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Original Research Article

Search and Matching Model Performance in Selected Developing Countries with a focus on Iran

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This paper shows the inability of standard search and matching model to replicate labor market volatility in a selected developing country and especially in Iran's economy. To do this, we present empirical evidence on the cyclical behavior of the labor market variables in the selected developing countries. We then build, parameterize, and simulate the standard search and matching model and compare the simulated statistics to the data. The results indicate how those models fail in replicating the stylized facts concerning the unemployment and job vacancy volatilities following a standard productive shock. Likewise, the model is unable to generate as much volatility on the market tightness as in the data. Also, the search and matching model cannot explain the observed volatilities in unemployment and job vacancy in Iran's labor market in response to the labor productivity shock, and the calibrated model is able to explain less than 0.25 percent of the observed volatilities in the market tightness. This suggests a need to explore alternative sources of shocks and frictions in labor market of Iran. In general, one could contemplate augmenting the search and matching model with features such as wage flexibility, price stickiness, endogenous job separation under different types of shocks along with some developing countries-specific features. All in all, this paper contributes essentially to the literature on empirical investigation of the business cycle properties of labor market variables within a search and matching prototype for selected developing economies. The inability of search and matching model to predict fluctuations in the labor market variables in Iran's economy and developing countries have not been quantitatively investigated so far, and this paper is the first quantitative work in this field.

Keywords: Labor Market, Vacancies, Unemployment, Market Tightness, Developing Countries
JEL Classification: E24, E32, J63, J64

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1 Introduction

Diamond (1982), Mortensen and Pissarides (1994), and Pissarides (2000) search and matching model in labor market literature is popular because with simple productivity shocks, the model correctly indicates the key empirical regularities in labor market variables. Despite this success, however, Shimer (2005) questioned the validity of this model by showing that, the search and matching model is unable to replicate the basic cyclical properties of the U.S. labor market data. This failure of the model when used at business cycle frequencies has come to be known as the "Shimer Puzzle," which states that the basic search and matching model is not able, using empirically plausible movements in productivity, to generate as much volatility in the ratio of unemployment to vacancies as is observed in the data. Although a large number of related studies has emerged to address this challenge, there has not been systematic work to check if this failure of the Mortensen-Pissarides model can be observed in developing countries as well. This paper fills this gap by examining the business cycle in the developing countries especially Iranian labor market. So, the aim of this paper is to analyze whether this volatility puzzle, which was originally found for the U.S., holds for the developing economies. We first provide empirical evidence on the cyclical properties of the developing countries including Brazil, Bulgaria, Chile, Colombia, Costa Rica, Czech Republic, Estonia, Hungary, Jamaica, Mexico, Peru, Slovenia, Thailand, Turkey, and Iran. We then build a search and matching model; we calibrate the model parameters to match the long-run evidence of the developing countries, and we simulate the model to assess whether the "Shimer Puzzle" holds or not.

Over the business cycle, both unemployment and job vacancies are volatile and persistent, and these two variables have a strong negative correlation (Beveridge curve). Workers find jobs more easily in booms than in recessions, while firms fill their vacancies more easily in recessions than in booms. Consistent with the way the matching is modelled in the Mortensen-Pissarides model, the job-finding and the vacancy-filling rates correlate closely, and with opposite signs, with the vacancy-unemployment ratio. Qualitatively, all these observations are correctly predicted by the standard Mortensen-Pissarides model with productivity shocks. However, when the model is calibrated assuming that workers do not value their time much while they are unemployed, the model predicts only a small fraction of the observed variation in unemployment and job vacancies in developing countries.

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The Shimer puzzle induced a large literature assessing the conditions that Shimer puzzle holds or not. Shimer (2004) and Hall (2005a, b) emphasis on real wage stickiness Hagedorn and Manovskii (2008) show that calibrating the lisure bring the mode close to data. Moreover, Pissarides (2009) suggests that taking into account that the wages of newly hired workers reproduce correctly labor market fluctuations. In addition, for increasing amplification mechanism in DMP model, Silva and Toledo (2009) and Petrosky-Nadeau and Wasmer (2013), use labor turnover costs and financial frictions, respectively. Moreover, the number of scholars become active in testing the soundness of the unemployment volatility puzzle even outside the US economy. First, Zhang (2008) tests the Shimer Puzzle in Canada, Miyamoto (2011) in Japan, and Gartner et al. (2012) do the same in Germany. All those authors find that in all the countries taken into consideration the volatility of labor market tightness is much higher than the one attached to productivity. More recently, Justiniano and Michelacci (2011) as well as Amaral and Tasci (2013) test Shimer's (2004, 2005) empirical results over a set of OECD countries in which a number of EU members is included. However, until now, nothing has been said about the cyclical behavior of unemployment and vacancies in the developing countries context especially in Iran.

The rest of the paper is organized as follows. Section 2 documents the business cycle properties of labor market variables. Section3 lays out our model. Section4 explains calibration, solution, and main quantitative findings. Finally, Section5 concludes.

2 Primary Empirical Evidences

This section presents empirical facts to describe the characteristics of labor market business cycles for the variables of unemployment, productivity, vacancies, and labor market tightness in developing countries including Brazil, Bulgaria, Chile, Colombia, Costa Rica, Czech Republic, Estonia, Hungary, Jamaica, Mexico, Peru, Slovenia, Thailand, Turkey, and Iran. We use data for two purposes: to compute the data moments against which we measure the model's performance and to calibrate the parameters that discipline the model. With the first purpose in mind we collect unbalanced data panels at a quarterly frequency on vacancies, unemployment, real GDP and productivity for developing countries. Production per worker is considered as a proxy for productivity and is defined as the ratio of GDP to

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the number of employees. Job vacancy[1] data are obtained from various sources. Unemployment and employment data for each country are collected from the World Bank[2] and GDP data from the TED[3]. In order to obtain business cycle fluctuations, all variables are quarterly, seasonally adjusted with Census X12, and reported as log deviations from an HP trend with the smoothing parameter $\lambda = 1600$. Since our panel data is unbalanced across countries, and even across variables for the same country, we compute statistics pertaining to the period for which all variables are available for each country. Thus, for instance, the sample for Brazil extends from the first quarter of 2007 (before that vacancy data was not available) to the fourth quarter of 2011. This means that we have different sample periods for different countries. When we use a shorter, more common period (from 2008 to 2015) for all countries, the empirical facts for the data remain unaltered.

Looking at the statistical properties of the cyclical component of our sample of labor market variables, summarized in Tables 1-4, provide useful benchmarks for business-cycle models of the labor market in the developing countries.

Table 1
Vacancy (v)

Country	**Start data**	**End data**	**Std. dev.**	**Autocorr.**
BRA(Brazil)	Q1-2007	Q4-2019	0.4727	0.921
BG(Bulgaria)	Q1-2005	Q4-2019	0.4472	0.944
CHL(Chile)	Q1- 1987	Q4-2019	0.4473	0.944
COL(Colombia)	Q1-1980	Q4-2012	0.2065	0.953
CR (Costa Rica)	Q1-2001	Q4-2019	0.1033	0.937
CZE (Czech Republic)	Q1-1991	Q4-2019	0.6262	0.941
EE(Estonia)	Q1-2005	Q2-2020	0.2564	0.947
HUN(Hungary)	Q1-1992	Q2-2020	0.3042	0.946
JM(Jamaica)	Q1-2005	Q4-2019	0.3186	0.919
Mexico (MX)	Q1-2005	Q4-2019	0.2804	0.948
Thailand (TH)	Q4-2001	Q2-2020	0.2729	0.949
TUR(Turkey)	Q1-2000	Q3-2020	0.9517	0.961
IR(Iran)	Q1-2001	Q4-2017	0.4272	0.970

[1] The vacancy rate is also obtained by dividing the number of vacancies by (employed population + number of vacancies).
[2] https://datatopics.worldbank.org/jobs/topic/unemployment
[3] Conference Board Total Economy Database

PE(Peru)	Q1-2001	Q4-2019	0.2253	0.961
SI(Slovenia)	Q1-2008	Q2-2020	0.4468	0.9150

Note: All variables are quarterly, seasonally adjusted, and reported as log deviations from an HP trend with smoothing parameter $\lambda = 1600$.
Source: Research finding

Table 2
Unemployment(u)

