match

achieve long run goal of the economy lesser friction may be an inferior solution and a benevolent social planner would want a certain optimal level of labor market friction to prevail.

Now the major concern is to identify the policy to reach at M^{**}. Note that, M^{**} does not depend on s.Since, it has been shown (in section 3) that M^{*} is falling with respect to s and M^{**} is independent of s, for specific parametric restrictions M^{*} and M^{**} cut each other in (M, s) plane. Hence, social planner may achieve M^{**} by suitably choosing s^{*} such that,

$$M^{**} = M^{*}(s^{*}; d, \beta, \gamma) \tag{23}$$

This hypothetical economy grows at a constant rate and equal to,

$$g \equiv \frac{\Delta GDP_{t+1}}{GDP_t} = \frac{\psi+1}{1+\frac{2\;A_t}{1-M\psi^t}} = \psi - 1. \text{ (Using equation (21)).} \tag{24}$$

g does not depend on M either. That is, if the economy moves along the optimal path then also growth rate of the economy remains unperturbed. Hence, s^{*}can be set with a fixed per period growth rate.

Turning to the comparative statics exercise, it is easy to show by partially differentiating equation (14) with respect to γ around M^*, that:

$$\frac{\partial M^*}{\partial \gamma} = \frac{1}{\left(1-\frac{sM^*}{2}\right)^2 + \frac{(1-\beta)sd}{2}} > 0, \text{ for any value of s.}$$

That is, given all other parameters fixed, if the overall efficiency of the labor market increases then market determined equilibrium level of job match also rises. This result combined with the figure 1 gives us more insight. Since, for each s, M^* increases for higher γ, therefore in the figure 1, M^* curve moves up. That leads to higher s^*. Therefore, economies with higher level of labor market efficiency should pay more to the R&D sector workers than the one with lesser labor market efficiency. On the other hand, in many developing countries, it may be the case that they are paying high to the R&D sector worker than the optimal. This point is important to bring under discussion because empirical literature draws attention to the prevalence of investment in over-education in several countries (see, McGuinness 2006). Therefore, when the present model focuses on the issue of the optimal level of labor market friction (which also implies the optimal level of payment to the R&D sector workers), then it indicates the possibility of over-payment in the R&D sector too.

4.4. Extension: Government with a Balance Budget Constraint

The previous section develops a rudimentary model, which does not involve the financial constraints of the government. Specifically, government has no budget constraint. This section relaxes this assumption and incorporate a budget (hence forth BB) constraint for government, which has to be balanced. It is shown that all the key results of the previous section hold even if government finances its own expenditure for R&D activity from the given budget.

Government has the power to freely impose discriminatory tax on the individuals. Using that authority, government taxes the individuals who get the job as a worker in a firm once on a lump-sum basis, and thus, finances the cost incurred for R&D activity. This tax rate, τ_t, is known to all at the beginning of any period, t (say). So, workers bargain on their effective wage after getting matched with a firm. Therefore, the new wage rate, w_t^τ, is:

$$w_t^\tau = \underset{w_t^\tau}{\arg\max} \left(2(A_t - w_t^\tau)\right)^\beta (2w_t^\tau - \tau_t - R_{t+1}^\tau)^{1-\beta}.$$

That is,

$$w_t^\tau = \frac{(1-\beta)A_t + \frac{\beta}{2}\tau_t}{1-\frac{1-\beta}{2}sM_t^\tau}. \tag{25}$$

Government in each period spends the entire revenue, earned from taxation, in research activity. Hence, the budget balance constraint is the following:

$$\tau M_t^\tau = (1 - M_t^\tau)R_{t+1}^\tau \tag{26}$$

Equation (8) still holds in this set-up. That is, government pays researcher as a proportion of the expected wage (what they may get if they would work in a firm). So, substituting equation (8) in equation (26) and then replacing w_t^τ from equation (25), equilibrium tax rate can be solved:

$$\tau_t^* = \frac{s(1-\beta)}{1-\frac{s\beta}{2}} A_t(1 - M_t^\tau). \tag{27}$$

For solving the equilibrium value of market determined overall successful matching we would recall equation (13). For the present purpose the equation is rewritten with new notation:

$$M_t^\tau = \gamma - \frac{dA_t}{2(A_t - w_t^\tau)}. \tag{28}$$

It is straight forward to understand, in this version also all individuals first search for a job in a firm, and then who ever fails to get employment receives education and joins R&D activity at the second period. Therefore, equations (10) and (11) remain unchanged. Now, first substituting equation (27) into equation (25) and then, replacing the value of w_t^{τ} back into equation (28) we get the following equation which can solve for the equilibrium $0 < M^{\tau*} < 1$:

$$M_t^{\tau} + \frac{d}{2\beta}\left[\frac{1-\frac{1}{2}sM_t^{\tau}}{1-\frac{\beta}{2}sM_t^{\tau}} - \frac{(1-M_t^{\tau})s(1-\beta)}{2-s\beta}\right]^{-1} = \gamma. \tag{29}$$

