On the persistence of unemployment in small open economies

by

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Abstract

The paper attempts to measure the persistent effects of structural shocks to labour market fluctuations, particularly unemployment in the period 1974-2010 in the context of two small open economies: Barbados with a fixed exchange rate regime and Trinidad and Tobago with a flexible exchange rate regime. Using a rational expectations model and performing parameterizations and simulations for the two countries, the paper finds that external and supply shocks are the main sources of unemployment or labour market fluctuations in fixed exchange rate countries. In flexible exchange rate countries, the fluctuations are primarily attributed to world interest rate and domestic demand (monetary) shocks.

JEL classification codes: J51,E24,C15

Keywords: Unemployment persistence, labour market, hysteresis, insider-outsider theory, rational expectations.
1. Introduction

Using a rational expectations model à la Blanchard and Summers (1986) while assuming that labour markets are controlled by insiders, this paper theoretically and empirically examines the persistence of unemployment due to various structural shocks in the context of small open economies under two different exchange rate regimes. The paper applies the theoretical model to two Caribbean countries in the period 1974–2010: Barbados with a fixed exchange rate regime and Trinidad and Tobago with a flexible exchange regime.

The paper finds its motivation in the fact that the major shocks that drive the path of unemployment (rate) or labour market in the countries of interest, can affect their economic growth as well as their economic integration into the global market.

Several studies including Albagli et al. (2004,1) note two contrasting phenomena concerning the behavior of labour markets. In the first instance, there is the rapidly adjusting labour market to disturbances or shocks observed in many Asian economies such as Hong Kong, Taiwan and the Republic of Korea. In the second instance, there is the relative sluggishness with which labour markets adapt to shocks in emerging economies such as the Caribbean economies, the Latin American economies and some European economies.

The slow response of labour markets in emerging countries emanating from constraints generated by the countries’ openness and their limited economies of scale, is a pertinent issue given that labour market rigidities generally impede economic growth. An important feature of the countries under study is the high and persistent unemployment (rates) primarily attributed to labour market rigidities. The latter are thought to be a consequence of stringent labour market regulations and the power of trade unions.

Several studies have analysed the role of microeconomic rigidities in labour market distortions (see, for example, Nickel 1997; Lafontaine and Sivadasan 2009). Indeed, distortions related to persistence or hysteresis in unemployment have been analysed and
found to originate from the relationship between employment and insider status (see Lindbeck and Snower 1986). In this connection, it is well acknowledged that labour markets are largely influenced by trade unions or insiders. In a dynamic perspective, adverse shocks that contribute to a reduction in labour demand decrease the number of insiders, lessen next periods employment target, and affect the nominal wage rate. In other words, trade union membership considerations explain to a greater extent the dependence of unemployment on insider power. Extant studies argue that the distortions present in labour markets explain the persistent unemployment in industrialized countries. Precisely, these distortions emerge from wage setting where a trade union selects an employment target that consists only of current union members (see, for example, Blanchard and Summers 1986; Lockwood and Philippopoulos 1994; Blanchard and Wolfers 2000).

The paper contributes to the literature in three ways. First, while incorporating the openness of economies, the paper develops a theoretical framework for analysing external shocks effects in the dynamic model of unemployment. It deviates from Albagli et al. (2004) by explicitly introducing the behavior of insiders and distinguishing two exchange rate regimes: fixed and flexible. Second, it extends the analysis of the sources of the persistence of unemployment to two new emerging countries (Barbados, and Trinidad and Tobago). Contrary to previous authors like Blanchard and Summers (1986), in addition to domestic shocks, we theoretically and empirically analyse the role of external or foreign shocks in explaining labour market dynamics. Naturally, we distinguish between two exchange rate regimes: fixed and flexible. Third, the paper simulates the theoretical models to check whether the characteristics of the empirical data match the predictions of the theoretical models.

The remainder of the paper is organized as follows. Section 2 briefly reviews stylized facts about unemployment in the Caribbean in order to identify shocks that might have affected the labour market. Section 3 deals, at the theoretical level, with unemployment persistence and hysteresis. Section 4 develops a macroeconomic model to explain unemployment persistence and hysteresis. Section 5 contains the empirical results.
obtained from the calibration of the model for the Caribbean economies (Barbados and Trinidad and Tobago). Section 6 concludes.

2. Unemployment in the Caribbean: some stylized facts

This section focuses on the characteristics of the labour market in the English-speaking Caribbean countries with emphasis on Barbados, Jamaica, and Trinidad and Tobago. The period of interest is 1974-2010. At the outset, it is important to note that the trend and other characteristics of the labour market and unemployment in particular, may depend on the chosen period; a fact often neglected in many studies.

Over the past decades, the Caribbean labour markets have undergone significant changes in response to demographic and production changes (Downes 2009,13). The supply side is characterized by low growth in the labour force as a result of low population growth. From 2000-2010, the three countries of interest, Barbados, Jamaica, and Trinidad and Tobago, recorded an annual population growth rate of 0.30, 0.42, and 0.40 percent, respectively, which translated into a stagnant growth of the labour force participation rate of -1.8 percent for Barbados, -2.8 percent for Jamaica and 3.3 percent for Trinidad and Tobago. This consequently resulted in the emergence of an ageing population. Remarkably, the female labour participation rate has increased compared to the male labour participation rate though the male labour participation rate remains higher. Overtime, the labour force has been improving in terms of education attainment reflected by the increase in workers with universal primary level education and high enrolment rates at the secondary level. The tertiary level attainment is however less than that of the lower levels. For example, in 2000, only between 5 to 13 percent of the labour force had attained the tertiary level.