Country	Start data	End data	Std. dev.	Autocorr.
BRA(Brazil)	Q1-1981	Q4-2015	26690.	0.973
BG(Bulgaria)	Q1-1991	Q4-2019	28600.	0.915
CHL(Chile)	Q1-1986	Q4-2019	15470.	0.963
COL(Colombia)	Q1-2007	Q4-2019	08300.	0.976
CR (Costa Rica)	Q1-1991	Q4-2020	26170.	0.974
CZE (Czech Republic)	Q1-1998	Q4-2019	38650.	0.943
EE(Estonia)	Q1-1991	Q4-2019	29860.	0.938
HUN(Hungary)	Q1-1990	Q4-2019	30930.	0.949
JM(Jamaica)	Q1-1991	Q4-2019	17710.	0.958
Mexico (MX)	Q1-1987	Q4-2019	17580.	0.993
Thailand (TH)	Q1-1991	Q4-2019	46180.	0.988
TUR(Turkey)	Q1-2006	Q4-2019	09580.	0.911
IR(Iran)	Q1-1991	Q4-2017	48470.	0.899
PE(Peru)	Q1-1999	Q4-2019	24120.	0.991
SI(Slovenia)	Q1-1990	Q4-2019	18620.	0.955

Source: Research finding

Table 3
Productivity(p)

Country	Start data	End data	Std. dev.	Autocorr.
BRA(Brazil)	Q1-1980	Q4-2019	0.3919	0.989
BG(Bulgaria)	Q1-1995	Q4-2019	0.20005	0.981
CHL(Chile)	Q1-1980	Q4-2019	0.1571	0.993
COL(Colombia)	Q1-1980	Q4-2019	0.3041	0.985
CR (Costa Rica)	Q1-1987	Q4-2019	0.1906	0.976
CZE (Czech Republic)	Q1-1993	Q4-2019	0.2066	0.976
EE(Estonia)	Q1-1995	Q4-2019	0.2939	0.964
HUN(Hungary)	Q1-1980	Q4-2019	0.2643	0.984
JM(Jamaica)	Q1-1986	Q4-2002	0.0137	0.967
Mexico (MX)	Q1-1980	Q4-2019	0.2470	0.982
Thailand (TH)	Q1-1980	Q4-2019	0.5595	0.986
TUR(Turkey)	Q1-1980	Q4-2019	0.4191	0.983
IR(Iran)	Q1-2000	Q4-2017	0.1068	0.957
PE(Peru)	Q1-1980	Q4-2019	0.2995	0.983
SI(Slovenia)	Q1-1995	Q4-2019	0.1672	0.963

Source: Research finding

Table 4
Vacancy- Unemployment ratio (θ)

Country	Start data	End data	Std. dev.	Autocorr.
BRA(Brazil)	Q1-2007	Q3-2015	0.2566	0.913
BG(Bulgaria)	Q1-2003	Q4-2019	0.2039	0.979
CHL(Chile)	Q1-1987	Q4-2019	0.2374	0.937
COL(Colombia)	Q1-2006	Q4-2012	0.1069	0.932
CR (Costa Rica)	Q1-2001	Q4-2019	0.0606	0.940
CZE (Czech Republic)	Q1-2008	Q4-2018	0.6846	0.919
EE(Estonia)	Q1-2005	Q4-2018	0.1723	0.939
HUN(Hungary)	Q1-2006	Q4-2018	0.2452	0.938
JM(Jamaica)	Q1-2007	Q4-2019	0.1505	0.915
Mexico (MX)	Q1-2005	Q4-2019	0.1961	0.946
Thailand(TH)	Q1-1980	Q4-2019	0.5901	0.961
TUR(Turkey)	Q1-1980	Q4-2019	0.4744	0.950
IR(Iran)	Q1-2000	Q4-2017	0.2188	0.930
PE(Peru)	Q1-2001	Q4-2019	0.1919	0.963
SI(Slovenia)	Q1-2008	Q4-2019	0.2594	0.943

Source: Research finding

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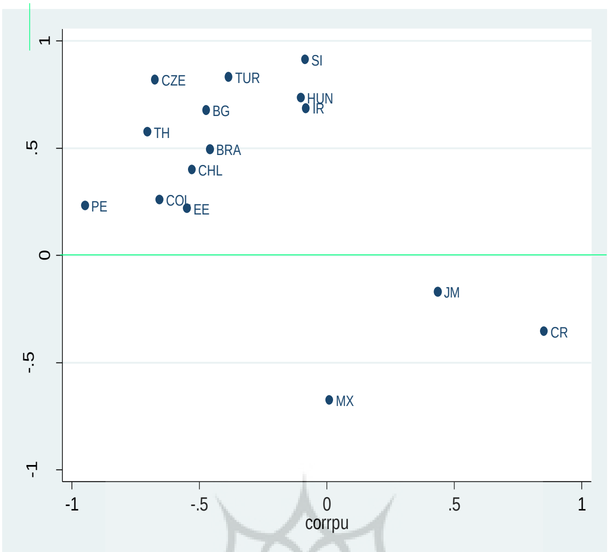

Figure 1. Correlation between productivity and labor market variables
Source: Research finding

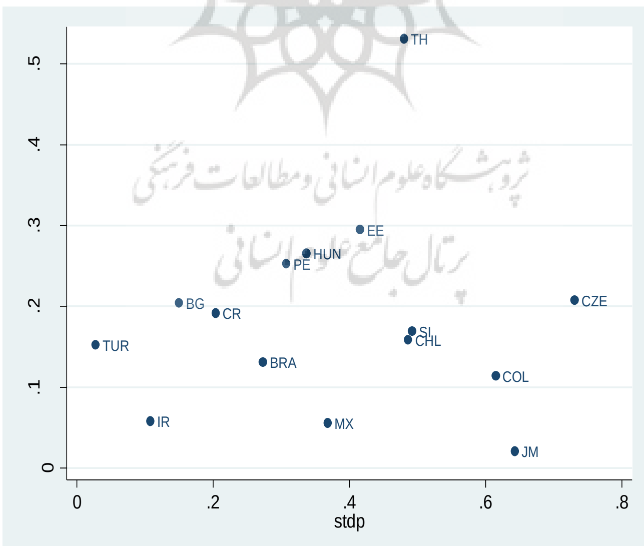

Figure 2. Productivity and unemployment
Source: Research finding

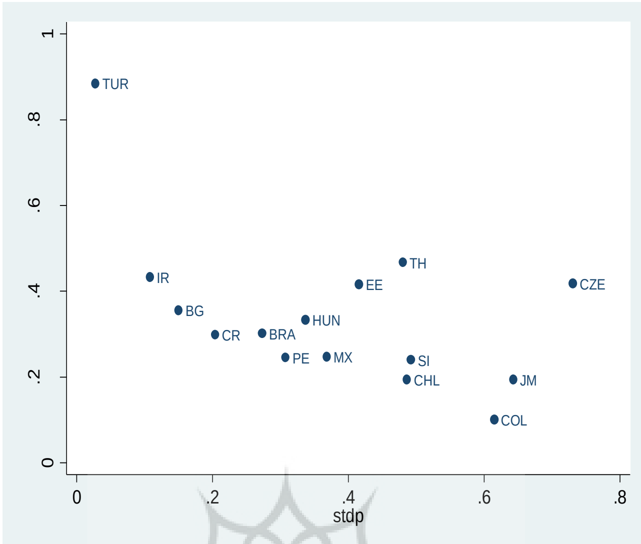

Figure 3. Productivity and vacancies
Source: Research finding

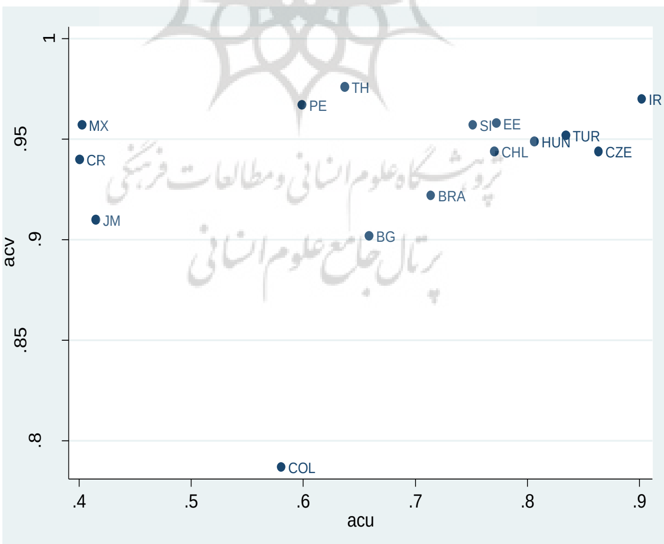

Figure 4. Persistence of labor market variables
Source: Research finding

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There is substantial variation in the degree of correlation between productivity and unemployment and between productivity and vacancies as shown in Figure 1. Moreover, the close linear relationship between the two sets of correlations suggests that whatever is driving a wedge between the behavior of productivity and labor market variables affects unemployment and vacancies equally. While this correlation often has the expected sign (negative for unemployment and positive for vacancies), there are exceptions lying outside the NW quadrant of the figure; this is, in Costa Rica, Jamaica, and Mexico, labor market variables are not associated with productivity, as expected. More to the point, for these three countries it seems like productivity and vacancies do not co-move at all, while productivity and unemployment exhibit a puzzling positive correlation and there is a negative relationship between productivity and vacancies. These observations show the limitations of technology shocks as the only leading mechanism in the DMP model. This suggests other mechanisms may be at work.