LHS of the above equation has a positive relation with M_t^{τ}. Hence, for $\frac{d}{2\beta}\left(1-\frac{s(1-\beta)}{2-s\beta}\right) < \gamma$, there exists a unique solution for M^{τ^*}. Note that, $M^* < M^{\tau*}$. Moreover, $\frac{\partial M^{\tau^*}}{\partial s} < 0$ and $M^{\tau*}(0; d, \beta, \gamma) > 0$ still holds.

Since, BB policy is a redistributive instrument, GDP value of any period does not change compared to the benchmark case (without BB constraint). Hence the optimal $\Gamma_t^*(M^{**})$and growth rate of the economy remain unchanged. However, to reach that $s^{\tau*}$ is to be set such that $M^{\tau^*} = M^{**}$, and it is not difficult to show that $s^* > s^{\tau*}$.

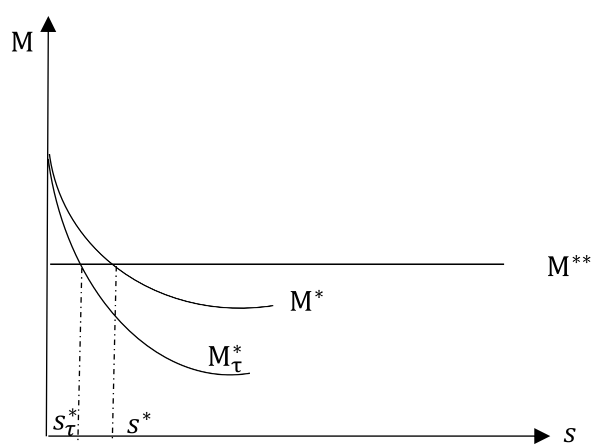

Figure 4.2.: Market Determined Rate of Job Match Vis-À-Vis Optimal Job Match When BB Satisfies

4.5. Extension: Stochastic fluctuation in Output

This section we extend the model further by allowing some stochastic element in the model. This is to check how the results vary from the basic model when economy varies from one state to another. This analysis can be interpreted as the stochastic fluctuation in the impact of the research outcome on the productivity of the labor. That is, once the research outcome is available, then also the usage of that outcome on the productivity level is uncertain. Say, the productivity depends on a random parameter, ϕ. Whatever be the technological outcome, the usefulness on the productivity also depends on ϕ too. To make the analysis simple it is assumed that ϕ can take only two positive values: $\phi_t = \{\phi_1, \ \phi_2\}$, and follows a stationary Markov process. To avoid the cumbersome analysis, we once again ignore the budget constraint of the government.

Instead of A_t, productivity from a successful matching at period t is now:

$$\Psi_t = A_t \phi_t. \tag{30}$$

Φ is a stochastic term. To make the analysis simple it is assumed that ϕ can take only two positive values: $\phi_t = \{\phi_1, \ \phi_2\}$, and follows a stationary Markov process. Value of ϕ_t is known to all only at the beginning of the period t. That is, at the beginning of a time period firms and workers both know what is going to be the productivity level of a new matching at that period. Transition matrix for ϕ is Π (say),

$$\Pi = \begin{bmatrix} \overline{\pi} & 1 - \overline{\pi} \\ \underline{\pi} & 1 - \underline{\pi} \end{bmatrix}. \tag{31}$$

Where, $0 < \Pi_{ij} < 1$. Therefore, if at time period t,ϕ takes the value ϕ_1 then the probability of repeating ϕ_1 at period (t+1) is $\overline{\pi}$ and the probability of a change to ϕ_2 is $1 - \overline{\pi}$. On the other hand, if ϕ is ϕ_2 at period t, then at period (t+1),ϕ takes the value ϕ_1 with the probability $\underline{\pi}$ and it remains ϕ_2 with the probability $1 - \underline{\pi}$.

