International Journal of Contemporary Economics and Administrative Sciences
ISSN: 1925 – 4423
Volume :7, Issue:1-2, Year:2017, pp.160-173

IS LABOR PRODUCTIVITY INTERPRETIVE FOR FLUCTUATIONS IN NAIRU? PANEL-VAR EVIDENCE FROM OECD COUNTRIES

Mehdi MOHEBI[1]

Abstract

In this study, the impact of productivity on NAIRU is analysed using 19 OECD countries' yearly data, for the period of 1997 to 2012. The main purpose of this paper is to scrutinize the reaction of NAIRU in the face of a shock in labour productivity, both in level and its lags as well as, investigating whether productivity has a positive or negative effect on fluctuations in NAIRU in growth framework. Engaging the Panel-Vector Auto-regressive models negatively supports the impact of NAIRU on variation in productivity.

Keywords: Economic Growth, Fluctuations in NAIRU, Labour Productivity, NAIRU, Panel VAR

JEL Classification: C630, E240, J640, O470

Introduction

Non-accelerating Inflation Rate of Unemployment in abbreviated form known as NAIRU has been a subject of discussion over a considerable period of time. The trend of NAIRU, as well as factors affecting of its fluctuation, is one issue which is in the permanent attention of economist. It is an indicator of labour market equilibrium in Philips curve context and is an important factor determining whether unemployment is adjusted to its optimum level or not. In the labour market, factors from both sides of supply and demand affect unemployment pattern. The most important determinant of the concern of this paper this paper is the role of labour productivity. Laurence Ball and Gregory Mankiw in their

[1] Researcher, University of Tehran, Faculty of Economics, Iran, meh_moh20@yahoo.com

paper, NAIRU in theory and practice (2002), emphasised the influence of productivity as one important factor in explaining NAIRU behaviour and opened up the path for future studies in this area. Timothy J. Hatton (2007), has investigated this relationship for England by including productivity in their model of NAIRU and analysed it for a long period, which enforced the idea of faster productivity growth and its diminishing influence on NAIRU.

Komijani and Mohebi (2013), studied the effect of oscillating NAIRU on economic growth, with respect to the behaviour of productivity, in a panel of oil exporting countries and proved as expected, the Intensity of NAIRU as a cause of decrease in economic growth. In this paper, the analysis of the direct relationship between NAIRU and productivity for OECD countries was made, using a SOLOW based, growth model containing unemployment. This was investigated in a panel of 19 countries by lag level of each variable to provide a dynamic nature and catch the share of past periods in level analysis. Impulse Responses based on Monte Carlo simulations enforced our premise of the counter-productivity effect of NAIRU Intensity (coefficient of NAIRU fluctuations in economic growth function) on change of output. The following sections are arranged as follows: The first part is dedicated to the analysis of the trend of NAIRU in OECD countries, the second part deals with theoretical background and defined a model in which productivity, as well as NAIRU, are considered in a growth framework, estimating the result of Panel VAR model is the third part and conclusive section.

Modelling Economic Growth Regarding NAIRU

In this section, we are aiming at modelling NAIRU from an economic growth point of view regarding the role of productivity as an illustrative part, and further analyzing the functionality of economic growth in the presence of unemployment as a descriptive variable. Thus our upcoming investigation is in threefold, how economic growth and unemployment are interrelated, as well as with growth and productivity. These two, at

International Journal of Contemporary Economics and Administrative Sciences
ISSN: 1925 – 4423
Volume :7, Issue:1-2, Year:2017, pp.160-173

last, lead us to our modelling representation which reflects how NAIRU will behave in the presence of labour productivity. NAIRU and its impact on output function is the main focus of this study, and the point of emphasis is to determine how productivity will be in relevance to the fluctuations of NAIRU, and to what extent it explains the behaviour of unemployment.