Turning to the demand side, the region shifted from agricultural activities to services production. For example, in Barbados, services captured 80.8 percent of total employment in 2006 compared to 78.6 percent in 2000, in Jamaica it reached 64.8 percent in 2006 from 56 percent in 2000, and in Trinidad and Tobago it amounted to 65 percent in 2006 up from 56.9 percent in 2000. The regression of the agricultural sector is
quite striking; nowadays, it only has 5 percent of the labour force employed in each country. The number of self-employed persons is increasing as well as for small and micro-enterprises. Furthermore, there is a significant presence of the informal sector and stagnant growth of formal sector employment. Institutionally, there is a gradual decrease in the number of union members despite the strength of unions in some key sectors of the economy (ports, public services, utilities) (see Downes 2009,13). The number of people employed has been on the rise up to recently and so has the employment rate, at least in Jamaica and Trinidad and Tobago. No firm lesson can be drawn from the wage level except that the nominal wage has been on the rise and that the level reached is the result of bargaining processes with unions and/or labour legislation. The minimum wage scheme is an example of the labour legislation used in many Caribbean countries.

The paper centres on the unemployment rate, a component of the labour market. Table 1 displays the features of unemployment rates for the three countries of interest. The average unemployment rate in the period of interest (1974-2010) is at least 14.60 percent. Contrary to our expectations, Trinidad and Tobago’s unemployment rate (19.12 percent) is above those of Jamaica (18.40 percent) and Barbados (14.60 percent). The above ranking of unemployment rates also holds for the median: 29.86 percent for Trinidad and Tobago, 21.2 percent for Jamaica, and 17.6 percent for Barbados. The standard deviation of unemployment rate reads as follows: 9.12 percent for Trinidad and Tobago, 5.91 percent for Jamaica, and 4.76 percent for Barbados. Note that Trinidad and Tobago’s unemployment rate was very high in the 1970s before sensibly declining in the 2000s. Although the unemployment rates statistics for the full period are not fully available for the majority of other English-speaking Caribbean countries, on the surface we can state that their unemployment situations are not too different from those of the three countries presented above.

In summary, the unemployment rate has the following salient features in the English-speaking Caribbean countries. First, over the period of interest (1974-2010), the unemployment rate is on average in the double digits. This is a matter of concern as high unemployment can negatively affect economic growth. Second, in terms of trend, while
the three countries have witnessed decreases in unemployment rates from 1974 to 2010, the downward trend in the unemployment rate for Trinidad and Tobago is noticeable.

Table 1. Basic statistics of the unemployment rate (%): Barbados, Jamaica and Trinidad and Tobago, 1974-2010

<table>
<thead>
<tr>
<th></th>
<th>UNEBARB</th>
<th>UNEJAM</th>
<th>UNETRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>14.60</td>
<td>18.40</td>
<td>19.12</td>
</tr>
<tr>
<td>Median</td>
<td>14.50</td>
<td>16.20</td>
<td>19.60</td>
</tr>
<tr>
<td>Maximum</td>
<td>24.30</td>
<td>31.10</td>
<td>34.36</td>
</tr>
<tr>
<td>Minimum</td>
<td>6.70</td>
<td>9.90</td>
<td>4.50</td>
</tr>
<tr>
<td>Std.Dev.</td>
<td>4.76</td>
<td>5.91</td>
<td>9.12</td>
</tr>
<tr>
<td>Skewness</td>
<td>0.29</td>
<td>0.42</td>
<td>0.00</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>2.14</td>
<td>1.99</td>
<td>1.79</td>
</tr>
<tr>
<td>Jarque-Bera</td>
<td>1.67</td>
<td>2.65</td>
<td>2.24</td>
</tr>
<tr>
<td>Probability</td>
<td>0.43</td>
<td>0.27</td>
<td>0.33</td>
</tr>
</tbody>
</table>

Source of data: CIA Factbook, 2011
Note: UNEBARB: unemployment rate for Barbados; UNEJAM: unemployment rate for Jamaica; UNETRI: unemployment rate for Trinidad and Tobago.

Jamaica and Barbados unemployment rates are characterized by structural changes in the years 1990 and 2007. The above means that unemployment persistence does exist but with different magnitudes. Third, it is often argued that differences in unemployment rates between countries or regions are attributed to different degrees of labour market rigidity. Labour market rigidity itself can be explained or is highly affected by labour market regulations. Rama (1995), in his study, established labour market rigidity indices for several countries. Table 2 indicates that the English-speaking Caribbean countries are characterized by various degrees of market labour market rigidity with Barbados being relatively the most labour market rigid country. Indeed, of the eleven Caribbean countries registered in Table 2, Barbados occupied the first position with an index of 0.580, Trinidad and Tobago was in the 5th position with 0.354, and Jamaica occupied
the 8th position with 0.278. It is important to note that the labour market regulations measures in the Caribbean are centred around the following: “establishment and protection of workers’ rights, protection of the vulnerable, establishment of minimum compensation for work, assurance of decent working conditions, provision of income security” (Downes et al. 2004, 518). These labour market features are not in general the features of a flexible labour market, that is, a labour market conducive for economic growth.

Table 2. Labour market rigidity index

<table>
<thead>
<tr>
<th>Country</th>
<th>Unionization (labour force %)</th>
<th>Labour Market Rigidity (index)</th>
<th>Rank (1=highest value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antigua &amp; Barbuda</td>
<td>24</td>
<td>0.380</td>
<td>4</td>
</tr>
<tr>
<td>Barbados</td>
<td>31</td>
<td>0.580</td>
<td>1</td>
</tr>
<tr>
<td>Belize</td>
<td>13</td>
<td>0.182</td>
<td>11</td>
</tr>
<tr>
<td>Dominica</td>
<td>25</td>
<td>0.223</td>
<td>10</td>
</tr>
<tr>
<td>Grenada</td>
<td>47</td>
<td>0.328</td>
<td>6</td>
</tr>
<tr>
<td>Guyana</td>
<td>32</td>
<td>0.415</td>
<td>3</td>
</tr>
<tr>
<td>Jamaica</td>
<td>24</td>
<td>0.278</td>
<td>8</td>
</tr>
<tr>
<td>St. Kitts &amp; Nevis</td>
<td>34</td>
<td>0.476</td>
<td>2</td>
</tr>
<tr>
<td>St. Lucia</td>
<td>20</td>
<td>0.306</td>
<td>7</td>
</tr>
<tr>
<td>St. Vincent &amp; The Grenadines</td>
<td>12</td>
<td>0.251</td>
<td>9</td>
</tr>
<tr>
<td>Trinidad &amp; Tobago</td>
<td>28</td>
<td>0.354</td>
<td>5</td>
</tr>
</tbody>
</table>


