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# Determinants of structural unemployment in Colombia. A search approach

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**Abstract**

*This paper is aimed to identify the main determinants of the structural unemployment rate (SUR) in Colombia. To this end, we initially look up theoretical determinants of structural unemployment as defined by a basic search and matching model. Then, we estimate different measures of the SUR including the one that emerges from the search-theoretic. Next, we test empirically each of the determinants in the Colombian case. We find that the main explanations of structural unemployment rate (SUR) in Colombia are; the real minimum wage, the real interest rate, a hiring cost indicator, sectoral shifts, non-wage labour costs, and some demographic factors such as the proportion of male, workers between 46 and 56 years old, and workers with no college education in the labour force. Finally, we use these variables to estimate the structural unemployment rate. Given the time series properties of the variables we applied a cointegrating approach with the Fully Modified Ordinary Least Squares (FMOLS) method which allows us to take into account the endogeneity of the vacancy rate.*

*JEL classification: E24, J3, J4*
*Keywords:* search model, structural unemployment rate, vacancy rate, hiring cost indicator.

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# 1. Introduction

The structural unemployment rate (SUR) cannot be observed directly. However, it is a critical piece of information for workers, firms and policy makers to understand the workings of the labour market. SUR also helps monetary authorities to determine the opportunity, intensity and duration of monetary policy actions to remedy or anticipate possible inflation pressures. Unfortunately, the estimation of SUR is not an easy task, which is why policy makers welcome every effort to get more information about this variable.

A great deal of research in Colombia during the last two decades suggests that SUR (either the natural rate of unemployment[1] or the Nairu[2]) lies between 6.1% and 12.5% (see Clavijo, 1994; Farné, Vivas, and Yepes, 1995; Nuñez and Bernal, 1997; Henao and Rojas, 1998; Guataquí, 2000; Yarce, 2000; Julio, 2001; Arango, García, and Posada, 2013.). However, much less has been said about the determinants of SUR. A few notable exceptions include Arango and Posada (2009), Tamayo (2008), and Echavarría et al. (2013.) Using a cointegration approach, Arango and Posada (2009) found that the determinants of the unemployment rate in the long run are the hourly real wage, non-wage labour costs and the capital accumulation. Tamayo (2008) used the wage bargaining model developed by Blanchard (1991) and Blanchard and Katz (1997) to estimate the SUR for the period 1984-2006 and found that the non-wage costs and the working age population are its major determinants, while the minimum wage had no effect on the SUR. By contrast, Echavarría at al. (2013) using a VAR-X approach concluded that the minimum wage and non-wage labour costs had a significant effect on the hysteresis in unemployment between the eighties and the first decade of this century. Other aspects of the unemployment rate dynamics are connected to labour force, aggregate demand and productivity shocks.

While the above-mentioned literature has provided important insights, recent developments in the Colombian labour market call for new estimations of SUR and its determinants. There are at least three developments to carry out new estimations. First, the reform of 2002 (Act 789) that reduced the dismissal costs and modified the day-shifts of workers. This reform also introduced a contingency on the wages of apprentices effective since 2014.[3] Second, new legislation (Act 797 of 2003, Act 1429 of 2010 and Act 1607 of 2012) that modified pension contributions, and non-wage labour costs, among other things. Finally, the irruption of new information systems on the labour market offers and vacancies which greatly reduced the search costs for firms and workers.

To revisit SUR and its determinants, we initially look up theoretical determinants of structural unemployment as defined by a basic search-matching model. The version we use of the model is

[1] Defined by Friedman (1968, p.8) as: "… as the level that would be ground out by the Walrasian system of general equilibrium equations, provided there is imbedded in them the actual structural characteristics of the labor and commodity markets, including market imperfections, stochastic variability in demands and supplies, the cost of gathering information about job vacancies and labor availabilities, the costs of mobility and so on".

[2] Modigliani and Papademos (1975) defined the Nairu as the unemployment rate consistent with a stable inflation. The controversy about the difference or similarity of the concept of natural rate and Nairu has not been solved. Nevertheless, Ball and Mankiw (2002), among other author, argue that there is no difference between them.

[3] The wage of apprentices will increase up to 100% of the minimum wage if the unemployment rate is lower than 10%. Otherwise, it will be 75% of the minimum wage.

a simplification of the one developed by Pissarides (2000, chapter 1) which, in essence, describes the behaviour of firms and workers taking into account labour market frictions and the search processes.

Once we have identified the theoretical determinants of SUR through the search- matching model we test them empirically in the Colombian case. In order to do so, we first provide estimates of the Colombian SUR for the period 1984-2015 by using three different methods (Shimer, 2012; Ball and Mankiw, 2002; and King and Morley, 2007). Then we use these estimates to first calculate the average SUR estimate resulting from these three methodologies and to explore the main determinants of SUR in each of them. We pay special attention to Shimer's approach, because it is derived from the search-matching model.

In a cointegrating environment between SUR and the vacancy rate (or the help wanted index), we identify a list SUR's determinants predicted by the search model such as the real minimum wage, the real interest rate, a hiring cost indicator, and sectoral shifts; some demographic factors such as the proportions of males, workers between 46 and 65 years old and less educated workers (with no college education) in the labour force are also important determinants of SUR. This list represents most of the common determinants of SUR during the whole sample period across all three methods used to estimate SUR. This set of variables was also used to estimate the structural unemployment rate called the true SUR (TSUR) in the text. To the best of our knowledge this is the first time that this component of the unemployment rate is estimated in this way in Colombia.

Our analysis resembles King and Morley's (2007). However, we differ from theirs in at least three respects. First, our analysis includes an estimation of SUR based on the search-matching model. Second, instead of privileging a single measure of SUR we employ the three measures already mentioned and their average. Third, we take advantage of the time-series properties of the variables and use a cointegration approach to estimate the determinants of SUR in the long run, which allows us to correct for the endogeneity of the vacancy rate. By contrast, King and Morley (2007) modelled the SUR in differences and use an instrumental variables procedure to estimate the short run determinants.

Apart from this introduction, the article has five sections that we develop as follows. The second section presents a simple version of the search model that helps us to select some of the main determinants of SUR. The third section describes the approaches used to estimate SUR as Shimer (2012), Ball and Mankiw (2002), and King and Morley (2007). The fourth section presents the determinants of SUR under Fully Modified Ordinary Least Squares methodology. The fifth section presents the determinants of the SUR for the main four cities (Barranquilla, Bogotá, Cali y Medellín) given that the labour market in Colombia is highly heterogeneous from the geographical point of view. Finally, the last section raises some policy issues.

## 2. The search-theoretic guide

In this section we reproduce the simplest version of the search model to justify some SUR's determinants employed in the empirical section. The fully-fledged version of the model can be found in Pissarides (2000). The search model rests on the assumption that information about workers and vacancies in the trading process is costly. However, the price is not the only allocation mechanism in the market; as a result congestion externalities arise. In this sense, the stochastic rationing that emerges cannot be eliminated via prices.

First, we start with the evolution of the mean unemployment rate, $\dot{u}$, which is given by: $\dot{u} = \lambda(1-u) - \theta q(\theta)u$. This familiar expression corresponds to the difference between the average proportion of workers that flow into unemployment, $\lambda(1-u)$, during a time interval and the proportion that flow out of unemployment, $\theta q(\theta)u$. In this case, $\lambda$, $\theta$, and $q(\theta)$ represents a process of job destruction, the ratio of vacancy to unemployment rate, $\theta = v/u$, the probability that an unemployed worker is matched to a vacant job[4], respectively. The product $\theta q(\theta)u$ is the probability that unemployed workers become employed. Variable $\theta$ is usually referred to as the labour market tightness. In steady-state we have:

$$u = \lambda/[\lambda + \theta q(\theta)]; \qquad \partial u/\partial\lambda > 0; \quad \partial u/\partial\theta < 0 \qquad (1)$$

Equation (1) corresponds to the Beveridge curve. To obtain the job creation curve, denote the present discounted values of a vacant and an occupied job, respectively, by $V$ and $J$. In an infinite horizon, under perfect capital markets, we can write the Bellman equation: $rV = -pc + q(\theta)(J - V)$, where $p$ (>0) and $pc$ (>0) correspond to the output of a job and the fixed cost of hiring[5] per time unit, respectively; the latter is computed as a proportion of labour productivity. The asset value of an occupied job can be expressed as: $rJ = p - w - \lambda J$, where we can observe the negative relation of job creation with the real interest rate. Assuming that in equilibrium $V = 0$, then $J = cp/q(\theta)$, which implies that the expected profit from a new job is equal to the expected cost of hiring a worker. Using the last two equations we obtain:

$$p - w = (r + \lambda)pc/q(\theta)\,, \qquad (2)$$

where it is clear that under no hiring cost, the labour cost should be equal to the marginal product of labour and $1/q(\theta)$ is the mean duration of a vacancy. Equation (2) corresponds to the job creation condition.

