ARAB REPUBLIC OF EGYPT

THE INSTITUTE OF NATIONAL PLANNING

Memo No (1646)

Using PEPA to Model the Unemployment Problem

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September 2010

CAIRO
SALAH SALEM St-NASR CITY

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Case Study Egypt

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Abstract- In this paper, we use performance evaluation process algebra PEPA to model the interactivity between different variables affecting unemployment in four basic modules representing the balance between job seekers and job opportunities. This model constitutes a new application area for this process algebra formalism. We focus on the particularity of Egypt's labour market showing the dynamics between the supply and demand of job opportunities in the market.

This has the advantage over the current techniques of demonstrating to decision makers the multiple dimensions and consequences of applying different strategic policies. It also allows looking into the specifics of not only the increase or decrease of the unemployment rate, but also the stability of the unemployment rate i.e., turnover of employees/works.

Keywords: Stochastic Process Algebra, PEPA, Unemployment Problem, Decision Making

I. INTRODUCTION

Unemployment is a persistent and alarming problem to the worldwide nations. According to the International Labour Organization (ILO), 160 million people in the world today are unemployed [1]. In Egypt, which is considered a youth society, the problem is expanding. With the increasing number of educated people, the yearly cumulative outcome of the education system is more than can be absorbed by the labour market and that raises imbalances in the Egyptian labor market [2] Data published by the Central Agency for Public Mobilization and Statistics (CAPMAS) [3] indicate that unemployment rates have increased from 8.8 percent in the second quarter of 2008 to 9.2 percent in the same period of 2009, i.e., there were some 2.34 million people unemployed out of a workforce of 25 million.

According to the World Bank and Ministry of Trade and Industry, although Egypt has invested in the education sector in recent years, the high rate of illiteracy (more than 30 per cent) points to serious shortcomings in the education system. Every year another 800,000 school leavers flood onto the labour market, and only about 31% of them manage to find a job [4]. Additionally, job hunting duration for

fresh graduates could extend to 3 years [5].

This unemployment problem is complicated and it is neither due to the sluggishness of growth nor the return of growth. However, "it is the manner in which each country manages this process that results in that country having more or less growth or more of fewer unemployed persons" [6]. Governments apply different strategies and policies to solve this problem, but, due to the complexity of the problem, the consequences of implementing any strategy are not clear.

The complexity of the unemployment problem can be represented by a network of multiple factors (entities) and their interactions in an economic system. These interactions are often difficult to represent and analyse. Process algebra models, which originally have been developed for concurrent systems analysis, support representation and reasoning complex interactions between components as stochastic process algebra defines time and maps models to stochastic processes. These models representation is program like source codes whose interpretation, according to defined syntax- driven rules (operational semantics), is exact and precise. By using process algebras, it is possible to first design individual components and then construct modules as their combination, thus supporting compositionality.

Process algebras, from their use in computer science, have been equipped with steady-state and transient model analysis tools, as well as applications for simulation and (probabilistic) model checking of models. Performance Evaluation Process Algebra (PEPA) language has few but powerful operators that represent basic actions and elements of the system, thus permitting the modellers to tune the level of detail of the model represented and avoid unnecesary complex details. Also, PEPA has the ability to handle multi-way synchronizations [7].

In the paper, we are using PEPA to model labour distribution among different labour markets (i.e., government, public sector, private sector, and aboard labour markets) and accordingly, we can calculate the unemployment rate and visualize the impact of any changes. The next section portrays the unemployment problem in Egypt and demonstrates the limitations of techniques measuring unemployment rates. The third section recaps the syntax and semantics of Performance Evaluation Process Algebra PEPA. In the fourth section, the unemployment model is described focusing on Egypt's case. The fifth section is about the experiments and results. The conclusion and future work is in the final section.