3. Unemployment persistence and hysteresis effects

This section briefly introduces unemployment persistence and hysteresis phenomena as well as the relevant literature. Without any loss of generality, one simple representation of unemployment rate dynamics is

\[ u_t = \beta + \gamma u_{t-1} + \varepsilon_t \] (1)
where $\gamma \in [0,1]$, $\epsilon_t$ represents shocks with $E(\epsilon_t) = 0$ and $Var(\epsilon_t) = \sigma^2$ and $u_t$ is the unemployment rate defined as the ratio of unemployment (the difference between the labour force and employment) to the labour force.

The behaviour of $\gamma$ allows us to define statistical persistence and hysteresis. If $0 < \gamma < 1$, then equation (1) is an autoregressive process of order one with the following implication:

$$u_t = \gamma^t u_0 + \beta \sum_{i=0}^{t} \gamma^i + \sum_{i=0}^{t} \gamma^i \epsilon_{t-i}$$

where $u_0$ represents the initial observation of the unemployment rate. In general, it is assumed to be zero. Exploiting the Wold’s theorem, with $u_0 = 0$ the solution to equation (1) can also be written as follows:

$$u_t = \beta (1-\gamma)^{-1} + \sum_{i=0}^{\infty} \gamma^i \epsilon_{t-i}$$

Equation (3) implies that

$$E(u_t) = \frac{\beta}{1-\gamma} = u^*$$

where $u^*$ represents the equilibrium unemployment rate or a weak form of the natural rate of unemployment. As can be seen, with $0 < \gamma < 1$ equation (4) states that in the long run the unemployment rate converges to its initial position or precisely to its natural rate equilibrium. Equations (2) and (3) indicate a whole range of persistence depending on the value taken by $\gamma$. Overall, adverse disturbances or shocks will have lasting or persistent effects without being permanent, that is, the effects gradually fade away over time. The persistence hypothesis or the natural rate of unemployment indicates that the unemployment rate is a stationary process, that is, it tends to return to its mean (equilibrium) in the long run after a shock. In such a case, “past unemployment affects the natural rate” (Song and Wu 1997, 236). If $\gamma = 0$, then there is a complete absence of persistent effect of shocks. If $\gamma = 1$, then equation (1) reads as follows:

$$u_t = \beta + u_{t-1} + \epsilon_t$$

(5)
That is, the unemployment rate follows a random walk process with a drift. Equation (6) below is the solution to equation (5):

\[ u_t = u_0 + \beta t + \sum_{i=0}^{t-1} \varepsilon_{t-i} \]  

(6)

Equations (5) and (6) characterize the hysteresis phenomenon. As can be deducted, hysteresis can be viewed as the past history of shocks or disturbances which leads to a permanent gap between the unemployment rate and a deterministic linear trend \( u_0 + \beta t \).

Thus, the unemployment rate has a state dependence on the path followed. Put differently, a temporary disturbance has a permanent effect on unemployment (Blanchard and Summers 1986). This is not the only meaning of hysteresis in unemployment. To the best of our knowledge, three theories at the very least explain the hysteresis phenomenon: duration theory which essentially states that the longer the unemployment spell, the harder for the unemployed to find jobs again; insider-outsider theory (see next section) which underlines the negative role of insiders in high persistence of unemployment; and capital stock theory which targets the negative effects of adverse demand shocks on plant capacity (see Romer 2001).

The demarcation line between persistence and hysteresis is often blurred in empirical work as it is not always easy to distinguish between high persistence and hysteresis. For example, it might be the case that \( \gamma = 0.98 \) and \( \gamma = 1 \) are statistically indistinguishable in small samples in the context of time series data.

The hysteresis hypothesis can be tested using a univariate or multivariate framework. A look at the literature reveals that recently the univariate framework has become prevalent. In this context, testing for unemployment hysteresis is equivalent to testing for unit root in the unemployment rate. It is important to note that the usual tests for unit root (the ADF test, the PP test, the KPSS test, etc.) are not too useful under the following scenarios: the sample size is small in which case the tests will have low power against alternatives; structural break(s) is (are) present in the data in which case the power of tests will be distorted; the relationship is non-linear in which case the power of tests will also be distorted. To boost the power of unit root tests, one often uses panel data instead.
of time series data. To deal with structural break(s), one utilises appropriate unit root tests such as the Zivot and Andrews test in the context of time series and some modification of panel unit root tests in the context of panel data. As far as non-linearity is concerned, new tests such as the KSS (Kaetanios-Snell-Shin) test can be of interest.