Given the number of unknowns ($p, w, u$ and $v$) in equations (1) and (2), it is convenient to consider the behaviour of workers to complete the model. This assumes a dynamic context of search where an individual devotes all his effort to find a job without knowing exactly the wage associated with each offer. As in the case of the firm, for the worker we define $rW^U = z + \theta q(\theta)(W - W^U)$ and $rW = w + \lambda(W^U - W)$ as the present-discounted values of expected income streams of unemployed and employed workers, respectively. First, the unemployed

[4] Given an homogeneous matching function, $m(u,v)$, $q(\theta)$ corresponds to $m(u/v\,,1)$ where $q'(\theta) \leq 0$. Thus, $m(u,v) = \theta q(\theta)u$.

[5] You can think of this as all cost items beyond the wage such as the recruitment costs (job posting, review of applicants, pre-screening, interviewing, etc.), training, benefit packages, equipment endowment, etc.

receives some benefits ($z$) and with probability $\theta q(\theta)$ will have the income stream of an employed. Thus, $rW^U$ can be interpreted as the reservation wage in the sense that it is the minimum income acceptable to stop job search. Second, an employed worker perceives that the permanent income is different from the current income given the probability of job destruction causing an asset loss of $W - W^U$.

By solving the expressions for $rW^U$ and $rW$ we obtain:

$$rW^U = \frac{(r+\lambda)z+\theta q(\theta)w}{r+\lambda+\theta q(\theta)}$$

and,

$$rW = \frac{\lambda z+[r+\theta q(\theta)]w}{r+\lambda+\theta q(\theta)} = \frac{[w-z]r}{r+\lambda+\theta q(\theta)} + rW^U$$

where we can observe that $w \geq z$ is a necessary and sufficient condition that must hold to look for a job.

Employer and employee get into a contract which consists of a periodic wage $w_i$ and a separation policy depending on the revealed shock. With this wage, the firm obtains an expected return given by: $rJ_i = p - w_i - \lambda J_i$ while the worker's is given by: $rW_i = w_i - \lambda(W_i - W^U)$. The generalized Nash bargaining solution allows us to obtain the wage rate as:

$$\text{Max}_{w_i}\, \zeta = \beta \log(W_i - W^U) + (1-\beta) log\,(J_i - V)$$

where $0 \leq \beta \leq 1$ and $(1-\beta)$ are the relative bargaining power of the worker and the employer, respectively. The rent-sharing rule linked to the first-order condition is given by:

$$\frac{\beta}{(W_i-U)} = \frac{(1-\beta)}{(J_i-V)}$$

which can be written as a wage equation: $w_i = (1-\beta)rW^U + \beta p$, where the condition $V = 0$ has been imposed. Accordingly, the wage obtained by the worker is a weighted average of the reservation wage ($rW^U$) and the marginal product. Taking into account that the wage offered by all firms will be the same, the first order condition, and the expressions $J = cp/q(\theta)$ and $rW^U = z + \theta q(\theta)(W - W^U)$, the reservation wage can be written as: $rW^U = z + [\beta/(1-\beta)]\, pc\theta$ which when replaced in the wage equation renders the equilibrium rate of wage:

$$w = (1-\beta)z + \beta p(1 + c\theta) \qquad (3)$$

Equations (1), (2) and (3) define the equilibrium of the system which is unique; in this representation, the interest rate is assumed to be exogenous[6]. Moreover, from equations (2) and (3), we can obtain the job creation curve:

$$(p-z)(1-\beta) = [(r+\lambda) + \beta\theta q(\theta)]pc/q(\theta) \qquad (4)$$

[6] Equations (2) and (3) are the labour demand and labour supply curves in the neoclassical framework. They are usually drawn in the $w, \theta$ space.

The SUR is obtained as the intersection of equations (1) and (4) in the vacancy-unemployment space as in Figure 1. Moreover, solving these two equations we can get the solution for $\theta$, which in terms of $u$ and $v$ can be written as:

$$\lambda u(1-u)(p-z)(1-\beta) - [u(r+\lambda) + \beta\lambda(1-u)]pcv = 0 \qquad (5)$$

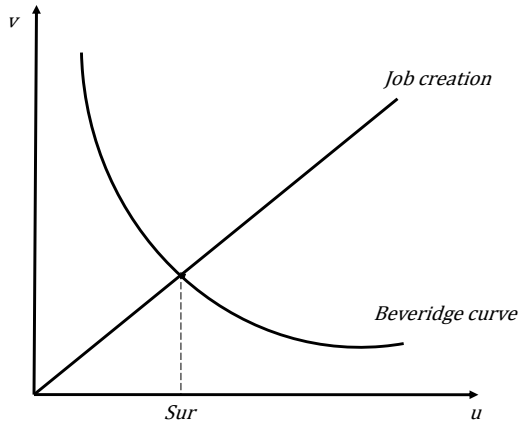
Accordingly, the SUR and vacancy rate are simultaneously determined, and the derivative $du/dv$ is given by:

$$\frac{du}{dv} = \frac{[u(r+\lambda)+\beta\lambda(1-u)]pc}{\lambda(1-2u)(p-z)(1-\beta)-[r+\lambda(1-\beta)]pcv}$$

which can be either positive or negative depending on the sign of the denominator.

$$\frac{du}{dv} \begin{matrix} > 0 \\ = 0 \\ < 0 \end{matrix} \quad \lambda(1-2u)(p-z)(1-\beta) \begin{matrix} > \\ = \\ < \end{matrix} [r+\lambda(1-\beta)]pcv \qquad (6)$$

**Figure 1. SUR determination in the search model**




Apart from the SUR and vacancy rate which are jointly determined, other intervenient variables are the wage bargaining power, the real interest rate, finding and separation rates, the labour productivity, the hiring cost, and the reservation wage. This sketch of the search model is used as a theoretical guide for the empirical explanations of SUR. Hence, an estimation method of the determinants of SUR should take into account this fact. In the next section we propose the cointegration approach that allows for the simultaneity between unemployment and vacancy rates.

## 3. Estimates of the structural unemployment rate

In accordance with the previous section, we now present an estimate of the structural unemployment rate based on Shimer (2012), compatible with the steady-state unemployment presented in the search-matching model. Given that the aim of this article is to estimate the determinants of the SUR, we also present three more estimates. The second is based in Ball and Mankiw (2002), the third in King and Morley (2007) and, finally an estimate based in the Perry-weighted unemployment rate under the methodology of King and Morley (2007).

### 3.1. Shimer (2012)

Our first estimate of the SUR corresponds to the one presented by Shimer (2012). Using a continuous time environment, he refers to the interval $[t, t+1)$ as period $t$ and $\tau \in [0,1]$ the time elapsed since the last measurement date. We present Shimer's approach to show how we operationalize equation (1) which is our measure of SUR along this line of analysis.

The approach assumes that unemployed workers find a job according to a Poisson process with arrival rate given by $\theta q(\theta)_t \equiv -\log(1-\theta Q(\theta)_t) \geq 0$ and that all employed workers lose their job according to a Poisson process with arrival rate given by $\lambda_t \equiv -\log(1-\Gamma_t) \geq 0$, where $\theta Q(\theta)_t$ and $\Gamma_t$ refer to the corresponding probabilities. Let us denote by $E_{t+\tau}$ the number of employed workers at time $t+\tau$, $U_{t+\tau}$ the number of unemployed workers at $t+\tau$ and $U_t^S(\tau)$ the number of short term unemployed workers; that is, workers who were employed at some moment in $t' \in [t, t+\tau)$ but are unemployed at $t+\tau$.

Given the previous definitions, the unemployment and short term unemployment move as:

$$\dot{U}_{t+\tau} = E_{t+\tau}\,\lambda_t - U_{t+\tau}\theta q(\theta)_t \tag{7}$$

$$\dot{U}_t^S(\tau) = E_{t+\tau}\,\lambda_t - U_t^S(\tau)\theta q(\theta)_t \tag{8}$$

The solution of the differential equation for $U_{t+1}$ which results after replacing (8) in (7) for $E_{t+\tau}\,\lambda_t$ is given by:

$$U_{t+1} = \big(1-\theta Q(\theta)_t\big)U_t + U_{t+1}^S \tag{9}$$

This implies that at any moment of time, the number of unemployed workers is equal to the number of unemployed workers in $t$ that do not find a job, plus the short term unemployed workers. This equation can be rewritten as:

$$\theta Q(\theta)_t = 1 - \frac{U_{t+1}-U_{t+1}^S}{U_t} \tag{10}$$

Moreover, the differential equation (7) can be solved forward to obtain an implicit expression for the employment exit rate ($\lambda_t$):

$$U_{t+1} = \frac{(1-e^{-\theta q(\theta)_t-\lambda_t})\lambda_t}{\theta q(\theta)_t+\lambda_t} L_t + e^{-\theta q(\theta)_t-\lambda_t} U_t \tag{11}$$

where $L_t \equiv U_t + E_t$ is the size of the labour force. Accordingly, in steady state the unemployment rate is given by:

$$\frac{U_t^{SS}}{L_t} = u_t^{SS} = \frac{\lambda_t}{\theta q(\theta)_t+\lambda_t} \tag{12}$$