NAIRU, an acronym for Non-Accelerating Inflation Rate of Unemployment is an economic terminology indicating the rate of unemployment in which there is no force in the economy to speed up inflation which is not necessarily homogenous with natural unemployment as the main differentiating point, is the points in the Phillips curve where there is no inflationary situation in the economy. NAIRU, due to its nature is not at a fixed point over time and economic shocks influencing unemployment and inflation will change it; specifically, factors related to the labour market and production function. As these changes occur, estimating the NAIRU and determining its interdependence with relevant factors is really important. Changes in productivity growth appear to shift the inflation-unemployment tradeoff. In the past, most macroeconomists studying the Phillips curve have concentrated their attention on the dynamic relationship between inflation and unemployment. In the future, they should expand their scope to build and test models of inflation, unemployment and productivity (Laurence Ball and N. Gregory Mankiw (2002)). NAIRU is representative of the mentioned trade-off as it is a rate of unemployment in which the price inflation is non-accelerating. In order to analyse the role of productivity on NAIRU, we model an output function in which NAIRU as an indigenous variable changes the level of production.

The notion of relationship between variation in unemployment rate and size of the gap between "potential output" and “actual output”, firstly, is defined as a concept of Okun’s Law,

$$U = f(Q_A, Q_p), \quad f_1 < 0, f_2 > 0 \tag{1}$$

Where Q_A is actual output and Q_p is potential output. The main contribution of the above equation to our model is the negative relationship between unemployment and actual production. This concept is in accordance with Okun's Law which specifies the "potential output" of the economy at full employment and the "gap" between actual output and this potential measure. The simplifying assumption of Okun's Law is that of changes in productivity and the labour force, and hence potential output occurs at a steady rate over time, which is a limitation to studying productivity role in output. The relationship between unemployment and real output can be specified as,

$$Q_A = f(U), \quad f' < 0 \tag{2}$$

According to the neoclassic output theory, output is dependent on the number of labour participated in the production process and the amount of physical capital. We have,

$$Q_A = f(K, L) \tag{3}$$

In which K stands for physical capital and L for labour participated in production. Extended output function in terms of their determinants which reflects the real share of labour and capital in production in Cobb-Douglas form can be shown as,

$$Q_A = \Omega(\text{Total Capital})^{\alpha}(\text{Employed})^{1-\alpha} \tag{4}$$

In the above formula, Q_A is total output; Ω is the coefficient factors other than labour and physical capital in production function; such as technological advances, productivity which presented as an exogenous variable in our model.

We defined Labor force as employed workers added to unemployed in the form of, LF = Employed Workers + Unemployed Workers, in which the number of unemployed workers in an economy can be calculated by multiplying Labor Force (or total active labour in an economy) by unemployment rate. Applying above in LF gives us:

International Journal of Contemporary Economics and Administrative Sciences
ISSN: 1925 – 4423
Volume :7, Issue:1-2, Year:2017, pp.160-173

Employed Workers = LF – LF*Unemployment Rate, substituting this in production function will give;

$$Q_A = \Omega(\text{Total Capital})^{\Gamma}(\text{LF} - \text{LF*Unemployment Rate})^{1-\alpha} \quad (5)$$

Assume the Ω has an exponential form as $\Omega = \Omega\,(0)e^{gt}$ where g is the rate of productivity growth and reflects the dependency of it to the time with t factor.

Writing output specification above in growth form gives us a model consisting of three parts; First, is Ω which reflects all factors affecting output like technological advances and productivity, the second part is total capital, which reflects the share of capital in the economic growth and the last part is the labour participation in output. The production function in its simplest form includes labour as the major input; besides, the inclusion other inputs in production will enhance the performances of other inputs and their combination, will increase output. Adding capital to our production function as the main combination with labour will change our model. Total capital has three components; Human Capital which is a stock of competences, knowledge and personality attributes, embodied in the ability to perform labour in a way that produces economic value. Human capital, in our model, affects production level by means of the optimum usage of physical capital by labour force and thus leading to more efficiency in production, besides flow of knowledge and technology from other countries as well as the formation of new enterprises increase with high-quality labour force. The proxy for human capital is tertiary school enrolment.