A word of caution is in order regarding over interpretation of these correlations' magnitude. As Hagedorn and Manovskii (2008) show for the US case, this correlation can vary considerably depending on the employment series used in the denominator of the productivity computation. It can be seen from Figure 2 that there is a positive relationship between productivity fluctuations and that of unemployment for some countries, which shows that the DMP model with neutral technical shocks as the main driver is, by and large, an appropriate modeling framework or, at the very least, one that is not rejected by these data. Figure 3 does not show any specific behavior between vacancies and productivity fluctuations, which can be due to lack of business environment, financial friction, firm recession, insufficient entry or exit of firms, demand constraints and the existence of market imperfection in developing countries.

In Figure 4, except for the three countries (that is, Costa Rica, Jamaica, and Mexico), the first-order correlation between unemployment and vacancies for other countries indicates persistence in both unemployment and vacancies.

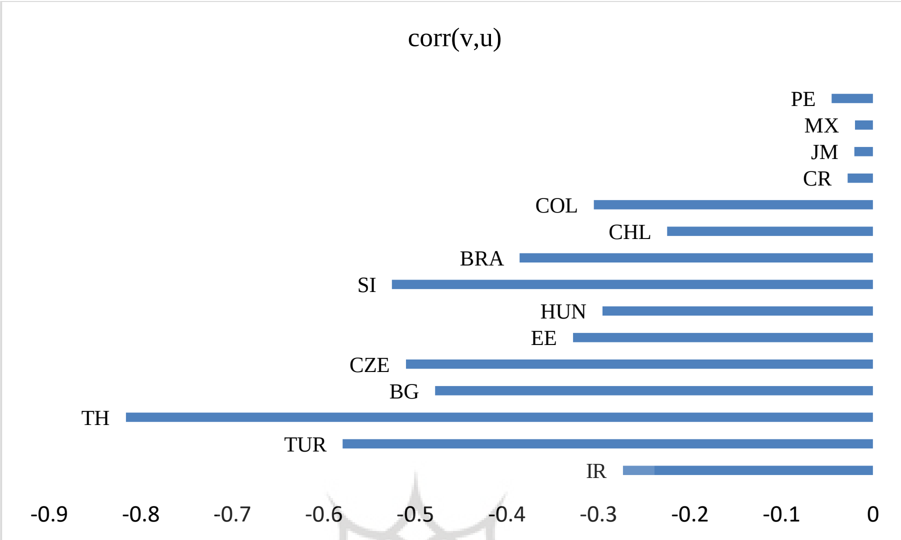

Figure 5. Vacancies-unemployment correlation
Source: Research finding

Figure 5 shows that the relationship between unemployment and vacancies is negative for most countries, although the strength of this relationship is not the same between these countries. This suggests that institutional characteristics may play an important role in introducing frictions that create such differences in the correlation between labor market variables in the developing countries.

For a more detailed study of the behavior of labor market variables, 15 developing countries are divided into three groups:

Group 1: Iran, Turkey and Thailand

Group 2: Bulgaria, Czech Republic, Estonia, Hungary and Slovenia

Group 3: Brazil, Chile, Colombia, Costa Rica, Jamaica, Mexico and Peru

These three groups differ in terms of labor market cycle characteristics as well as in terms of unemployment fluctuations and vacancies. But the countries within each group have similarities in terms of labor market variables.

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Figure 6. Labor market moments for group1
Source: Research finding

In the top-right panel of Figure 6 the degree of correlation between productivity and vacancies and between productivity and unemployment for Thailand is higher than in Turkey and Iran. While labor market variables in Iran compared to Turkey and Thailand, it, seem to be largely insulated from business cycle fluctuations. This suggests other mechanisms are at work. In the top-left panel of Figure 6 we see no strong relationship between productivity and unemployment fluctuations and between productivity fluctuations and vacancies for Iran and Turkey, although these relationships seem to be strong for Thailand compared to the other two countries and it indicates, in the framework, of the search and matching model, the reaction of the labor market variables of Iran and Turkey should be examined with other shocks in addition to the productivity shock. As can be seen from the figure the bottom-right panel of Figure 6 the correlation between unemployment and vacancies is positive for the three countries, which indicates the persistency between unemployment and vacancies, although the intensity of this correlation for Iran is less than that of Thailand and Turkey.

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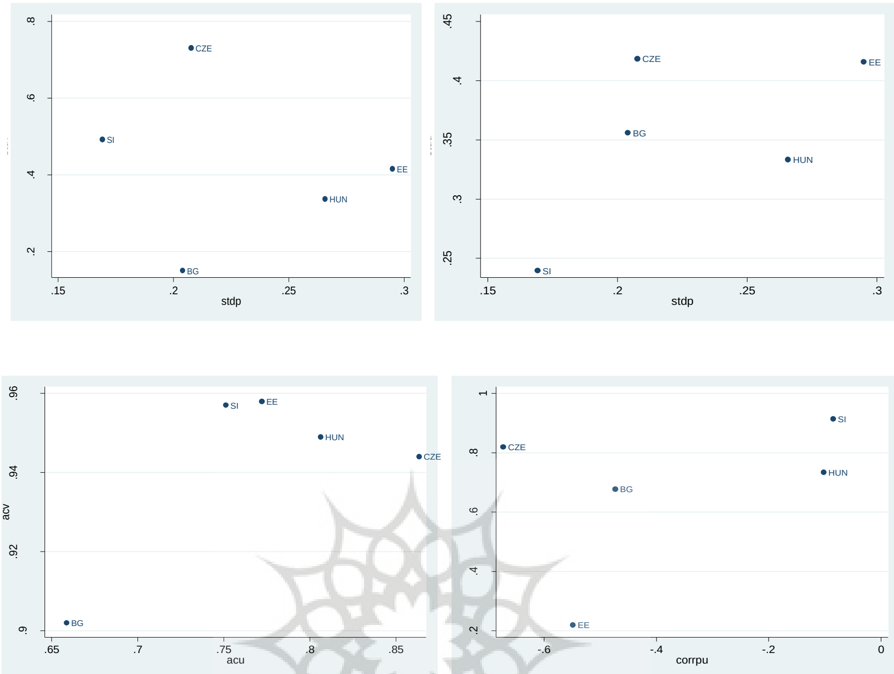

Figure 7. Labor market moments for group2
Source: Research finding

The top-right panel of Figure 7 shows that for the second group of countries, there are significant changes in the degree of correlation between productivity and unemployment, and between productivity and vacancies, and this correlation is as expected for all four countries. From the top and bottom-left panels of Figure 7 it can be seen that technology shock is the main driving force in these countries, while its share in labor market fluctuations in these countries is different. The bottom-right panel of Figure 7 shows that despite the positive correlation between unemployment and vacancies for the second group, the degree of correlation between unemployment and vacancies for Bulgaria is lower than for the other three countries.

The behavior of the third group countries in terms of fluctuations of labor market variables is different from the first and second groups.