Then using the observed data, from equation (10), we can get the value of $\theta Q(\theta)_t$ [and $\theta q(\theta)_t$] and solve equation (11) for the value of $\lambda_t$. Given the job finding rate ($\theta q(\theta)_t$) and the job separation rate ($\lambda_t$) the steady state unemployment can be obtained. Assuming that job creation curve (4) crosses the Beveridge curve to determine the SUR, this is obtained as the long term of the job finding and job separation rates [see Tasci and Zaman (2010)]:

$$u_t^{SUR} = \frac{\overline{\lambda}_t}{\overline{\lambda}_t+\overline{\theta q(\theta)}} \tag{13}$$

### 3.2. Ball and Mankiw (2002)

Ball and Mankiw (2002) estimate the Nairu as the level of unemployment consistent with stable inflation, which in the long-run should be the same as the natural rate of unemployment. This unemployment rate, that we also call SUR, is estimated by means of a Phillips curve:

$$\pi_t = \pi_t^e - \alpha(u_t - u_t^{SUR}) + \mu_t \quad (14)$$

where $\pi_t$ represents the inflation rate, $\pi_t^e$ the expected inflation, $u_t$ the observed unemployment rate, $u_t^{SUR}$ the SUR and $\mu_t$ the "supply shocks". According to Ball and Mankiw (2002, p.118), the latter "… are related with disruptions in the inflation process such as movements in the exchange rate and oil prices shocks, among others." Assuming that agents have adaptive expectations the Phillips curve can be written as:[7]

$$\Delta\pi_t = \alpha u_t^{SUR} - \alpha u_t + \mu_t \quad (15)$$

Provided the value of the parameter $\alpha$ is known and rearranging the previous equation we can get:

$$u_t^{SUR} + \frac{\mu_t}{\alpha} = u_t + \frac{\Delta\pi_t}{\alpha} \quad (16)$$

The right-hand side of expression (16) is computed from the data, given an estimate of the left-hand side, which represents the long-term trend and the shorter-term supply shocks.[8] Using the Hodrick-Prescott filter, Ball and Mankiw obtain the trend which captures the natural rate of unemployment.

### 3.3 King and Morley (2007)

The concept of King and Morley (2007, p. 551) about the SUR is very close to Friedman's (1968). According to them "the unemployment rate is determined by a stable dynamic process and, in the absence of exogenous shocks, converges to unique steady-state equilibrium. Importantly, this equilibrium is itself endogenous, determined by technological, institutional, and demographic factors, and is therefore not necessarily constant over time".

Accordingly, King and Morley use a structural vector autoregression (SVAR) model[9] to estimate the time-varying steady state of unemployment rate. They use a vector given by: $x_t = [p_t \quad cpi_t \quad u_t]$, where $p_t$ is the log of real GDP, $cpi_t$ is the log of the consumer price index and $u_t$ is the unemployment rate. The reduced-form of the first difference of these series can be described as:

$$\Delta x_t = c + \sum_{k=1}^{K} F_k \Delta x_{t-k} + e_t, \quad (17)$$

[7] The search model also implies the existence of a long-run Phillips curve in an inflation-unemployment quadrant. A negative slope could emerge if there is an inflation-tax effect on the equilibrium real interest rate (Pissarides, 2000, xvii).

[8] The parameter *a* can be estimated from the regression of $\Delta\pi_t$ on the unemployment rate and a constant.

[9] Balmaseda, *et al.* (2000), use the SVAR methodology and impose the Blanchard and Quah (1989) restrictions to determine the natural rate of unemployment for a set of different OECD countries. Similarly, Groenewold and Hagger (2000, 2003), find an estimate for the Australian SUR. For the case of Colombia this approach was used by Arango, Iregui and Melo (2006) and Echavarría et al. (2006).

while the structural model can be represented by an infinite-order moving-average process MA(∞):

$$\Delta x_t = m + \sum_{k=0}^{\infty} A_k v_{t-k} \qquad (18)$$

where $v_t$ represents a vector of three structural shocks: "aggregate supply shocks", "aggregate demand shocks" and "natural rate shocks". Following Blanchard and Quah (1989) the authors impose the following long-run identification restrictions: the "aggregate supply shocks" have no long-run effects on the unemployment rate while the "aggregate demand shocks" have long-run effects on neither output nor unemployment rate. The identifying restrictions are given by:

$$\sum_{k=0}^{\infty} a_{31,k} = 0,\ \sum_{k=0}^{\infty} a_{32,k} = 0, \sum_{k=0}^{\infty} a_{12,k} = 0 \qquad (19)$$

Using the estimate of the SVAR model, the estimate of the SUR can be recovered.

### 3.4. Perry (1970) adjustment of the unemployment rate

In this section we introduce the adjusted unemployment rate proposed by Perry (1970) to re-estimate the SUR. Perry argued that demographic changes of the labour force, by age-sex groups, may have an impact in the unemployment rate. For example, on average, prime-age men work more hours per week, than prime-age women, younger and older persons. To account for this difference among groups, we assume that the unemployed person in each different group is offering an average number of hours of work similar to that provided by their employed counterparts. A similar adjustment is accomplished for average wages which also vary systematically among age-sex groups.

The adjustment of the unemployment rate needs a reference group. In this case, we choose the group of men, households-heads, between 30-45 years old since it presents less unemployment rate across the cycles. Then, we divide the labour force by gender and the age groups: 12-17, 18-25, 26-45, 46-65, and more than 65 years old.

The Perry's (1970) adjustment uses weighting index:

$$I_i = J_i K_i$$

where $J_i$ is the ratio of average hours worked by persons in the *i*th age-sex group to the average hours worked by the reference group and $K_i$ is the ratio of average hourly earnings of employed persons in the *i*th age-sex group to the average of the reference group. Then, using this index we can calculate the weighted unemployment as:

$$u^w = \frac{\sum I_i U_i}{\sum I_i L_i}$$

where $U_i$ is the number of unemployed and $L_i$ the number in the labour force in the *i*th group and the sums are taken over all age-sex groups (see Figure 2). It is worth mentioning that in 2000 there was a change in the survey used to compute the labour markets statistics; that is why we observe a jump in the correction. Regardless of this shift, we keep using this adjusted unemployment rate in what follows.[10]

[10] The correction introduced by Arango, et al. (2006) to the unemployment rate is used all over the article. However, its use is not possible for the Perry-adjustment given the number of groups required.

**Figure 2. Unemployment and inflation rate 1985-2015. Quarterly data**


**Source: DANE; Arango, et al. (2006), and authors' calculations.**

According to the Perry-adjustment, at the beginning of the new century the unemployment rate was about two percentage points lower than the observed unemployment rate. More recently, this difference was about one percentage point. In other words, the unemployed labour force is relatively less productive nowadays than during the eighties. The Perry-adjusted unemployment rate is used to estimate the SUR under the approach of King and Morley (2007).