The share of the total capital Γ breaks into two parts, that is ß, the share of human capital and ϴ, the share of physical capital. In this way we can write:

$$\Gamma = \beta + \Theta \quad , \quad \Gamma < 1 \quad (6)$$

The resulting production function involving both human capital and physical capital has the form;

Q_A = [Ω][(Physical capital)^{ß}(Human capital)^{Θ}][LF – LF*Unemployment Rate]$^{1 - ß - Θ}$ (7)

Our main assumption is that monetary authorities tend to control inflation in certain stable trend, and regulate both expansionary and tight policies to maintain stability. With the response, firms will change their plans to accommodate new investment plans and change the current production level. If there are no long-run contracts between workers and firms; employment and its equilibrium rate will vary in each hiring period. If policies are systematic and regulates in a specific time period, hiring policy of the firms will adapt in response and the number of workers fluctuates. The contribution of above explanation to our model is to include a rate of unemployment reflecting the stable inflation or NAIRU. Substituting Non-Accelerating Inflation Rate of Unemployment with unemployment gives us equilibrium production function,

Q_A = [Ω][(Physical capital)^{ß}(Human capital)^{Θ}][LF – LF*NAIRU]$^{1- ß - Θ}$ (8)

Ln QA = Ln $Ω_{it}$ + ßLnPhysicalcapital$_{it}$ + ΘLnHumancapital$_{it}$ - (1 - ß - Θ)LnNAIRU$_{it}$ + U_{it} (9)

Writing in Growth form gives a relationship of economic growth with its determinants and mainly provide a coefficient of NAIRU Intensity (NI), which is an indicator of severity of the effects of fluctuations of NAIRU on economic growth,

dLnQA$_{it}$ = dLnΩ$_{it}$ + ßdLn physical capita l$_{it}$ + Θ dLnHumanCapital$_{it}$ - (1 - ß - Θ) dLnNAIRU$_{it}$ + U_{it} (10)

Equation (10) is an extended SOLOW growth model including NAIRU as an explanatory variable, reflecting how the level of unemployment or the inactive part of the economy causes the total output to vary. The sign of NAIRU being achieved is negative, reflecting its counter-productive effects in production level. Production level calculated is economy’s equilibrium level of output and varies from levels of output achieved by inclusion of labour as a major input. On the other hand, labour is assumed to be a major input and production is not, therefore, Physical capital produces economic value in combination with the labour force. In addition, NAIRU term omits parts of labour with zero productivity or inefficiency and thus causes a change in the production levels where there are increased or decreased pressures on the economy; therefore, firms will systematically reduce labour force in response to monetary policies. In a decision to change the level of labour input, firms are concerned with the time wasted by employees in the workplace otherwise considered as disguised unemployment, and with different devices, determine lazy workers and remove them from the production process. The unemployment rate in an economy correlates both firms the unemployed population to an optimum point, where inflation is stable. Thus the above model calculates pure production level or Equilibrium Production (EP) growth.

Panel in VAR framework

The panel VAR technique is applied to output data which is the combination of including all variables as endogenous with estimation method of Panel firstly employed by Holtz-Eakin et al (1988).

Different estimators proposed to estimate Panel-VAR for small T, large N data settings, given by Binder et al (2005). We consider the first lag Panel VAR as:

$$Z_{i,t} = \eta_0 + \eta_1 Z_{i,t-1} + U_{it} \quad (11)$$

Where Z_{it} is a m*1vector of endogenous variables, $Z_{it,1}$ = [LnQAit , $Ln\Omega_{it}$, $LnPhysicalcapital_{it}$, $LnHumancapital_{it}$, LnNAIRUit], $Z_{it,2}$ = [$dLnQA_{it}$, $dLn\Omega_{it}$, $dLnphysicalcapital_{it}$, dLnHumanCapitalit , $dLnNAIRU_{it}$], η_1 is an m*m matrix of coefficients U_{it} which is an m*1 vector of the composed error term. There are numerous methods offered in literature for the above equation with further consideration for the lagged dependent variable on the right-hand side of the equation. Arelano and Bond (1991), proposed a GMM estimator employing first differences as instruments,