An ample literature on unemployment hysteresis exists for Europe, the United States, and Canada. Gordon (1989) uses a Phillips-type equation to test for unemployment hysteresis for France, Germany, the United Kingdom, Japan and the United States for 1870-1986. Recall that the equation of interest states that inflation depends on its immediate past and the gap between the unemployment rate and the natural rate of unemployment. The study rejects the full hysteresis hypothesis in these countries in the period of interest. Graafland (1991) uses a four system equations model for The Netherlands for the time period 1960-1987 to describe “the dynamics of wages, employment, long-term unemployment and vacancies.” In particular, the author is interested in explaining unemployment hysteresis in the period of interest. He uncovers duration effects after 1982 in the data. Song and Wu (1997) use panel-based tests for unit root which exploit cross-section restrictions to show that the hypothesis of hysteresis does not hold in 48 contiguous US states over the period 1962-1993. Blanchard and Wolfers (1999) deal with the role of shocks and institutions in the rise of European unemployment from the 1960s up to the 1990s. In fact, they attempt to explain two facts of European unemployment: “the rise in unemployment since the 1960s, and the heterogeneity of individual country experiences.” Using a panel of institutions and shocks for 20 OECD nations since 1960, they find that the interaction between shocks and institutions explains largely the two stylized facts. Leon-Ledesma and Macadam (2003) evaluate unemployment hysteresis situations in many European transition economies using an array of techniques. They pay particular attention to the issues of structural change and non-linear dynamics while testing for hysteresis. In addition, they consider the issue of multiple equilibria in unemployment. Overall the unit root hypothesis is rejected after controlling for structural changes and business cycle effects. Camarero et al. (2006) test for unemployment hysteresis in 19 OECD countries covering the period 1956-2001 using stationary panel tests with breaks. They reject the hysteresis hypothesis.
Only a handful of papers have dealt with the topic of interest for the Caribbean. Downes (1998) conducts an economic analysis of unemployment in Trinidad and Tobago in the time period 1963-1996. Using the ADF and PP tests, he does not reject the null hypothesis of unit root, that is, the hysteresis hypothesis. This means that a temporary disturbance has a permanent effect on unemployment, or better, “the natural rate of unemployment depends on the history of actual unemployment rate” (ibidem 1998). Duration theory coupled with labour market rigidity resulting from labour laws and regulations can explain the finding. In fact, since structural breaks are present in the series as acknowledged by the author, the use of the unit root tests which take structural breaks into account might possibly lead to another conclusion, that is, instead of hysteresis, one might have high persistence. Craigwell and Warner (2000) deal with the causes of unemployment in Barbados in the time period 1980-1996 using the autoregressive distributed lag framework. Their high unemployment persistence finding is explained by high wage levels and high levels of firing and hiring costs. Borda (2000) confirms unemployment hysteresis for Guadeloupe. Craigwell et al. (2011) study the hysteresis phenomenon in the English-speaking Caribbean countries using non-linear models for the periods 1975-2010 for Barbados and 1971-2010 for Trinidad and Tobago with quarterly data. They acknowledge the fact that in the Caribbean basin unemployment rates vary between 15 percent and 30 percent. They confirm the hysteresis hypothesis in the two countries of interest. However, they underline that the non-linear model is more appropriate than the linear one. In addition, they also uncover the “existence of two equilibria of differentiated rates.”

4. Why does unemployment persist? A macroeconomic model

We consider an augmented insider-outsider model with open-economy and stochastic process considerations. The firm maximizes its profits with respect to the labour demand taking the union’s wage level as given. The model does not allow for human and physical capital accumulation.
4.1 Aggregate supply and labour demand relations

Let us consider an economy which is endowed with only one sector in which firms produce a consumer good, denoted \( Y_t \), with a Cobb-Douglas technology \( Y_t = A_t L_t^\alpha \) where \( \alpha \in [0,1] \), \( L_t \) and \( A_t \) are employment level and technology level, respectively, and \( t \) stands for time index. Technology level is captured by

\[
A_t = A_{t-1} \bar{G} E^s_t
\]

where \( \bar{G} \) can be interpreted as technical progress and \( E \) is some random variable. Equation (7) allows us to derive \( \hat{a}_t \), the technology level in deviation from the steady state, as follows:

\[
\hat{a}_t = \hat{a}_{t-1} + \hat{g} + \epsilon^s_t
\]

where “\( ^s \)” stands for “in deviation from the steady state”, \( \hat{g} \) is the technical progress in deviation from the steady state and \( \epsilon^s_t \) is an i.i.d random variable satisfying \( E[\epsilon^s_t] = 0 \) and a constant variance. The disturbances here can be considered a domestic supply shock. As firms are price-takers, real wage is equal to marginal product of labour. Labour demand is obtained in terms of deviation from the steady state as follows:

\[
\hat{p}^d_t = -\frac{1}{1-\alpha} (\hat{w}_t - \hat{p}_t - \hat{a}_t) \Leftrightarrow \hat{\ell}^d_t = -\delta(\hat{w}_t - \hat{p}_t - \hat{a}_t)
\]

where “\( ^d \)” stands for demand, \( \delta = (1-\alpha)^{-1} \), \( \hat{p}_t \) is price in deviation from the steady state, \( \hat{w}_t \) represents the nominal wage in deviation from the steady state, and \( \hat{a}_t \) is defined as above. As expected, the labour demand is a decreasing function in the real wage. The nominal wage is set by minimizing a 1-period loss function:

\[
\min_{\hat{\ell}^d_t} \Omega_t = \frac{1}{2} E_{t-1} \left( \hat{\ell}^d_t - \ell^*_t \right)^2.
\]

Equation (10) indicates that insiders accept any wage in order to maintain their status given \( \ell^*_t \), the union’s targeted rate of employment. The latter is formed according to the following law:
\[
\ell_t^* = \gamma \hat{\ell}_{t-1} + (1 - \gamma) \bar{\ell} \quad \gamma \in [0,1]
\]  
(11)

where \( \bar{\ell} \) is the size of the labour force, \( \gamma \) is the proportion of insiders or the measure of insider power in wage setting, and \((1 - \gamma)\) represents the proportion of outsiders. We assume that at each point in time \( \hat{\ell}_t^d = \hat{\ell}_t \). Equation (11) indicates that at each point in time, the union’s targeted rate of employment is a weighted sum of the past labour demand and the labour force. Thus, if \( \gamma = 1 \), then the labour market exhibits a hysteresis phenomenon, that is, shocks are ever lasting. On the contrary, if \( \gamma = 0 \), union’s policy is independent of history so shocks are not persistent. This setting is used to introduce rigidity in the labour market that prevents nominal wages from adjusting quickly to equilibrium. The first order condition of equation (10) yields

\[
E_{t-1}\left( \hat{\ell}_t^d - \ell_t^* \right) = 0
\]  
(12)

Using equations (8), (9), and (11) in equation (12) helps derive nominal wage setting:

\[
\hat{w}_t = E_{t-1} \hat{p}_t + \hat{a}_{t-1} + \hat{g} - \hat{\gamma} \frac{\hat{\ell}_t^d}{\delta} \hat{t}_{t-1} - \frac{1 - \hat{\gamma}}{\delta} \bar{\ell}.
\]  
(13)

Equation (13) expresses the dependence of the nominal wage \( \hat{w}_t \) on expected price level, past technology level, technical progress, past employment level, and labour force level. In order to find a solution to the equation we need to compute change in nominal level. Solving equation (9) for \( \hat{a}_{t-1} \) and substituting it into equation (13) and solving for \( \Delta \hat{w}_t \), we obtain

\[
\Delta \hat{w}_t = E_{t-1} \Delta \hat{p}_t + \hat{g} - \left( \frac{1 - \hat{\gamma}}{\delta} \right) \hat{u}_{t-1}.
\]  
(14)

where \( \hat{u}_{t-1} \) is the lagged unemployment rate in deviation from the steady state.