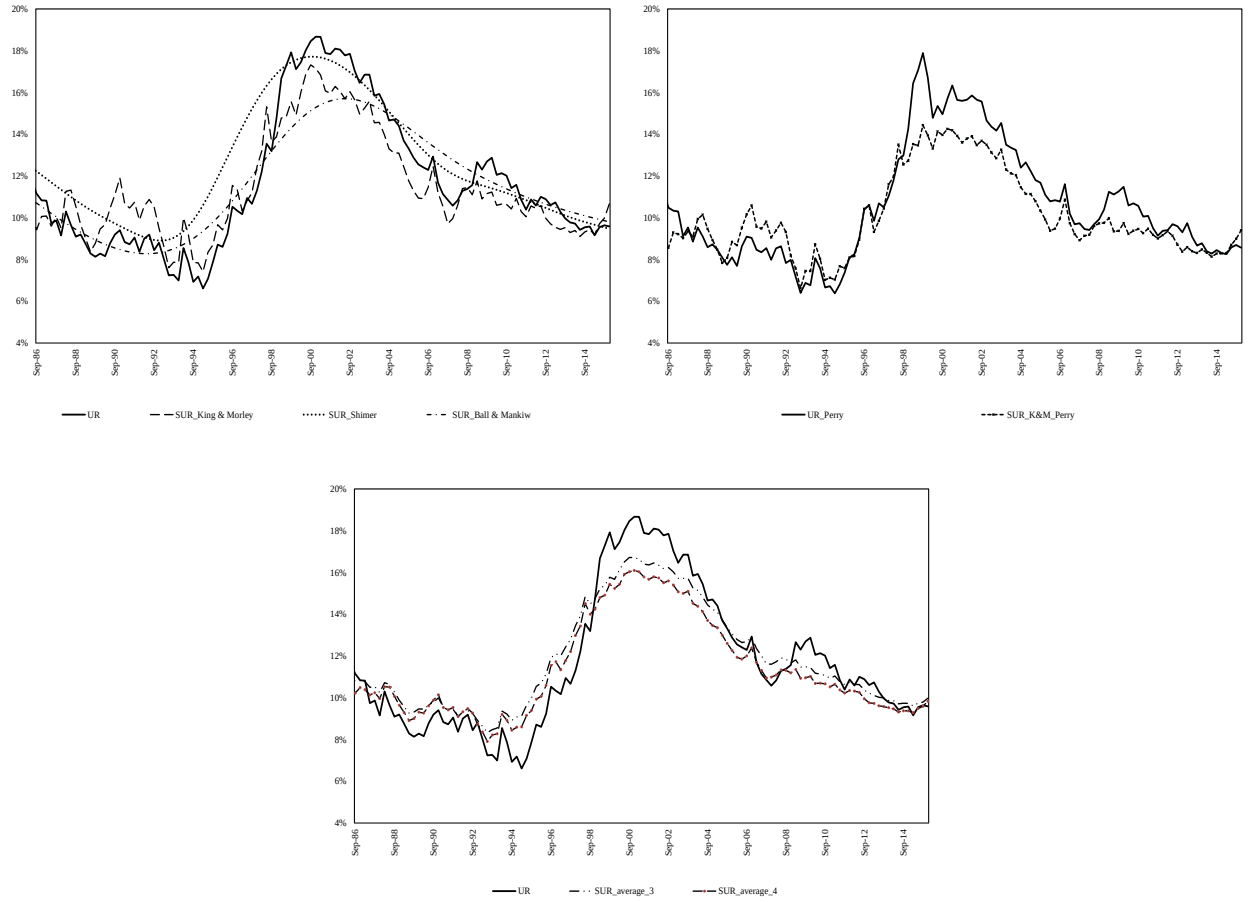
### 3.5. Estimates of the SUR

Figure 3 shows the estimation of the SUR under the methodologies of Shimer (2012), Ball and Mankiw (2002) and King and Morley (2007).[11] This figure also shows the average of SUR with the three methodologies and including the Perry-weighted unemployment rate. The latter average is named SUR_average_4 while the former is SUR_average_3.

The Appendix 1 reports the time series properties of the observed unemployment rate, the different SUR estimates and the cyclical unemployment component (that is, the difference between the observed unemployment and each SUR estimate). Importantly, the evidence we provide suggests that in Colombia the former is non-stationary as well as the different estimates of SUR while the cyclical unemployment estimates are stationary processes.

[11] For Ball and Mankiw's (2002) and King and Morley's (2012) methodologies we use the headline inflation. For the VAR of King and Morley (2007) we choose four lags; this is the minimum number for which the cyclical component is stationary. Following Tasci and Zaman (2010) we use the Hodrick-Presscot filter to compute the trend of the job finding and job separation rates for the Shimer's (2012) approach. For Ball and Mankiw (2002), we estimate the coefficient $\alpha$ with annual data.

**Figure 3. Estimates of SUR. 1986-2015.**




**Source: DANE; Arango, et al. (2006), and autors' calculations.**

## 4. Determinants of SUR

As stated before, this article is aimed to find the determinants of the SUR. According to the sketch of the search-matching model presented in section two, the main determinants of the long-run unemployment rate are bargaining power, real interest rate, reservation wage, labour productivity, and the vacancy rate (see Pissarides, 2000; and King and Morley, 2007). On the other hand, Ball and Mankiw (2002, p.118), argue that "…the natural rate is thought to reflect how well the labour market matches workers and jobs. It is altered, for instance, by changes in demographics or labour-market institutions and is thought to move slowly overtime." Thus, in general, the determinants of the SUR are close to each other independently of the theory used to derive them (see also footnotes 1 and 2 above).

Here we consider some of them[12]. In first place, the vacancy rate, a variable jointly determined with the SUR [see Figure 1 and equation (5)] is included in the empirical model; recall it is also the numerator of the variable $\theta$,[13] and, therefore, a central variable of the search model. The sign of the accompanying coefficient of vacancy rate is not ex-ante determined and, according to equation (6), depends on some other elements of the model.[14] This variable has some virtues apart from being the couple of the unemployment rate in the Beveridge diagram. It encompasses information about the business cycle and the capacity of the economy to apprise about the unsatisfied labour demand.

The real minimum wage can be used as a proxy of the bargaining power in Colombia; thus, the higher the bargaining power of workers, the higher the minimum wage and the higher the SUR. The non-wage labour costs, which in Colombia account for about 56% of the wage, can be regarded as a mix of bargaining power of workers and institutional arrangements. This bundle includes health and pension costs, fringe benefits, severance payments, and so on.[15] One of the most interesting hypotheses of this work is related to these two variables (minimum wage and non-wage labour costs) since the common belief is that they are among the main determinants of the SUR in Colombia. Hence, the expected sign of them should be positive. The third variable is the real interest rate, measured as the active rate in the credit market in Colombia; its effect on SUR is also expected to be positive since the higher the real interest rate, the less the present value of the returns of an occupied vacancy, as a result the expected hiring should decrease (Figures in Appendix 2 show the behaviour of all variables). In the Beveridge diagram, an increase of the interest rate moves down the job creation curve without altering the Beveridge curve, and, we should expect an increase in unemployment rate and a reduction in vacancies (see Pissarides, 2000, p. 22).

Given that both the labour productivity $p$ and the real wage $w$ are highly related each other, it is possible to have some collinearity in the empirical specification. This is why we decide to include the difference $p - w$ as an indicator of the hiring cost, $(r + \lambda)pc/q(\theta)$, as expressed in equation (2). Thus, the higher the hiring cost indicator, the higher the SUR. The sectoral shifts are used as an indicator of the proportion of workers needing new job training when the relative labour demand in various industries is changing. This is because the movers must acquire new skills which, in the meantime, could potentially affect the SUR (Lilien, 1982; King and Morley, 2007). This variable is measured as the sum of the absolute value of the quarterly changes of employment composition in manufacture, construction, retail sales, transport and communications, finance, and personal and real estate services.

The proportion of males in the labour force will be used as a proxy of the reservation wage's influence. In equations (1) and (13) the reservation wage will affect the probability of accepting a

[12] In Appendix 2 we show the behavior of the determinants jointly with the unemployment rate.
[13] See Alvarez and Hofstetter (2013) and Arango (2013b) for the construction of the vacancy rate.
[14] The help wanted index (HWI) is a variable used instead of the vacancy rate (see Table 4 below).
[15] Recently, the 1607 Act of 2012 reduced the total nonwage labor costs by 13.5 percentage points for workers that earn less than two minimum wages.

job offer, $\theta q(\theta)$; thus, the lower this term the higher the SUR.[16] Presumably, women in the working age have a higher reservation wage and so a higher unemployment rate.[17] This could be explained in the light of the number of children which expend their early childhood at home. Thus, we expect that the proportion of males in the labour force reduces the SUR since these are persons of smaller reservation wages. Another, demographic factor included in the specification is the proportion of working age population older than 45 years. Since this population is expected to be displaced by technology progress, this proportion should increase the SUR. Finally, we include the proportion of workers with no college education. As the technology process advances, it is expected that the lowly educated population face more difficulties to find a job; as a result, the SUR should increase (see the behaviour of all variables in Appendix 2).

Given the time series properties of the variables we use the test of Phillips and Ouliaris (1990) to check for the presence of cointegrating relationships among the variables[18] (see Hamilton, 1994, p. 598-601). According to Table 1, the measures of SUR, with the exception of Ball and Mankiw's approach, cointegrate with the variables of the model. That is: there exists an equilibrium relationship among the variables in the model. With this information we use the Fully Modified Ordinary Least Squares, FMOLS, of Phillip and Hansen (1990) to estimate the cointegrating, among those variables with one unit root. These variables are: the different SUR estimates, the nonwage labour costs, the real minimum wage, the hiring cost indicator, the proportion of male in the labour force and the proportion of working age population between 46 and 65 years old (see Appendix 1). The evidence suggests that the vacancy rate is a stationary variable while the help wanted index (HWI) is not.[19]

**Table 1. Phillips-Ouliaris cointegration test**

| SUR | *Tau*-statistic | | *Z*-statistic | |
|---|---|---|---|---|
| | **Value** | ***p*-value** | **Value** | ***p*-value** |
| *Shimer* | -8.117 | 0.000 | -117.874 | 0.000 |
| *Ball & Mankiw* | -4.371 | 0.341 | -29.550 | 0.500 |
| *King & Morley* | -6.963 | 0.000 | -74.844 | 0.000 |
| *Perry-adjusted King & Morley* | -7.273 | 0.000 | -86.110 | 0.000 |
| *Average 3* | -6.529 | 0.002 | -71.155 | 0.000 |
| *Average 4* | -6.747 | 0.001 | -75.608 | 0.000 |
| *Unemployment rate* | -8.945 | 0.000 | -136.884 | 0.000 |
| *Adjusted unemployment rate* | -8.372 | 0.000 | -113.750 | 0.000 |
| *Number of observations* | 119 | 119 | 119 | 119 |

**Source: Author's calculations.**

[16] The inverse of $\theta q(\theta)$ is the mean duration of unemployment.

[17] In Colombia, the female unemployment rate is about percentage points higher than the male unemployment rate. The volume edited by Arango, Castellani and Lora (2016), forthcoming, provide some of the explanations for this fact.

[18] See Appendix 1.