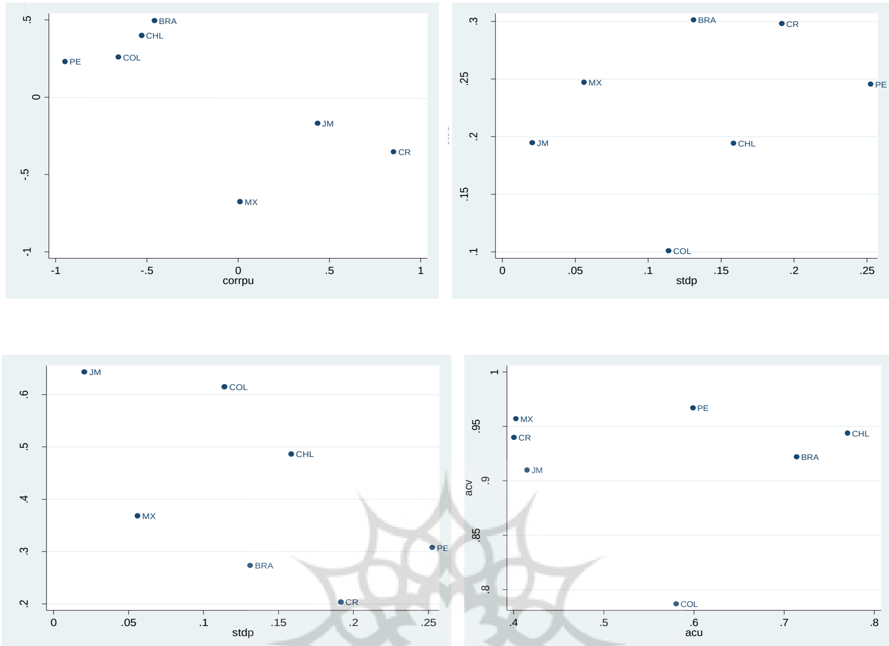

Figure 8. Labor market moments for group3
Source: Research finding

The behavior of the third group countries in terms of fluctuations of labor market variables is different from the first and second groups. In the event of a productivity shock, unemployment increases for Mexico, Costa Rica and Jamaica, and unemployment in other countries of this group shows little response to the productivity shock (Figure 8, the top- right panel). On the other hand, there is no relationship between productivity volatility and unemployment volatility, and between productivity volatility and vacancies volatility that can indicate that the productivity does not contribute to the explanation of fluctuations in unemployment and vacancies for these countries (the top and bottom- left of Figures 8). The bottom right panel of figure 8 shows that for Mexico, Costa Rica and Jamaica, there is no relationship between unemployment and vacancies because the unemployment does not necessarily decrease as vacancies increase. The correlation between these two variables indicates the lack of persistency for the rest of the countries in this group.

3 The Setup

We use a stochastic, discrete time version of the DMP model. Each country is a closed economy and even though the calibration below is country-specific, we abstract from country-indexing to make the notation easier to follow. There is an underlying exogenous productivity process $\{p_t\}_{t=0}^{\infty}$whose log evolves according to an AR (1) process:

$$\log p_t = \rho \log p_{t-1} + \varepsilon_t \quad {\scriptstyle \varepsilon \sim N(0,\sigma_\varepsilon^2)} \tag{1}$$

Where ρ is persistence of productivity process.

The economy is populated by two types of risk-neutral, infinitely-lived agents: a measure one of workers and a continuum of Workers that have preferences defined over stochastic streams of income$\{y_t\}_{t=0}^{\infty}$, and maximize their expected lifetime utility $E_0 \sum_{t=0}^{\infty} \delta^t y_t$, where the discount rate, $\delta \in (0,1)$ is also the same rate at which firms discount profits. At any point in time a worker is either matched with a firm or not. Unmatched workers are said to be unemployed and search for jobs while receiving a utility flow of, the opportunity cost of employment (z). Matched workers are said to be employed and while they are not allowed to search, they earn a period wage w_t. This wage rate is the outcome of a generalized Nash bargaining problem where firms and workers bargain over the match surplus. The worker's bargaining power is denoted by $\beta \in (0,1)$; Firms and workers get separated with exogenous probability,s. Firms are free to enter the market but have to pay a fixed vacancy posting cost of c to be able to obtain a match. Let v_t denote the measure of vacancies posted, and n_t denote the measure of employed people. Then $u_t = 1 - n_t$ denotes the unemployment rate. The vacancy-to-unemployment ratio $\theta_t = \frac{v_t}{u_t}$ or market tightness, will turn out to be a key variable in the model, as it fully describes the state of the economy. We assume the flow of new matches is given by a Cobb-Douglas function:

$$m_t = A{u_t}^{\alpha}{v_t}^{1-\alpha} \tag{2}$$

Where A parameter of matching is function, u_t and $v_t$denote the unemployment rate and job vacancy and α is elasticity of matching function.

The rate at which workers find a new job (f_t) is:

$$f_t = \frac{m_t}{u_t} = A(\frac{v_t}{u_t})^{1-\alpha} = A\theta^{1-\alpha} \tag{3}$$

While the rate at which firms fill vacancies (q_t) is:

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$$q_t = \frac{m_t}{v_t} = A(\frac{u_t}{v_t})^\alpha = A(\frac{1}{\theta})^\alpha = \frac{f_t}{\theta_t} \quad (4)$$

Employment evolves according to

$$n_{t+1} = (1-s)n_t + q(\theta_t)v_t \quad (5)$$

Where s is the rate of job separation.
While unemployment's law of motion is:

$$u_{t+1} = u_t + s(1-u_t) - f_t u_t. \quad (6)$$

The firm uses labor to produce output, Y_t with a constant returns to scale production technology, $Y_t = p_t n_t$.The dividends to the firm's shareholders are given by $D_t = p_t n_t - w_t n_t - \kappa v_t$ in which w_t, p_t and κ are the wage rate, price and Cost of posting a vacancy respectively. In this model, there is a unique equilibrium in which the vacancy-to-unemployment ratio, and consequently all other variables, depends exclusively on p and not on, u. This is the equilibrium on which we focus.

The value of a filled position for a firm is given by:

$$J(p_{t)} = p_t - w(p_t) + \delta E_t\{(1-s)J(p_{t+1}) + sV(p_{t+1})\}. \quad (7)$$

Where the value of an unfilled vacancy for the firm is given by:

$$V(p_{t)} = -\kappa + \delta E_t\{q(p_t)J(p_{t+1}) + (1-q(p_t))V(p_{t+1})\}. \quad (8)$$

The value of a job for a worker is:

$$W(p_{t)} = w(p_t) + \delta E_t\{sU(p_t) + (1-s)W(p_{t+1})\} \quad (9)$$

where the value of being unemployed is:

$$U(p_{t)} = z + \delta E_t\{f(p_t)W(p_{t+1}) + (1-f(p_t))U(p_{t+1})\}. \quad (10)$$

The firms' free entry condition implies that, in equilibrium, entry occurs until the value of a vacancy is driven all the way down to zero: $q(\mathrm{p}_t) = 0$for all p_t. This means the match surplus is given by:

$$S(p_t) = W(p_t) + J(p_t) - U(p_t). \quad (11)$$

Given the Nash bargaining weights, this means the firm gets,$J(p_t) = (1-\beta)S(p_t)$, and the worker gets, $W(p_t) - U(p_t) = \beta S(p_t)$. Noting that the free entry condition implies:

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$$\kappa = \delta q_t(p_t)E_t J(p_{t+1}), \qquad (12)$$

This means that

$$w(p_t) = \beta p_t + (1-\beta)z + \beta\kappa\theta(p_t). \qquad (13)$$

Finally, substituting this and the free entry condition into the value of a filled position for a firm yields first-order difference equation that can be used to compute the equilibrium:

$$\frac{\kappa}{\delta q(p_t)} = E_t\left[(1-\beta)(p_{t+1}-z) - \beta\kappa\theta(p_{t+1}) + (1-s)\frac{\kappa}{q(p_{t+1})}\right]. \qquad (14)$$

Intuitively the marginal costs of hiring at time t (with the non- negativity constraint accounted for) equal the marginal value of a worker to the firm, which in turn equals the marginal benefits of hiring at period t + 1, discounted to t with the discount factor, β. The marginal benefits at t + 1 include the marginal product of labor, net of the hiring cost, plus the marginal value of a worker, which equals the marginal costs of hiring at t + 1, net of separation. Equation (15) can be used to calculate equilibrium.

Market clearing condition for good market is:

$$c_t + \kappa v_t = p_t n_t. \qquad (15)$$

4 The Model Calibration

The process called calibration has a long tradition in economics. It has found widespread use in computable general equilibrium models of public finance and international trade as described in Shoven and Whalley (1984) and Auerbach and Kotlikoff (1988), Calibration is a strategy for finding numerical values for the parameters of artificial economic worlds, The use of calibrated models and quantitative theory has grown rapidly in the past decade and practitioners are struggling to define and refine the methods just as the followers of the Cowles commission program did with estimation and inference in the early days of their program. Calibration, at its current stage of development, seems not to be well understood. Hoover (1995), for example, describes it thus: A model is calibrated when its parameters are quantified from casual empiricism or unrelated econometric studies or are chosen to guarantee that the model mimics some particular feature of the historical data.

The calibration method relies on the assumption that the economy is in equilibrium. This is established by a benchmark data set that represents an

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equilibrium for the economy so that the model is actually solved from equilibrium data for its parameter values rather than vice versa.