Putting equations (2) and (7) into equation (13) yields the following labour demand:

\[
\hat{\ell}_t^d = \delta(\Delta \hat{p}_t - E_{t-1} \Delta \hat{p}_t) - \gamma \hat{u}_{t-1} + \delta \hat{e}^s.
\]  
(15)

Equation (15) states that the labour demand depends on inflation surprise, past unemployment rate and supply shock. Precisely, an increase in the unemployment rate
decreases the labour demand and a positive supply shock leads to an increase in the labour demand. Note that the unemployment rate defined above follows the rule below:

\[ \hat{u}_t = \gamma \hat{u}_{t-1} - \delta (\hat{\pi}_t - E_{t-1} \hat{\pi}_t) - \delta \hat{e}_t \]  

(16)

where \( \hat{\pi}_t \) stands for domestic inflation rate in deviation from the steady state. Equation (16) indicates that the behaviour of the unemployment rate is contingent upon three elements: its own history, inflation surprise, and supply shock. Thus, if \( \gamma = 1 \) then the unemployment rate has a long memory. In addition, a positive domestic supply shock brings about a decrease in unemployment. The role of the surprise term is explored in detail in the next subsection.

4.2 The aggregate demand relation

In this subsection, we specify the aggregate demand. The price level \( \hat{p}_t \) is defined as follows:

\[ \hat{p}_t = \hat{p}^f_t + \hat{\epsilon}_t \]  

(17)

where \( p^f_t \) is the foreign or imported price level, \( e_t \) stands for the nominal exchange rate and “\(^\hat{\ }\)” means “in deviation from the steady state.” Our specification assumes that the system is “bombarded” with permanent shocks in a random walk manner:

\[ \hat{p}^f_t = \hat{p}^f_{t-1} + \hat{\pi}^f_t + \epsilon^f_t \]  

where \( \hat{\pi}^f_t \) is foreign inflation in deviation from the steady state and \( \epsilon^f_t \) captures foreign shocks. To complete the model, we introduce equation (18) which represents the condition for equilibrium in the money market:

\[ \hat{m}_t - \hat{p}_t = \bar{y}_t - \eta \hat{i}_t + \nu_t \quad \eta > 0, \]  

(18)

where \( \hat{m}_t, \hat{i}_t, \) and \( \nu_t \) are money supply, interest rate, and disturbances, respectively, and

\[ \bar{y}_t = \alpha \bar{\ell} + \hat{\alpha}_t, \]  

(19)

We assume that the disturbances, \( \nu_t \), follow a random walk process:

\[ \nu_t = \nu_{t-1} + \epsilon^m_t \]  

(20)

where \( \epsilon^m_t \) stands for monetary shock. Uncovered interest rate parity links home nominal interest rates to exchange rate, \( \hat{\epsilon}_t \), exchange rate expectation, \( E_t \hat{\epsilon}_{t+1} \), and foreign nominal
interest rates, $\hat{i}_t^f$. Given perfect capital mobility, nominal interest rates on bonds are set at the beginning of each period as

$$\hat{i}_t = E_t \hat{\hat{i}}_{t+1} - \hat{\hat{\hat{i}}}_t + \hat{i}_t^f.$$  \hspace{1cm} (21)

We assume that $\hat{i}_t^f$ follows a random walk process, $\hat{i}_t^f = \hat{i}_{t-1}^f + \varepsilon_t^f$. World interest rate shock is captured by $\varepsilon_t^f$. The equations (8)-(21) can be solved for nominal wage, employment, price level and unemployment rate.

4.3 The law of motion of unemployment

To determine how unemployment behaves in response to structural shocks, we compute the rational expectations solution to the previous model given the exchange rate regime.

4.3.1 Unemployment dynamics under flexible exchange rates

We use the approach developed by Sargent (1987) to solve for linear rational expectations models. Substituting equations (11), (13), and (15) into equation (12), we get:

$$\hat{\varepsilon}_t = \frac{1}{1 + \eta} [\hat{m}_t - \hat{\hat{p}}_t^f - \alpha \hat{\ell} - \hat{\hat{a}}_t + \eta \hat{\hat{i}}_t^f + \varepsilon_t + \eta E_t \hat{\hat{\hat{i}}}_{t+1}] \Leftrightarrow \left(J - \frac{1 + \eta}{\eta}\right) \hat{\varepsilon}_t = \frac{1}{\eta} \hat{x}_t,$$  \hspace{1cm} (22)

with $\hat{x}_t = \hat{m}_t - \hat{\hat{p}}_t^f - \alpha \hat{\ell} - \hat{\hat{a}}_t + \eta \hat{\hat{i}}_t^f + \varepsilon_t$ and $J$ as the forward operator: e.g., $J \hat{\varepsilon}_t = \hat{\varepsilon}_{t+1}$.

Equation (22) indicates that the nominal exchange rate depends on the current paths of money supply, foreign price, labour force, technical level, and foreign interest rate (see, for instance, Walsh 2003).