[19] Phillips (1995), shows that FMOLS can also be used with a mix of I(1) and stationary regressors. The results of most variables remain; however, real interest rate and non-wage labour costs interchange statistical significances.

FMOLS is used since it is a consistent (asymptotically unbiased) and fully efficient estimator that introduces corrections for the presence of variables with unit roots and possible endogeneity with stochastic regressor innovations (see Hamilton, 1994, p. 613).[20] More precisely, Phillips and Hansen (1990) show that when there is endogeneity in the regressors, as occurs with the vacancy rate in the SUR regression, bias effects might remain by using instruments. Instead, they introduce semiparametric serial correlation and long-run endogeneity corrections, that can be used in OLS or instrumental variables regressions, which leads to asymptotically median-unbiased estimators.

Table 2 shows the determinants of the different SUR estimates for period 1986-2015. The evidence suggests that the derived from Shimer (2012) is explained by all variables but the hiring cost indicator, regardless if it has the expected sign. In the case of the real minimum wage, an increase of 1% will increase SUR in 0.137 percentage points (pp) according to our estimate with Shimer's (2012) methodology. On the other hand, an increase of the real interest rate of one pp will increase SUR a quarter of one pp. The real minimum wage and the proportion of men in the labour force, both with the expected signs, appear as determinants of SUR across the different estimations (Ball-Mankiw, King-Morley and Perry adjusted King-Morley).[21] The vacancy rate, an endogenous variable in the model, with negative sign, is also a determinant of the unemployment rate.

Sectoral shifts and the proportion of workforce between 46 and 65 years old are also important. The latter has negative sign, which is different from the expected. The intuition behind this result could be the important increase in labour participation and occupation rate of this population group during the past decade.[22]

Surprisingly, non-wage labour costs, a variable frequently invoked as explanation of the high unemployment rate and SUR in Colombia (see Arango and Posada, 2009) is only significant for the Shimer and Ball-Mankiw's approaches (recall that the latter measure that does not render a cointegrating relationship among the variables). Thus, this partial overview of the results suggests that it is possible to find a number of common determinants of SUR across the different methodologies used to estimate it. In addition, there is plenty of room to suggest policy actions in order to reduce the SUR. This is the case with the real minimum wage, non-wage labour cost, search costs, and so on. However, we postpone this discussion for the last section of the paper.

Given the lack of credibility that a single estimate of SUR usually has, we explore the evidence of its determinants using the average of the four measures (Shimer, Ball-Mankiw, King-Morley, and Perry-weighted King-Morley) already estimated (we called it SUR_Average 4), the average of them excluding the Perry-weighted King-Morley (SUR_average_3) and, of course, the Shimer estimate since this approach is the closest to the search model.

[20] Under dynamic OLS, *DOLS*, methodology, with one lag, the results are almost the same.

[21] It is important to mention that in Table 2 we retain the significant variables. Thus, a variable such as labor force growth was not included in the regressions since it was not statistically significant.

[22] This assertion is based in the information processed by the group of labor market analysis of the central bank (available upon request).

**Table 2. Determinants of different SUR measures**
**FMOLS. 1986 - 2015**

| Variables | *Shimer* | *Ball-Mankiw* | *King-Morley* | *King-Morley-Perry adjusted* |
|---|---|---|---|---|
| **Search model** | **(1)** | **(2)** | **(3)** | **(4)** |
| **Real minimum wage** | 0.137*** | 0.054*** | 0.092*** | 0.077*** |
| | (6.26) | (3.26) | (6.53) | (6.29) |
| **Real interest rate** | 0.254*** | 0.132** | 0.029 | 0.060 |
| | (3.72) | (2.53) | (0.66) | (1.57) |
| **Vacancy rate** | -0.019*** | -0.012** | -0.023*** | -0.020*** |
| | (-4.14) | (-3.44) | (-7.75) | (-7.80) |
| **Hiring cost indicator** | 0.014 | 0.161*** | 0.092*** | 0.065*** |
| | (0.35) | (5.15) | (3.50) | (2.86) |
| **% Sectoral shifts** | 0.403* | 0.160 | 0.325** | 0.316*** |
| | (1.94) | (1.01) | (2.43) | (2.71) |
| **Institutional factors** | | | | |
| **Non-wage labour cost** | 0.096* | 0.125*** | 0.046 | 0.030 |
| | (1.79) | (3.06) | (1.32) | (1.00) |
| **Demographic factors** | | | | |
| **% Male in the labour force** | -1.363*** | -0.766*** | -0.910*** | -0.737*** |
| | (-6.79) | (-4.99) | (-7.02) | (-6.54) |
| **% Workers between 46-65 years old in the labour force** | -1.028*** | -0.237* | -0.650*** | -0.547*** |
| | (-5.57) | (-1.68) | (-5.46) | (-5.28) |
| **Adjusted $R^2$** | 0.810 | 0.861 | 0.808 | 0.792 |
| ***N (observations)*** | *119* | *119* | *119* | *119* |

**Note: *t*-statistics in parentheses. Significance levels: * = 10%, ** = 5%,*** = 1%; Newey West standard errors. Source: authors' calculations.**

Models in odd columns of Table 3 refer to the whole sample period and include the variables of our model.[23] Interestingly, with the exception of hiring cost indicator (not significant) and vacancy rate coefficients, the rest of them in the Shimer's model are higher than the corresponding to models SUR_average_3 and SUR_average_4. This is particularly important in the case of demographic factors and, of course, has consequences in terms of policy design aimed to reduce the SUR.

Models in even columns of Table 3 present other estimations of the SUR for the subsample 2000-2015. The motivation to modify the sample period, as stated in the Introduction, is the list of reforms to the labour market occurred along this century (e.g. Acts 789 of 2002, 797 of 2003, 1429 of 2010, and 1607 of 2012) apart from the access of new information systems to improve the matching process between workers and firms and the notorious increase in the participation of women relative to men.

During this subsample, the nonwage labour costs as well as the proportion of male in the workforce are no longer significant. It is possible that the two series do not have enough variability in this shorter sample period to explain the SUR. For example, the % workforce male is almost constant since 2004. This is why we exclude them from the specification. Then, during the subsample 2000-2015, the explanation of the SUR depends on the vacancy rates, the

[23] Column (1) shows the model of Shimer already presented in Table 2.

proportions of workers between 46 and 65 years old and less educated people and to some extent on the real minimum wage. Although the goodness of fit is much higher for the subsample 2000-2015 than for the whole period, these results should be taken with caution given the sample size.

**Table 3. Determinants of average SUR. FMOLS**

| | Shimer | | SUR_average_3 | | SUR_average_4 | |
|---|---|---|---|---|---|---|
| | 1986-2015 | 2000-2015 | 1986-2015 | 2000-2015 | 1986-2015 | 2000-2015 |
| | (1) | (2) | (3) | (4) | (5) | (6) |
| **Search theory** | | | | | | |
| **Real minimum wage** | 0.137*** | 0.036** | 0.095*** | 0.029*** | 0.090*** | 0.028*** |
| | (6.26) | (2.59) | (5.91) | (3.27) | (6.14) | (2.90) |
| **Real interest rate** | 0.254*** | 0.196** | 0.138*** | 0.019 | 0.119** | 0.003 |
| | (3.72) | (2.04) | (2.77) | (0.31) | (2.59) | (0.05) |
| **Vacancy rate** | -0.019*** | -0.012*** | -0.018*** | -0.010*** | -0.018*** | -0.011*** |
| | (-4.14) | (-3.53) | (-5.36) | (-4.32) | (-6.01) | (-4.56) |
| **Search costs indicator** | 0.014 | -0.096*** | 0.089*** | -0.002 | 0.083*** | 0.002 |
| | (0.35) | (-3.49) | (2.98) | (-0.13) | (3.03) | (0.10) |
| **% Sectoral shifts** | 0.403* | 0.238* | 0.296* | 0.077 | 0.301** | 0.08 |
| | (1.94) | (1.87) | (1.95) | (0.92) | (2.16) | (0.98) |
| **Institutional factors** | | | | | | |
| **Non-wage labour cost** | 0.096* | | 0.089** | | 0.074** | |
| | (1.79) | | (2.27) | | (2.06) | |
| **Demographic factors** | | | | | | |
| **% Male in the labour force** | -1.363*** | | -1.013*** | | -0.944*** | |
| | (-6.79) | | (-6.89) | | (-7.00) | |
| **% Workers between 46-65 years old in the labour force** | -1.028*** | -0.876*** | -0.638*** | -0.672*** | -0.615*** | -0.617*** |
| | (-5.57) | (-5.00) | (-4.73) | (-5.84) | (-4.96) | (-5.06) |
| **% less educated labour force** | | 0.194** | | 0.110* | | 0.103 |
| | | (2.08) | | (1.807) | | (1.60) |
| **Adjusted $R^2$** | 0.810 | 0.925 | 0.852 | 0.950 | 0.847 | 0.939 |
| ***N (observations)*** | *119* | *64* | *119* | *64* | *119* | *64* |

**Note: Significance levels: * = 0.10, ** = 0.05, *** = 0.001; *t*-statistics in parentheses. Newey-West standard errors.**

The empirical evidence suggests that whatever the construction of this unobservable variable named SUR, the determinants for the whole sample period include the real minimum wage, the real interest rate, the vacancy rate, the hiring cost indicator, the sectoral shifts, the nonwage labour costs[24], and the demographic factors. Thus, with these determinants we can estimate (construct) a less artificial structural unemployment rate. The strategy to arrive at this estimation consists of using these very same variables to estimate the structural unemployment rate. The resulting estimate will be the true SUR (TSUR). This methodology is similar to that used to

[24] For a panel of 19 Latin American countries, Ball *et al*. (2013) also found that higher social security contributions imply higher structural unemployment. They explore different measures of economic development as rural population as a percentage of total population and find that this variable has a negative sign and is significant to explain the structural unemployment across the different Latin American countries. Recall that our study focusses on the urban SUR. On the other hand, Ball *et al*. (2013) also argue that for countries like Chile, Colombia and Venezuela, the effect of a tightness monetary policy may affect the long term unemployment. These results would be similar to ours if we accept that monetary policy can affect the real interest rate.

estimate the Solow residual and especially to the methodology used to obtain by means of mechanical filters the permanent component of a given variable. The only difference with respect to the latter and the similarity with respect to the former is that, in this case, we are using the theory to find the structural component of unemployment rate.