Firms expected infinite return from a vacant job is now,

$$EV_t = -d\Psi_t + M(\theta_t^{-1}, 1)(2(\Psi_t - w_t) + EV_{t+2}) + \left(1 - M(\theta_t^{-1}, 1)\right)EV_{t+1}.$$

The equilibrium free entry condition leads to$EV_t = 0$, which implies,

$$M(\theta_t^{-1}, 1) = \frac{d\Psi_t}{2(\Psi_t - w_t)}. \quad (32)$$

After a successful matching workers and firm bargain on Ψ and decides per period return. That is,

$$w_t = \underset{w_t}{\arg\max} \left(2(\Psi_t - w_t)\right)^{\beta} (2\Psi_t - R_{t+1})^{1-\beta}.$$

The wage rate is solved using equation (8) (which still remains a valid relation) as the following:

$$w_t = \frac{1-\beta}{1-\frac{\beta}{2}sM(1,\theta_t)}\Psi_t. \quad (33)$$

Wage, therefore, fluctuates with stochastic shocks. Equations (10) and (11) hold in this version of the model also. Therefore, using equation (12), equation (32) can be rewritten as,

$$M_t = \gamma - \frac{d}{2\left(1-\frac{1-\beta}{1-\frac{\beta}{2}sM_t}\right)}.$$

It is straight forward to prove that above equation can be reduced to equation (14), from where one can solve for M^*. Therefore, overall per period matching level of the economy remains the same and time invariant. This is because, in this hypothetical economy, firms and workers are absorbing all the effect of the productivity shock.

Determination of long run optimal path is now based on the maximization of the expected time discounted long run sum of GDP values. Therefore, the objective function for this analysis is,

$$E\Gamma_t = \sum_l p_l^*\left(E_{t-1}^l\Gamma_t\right). \tag{34}$$

Where, $l = \{1, 2\}$ and $E_{t-1}^l\Gamma_t$ is the long run time discounted sum of expected GDP values given the value of ϕ at the period (t-1). Stationary state value of $P(\phi = \phi_l)$ at any period is denoted as p_l^*. Following equation specifies $E_{t-1}^l\Gamma_t$ given $(\phi = \phi_l)$:

$$E_{t-1}^l\Gamma_t = E_{t-1}^l[\sum_{n=0}^{\infty} \delta^n M(\Psi_{t+n-1} + \Psi_{t+n})].$$

Kolmogorov-Chapman[9] equation helps to reduce the above mentioned infinite sum into the following expression:

$$E_{t-1}^l\Gamma_t = M\left[A_{t-1}\left[\phi_l + (1+\delta)\Pi(l;:)_{1\times2}[I-\delta\Pi]^{-1}{}_{2\times2}[\phi]_{2\times1}\right]\right]$$

$$+M(1-M)\psi^{t-1}(1+\delta)\left[\Pi(l;:)_{1\times2}[I-\delta\psi\Pi]^{-1}{}_{2\times2}[I-\delta\Pi]^{-1}{}_{2\times2}[\phi]_{2\times1}\right]. \tag{35}$$

So, to maximize equation (34) we only need to specifyp_l^*. Here we propose a stationary state as follows:

$$p_1 = \overline{\pi}p_1 + \underline{\pi}p_2, \tag{36}$$

$$p_2 = (1-\overline{\pi})p_1 + \left(1-\underline{\pi}\right)p_2 \tag{37}$$

and, $p_1 + p_2 = 1.$ (38)

All these three equations hold simultaneous in stationary state. Solving equations (36) to (38) we find:

[9]Kolmogorov-Chapman equation: $\Pi^{(n+m)} = \Pi^{(n)}\Pi^{(m)}$. $(n+m)$, (n) and (m) are denoted as steps of transition.

$$p_1 = \frac{\overline{\pi}}{\underline{\pi}+(1-\overline{\pi})}, \tag{39}$$

and, $$p_2 = \frac{1-\overline{\pi}}{\underline{\pi}+(1-\overline{\pi})}. \tag{40}$$

Now equation (34) can be maximized with respect to M by incorporating equations (35), (39) and (40). $0 < M_{\phi}^{**} < 1$ maximizes (30) and the value of M_{ϕ}^{**} is the following,

$$M_{\phi}^{**} = 1 - \frac{1}{2+\frac{1}{(1+\delta)(\psi-1)}\left(\frac{pA_1+qA_2}{pB_1+qB_2}\right)}. \tag{41}$$

Where, $A_l = \phi_l + (1+\delta)\Pi(l;:)(I-\delta\Pi)^{-1}[\phi]$ and $B_l = \Pi(l;:)(I-\delta\psi\Pi)^{-1}(I-\delta\Pi)^{-1}[\phi]$. Correspondingly, government can solve s_{ϕ}^{**} such that $M^* = M_{\phi}^{**}$, (recall, market determined equilibrium matching, M^*, is negatively related withs).