Using equation (22) recursively to eliminate the expectation operator on nominal exchange rate, we obtain the no-bubbles solution:

$$\hat{\varepsilon}_t = \frac{1}{1 + \eta} \sum_{i=0}^{\infty} \left(\frac{\eta}{1 + \eta}\right)^i \hat{x}_{t+i}.$$  \hspace{1cm} (23)
Exploiting equations (8) and (20) and the law of iterative expectations, we find the solution for equation (23):

\[ \hat{e}_i = \hat{x}_i + \frac{\eta}{1+\eta} (\hat{\mu} - \hat{g} - \hat{\pi}_i^e), \]  

(24)

where \( \hat{\mu} = \hat{m}_t - \hat{m}_{t-1} \) represents money growth and other variables are defined as above. We apply the expectation operator to equation (24) to obtain

\[ E_t \Delta \hat{e}_{t+1} = \hat{\mu} - \hat{g} - \hat{\pi}_i^e. \]  

(25)

In the same way, using equations (17) and (24) and applying the expectation operator, we get

\[ E_t \hat{\pi}_{t+1} = \hat{\mu} - \hat{g}. \]  

(26)

Equation (26) indicates that the authorities stabilize inflation if money supply growth is equal to productivity growth or technical progress. In the same vein, it can be shown that foreign shocks, interest rate shocks, supply shocks and demand shocks would affect nominal exchange rate expectations:

\[ \hat{e}_i - E_{t-1} \hat{e}_i = \eta \epsilon_i^s + \epsilon_i^m - \epsilon_i^e \]  

(27)

Substituting the solution for \( \hat{e}_i \) given by equation (24) into equation (27), we obtain the domestic inflation rate in terms of economic conditions and shocks:

\[ \hat{\pi}_i = \hat{\mu} - \hat{g} + \eta \epsilon_i^s + \epsilon_i^m - \epsilon_i^e. \]  

(28)

How do structural shocks affect the dynamics of unemployment in a small-open economy? The answer is obtained by solving equations (16), (24) and (25). The reduced form for the unemployment rate dynamics is given by

\[ \hat{u}_i = \gamma \hat{u}_{t-1} - \delta (\eta \epsilon_i^d + \epsilon_i^m). \]  

(29)

The autoregressive form \( \gamma \hat{u}_{t-1} \) shows how the persistence of the unemployment rate arises from the insider power in wage setting. If \( \gamma < 1 \), then adverse disturbances like world interest rate shocks, or monetary shocks, have persistent effect, that is, long lasting effect without being permanent. It is possible to solve equation (29) iteratively. The solution to equation (29) is given by:
\[
\hat{u}_t = \gamma' \hat{u}_0 - \delta \eta \sum_{k=0}^{i-1} \gamma^k \varepsilon_{i-k} - \delta \sum_{k=0}^{i-1} \gamma^k \varepsilon_{i-k}^m. \tag{30}
\]

This is a standard autoregressive equation, in which changes in the unemployment rate are driven by previous unemployment rate, domestic shocks and external shocks. Concretely, equation (30) shows that positive interest rate shocks and positive monetary shocks have a negative influence on the unemployment rate. The latter impact is realised through \( \gamma \), \( \delta \) and/or \( \eta \). In fact, an increase in \( \delta \) and \( \eta \) reinforces the shocks effects as well as their persistence.

### 4.3.2 Unemployment dynamics under fixed exchange rates

Under fixed exchange rate systems we have \( \hat{e}_t = \tilde{e} \). If the system is stable and time consistent credible, then \( \hat{\pi}_t = \hat{\pi}_t^f \) so that from equation (17) the uncovered interest parity implies that the domestic inflation rate is given by \( \hat{\pi}_t = \hat{\pi}_t^f \). Using the previous conditions and equation (16), the unemployment dynamics can be re-expressed as:

\[
\hat{u}_t = \gamma' \hat{u}_{t-1} - \delta (\varepsilon_t^f + \varepsilon_t^s). \tag{31}
\]

According to equation (31) productivity shock \( \varepsilon_t^s \) and external demand shock \( \varepsilon_t^f \) decrease the unemployment rate. By iterating equation (31) we obtain:

\[
\hat{u}_t = \gamma' \hat{u}_{t-1} - \delta \sum_{k=0}^{i-1} \gamma^k \varepsilon_{i-k}^f - \delta \sum_{k=0}^{i-1} \gamma^k \varepsilon_{i-k}^s. \tag{32}
\]

In the long run, the unemployment rate depends on the past history of shocks. Contrary to the flexible exchange rate system, we see that foreign shocks and supply shocks have similar impact on the unemployment rate. The persistence of shocks comes from the assumption of labour market rigidity. If \( \gamma < 1 \), then unemployment follows a gradual path to its equilibrium level, with a persistence that reflects the degree of union’s power.

It is interesting to analyse the labour market dynamics when the system is hit by some disturbances. Equations (30) and (32) are essential to understand the propagation of
shocks to the labour market. In the following section, empirical results based on simulations of the previous models will be examined.

5. Empirical Results

This section is devoted to the computation of the responses of some key variables of labour market (output, real wage and unemployment) to structural disturbances.

Equations (8), (13), (15) and (17) for flexible exchange rate regimes and equations (15), (17), (20), (21) and (31) for fixed exchange rate regimes form a linear rational expectations system \( \hat{\eta}_t, \hat{I}_t, \hat{\pi}_t, \hat{\pi}_t^f, \hat{a}_t, \hat{\mu}_t, \hat{\varepsilon}_t \) that is driven by the vector of shocks \( \xi_t^f, \xi_t^i, \xi_t^m, \xi_t^e \). First, we solve the equilibrium model by taking into account the rational expectations hypothesis and perform the parameterization for the model. We simulate the model using Dynare software developed mainly by Juillard (1996). We first perform a static exercise assessing the steady state implications of economic changes in the model.

The calibration exercise aims at illustrating the qualitative properties of the model. Precisely, the ultimate aim of the exercise is to gain a better understanding of the role of wage rigidity in the transmission of external shocks to the labour market. We simulate the model for Barbados, and Trinidad and Tobago. The most important source of data is CIA factbook. The dynamic properties of the model are captured by the impulse response functions. Basically, we are interested in observing how the labour market responds to a shock to, for example, one of the error terms.