Table 4 shows the estimates of the structural component of the unemployment and adjusted unemployment rates using a cointegrating framework.[25] The cyclical components (the residuals of the regressions) are stationary each (See Table A1 in Appendix 1). Remarkably that the inclusion of HWI instead of vacancy rate makes the non-wage labour costs not significant statistically while produce the converse result with the real interest rate. Figure 4 shows the behaviour of the TSUR and the adjusted TSUR, based on models of columns (1) and (3), which closed in 2015 at 9.3% and 8.1%, respectively. Notice that all the determinants play an important role. In other words, by observing the individual behaviour of each of the main determinants of the SUR it is difficult to say that the TSUR is driven by any single variable in particular (see Figure A1 in Appendix 2).

**Table 4. Determinants of structural component of unemployment rate**
**FMOLS. 1986 - 2015**

| Variables | *Unemployment rate* | | *Perry -adjusted unemployment rate* | |
|---|---|---|---|---|
| **Search model** | **(1)** | **(2)** | **(3)** | **(4)** |
| **Real minimum wage** | 0.095*** | 0.123*** | 0.083*** | 0.109*** |
| | (4.67) | (7.07) | (4.83) | (7.20) |
| **Real interest rate** | 0.078 | 0.122** | 0.147*** | 0.185*** |
| | (1.24) | (2.11) | (2.75) | (3.71) |
| **Vacancy rate** | -0.032*** | | -0.029*** | |
| | (-7.70) | | (-8.15) | |
| **Help wanted index** | | -0.004*** | | -0.003*** |
| | | (-8.57) | | (-8.68) |
| **Hiring cost indicator** | 0.133*** | 0.126*** | 0.093*** | 0.087*** |
| | (3.51) | (3.66) | (2.92) | (2.91) |
| **% Sectoral shifts** | 0.371* | 0.375** | 0.368** | 0.368** |
| | (1.93) | (2.14) | (2.26) | (2.42) |
| **Institutional factors** | | | | |
| **Non-wage labour cost** | 0.096* | 0.066 | 0.076* | 0.050 |
| | (1.93) | (1.47) | (1.80) | (1.28) |
| **Demographic factors** | | | | |
| **% Male in the labour force** | -1.035*** | -1.439*** | -0.868*** | -1.235*** |
| | (-5.57) | (-9.47) | (-5.52) | (-9.37) |
| **% Workers between 46-65 years old in the labour force** | -0.591*** | -0.486*** | -0.541*** | -0.455*** |
| | (-3.46) | (-3.04) | (-3.74) | (-3.29) |
| **Adjusted $R^2$** | 0.859 | 0.870 | 0.837 | 0.843 |
| ***N (observations)*** | *119* | *119* | *119* | *119* |

**Note: *t*-statistics in parentheses. Significance levels: * = 10%, ** = 5%, *** = 1%; Newey West standard errors. Source: authors' calculations.**

[25] As for the previous estimates of SUR, the cyclical unemployment rates are stationary processes.

**Figure 4. The true SUR (TSUR). 1986-2015.**


**Source: authors' calculations.**

## 5. Estimation SUR by cities

One salient characteristic of the labour market in Colombia is its regional heterogeneity. There have been periods during which the differences among regions with regard to the most conventional indicators (e.g. unemployment rate, participation rate and so on) have been higher than ten percentage points (see Arango, 2103a).There are, however few explanations as to the sources of such heterogeneity.

To address this issue also documented by Cárdenas *et al*. (2015), in this section we estimate the SUR using the Shimer approach for each of the four main cities in the country: Cali, Medellín, Barranquilla and Bogotá. The SUR's determinants are estimated for each city separately. For the complete sample, Table 5 shows that the four cities' common determinants of the SUR are the real minimum wage (with higher coefficients in Bogotá and Cali), the real interest rate, and the demographic factors.[26] In particular, the proportion of men in the workforce of Bogotá and Cali has a size that is about one third higher than for Barranquilla and Medellín. The difference among the coefficients is an aspect of the geographic heterogeneity already documented in Colombia. Moreover, the nonwage labour cost is significant in the cases of Barranquilla, Cali and Medellín, while the hiring cost indicator is significant only in Barranquilla and Cali, the latter with negative sign, a fact that suggests that increasing hiring costs would reduce the SUR. Sectoral shifts are only significant in Medellín. In summary, even though we identify some common factors that affect the SUR in these four cities, the magnitude of the

[26] It is worth to mention real interest rate, hiring cost indicator and sectoral shifts are not city specific; that is, they are aggregate variables. The vacancy rate, the other endogenous variable of the model, is also a determinant of the SUR under the assumption the FMOLS takes such endogeneity into account.

coefficients is different. This would suggest that policy measures should also be differential depending on the city.

**Table 5. Determinants of Shimer SUR by cities. FMOLS**

| | Barranquilla | | Bogotá | | Cali | | Medellín | |
|---|---|---|---|---|---|---|---|---|
| | 1986-2015 | 2000-2015 | 1986-2015 | 2000-2015 | 1986-2015 | 2000-2015 | 1986-2015 | 2000-2015 |
| **Search theory** | | | | | | | | |
| **Real minimum wage** | 0.068*** | 0.041*** | 0.116*** | 0.031** | 0.122*** | 0.031*** | 0.089*** | 0.006 |
| | (5.95) | (3.28) | (3.19) | (2.29) | (6.49) | (3.30) | (4.74) | (0.67) |
| **Real interest rate** | 0.181*** | 0.125 | 0.336*** | 0.343** | 0.324*** | 0.280*** | 0.218*** | 0.145* |
| | (2.89) | (0.96) | (2.90) | (2.22) | (3.82) | (2.82) | (3.16) | (1.91) |
| **Vacancy rate** | -0.105*** | -0.051 | -0.229*** | -0.139*** | -0.133*** | -0.184*** | -0.135*** | 0.007 |
| | (-3.20) | (-1.04) | (-4.14) | (-2.73) | (-3.19) | (-7.14) | (-3.82) | (0.33) |
| **Search costs indicator** | 0.141*** | 0.007 | 0.082 | -0.091** | -0.093** | -0.086*** | 0.016 | -0.139*** |
| | (3.77) | (0.18) | (1.37) | (-2.41) | (-2.19) | (-3.82) | (0.36) | (-5.42) |
| **Sectoral shifts** | 0.174 | 0.222 | 0.531 | 0.168 | -0.101 | 0.372*** | 0.557*** | 0.174* |
| | (0.92) | (1.31) | (1.54) | (0.79) | (-0.41) | (2.90) | (2.67) | (1.80) |
| **Institutional factors** | | | | | | | | |
| **Non-wage labour cost** | 0.129*** | | 0.081 | | 0.146** | | 0.125** | |
| | (2.92) | | (0.94) | | (2.48) | | (2.31) | |
| **Demographic factors** | | | | | | | | |
| **% Male in the labour force** | -0.756*** | | -1.270*** | | -1.046*** | | -0.770*** | |
| | (-7.04) | | (-3.17) | | (-6.73) | | (-5.42) | |
| **% Workers between 46-65 years old in the labour force** | -0.565*** | -0.841*** | -0.843*** | -0.994*** | -1.010*** | -0.665*** | -0.851*** | -0.369*** |
| | (-5.55) | (-6.00) | (-3.05) | (-5.10) | (-5.43) | (-6.05) | (-4.75) | (-2.74) |
| **% less educated labour force** | | -0.012 | | 0.275*** | | 0.163*** | | 0.376*** |
| | | (-0.13) | | (2.85) | | (2.89) | | (7.02) |
| **Adjusted $R^2$** | 0.788 | 0.906 | 0.690 | 0.880 | 0.730 | 0.760 | 0.715 | 0.911 |
| ***N (observations)*** | *111* | *64* | *111* | *64* | *111* | *64* | *111* | *64* |

**Note: Significance levels: * = .10, ** = .05, *** = .001; *t*-statistics in parentheses. Newey West correction.**

## 6. Policy analysis

In this paper we use different estimates of the structural unemployment rate (SUR) and identify the main determinants of this variable for the period 1985-2015. The SUR estimates are obtained by using different approaches such as Shimer (2012), Ball and Mankiw (2002), and King and Morley (2007). The latter was implemented with both the observed and Perry-adjusted unemployment rates. Given the endogeneity of the vacancy rate and the unemployment rate and the different orders of integration of variables in the model, we use fully modified OLS (FMOLS) to obtain the empirical evidence. Thus, the determinants of SUR in Colombia that we identify are: the real minimum wage, the real interest rate, the hiring cost indicator, the sectoral shifts, the nonwage labour costs, and the proportions of male, people aged between 46 and 65 and less educated workers in the labour force. This set of variables was also used to estimate the structural unemployment rate called the true SUR (TSUR) in the text. To the best of our knowledge this is the first time that this component of the unemployment rate has been estimated in this way in Colombia. The determinants of SUR presented in Table 4 allow policy recommendations aimed

to reduce the structural unemployment rate in Colombia, a country with one of the highest unemployment rates in Latin America (OIT, 2014).