II. LITERATURE REVIEW

A. Unemployment problem in Egypt

A number of factors affect the nature of unemployment problem in Egypt. The implementation of Egypt Reform and Structural Adjustment Program of 1991, ERSAP 91 has contributed to the unemployment problem and consequently the stability of the social welfare of the society. The process of privatising large State Corporations has led to a large reduction in the number of the staff [5]. Additionally, inability of the economic and investments policies to encourage labour intensive industry has failed to absorb more labour. The legislative and institutional rules have produced investment patterns that are biased against labour-intensive growth. This has weakened the ability to create jobs [8] & [9]. Besides these factors, the "education-occupations mismatch" has added to the problem [10]. "Although Egypt has made a substantial progress with respect to access to education, the education system is not providing markets with the quantity and quality of educated individuals most in demand" [11].

However, during 1998-2006, the unemployment rate has been slightly reduced. Assaad [11] refers this to three main factors: "(i) the slow-down in the growth of the working age population and the shift of the age

structure of the youth population away from the 15-19 age group, which had the highest unemployment rates in 1998; (ii) the slowdown in government hiring, which reduced the incentive of female graduates so as to remain unemployed while queuing for government jobs or withdrawing all together; (iii) the acceleration of employment growth in the private sector, leading to earlier transitions into employment, at least for young male new entrants"[12].

B. Unemployment Models

The difficulty is to represent these factors and their interactions by means of conventional analytical and/or statistical tools. Classical models such as, the classical model of the labour market, the natural rate of unemployment, Okun's law, structural unemployment, Non-Accelerating Inflation Rate of Unemployment (NAIRU), and Phillips curve[13] are simple and calculate different aspects of the problem focusing partially on certain elements and ignoring others. El Kassas and his colleagues use statistical methods to estimate separately the labor demand, the labor supply and the unemployment for different scenarios in Egypt [14]

The Social Accounting Matrix (SAM), which is the data base of the Computable General Equilibrium Model (CGE), addresses many factors simultaneously in a symmetric matrix. It represents the balance between

the supply and demand of the commodity, total income and total expenditure of the funds, or savings and investments of macroeconomic factors in a square of rows and columns [15]. This data base can show the effects of policy changes and track the distributional consequences of policy choices. However, it cannot be used for forecasting, since the calculations are calculated at a certain point of time i.e., coefficients are results of a specific year data (benchmark).

Although SAM appears simple conceptually, it requires a great deal of skills to calculate complicated matrices and high quality data. Because the supply and the demand sides are calculated separately, modifications and adjustments happen frequently to balance the matrices. The complexity usually increases while inverting very large matrices and recalculating the coefficients to maintain the balance. Clearly, it does not tolerate inconsistencies in data.

For developing countries, this is one of the major problems they suffer at two levels. Initially, because of the shortage in funds, the data collected are usually estimates. So, a lot of adjustments are made to fit the data in the matrix. For example, the changes made the Mozambique' SAM in 1995 to achieve a balance is an adjustment of 295 $ m. for a country where 38% of population live for less than 1$ in the period 1994 – 2004, this SAM adjustment added 4.40$ to each person's

income in the agricultural sector [16], [17], [18]. On the other level, developing countries, with ill-structured and malfunctioned management systems, a lot of resources are wasted, so estimates of productions outcomes are not usually exact.

Developing a different representation to the interactions and relationships between supply and demand of job opportunities would be a contribution especially if it avoids earlier problems and decomposes the effects of policy change and tracks the distributed consequences. This can help strategic decision makers because "strategic decision is likely to be complex in nature, be made in situation of uncertainty, affect operational decision, requires an integrated approach, and involves considerable changes" [19].

Performance Evaluation Process Algebra (PEPA) allows demonstrating the system by representing its components and the whole system consists of the interaction between those components. PEPA is based on the Markov chain theory and allows a large number of vector-matrix multiplications. The matrix size is the number of states in the Markov chain. Besides, in some models with strong structural conditions PEPA's underlying Markov chain is not solved as a single system of equations, but it is decomposed into sub-models. The sub-models behave as if they were independent and the decomposed solution yields the same