As a reminder, while Barbados is under a fixed exchange rate regime, Trinidad and Tobago experiences a flexible exchange rate regime. The parameters values (see Tables 3 and 4) are chosen or derived to replicate the steady state of the US and the Caribbean economies and are standard in the literature.
Table 3: Parameters values for the Caribbean countries

<table>
<thead>
<tr>
<th></th>
<th>$\alpha$</th>
<th>$\gamma$</th>
<th>$\eta$</th>
<th>$\bar{\ell}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barbados</td>
<td>0.928</td>
<td>0.962</td>
<td>0.011</td>
<td>1</td>
</tr>
<tr>
<td>Trinidad and Tobago</td>
<td>0.324</td>
<td>0.992</td>
<td>0.054</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: authors’ calculations (see the different models in the text).

We point out that some parameters values are borrowed from the business cycle literature. Table 3 reveals that the elasticity of output with respect to employment is 0.928 and 0.234 for Barbados and Trinidad and Tobago, respectively.

The degree of persistence is allowed to vary from completely non persistent to completely hysteretic such as $\gamma \in [0,1]$. In the baseline calibration, we normalize the Caribbean labour force to one ($\bar{\ell} = 1$). To calibrate the sources of the stochastic volatility, we assume that the US interest rate is the driving force describing the world nominal interest rate. The Central Bank (i.e., the Federal Reserve Bank) is assumed to follow the Taylor policy rule presented below:

$$\hat{i}_t = \psi + \xi \hat{i}_{t-1} f + (1 - \xi)(\omega E_t \pi_{t+1}^f + \kappa \hat{\pi}_t) + \varepsilon_t^i.$$  \hspace{1cm} (33)

For the calibration of the US monetary policy rule parameters, we follow the benchmark adopted by Cho and Moreno (2006) who estimated similar shocks with the generalized method of moments. To analyse the prediction of the model, we limit the analysis only to the cases of domestic productivity shocks, external shocks, and interest rate shocks.

Table 4. Parameters values for monetary rule

<table>
<thead>
<tr>
<th></th>
<th>$\xi$</th>
<th>$\omega$</th>
<th>$\kappa$</th>
<th>$\sigma_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>US economy</td>
<td>0.0045</td>
<td>1.6409</td>
<td>0.6038</td>
<td>0.7327</td>
</tr>
</tbody>
</table>

Note: see Cho and Moreno (2006). See the above equations for the meanings of parameters.
5.1. Response for Barbados

We show the dynamic response of the main variables under a fixed exchange rate regime for Barbados. Each figure below represents the response of a given variable to one standard deviation innovation with the Y axis capturing the response in the appropriate unit and the X axis the time (years, here).

**Figure 1. Impulse responses to $\varepsilon_{t}^{f}$: Barbados**

![Graphs showing impulse responses to $\varepsilon_{t}^{f}$ for Barbados](image)

5.1.1 External demand shocks

Figure 1a shows the output response to external demand shocks ($\varepsilon_{t}^{f}$). As can be seen, external demand shocks have an evenly significant impact on output. Precisely, the figure indicates that external demand shocks affect the supply of goods and services uniformly in both runs (short run and long run). As far as the real wage is concerned, figure 1b indicates the real wage response to the shocks is rather gradual with the smallest impact.
felt in the earlier years and the biggest in the last years. According to figure 1c, in the short and long runs, external demand shocks have a negative effect on the unemployment rate. However, in absolute value the effect tends to decrease substantially in the long run. The impulse response functions clearly reveal that the adjustment of unemployment rate is not the counterpart of that of real wage. Overall, the results seem to confirm on the one hand, the rigidity of real wage and the persistence of unemployment (rate) and on the other hand, the neutrality of demand shocks over the long-run dynamics of the labour and good markets.

5.1.2 Productivity Shocks.

The comparison of figure 1 and figure 2 reveals that the effects of productivity shocks and those of external demand shocks on output, real wage and unemployment have the same profiles (see equations (31) and (32)). Briefly, the analysis suggests that external

Fig. 2: Impulse responses to $\varepsilon_t^S$ : Barbados

![Impulse response functions](image)
demand shocks as well as productivity shocks, in addition to contractual characteristics of salary bargaining, largely explain the persistence of unemployment in the Barbadian economy.

5.1.3 Interest rate shocks.

The reaction of output to American interest rate shocks $\mathcal{E}^i_t$ (see figure 3a) is of a slanted dome-like type with some degree of persistence. The real wage negatively adjusts to the shocks (see figure 3b). The most important reaction is registered in the last years. Figure 3c shows that shocks of American interest rates give rise to persistent effect on the unemployment rate. The maximum negative effect is reached a few years after the shocks.

Figure 3. Impulse responses to $\mathcal{E}^i_t$: Barbados

Nevertheless, the shock effects do not die out after reaching the maximum. Remarkably, the unemployment rate response seems to be the counterpart, or the mirror-image, of that
of output and follows the same path as the real wage response. These different results underline a certain persistence in the adjustment of the labour market.

5.2 Response for Trinidad and Tobago.

What message can we extract from a flexible exchange rate regime? Figures 4 and 5 contain the elements of response. Indeed, the two types of figures which deal with impulse response functions, show each how the unemployment rate, real wage, and output react to different shocks under a flexible exchange rate regime (here Trinidad and Tobago). To repeat, as above, each given figure (e.g., figure 4a) represents the response of a given variable to one standard deviation innovation with the $Y$ axis capturing the response in the appropriate unit and the $X$ axis the time.

**Figure 4. Impulse responses to $\varepsilon_t^m$: Trinidad and Tobago**

![Figure 4](image)
5.2.1 Domestic monetary shocks

The major impression here is the low persistence of domestic monetary shocks \( e_t^m \) effects. Indeed, for example, figure 4a reveals that output (GDP) response to domestic monetary shocks portrays a low level of persistence, a result largely underlined in the literature --- demand shocks do not have a long-run effect. Figure 4b shows that the real wage reacts negatively to domestic monetary shocks in the first year before stabilising at -0.4. The unemployment rate (see figure 4c) also negatively reacts to domestic monetary shocks. The impact does not seem to vanish as time passes.