First, we found that increases in SUR are partially explained by the behaviour of the minimum wage. We introduce this variable in the model as a symptom of workers' bargaining power. If this would be so, there should be a disconnection between the minimum wage and labour productivity of less skilled workers. Therefore, changes in minimum wage levels should be revised so as to bring them closer to changes in productivity levels. In addition, the periodic revisions of the real minimum wage do not need to be annual. The modifications could be implemented every four years or so. Some rules depending on the performance of the informal sector and youth unemployment rate could be implemented.

Second, the nonwage labour costs should also be revised. For example, the four per cent of the payroll that nowadays firms pay to finance the activities carried out by Cajas de Compensación Familiar should be eliminated; such important services could be provided through another institutional arrangement. The evidence on the inconveniency of this payroll tax is abundant (Kugler and Kugler, 2009). The recent tax reforms carried out in 2010 and 2102 reduced the nonwage labour costs. This task should not be interrupted.

Third, more resources should be devoted to reduce the hiring and search costs for firms and workers to fill vacancies and find jobs, respectively. This involves more space for labour intermediaries and matching information systems. Recently the government created a new institution called Public Service of Employment (PSE) to improve the matching process and reduce hiring and search costs. This is an important impulse; however, more efforts to diffuse this service will increase the access to workers. In addition, the information provided by the PSE should be enhanced in some respects. For example, information on reservation wages of individuals and the labour market wages per occupation should be published. Also, the living cost across cities (including rent of houses), provision of public services (including public education) and the rate of crime should also be announced in order to make a more informed decision about moving from one city to another.

Fourth, although it is difficult to keep the market real interest rate in coherence with the labour market performance, the risk component of the real interest rate should be kept at minimum. In order to achieve this objective all agents, consumers, firms and the government, should respect their inter-temporal budget restrictions. In the case of agents, financial education is crucial. In the case of government, the permanent accomplishment of fiscal rule will help to keep lower real interest rates.

Fifth, the government should guarantee continuous training for workers to improve their mobility across different economic sectors. Sectoral shifts are highly related to education and the provision of new skills for workers. As the dynamics of the economy changes, people need to be able to move across different economic sectors. Thus they need to have the skills to adapt from one task to another; otherwise, they will undergo longer spells, increasing frictional unemployment.

Finally, the current or future workers also need to have access to the formal education system. This is the most frequent policy recommendation in Colombia. In the last fifteen years, the low level of education of the labour force has become important to explain the SUR, while the importance of male participation has fallen. Therefore, we need more measures that stimulate female participation in the labour market, such as flexible working hours. Many women cannot work eight to nine hours daily but would participate in the labour market through reduced daily working hours. This calls for a modification of the real wage from monthly to hourly rating.

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# Appendix 1

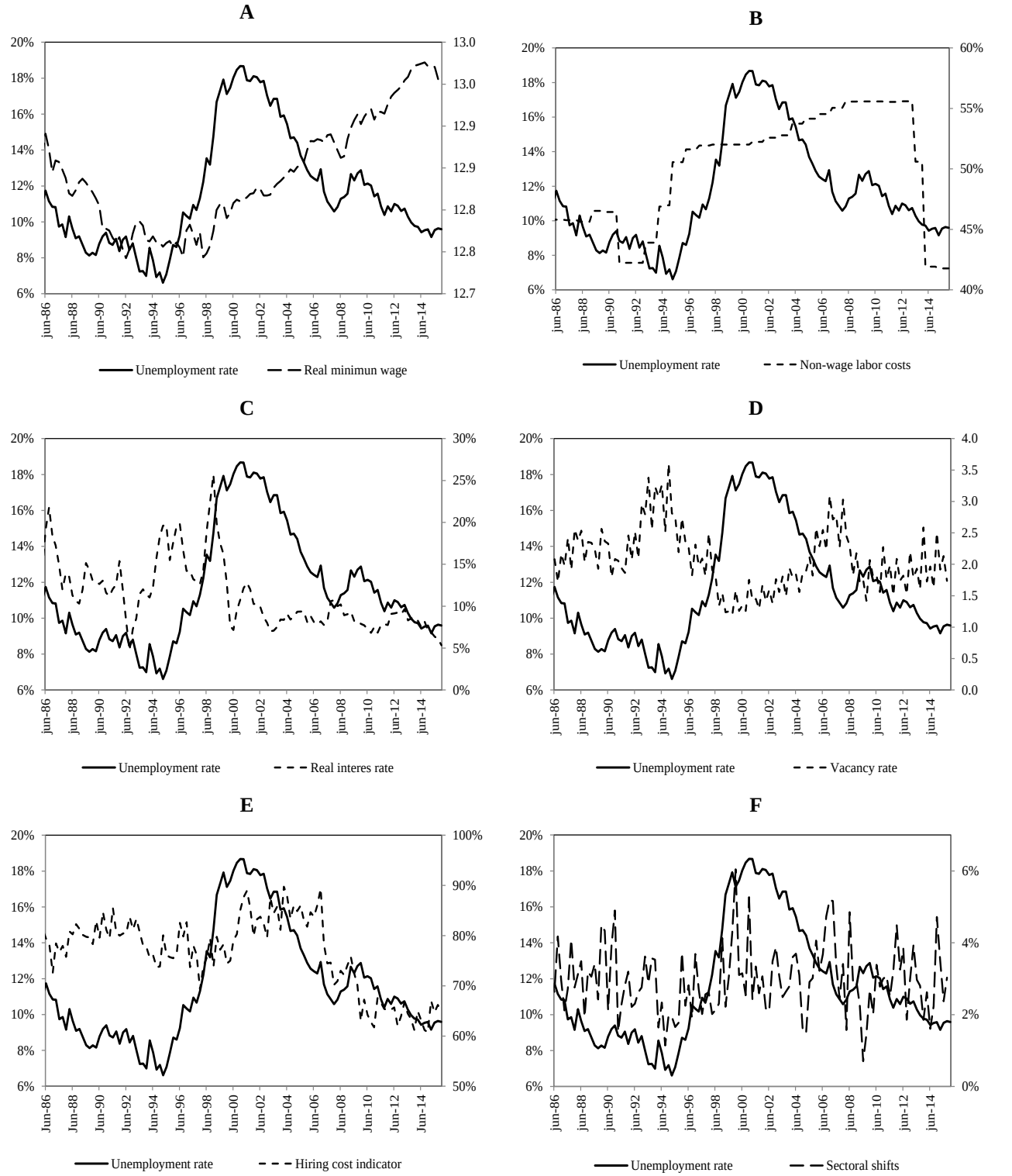
**Table A1. Unit Root Test (1985:II-2015:IV)**