The model's ability to replicate the data depends on modeling extensions and on the calibration details. To establish a benchmark for each country against, we use the same calibration method as in Shimer (2005). We will call this the standard calibration. While most of the parameters are country-specific, some are common across countries. In particular, we choose the model period to be a week and we set $\delta = 0.983$. The standard calibration uses the Hosios condition, which guarantees match efficiency and in the context of the model means $\alpha_i = \beta_i$. Although there are a wealth of studies estimating matching functions across different countries, not all the countries in our sample, as far as we could find, were the subject of such studies and, more importantly, different studies often use different underlying data and estimation methods, making it hard to compare across countries. As a result, we set, $\alpha_i = \beta_i = 0.72$ for all countries, the value Shimer (2005) estimates for the U.S. using data for the job-finding rate and the vacancy-to unemployment ratio based on the Current Population Survey. The remaining parameters are set on a country-by-country basis. The data on replacement rates, $\boldsymbol{z_i}$ are from various sources for each country and capture the average total benefit payable in a year of unemployment.

The separation and job-finding rates, s_i and f_i, are estimated using data on job-tenure and unemployment duration. Since the level of the vacancy-to-unemployment ratio is meaningless in this particular calibration of the model we normalize its steady-state value to one, which means setting $A_i = f_i$. Normalizing the steady-state value of productivity, $\bar{p}_i = 1$, we can recover the vacancy posting cost, $\boldsymbol{k_i}$, from the analogue of (14) in steady-state.

The parameters governing productivity's law of motion, ρ_i and σ_{ε_i}, are set such that the autocorrelation and the standard deviation of the HP-filtered residual productivity in the model and the data are the same for each country. We approximate the AR (1) process described above with a discrete Markov Chain. Finally, the model does not account for movements in and out of the labor force, as it assumes the labor force to be constant. When we adjust the raw data by the labor force, the statistics we obtain hardly change, as most labor force movements tend to be of relatively low frequency and are therefore filtered out. As a result, and for ease of comparison with most of the literature, we leave our data estimates unadjusted by the labor force. The calibrated parameters are summarized in table 5.

Table 5
Parameters (standard calibration)

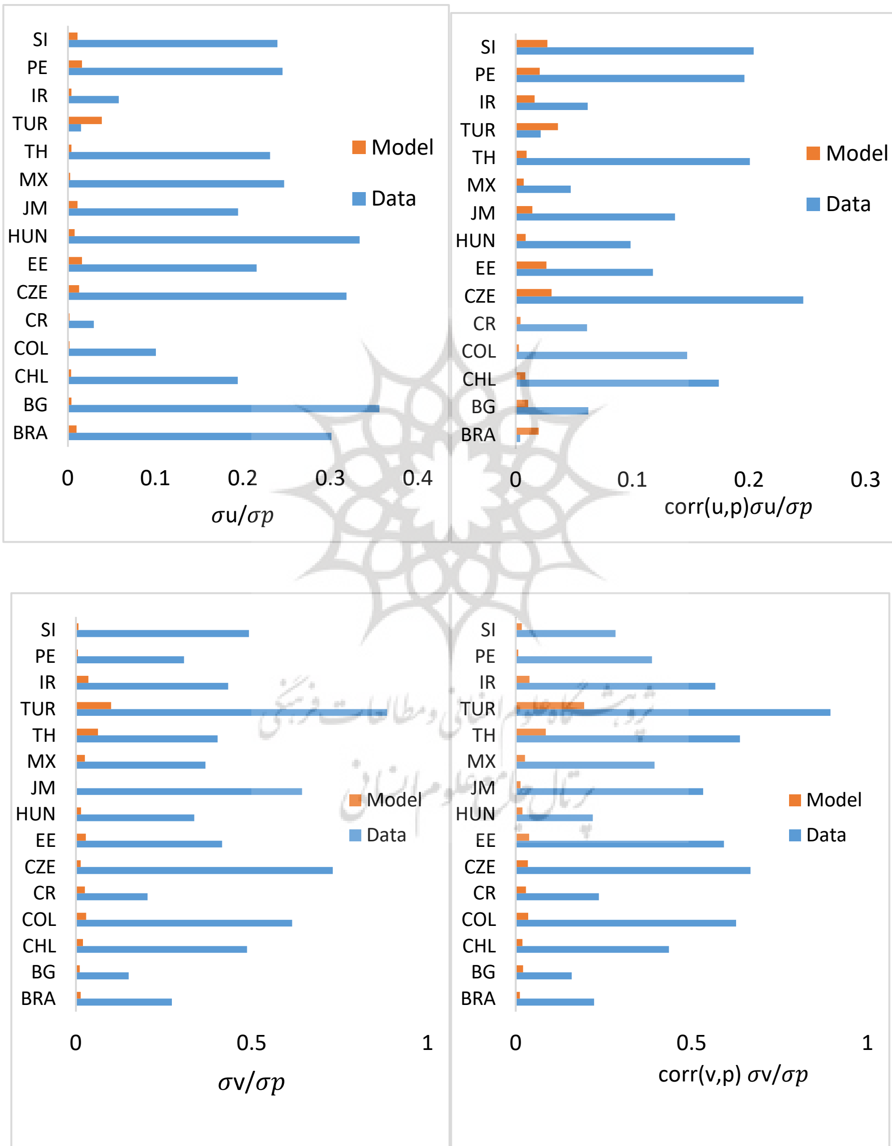
Country	σ	ρ	k	s	f	α	z	p
Parameter Description		persistence of productivity process	Cost of posting a vacancy	separation rate	Job finding rate	Elasticity of matching function	opportunity cost of employment	Labor productivity
BRA(Brazil)	0.0053	0.9850	0.2179	0.0072	0.0012	0.4526	0.3241	1
BG(Bulgaria)	0.0040	0.701	0.1201	0.0091	0.0329	0.3612	0.4522	1
CHL(Chile)	0.0025	0.9470	0.2179	0.0100	0.00291	0.4019	0.1259	1
COL(Colombia)	0.0026	0.6321	0.0612	0.0040	0.0403	0.05619	0.4001	1
CR (Costa Rica)	0.0014	0.945	0.1224	0.0074	0.0301	0.276	0.0231	1
CZE (Czech Republic)	0.0055	0.9850	0.1641	0.0094	0.0806	0.4766	0.5535	1
EE (Estonia)	0.0048	0.9350	0.1901	0.0152	0.0219	0.6357	0.5327	1
HUN(Hungary)	0.0029	0.9874	0.1185	0.1650	19210.	57450.	62040.	1
JM(Jamaica)	0.0049	0.894	0.16553	0.0023	0.00174	0.5971	0.4109	1
Mexico (MX)	0.0027	0.727	0.1529	0.0020	0.0023	0.4766	0.5362	1
Thailand (TH)	0.0038	0.9301	0.1045	0.0119	0.1521	0.4766	0.6987	1
TUR(Turkey)	0.0052	0.9850	0.168	0.0037	0.3196	0.6420	0.7455	1
IR(Iran)	0.0024	0.9603	0.1401	0.0403	0.301	0.6532	0.4691	1
PE(Peru)	0.0043	0.9211	0.0201	0.0062	0.0507	0.5813	0.4473	1
SI(Slovenia)	0.0028	0.9589	0.0485	0.0013	0.0246	0.5176	0.6282	

Source: Research finding

5 The Findings

Under the standard calibration we just detailed, and for all countries without exception, the model is unable to replicate the volatility in labor market variables by an order of magnitude. This is exactly what figure 9 illustrates. As the left-hand column of Figure 9 shows, using standard calibration, the model is unable to show fluctuations in labor market variables. According to this finding, the Shimer (2005) puzzle can be extended to a range of developing countries. Even though the overall performance of the model is very poor in this dimension, it is very heterogeneous among countries. Considering unemployment fluctuations (Figure 9, the model performs better for Turkey, but performs worse for Colombia.

According to Mortensen and Nagypál (2007), productivity shocks are not the only driving force behind the movements of labor market variables, so instead of comparing the relative fluctuations of the variable ($x \frac{\sigma_x}{\sigma_p}$) between data and model, we should compare the relative fluctuations in the model with the data using moment $corr(x,p)\frac{\sigma_x}{\sigma_p}$ and this coefficient is obtained by regressing the logarithm of x on the productivity logarithm, which is seen in right-hand column of Figure 9. Thus $\frac{\sigma_x}{\sigma_p}$ in the model will be compared with $corr(x,p)\frac{\sigma_x}{\sigma_p}$ in the data.