**Figure 5. Impulse responses to \( e_t^i \): Trinidad and Tobago**
5.2.2 Interest rate shocks
Contrary to the case of domestic monetary shocks, here output reacts to the American monetary policy shocks \( (\varepsilon_i') \) in a somewhat slanted dome-like shape (see figure 5a). A slight similar story can be told concerning the unemployment rate under this regime. Indeed, contrary to the response to domestic monetary shocks (see figure 4c), the response of unemployment rate to American monetary policy shocks is characterized by a slanted inverted dome-like profile, which underlines the strong propagation of external shocks (see figure 5c). The story of real wage reaction to American monetary policy is similar to that of the unemployment rate (see figure 5b). Consequently, the dynamic model is able to generate a certain rigidity in the labour market in response to some shock.

6. Conclusion
The paper attempts to measure the persistence of unemployment or labour market distortions to structural shocks in the context of small open economies. In this connection, we develop a general dynamic and stochastic equilibrium model for a small open economy according to exchange rate regimes to theoretically and numerically examine the impact of structural shocks on labour market variables. Concretely, we solve a dynamic stochastic small-open economy rational expectations model. The model assumes that markets are controlled by insiders. Parameterizations and simulations are performed on Barbados, a small open-economy with a fixed exchange rate regime, and Trinidad and Tobago, another small-open economy with a flexible exchange rate regime. The numerical solutions are compared with the actual regularities.

The key results are as follows. The main sources of unemployment or labour market fluctuations in the fixed exchange rate countries are foreign and domestic (supply) shocks. In the flexible exchange rate countries, the fluctuations are mainly attributed to world interest rate and domestic demand (monetary) shocks.
Endnotes

1 The insiders are workers who have some connection with the firm at the time of the bargaining, and whose interests are therefore taken into account in the contract (see Romer 2001, 436-437).

2 Labour market rigidity mainly deals with the question of whether the labour market costs can vary freely in response to shocks or changes in the labour demand. In the negative, the labour market is considered rigid, otherwise, it is flexible.

3 Overall, hysteresis represents “situations where one-time disturbances permanently affect the path of the economy” (Romer 2001, 443).

4 The basic rule followed for linear approximation is as follows:

$$\Psi(X_t) \approx \Psi(X) + \sum_{i=0}^{n} \left( \frac{\partial \Psi(X_t)}{\partial x_{i,t}} \right) \left( \frac{x_{i,t} - x_i}{x_i} \right) x_i,$$

where $X_t = (x_{1,t}, \ldots, x_{n,t})$. As $\Psi(X) = 0$, the previous relation becomes

$$\Psi(X_t) \approx \sum_{i=0}^{n} x_i \left( \frac{\partial \Psi(X_t)}{\partial x_{i,t}} \right) \left( \frac{x_{i,t} - x_i}{x_i} \right) \hat{x}_{it},$$

where $\hat{x}_{it}$ is the percentage deviations from the steady state.

5 Recall, the first order of profit maximization is as follows:

$$\alpha_t^\alpha \frac{A_t}{A_0} = \frac{w_t}{\alpha P_t}$$

Using a linear approximation to the previous expression in the neighbourhood of $L_0, A_0, P_0$ and $W_0$, leads to:

$$L_0^{\alpha-1} \left[ \frac{A_t - A_0}{A_0} \right] A_0 + (\alpha-1) A_0 L_0^{\alpha-2} \left[ \frac{L_t - L_0}{L_0} \right] L_0 = \frac{1}{\alpha P_0} \left[ \frac{w_t - w_0}{w_0} \right] w_0 - \frac{w_0}{\alpha P_0^2} \left[ \frac{P_t - P_0}{P_0} \right] P_0 \quad (a1)$$

In equation (a1), denote by small letters the following quantities:

$$\hat{A}_t = \frac{A_t - A_0}{A_0}, \; \hat{L}_t = \frac{L_t - L_0}{L_0}, \; \hat{w}_t = \frac{w_t - w_0}{w_0}, \; \hat{P}_t = \frac{P_t - P_0}{P_0}.$$
Rewrite equation (a1) with these notations, develop the left-hand side and use the first order condition into the right-hand side to get

\[ A_0 L_0^{a-1} \hat{a}_t + (\alpha - 1) A_0 L_0^{a-1} \hat{e}_t^d = A_0 L_0^{a-1} \hat{w}_t + A_0 L_0^{a-1} \hat{\rho}_t. \]

Simplify the above by \( A_0 L_0^{a-1} :\)

\[(\alpha - 1) \hat{e}_t^d = \hat{w}_t - \hat{\rho}_t - \hat{a}_t \iff \hat{e}_t^d = \left[ \frac{\hat{w}_t - \hat{\rho}_t - \hat{a}_t}{1 - \alpha} \right] \iff L_t = L_0 \left[ 1 - \left[ \frac{w_t - p_t - A_t}{w_0 - p_0 - A_0} \right] \right] \]

6 In the rest of the paper, we shall use the notation \( E_{t+k} x_{t+i} \) for the expectations framed for the period \( t+i \) on the basis of information available at time \( t+k, \ k \) being positive or negative.

7 Alogoskoufis and Manning (1988, 464-465) have suggested to modify the insiders’ objective function by including deviation in real wages and unemployment from their respective targets.

8 Since \( \hat{\rho}_t - E_{t-1} \hat{\rho}_t = \Delta \hat{\rho}_t - (E_{t-1} \hat{\rho}_t - \hat{\rho}_{t-1}) = \hat{\rho}_t - E_{t-1} \hat{\rho}_t \), the two formulations are equivalent.

9 General discussions about this approach can be found in Uhlig (1999) and Sargent (1987).

10 With \( \Delta \hat{w}_t^f = \hat{w}_t^f + \epsilon_t^f \).

11 Jamaica is excluded because of missing data for some variables.

References