| | ***Levels*** | | | | ***First difference*** | | | |
|---|---|---|---|---|---|---|---|---|
| | ***ADF*** | | ***Phillips-Perron*** | | ***ADF*** | | ***Phillips-Perron*** | |
| | **Value** | ***p*-value** | **Value** | ***p*-value** | **Value** | ***p*-value** | **Value** | ***p*-value** |
| **Unemployment rates** | | | | | | | | |
| Observed | -0.506 | 0.495 | -0.534 | 0.483 | -4.272 | 0.000 | -10.54 | 0.000 |
| *Perry-adjusted* | -0.571 | 0.467 | -0.571 | 0.467 | -10.09 | 0.000 | -10.19 | 0.000 |
| **SUR Measures** | | | | | | | | |
| *Shimer* | -2.749 | 0.068 | -1.250 | 0.650 | -2.531 | 0.011 | -1.887 | 0.056 |
| *Ball & Mankiw* | -3.283 | 0.017 | -0.991 | 0.754 | -2.039 | 0.040 | -1.447 | 0.137 |
| *King & Morley* | -1.594 | 0.482 | -1.638 | 0.460 | -10.47 | 0.000 | -10.49 | 0.000 |
| *Perry-adjusted King & Morley* | -1.562 | 0.498 | -1.636 | 0.460 | -10.54 | 0.000 | -10.54 | 0.000 |
| *Average 3* | -3.113 | 0.028 | -1.127 | 0.703 | -4.861 | 0.000 | -7.603 | 0.000 |
| *Average 4* | -0.974 | 0.760 | -1.162 | 0.688 | -8.432 | 0.000 | -8.586 | 0.000 |
| **Determinants** | | | | | | | | |
| Real minimum wage | 0.320 | 0.978 | -5.158 | 0.000 | -6.172 | 0.000 | -29.30 | 0.000 |
| Real interest rate | -3.634 | 0.006 | -2.030 | 0.273 | -8.215 | 0.000 | -8.260 | 0.000 |
| Vacancy rate | -3.141 | 0.026 | -6.208 | 0.000 | -3.860 | 0.000 | -25.64 | 0.000 |
| Help wanted index | -1.958 | 0.305 | -4.828 | 0.000 | -3.381 | 0.000 | -28.13 | 0.000 |
| Hiring cost indicator | -1.633 | 0.462 | -1.999 | 0.286 | -15.61 | 0.000 | -17.33 | 0.000 |
| % Sectoral shifts | -10.13 | 0.000 | -10.20 | 0.000 | -9.294 | 0.000 | -65.29 | 0.000 |
| Non-wage labour cost | -0.845 | 0.802 | -1.286 | 0.634 | -4.674 | 0.000 | -11.34 | 0.000 |
| % Male in labour force | -1.812 | 0.372 | -1.725 | 0.416 | -14.79 | 0.000 | -14.85 | 0.000 |
| % Workers between 46-65 | 1.715 | 0.999 | 2.358 | 1.000 | -16.52 | 0.000 | -15.85 | 0.000 |
| % Less educated labour force | -3.373 | 0.059 | -4.576 | 0.001 | -14.99 | 0.000 | -14.82 | 0.000 |
| **Cyclical component of unemployment rate** | | | | | | | | |
| Shimer | -2.682 | 0.007 | -1.989 | 0.045 | -7.513 | 0.000 | -8.917 | 0.000 |
| Ball & Mankiw | -2.270 | 0.022 | -2.238 | 0.024 | -11.78 | 0.000 | -11.79 | 0.000 |
| King & Morley | -2.541 | 0.011 | -1.949 | 0.049 | -8.227 | 0.000 | -7.932 | 0.000 |
| Perry-adjusted King & Morley | -2.682 | 0.007 | -1.989 | 0.045 | -7.513 | 0.000 | -8.917 | 0.000 |
| Average 3 | -2.048 | 0.039 | -2.069 | 0.037 | -5.871 | 0.000 | -11.13 | 0.000 |
| Average 4 | -1.757 | 0.075 | -1.966 | 0.047 | -5.480 | 0.000 | -10.46 | 0.000 |
| *Observed unemployment rate* | -3.296 | 0.001 | -9.114 | 0.000 | -10.94 | 0.000 | -26.19 | 0.000 |
| *Perry-adjusted unemployment rate* | -3.593 | 0.000 | -9.023 | 0.000 | -10.54 | 0.000 | -29.47 | 0.000 |
| *Observed unemployment rate-using HWI* | -3.438 | 0.000 | -11.63 | 0.000 | -9.527 | 0.000 | -28.05 | 0.000 |
| *Perry-adjusted unemployment rate-using HWI* | -3.717 | 0.000 | -11.131 | 0.000 | -8.955 | 0.000 | -30.40 | 0.000 |

**Source: Author's calculations.**

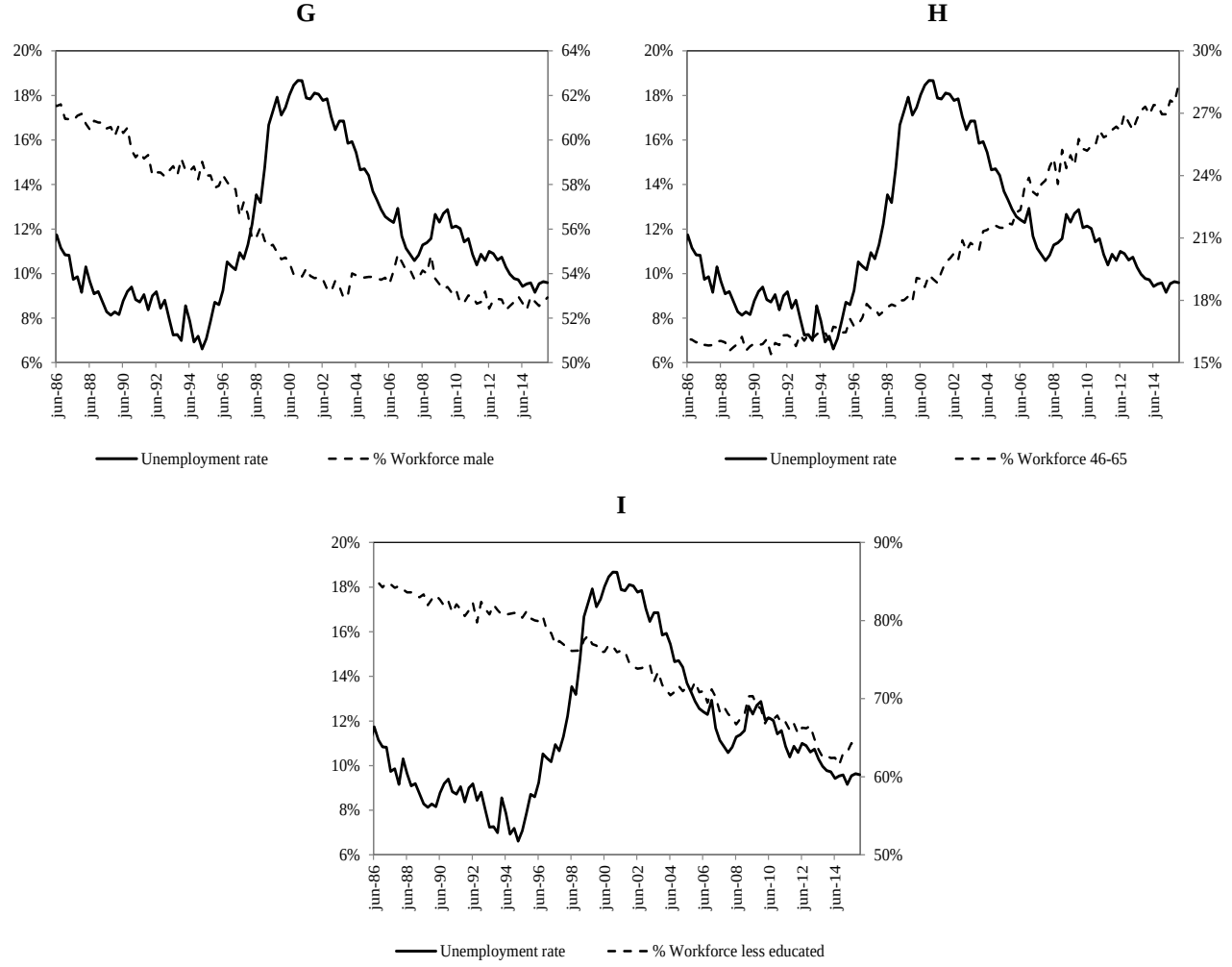
## Appendix 2: Data

**Figure A1. Determinants of SUR 1986-2015**




**Source: DANE, Autor´s calculation.**

**Figure A1. (continued). Determinants of SUR 1986-2015**




**Source: DANE, Autor´s calculation.**

**Table A2. Data sources**

| Variable | Source and calculation method |
|---|---|
| Real minimum wage | Nominal minimum wage and we deflated by CPI-low income. Source: Labour Ministry of Colombia and Banco de la República. |
| Non-wage labour cost | Correspond to the salary overhead. Source: Human Management Division - Banco de la República. |
| Real interest rate | Active nominal interest rate deflated by CPI inflation using the Fisher equation. |
| Vacancy rate | This rate was built using vacancy announcements in the main newspapers of the 7 principal's cities of Colombia. From 2003, we use the Barnichon (2010) correction, which allow us to adjust the data taking into account the emergence of the internet. |
| Hiring cost indicator | Corresponds to the difference between labour productivity (computed as the real GPD divided by the number occupied worker) and real median wage. |
| Sectoral shift | We use the data of the quarter variation of occupied workers by economic sectors provide by the household survey in Colombia called the *Great Integrated Household Survey* (GEIH is the Spanish acronym). To build this variable, we exclude employment in agricultural, mining and electricity, and gas and water sectors. |
| % of workforce male | This proportion was built with the data provided by GEIH. This variable measures the percentage of men in the Colombian labour force. |
| % of workforce people between 46-65 years old | This proportion was built with the data provided by GEIH. This variable measures the percentage of the labour force that is between 46 and 55 years old. |
| % of workforce of workers with no college education | This proportion was built with the data provided by GEIH. This variable measures the percentage of less educated workers in the Colombian labour force. |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