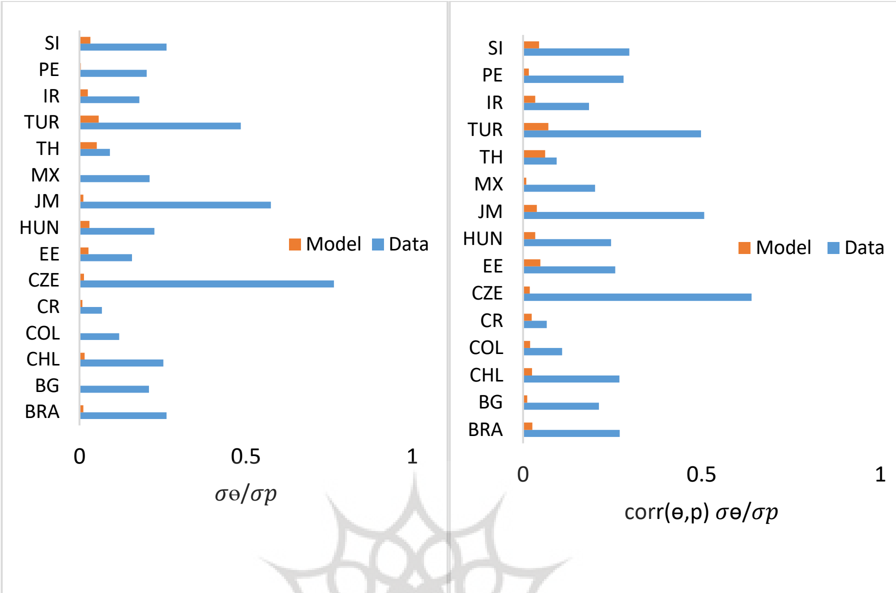


Figure 9. Labor market variables volatilities: model vs. data
Source: Research finding

As long as the correlations are significantly less than one (as the top- left column of Fig. 9 shows, the performance of the model will be much better with this criterion: countries whose labor markets are in terms of unemployment and job vacancies it is not affected by business cycles and has a correlation close to zero. Exactly in these countries, a model like this model whose driving force is due to productivity fluctuations does not have much to say.

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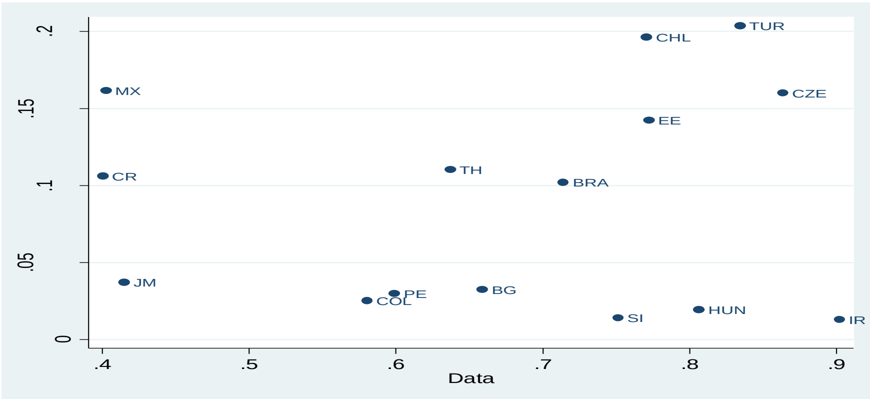

Figure 10. Unemployment auto-correlation
Source: Research finding

Figure (10) shows that the model performs better to show the persistence of unemployment in developing countries, but the model is unable to show a high degree of serial correlation in job vacancies (Figure 11).

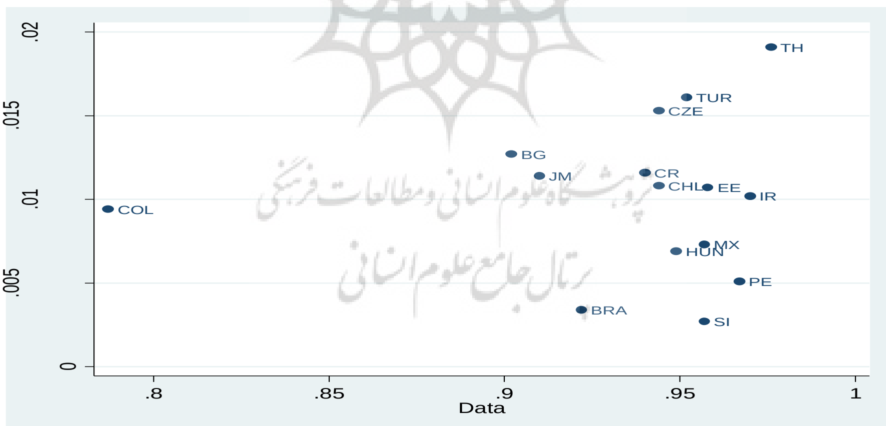

Figure 11. Vacancies auto-correlation
Source: Research finding

[DOI: 10.29252/jme.17.3.353]

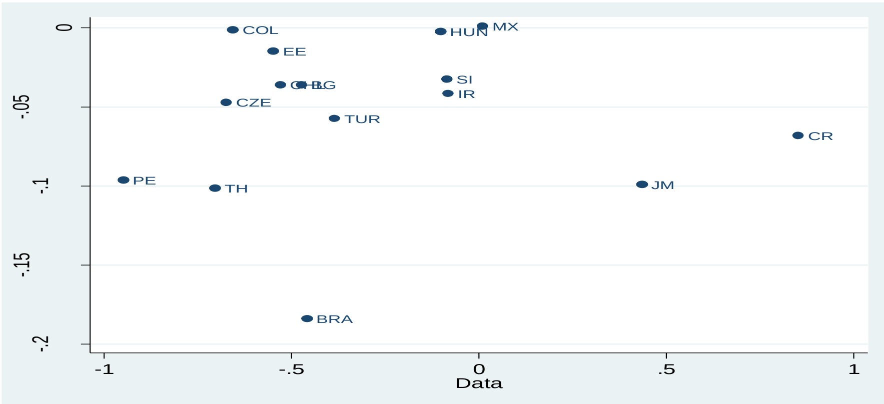

Figure. 12. Unemployment-productivity correlation
Source: Research finding

In terms of correlations, the DMP model's transmission mechanism is such that when there is a positive productivity shock, vacancies go up (as the value of an unfilled position goes up with the expected match surplus) and the next period's unemployment goes down, as more vacancies result in more matches. While most of the data conform to these correlation signs, there are some exceptions. As we have seen, in Mexico, Costa Rica and Jamaica, the correlation between productivity and unemployment is positive. In general, the model systematically over-predicts the (absolute) correlation between productivity and unemployment for countries where this correlation is negative, as shown in Figure (12).

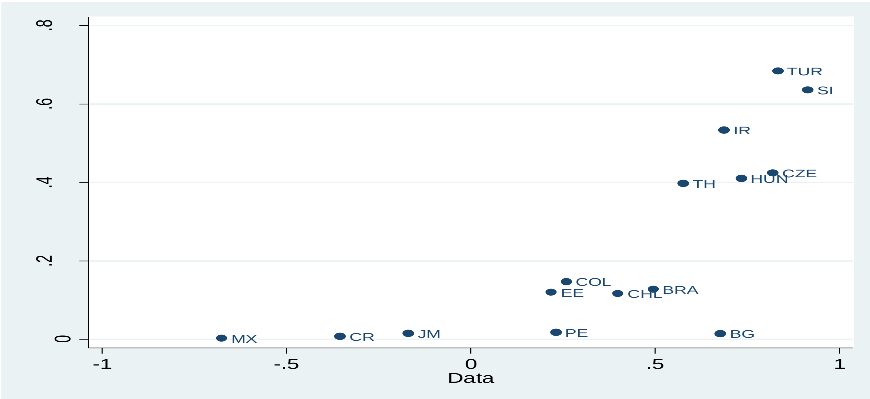

Figure 13. Vacancy-productivity correlation
***Source*:** Research finding

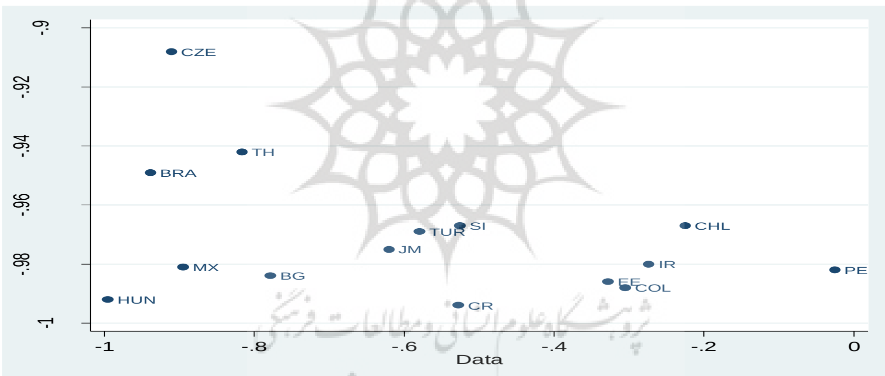

Figure 14. Unemployment-vacancies correlation
***Source*:** Research finding

One dimension along which the model's ability to match the data may have been overstated in the literature is along the unemployment-vacancies correlation. Figure (14) shows that the model predicts the degree of correlation less than expected.