In this version also, expected growth rate does not depend on the overall matching level of the economy and ψ has an unambiguous positive impact on growth rate. Hence government can choose the optimal path without hampering the growth rate. Growth rate is determined as,

$$Eg_t = \sum_l p_l^* E_{t-1}^l g_t, \tag{42}$$

where, $E_{t-1}^l g_t = \frac{\Pi(l;:)\Pi\phi\psi^2-\phi_l}{\Pi(l;:)\phi\psi+\phi_l}$.

4.6. Conclusion

This model views labor market friction from a different perspective compered to existing literature. After the introduction of search-matching framework in the literature of labor market friction, neo-classical general equilibrium models get a rigorous micro foundation for imperfect labor market to comment on different macroeconomic problems. Most of these effort aims to show that how positive level of friction in the labor market can drag the economy away from perfect competitive solutions. Another route of research determines the relation between unemployment and other important macroeconomics variables endogenously. Moving away from these common practice, our model looks for a positive role of labor market friction in a model with endogenous technological progress and suggests, instead of setting zero friction, economy can gain in long run if there exits an appropriate level of positive friction. Economy can achieve that even without changing its growth rate.

In a simple general equilibrium set up, this model assumes a (search) frictional labor market with endogenous technological progress to find an appropriate friction level which leads the economy to an optimal long run path. The market determined equilibrium level of search friction is determined and then it is showed that by choosing an optimal level of friction endogenously, the government can improve upon the market outcome. Growth rate is constant in this hypothetical economy and does not depend on the friction level of the economy. Therefore, even if economy moves into its optimal path, growth rate remains unaltered. It has shown that the results are consistent for self-financing government. That is, the main results remain unchanged if the government has to maintain a balanced budget. In other extension, we allow random fluctuations in the economy which shifts the productivity of a successful matching from one state to another. It is shown that the model is robust to introduction of stochastic shocks. Growth rate can change only due to random change in the productivity of a successful matching. Otherwise economy grows constantly with the rate of technological progress.

Appendix

Appendix 1

In the sub-section 4.1.5, we have claimed that the assumption made in equation 8 does not reduce the generality of the model. Following argument is made in support of that claim.

Using equation 7, for any R_{t+1}, equation 5 can be written as following

$$M(\theta_t^{-1}, 1) = \frac{dA_t}{2\left(\beta A_t - \frac{\beta}{2} R_{t+1}\right)}$$

$$\text{or, } M(\theta_t^{-1}, 1) = \frac{d}{2\beta\left(1 - \frac{R_{t+1}}{2A_t}\right)}. \quad (43)$$

Using equation 6 and the above equation,

$$M_t = \gamma - \frac{d}{2\beta\left(1 - \frac{R_{t+1}}{2A_t}\right)}. \quad (44)$$

As it is argued in sub-section 2.5, $0 < \frac{R_{t+1}}{2A_t} < 1$ for all t. Note that, $\frac{R_{t+1}}{2A_t}$ is negatively related to M_t and for certain restriction on γ, β and d, $0 < M_t < 1$ for all $0 < \frac{R_{t+1}}{2A_t} < 1$. These two properties of the above equation generate most of the important results of the model. In this model, $\frac{R_{t+1}}{2A_t}$ has been replaced by a specific $0 < s_t < 1$. To make the model more interesting and to ensure the convergence, the assumption in equation 8 is made.

Appendix 2

Consider the baseline model, but relaxing the assumptions of costless education and frictionless R&D sector. To make the model more comprehensive let us introduce a labor-input for providing the education. That is, not only to improve the technology level but also to develop educated labor force economy needs educated laborers (namely, 'teachers'). Therefore, the changed set up is the following. Agents who take education at period t, have to pay η_t. R&D sector hires λ proportion of the educated labor force. Rests are hired to provide education to the next generation (here, one can introduce some friction and generate an educated unemployed labor pull. That will introduce only another parameter but otherwise analysis will be the same). Both types of educated workers are receiving wage for only one period (i.e., for t+1th period) and the wages are denoted as R_{t+1} and Z_{t+1}, respectively. Budget balancedness for R&D sector has already been discussed above. Here, the discussion focuses on the additional cost that has to be incurred by the Government by paying the wage to the 'teachers'. To finance that budget, it is assumed that the revenue generated from the agents who pay the cost for the education, is distributed to the "teachers". Either the cost (η_t) or the wage payment of the 'teachers' (Z_t) can be considered as given. Here, the Z_t is considered as exogenously given, and is set similarly as R_{t+1}. Since all the other mechanisms of the model are exactly the same, here we avoid the repetition of argument that has been made about the assumption of R_{t+1}, and hence of Z_{t+1}.