Tables (6) to (20) show the simulation results of the search and matching model with the labor productivity shock for each country.

Table 6

A comparison of the model with the Iranian data

		Data				Model			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.4847	0.4272	0.2188	0.1068	0.02277	0.02178	0.0723	0.107826
Autocorr.		0.899	0.970	0.930	0.953	0.5033	0.2269	0.598	0.957
correlation	U	1	-0.58	-0.2191	-0.0816	1	-0.065	-0.1172	-0.0416
	V	-	1	0.9778	0.6874	-	1	0.6240	0.5339
	v/u	-	-	1	0.6343	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

The search and matching model cannot explain the observed volatilities in unemployment and job vacancy in Iran's labor market in response to the labor productivity shock, and the calibrated model is able to explain less than 0.25 percent of the observed volatilities in the market tightness. This suggests that Shimer puzzle holds in Iranian economy.

The central question in this paper is whether the search and matching model can explain the observed cyclical amplitude of unemployment and vacancy fluctuations in Iran. To explore this issue, we compute the impact of productivity shocks on equilibrium outcomes by calculating the steady-state response to a 1% increase in labor productivity p. we examine the steady-state response as an approximation to dynamic response of the full stochastic version of my model. In the literature, it is well known that comparative static results are essentially equivalent to the dynamic response of the full stochastic version of the model (See Shimer, 2005; Mortensen and Nagypa'l, 2007). To see why, here we provide a brief explanation. By using (6), the evolution of unemployment over time can be rewritten as:

$$u = \frac{s}{s+f(\theta)} \tag{16}$$

where u is the steady-state unemployment rate. Since the job finding rate is large and there are a lot of persistent in productivity, the deviations of unemployment from steady-state are short-lived. Thus, steady-state responses to aggregate shocks are very good approximations to the true dynamic response of the model. From the job creation condition, (14), we obtain the elasticity of the vacancy–unemployment ratio with respect to labor productivity,

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$$\varepsilon_{\theta,p} \equiv \frac{\partial Ln\theta}{\partial Lnp} = \frac{p}{p-z}\,\frac{\sigma+s+\beta f(\theta)}{(\beta+s)\big(1-\eta(\theta)+\beta f(\theta)\big)} \quad (17)$$

where $\eta(\theta) \equiv \theta[f(\theta)]'/f(\theta)$ is the elasticity of the matching function with respect to vacancies.

From (16), we obtain the elasticity of the unemployment rate with respect to labor productivity.

$$\varepsilon_{u,p} \equiv \frac{\partial Lnu}{\partial Lnp} = -\frac{\eta(\theta)f(\theta)\partial Ln\theta}{s+f(\theta)\partial Lnp} \quad (18)$$

Finally, the elasticity of vacancies with respect to labor productivity is

$$\varepsilon_{v,p} \equiv \frac{\partial Lnv}{\partial Lnp} = \frac{\partial Ln\theta}{\partial Lnp} + \frac{\partial Lnu}{\partial Lnp} \quad (19)$$

Table 6-1

Elasticity for data and model-Iran

Elasticity	**Data**		**Model**
	Unconditional on p	Conditional on p	
$\boldsymbol{\varepsilon_{\theta,p}}$	11.2	9.2	2.74
$\boldsymbol{\varepsilon_{u,p}}$	-4.23	-2.26	-1.73
$\boldsymbol{\varepsilon_{v,p}}$	3.17	-2.28	1

Source: Research finding

Table 6-1 reports the elasticities of relevant labor market variables with respect to labor productivity.

The vacancy– unemployment ratio and vacancies are procyclical, while the unemployment rate is counter-cyclical. Thus, the prediction of the model is consistent with basic Iranian labor market facts. Column (1) of Table 6-1 summarizes the main results from the model. To evaluate the performance of the model, we use two data moments: unconditional and conditional moments. The unconditional data moments are the ratios of standard deviations $\frac{\sigma_x}{\sigma_p}$ where σ_x is the standard deviation of the Lnx. They are calculated from the cyclical components of labor market variables. The conditional moments are obtained $\frac{\sigma_x}{\sigma_p}\rho_{xp}$, where ρ_{xp} is the correlation between Lnx and Lnp. This conditional criterion allows for the evaluation of the performance of the DMP model in predicting the response to productivity shocks without making the strong assumption that other shocks are not affecting labor market fluctuations. In any case, as Table 6-1 reports, the elasticities are far from those observed in

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the Iranian labor market, both conditional and unconditional. In the literature, the elasticity of the vacancy– unemployment ratio with respect to labor productivity is used to evaluate the performance of the model over the business cycle. In the unconditional data moment, the target value for this elasticity is 11.2. In the model, the elasticity is 2.74, which explains 22% of observed volatility of the vacancy–unemployment ratio. Even using the conditional criterion, the model can explain only 27% of it. Thus, we conclude that the standard DMP model fails to explain key business cycle properties of the Iranian labor market.

Table 7
Bulgaria

		Data				Model			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.2860	0.4472	0.2566	0.20005	0.114	0.0036	0.0065	0.204063
Autocorr.		0.915	0.944	0.913	0.981	0.226	0.146	0.361	0.5196
correlation	U	1	-0.6709	-0.4951	-0.4733	1	-0.047	-0.011	-0.036
	V	-	1	0.3037	0.6778	-	1	0.0021	0.014
	v/u	-	-	1	0.3403	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 8
Chile

		Data				Model			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.1547	0.4473	0.2374	0.1571	0.0026	0.362	0.268	0.158581
Autocorr.		0.963	0.944	0.937	0.993	0.226	0.651	0.147	0.5927
correlation	U	1	-0.0513	-0.5836	-0.5290	1	-0.012	-0.011	-0.036
	V	-	1	0.7773	0.4003	-	1	0.256	0.116
	v/u	-	-	1	0.0559	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

[DOI: 10.29252/jme.17.3.353]

Table 9
Colombia

		Data				Model			
		u	v	v/u	p	u	v	v/u	P
Std.Dev.		0.0830	0.2065	0.1069	0.3041	0.0041	0.0132	0.0022	0.114036
Autocorr.		0.976	0.953	0.932	0.985	0.256	0.1147	0.364	0.6060
correlation	U	1	-0.5644	-0.5569	-0.6565	1	-0.042	0.0023	-0.0011
	V	-	1	0.9997	0.2601	-	1	0.456	0.147
	v/u	-	-	1	0.4202	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 10
Coast Rica

		Data				**Model**			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.2617	0.1033	0.0606	0.1906	0.0027	0.0012	0.003	0.191665
Autocorr.		0.974	0.937	0.940	0.976	0.365	0.478	0.169	0.5037
correlation	U	1	-0.2948	-0.4593	0.8528	1	-0.0037	-0.001	-0.068
	V	-	1	0.9790	-0.3541	-	1	0.0012	0.0074
	v/u	-	-	1	0.4744	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 11
Czech Republic

		Data				**Model**			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.3865	0.6262	0.6846	0.2066	0.004	0.027	0.029	0.207712
Autocorr.		0.943	0.941	0.919	0.976	0.620	0.700	0.225	0.4739
correlation	U	1	-0.8225	-0.9181	-0.6732	1	-0.037	-0.545	-0.047
	V	-	1	0.9304	0.8195	-	1	0.2560	0.4236
	v/u	-	-	1	0.8436	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

[DOI: 10.29252/jme.17.3.353]

Table 12
Estonia

		Data				Model			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.2986	0.2564	0.1723	0.2939	0.1783	0.2256	0.0549	0.295094
Autocorr.		0.938	0.947	0.939	0.964	0.4112	0.6922	0.7563	0.2505
correlation	U	1	-0.5872	-0.7209	-0.5488	1	-0.036	0.1176	-0.0146
	V	-	1	0.9557	0.2194	-	1	0.4789	0.1196
	v/u	-	-	1	0.2389	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 13
Hungary

		Data				Model			
		U	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.3093	0.3042	0.2452	0.2643	0.1175	0.1873	0.0256	0.265808
Autocorr.		0.949	0.946	0.938	0.984	0.6500	0.7493	0.2694	0.5323
correlation	U	1	-0.9084	-0.9166	-0.1019	1	-0.096	-0.7128	-0.0022
	V	-	1	0.9820	0.7342	-	1	0.6804	0.4106
	v/u	-	-	1	0.6878	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 14
Jamaica

		Data				Model			
		U	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.1771	0.3186	0.1505	0.0137	0.036	0.0256	0.0146	0.020564
Autocorr.		0.958	0.919	0.915	0.967	0.381	0.159	0.1964	0.6606
correlation	U	1	-0.4035	-0.4867	0.4351	1	-0.0031	-0.011	-0.099
	V	-	1	0.9927	-0.1692	-	1	0.023	0.0156
	v/u	-	-	1	0.11358	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

[DOI: 10.29252/jme.17.3.353]

Table 15
Mexico

		Data				Model			
		U	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.1758	0.2804	0.1961	0.24701	0.0123	0.034	0.0017	0.056011
Autocorr.		0.993	0.948	0.946	0.982	0.0369	0.341	0.625	0.6186
correlation	U	1	-0.7787	-0.7788	0.0109	1	-0.0014	-0.002	0.0011
	V	-	1	0.9967	-0.6749	-	1	0.0362	0.0025
	v v/u	-	-	1	-0.2782	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 16
Thailand

		Data				Model			
		U	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.4618	0.2729	0.5901	0.5595	0.4203	0.1876	0.2307	0.480473
Autocorr.		0.988	0.949	0.961	0.986	0.4785	0.8360	0.049	0.4281
correlation	U	1	-0.4436	-0.2268	-0.7038	1	-0.0353	-0.0398	-0.1013
	V	-	1	0.3415	0.5768	-	1	0.1906	0.3977
	v/u	-	-	1	0.0597	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 17
Turkey

		Data				Model			
		U	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.0958	0.9517	0.4744	0.4191	0.0365	0.6912	0.1203	0.0277179
Autocorr.		0.911	0.961	0.950	0.983	0.7658	0.8901	0.7489	0.5699
correlation	U	1	-0.2121	-0.5234	-0.3843	1	-0.0756	-0.06981	-0.0573
	V	-	1	0.9416	0.8333	-	1	0.7411	0.6842
	v/u	-	-	1	0.9264	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

[DOI: 10.29252/jme.17.3.353]

Table 18
Brazil

		Data				Model			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.2669	0.4127	0.2566	0.3919	0.0184	0.0847	0.0063	0.131146
Autocorr.		0.973	0.921	0.913	0.989	0.4129	0.2631	0.1179	0.5803
correlation	U	1	-0.8171	-0.8597	-0.4590	1	-0.0657	-0.4510	-0.184
	V	-	1	0.9935	0.4957	-	1	0.4103	0.1277
	v/u	-	-	1	0.8443	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 19
Peru

		Data				Model			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.2412	0.2553	0.1919	0.2995	0.01362	0.1287	0.1125	0.252511
Autocorr.		0.991	0.961	0.963	0.983	0.1985	0.3220	0.5278	0.6593
correlation	U	1	-0.0170	-0.2735	-0.9485	1	-0.022	-0.0658	-0.0963
	V	-	1	0.9615	0.2315	-	1	0.6294	0.0174
	v/u	-	-	1	-0.0136	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

Table 20
Slovenia

		Data				Model			
		u	**v**	**v/u**	**p**	**u**	**v**	**v/u**	**P**
Std.Dev.		0.1862	0.4468	0.2594	0.1672	0.01256	0.2843	0.0428	0.169242
Autocorr.		0.955	0.950	0.943	0.963	.3208	0.0312	0.4150	0.5521
correlation	U	1	-0.3678	-0.4192	-0.0850	1	-0.0254	-0.2981	-0.0324
	V	-	1	0.9900	0.9144	-	1	0.2695	0.6355
	v/u	-	-	1	0.9418	-	-	1	1
	P	-	-	-	1	-	-	-	1

Source: Research finding

6 Conclusions

The search and matching model introduced by Mortensen and Pissarides (1994), has been a workhorse for economists in the last couple of decades. After the publication of two influential articles by Shimer (2004, 2005) in which he shows that the standard search and matching model is unable to replicate observed fluctuations in unemployment and job vacancies in response to productivity shocks of plausible magnitude the empirical appraisal of the cyclical behavior of equilibrium unemployment and vacancies has

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regained a lot of interest in the macroeconomic debate. Retrieving US quarterly data over a fifty-year time horizon, Shimer (2004, 2005) measures, inter-alia, the autocorrelation and the volatility of unemployment, vacancies and labor productivity. One of the most striking finding of his empirical explorations is that the standard deviation of the vacancy-unemployment ratio, i.e., the labor market tightness indicator, is almost twenty times as large as the standard deviation of labor productivity over the period under examination. The so-called 'Shimer puzzle' (or 'unemployment volatility puzzle') comes from the fact that the DMP model predicts that those two variables should have nearly the same volatility.

The Shimer puzzle induced a large literature assessing the conditions that Shimer puzzle holds or not. Some papers in this context divided to three categories. The first category attempt to study which features of the model are necessary to reconcile theory and data. A known example of this literature is Hagedorn and Manovskii (2008), which use the Nash bargaining wage. The papers such as Hall (2005), Gertler and Trigari (2009), or Hall and Milgrom (2008) study different wage arrangements that help reconcile the model with the data. The second category question whether the "Shimer Puzzle" holds at all for the U.S. economy: Fujita and Ramey (2009) is example of this strand of the literature. Other works, such as Sala and Silva (2005), and Sala, Silva and Toledo (2007), study how the model is able to explain the data for Spain, or the OECD countries, respectively. Finally, there are papers that study whether the "Shimer Puzzle" holds for other countries. Our paper falls into this category. The main aim of this paper is to analyze whether this volatility puzzle, which was originally found for the U.S., holds for the developing economies. We first provided empirical evidence on the cyclical properties of the developing countries including Brazil, Bulgaria, Chile, Colombia, Costa Rica, Czech Republic, Estonia, Hungary, Jamaica, Mexico, Peru, Slovenia, Thailand, Turkey, and Iran. We then built a search and matching model; we calibrated the model parameters to match the long-run evidence of the developing countries, and we simulated the model to assess whether the "Shimer Puzzle" holds or not.

The results show that although the standard DMP model correctly predicts the observed regularities in the cyclical fluctuations of unemployment and job vacancies, it cannot generate the observed unemployment and vacancy fluctuations in response to productivity shock of reasonable size. Since the model is unable to generate as much volatility on the market tightness as in the data, so the "Shimer Puzzle" does hold for of the developing countries. Also, the search and matching model cannot explain the observed volatilities in unemployment and job vacancy in Iran's labor market in response to the labor productivity shock, and the calibrated model is able to explain less than 0.25 percent of the observed volatilities in the market tightness. In the unconditional data moment, the target value for this elasticity is 11.2. In the model, the elasticity is 2.74, which explains 22% of observed volatility of the vacancy–unemployment ratio. Even using the conditional criterion, the model can explain only 27% of it. Thus, we conclude that the standard DMP model fails to explain key business cycle properties of the Iranian labor market. This suggests a need to explore alternative sources of shocks and frictions in labor market of Iran, while being mindful of what the standard model gets right. In order to adapt the search and matching model to the conditions of Iran's labor market and improved the model's ability to represent cyclical volatilities in labor market variables, it is better to augmented DSGE framework with the search and matching model which include the features such as wage flexibility, price stickiness, endogenously job separation with different shocks The results indicate that the labor market tightness and unemployment rate fluctuate more in data although the DMP model predicts smaller fluctuations in unemployment rate and labor market tightness. Further, considering endogenous job destruction rate with labor market reforms could help bring the model closer to the data in Iran's labor market. Because the unemployment rate is high in developing market, the results of this paper may provide an insight to the policy makers to apply the appropriate policies in the labor market to reduce the high unemployment rate. Also, future works should explore more developing countries-specific features of the model that could help bring the model closer to the data. This paper is the first attempt to assess from a descriptive point of view the business cycle properties of labor market variables and then explore the Shimer puzzle in developing countries. As long as the search and matching model is used to design and evaluate labor market policies in developing countries, it is essential to consider the business cycle characteristics of labor market variables.

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