In this set up the key equations which come up along with all major equations of Section 2, are the following.

Bargaining wage equation: $w_t = (1-\beta)A_t + \frac{\beta}{2}\left(\lambda R_{t+1} + (1-\lambda)Z_{t+1} - \eta_t\right).$ (43)

Second parenthesis involves the net expected opportunity cost for the laborer to join the production sector.

Budget equation for 'teachers': $N_t\eta_t = (1-\lambda)N_{t-1}Z_t$. (44)

Where, N_t denotes the number of agents willing to take education at period t. Note that 'teachers' who receive wage at period t have taken education at period $(t-1)$ and become 'teacher' with probability $(1-\lambda)$ at period t. Therefore, the right hand side of equation (44) represents the cost for paying teachers and the left hand side is the revenue from the agents who are willing to take education at period t.

Using similar argument as stated in baseline model, in equilibrium,[10]

$$N_t = 1 - M_t. \tag{45}$$

Let us assume, similar to R_{t+1} in equation (8), $Z_{t+1} = s'M_tw_t$. (46)

Where, $0 < s' < 1$.

Rearranging equation (5) and using equation (10) and (12): $M_t = \gamma - \frac{d}{2(1-w_t/A_t)}$. (47)

From equation (43), $\frac{w_t}{A_t}$ can be expressed in terms of $\left\{\frac{w_{t-1}}{A_{t-1}}, w_{t-1}, M_t, M_{t-1}, t\right\}$ using equations (1), (8), (10), (45) and (46). Specifically, the equation is the following,

$$\frac{w_t}{A_t}\left(1-\frac{\beta}{2}(\lambda s+(1-\lambda)s')M_t\right) = (1-\beta)-\frac{\beta}{2}(1-\lambda)\left(\frac{1-M_{t-1}}{1-M_t}\right)s'M_{t-1}\left(\frac{1}{\frac{A_{t-1}}{w_{t-1}}+\psi^{t-1}*\frac{1-M_{t-1}}{w_{t-1}}}\right). \tag{48}$$

[10] Note that, since the cost associated with getting education makes R&D ever less lucrative.

Note that, equation (47) says, M_t is a function of $\frac{w_t}{A_t}$ only. Therefore, equation (48) returns $\frac{w_t}{A_t}$ as a function of $\frac{w_{t-1}}{A_{t-1}}$, w_{t-1} and t.

To solve the steady state, first we define, there exists a steady state and then we check the consistency.

Say, at the steady state, $\frac{w_t}{A_t} = \omega$, (49)

and hence, $M_t = M(\omega) = \gamma - \frac{d}{2(1-\omega)}$. (50)

Therefore, equation (48) becomes,

$$\omega\left(1 - \frac{\beta}{2}(\lambda s + (1-\lambda)s')M\right) = (1-\beta) - \frac{\beta}{2}(1-\lambda)s'M\left(\frac{1}{\frac{1}{\omega}+\psi^{t-1}\frac{1-M}{w_{t-1}}}\right). \quad (51)$$

Now, one can solve for w_{t-1} and divide that by A_{t-1}. Using similar condition as of equation (21)[11] following can be obtained,

$$\omega^2\left(1 - \frac{\beta}{2}\lambda s M\right) - \omega\left(1 - \beta - \frac{(\psi-1)}{\lambda}\left(1 - \frac{\beta}{2}(\lambda s + (1-\lambda)s')M\right)\right) - \frac{(\psi-1)(1-\beta)}{\lambda} = 0. \quad (52)$$

It is clear that RHS of equation (52) is a third order polynomial (using the value of $M(\omega)$ from equation (50)) of ω. Therefore, there exists at least one real root of ω and parametric specification guarantees its value to be positive. Using the value of ω, steady state M can be solved too.

Thus, $M^* = M(s, s')$. (53)

Rest of the analysis is similar to the basic model described in section 4 and the main results hold.

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[11] Now $\frac{\psi^t}{A_t} = \frac{\psi-1}{\lambda(1-M)}$.

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