$E(y_{i,t-\rho}\Delta u_{i,t}) = 0$ for all $\rho = 2,\dots,t-1$ (12)

The equation above is 'standard moment condition' and is practical in estimation with the instruments of differences in endogenous variables in growth model. The resulting instrument matrix for past values can then be written as:

$$Z_i^{\Delta,(y)} = \begin{pmatrix} yi0 & 0 & \dots & \dots & 0 & \dots & 0 \\ 0 & yi0 & yi1 & 0 & 0 & \dots & 0 \\ 0 & \dots & \dots & \vdots & \vdots & \dots & 0 \\ 0 & \dots 0 & 0 & yi0 \dots & & yiT-2 & \end{pmatrix} \quad (13)$$

We can can write for exogenous explanatory variables (X_{it-1}):

$$Z_i^{\Delta,(x)} = \begin{pmatrix} X'i & \dots & X'iT-1 & 0 & \dots & \dots & 0 & \dots & 0 \\ 0 & \dots & 0 & X'i0 & \dots & X'iT & 0 & \dots & 0 \\ 0 & \dots & & \dots & 0 & \dots & & & 0 \\ 0 & \dots & \dots & \dots & 0 & X'i0 & \dots & X'iT-1 & \end{pmatrix} \quad (14)$$

Regarding above matrix specification of instruments for the first difference (FD) transformed model (Z^{Δ}_i) are:

$Z^{\Delta}_I = (Z_i^{\Delta,(y)}, Z_i^{\Delta,(X)})$ (15)

Due to weak empirical performance, other methods argued for estimation of Panel-VAR by Bond et al. (2001) suggesting IV and Generalised Method of Moments (GMM) estimators in first differences behave poorly, resulting from 'weak instruments' for subsequent first differences. To cope with this problem other estimation procedures developed, which also makes use of appropriate orthogonality conditions for the equation in levels (Blundell and Bond (1998)):

$E(\Delta y_{i,t-1}u_{i,t}) = 0$ for $t = 3,\dots,T$ (16)

Equation (16) is also called the 'stationary moment condition'. Blundell and Bond (1998) proposed a GMM estimator that uses both the standard and stationary moment conditions. This approach is typically known as 'system GMM (SYS-GMM) combining 'level' and 'difference'

International Journal of Contemporary Economics and Administrative Sciences
ISSN: 1925 – 4423
Volume :7, Issue:1-2, Year:2017, pp.160-173

GMM. This estimator in data system is considered a single-equation problem,

$$\begin{pmatrix}\Delta \mathbf{y}\\ \mathbf{y}\end{pmatrix} = \alpha\begin{pmatrix}\Delta \mathbf{y}-\mathbf{1}\\ \mathbf{y}-\mathbf{1}\end{pmatrix} + \beta\begin{pmatrix}\Delta \mathbf{X}-\mathbf{1}\\ \mathbf{X}-\mathbf{1}\end{pmatrix} + \begin{pmatrix}\Delta \mathbf{u}\\ \mathbf{u}\end{pmatrix} \quad (17)$$

The instruments set used for estimation, in this case, are $Z_i = (Z_i^{\Delta}, Z_i^{L})$, where when later set, will include equations in level form based on orthogonality conditions for $y_{i,t-1}$and $X_{i,t-1.}$

A common strategy to estimate the PVAR model basically involves stack data in the typical system way, and applies IV estimation using SYS-GMM estimation strategy. The resulting IV set Z_i^s for a system of m equations (with m = 1,…, M) is a combination of individual equations' IV sets, where we allow the instruments to differ among the equations of the system as,

$$Z_i^S = \begin{bmatrix} Zi1 & \cdots & 0\\ \vdots & \ddots & \vdots\\ 0 & \cdots & ZiM\end{bmatrix} \quad (18)$$

Stacking the equations for multiple-equation, GMM estimation may lead to further efficiency gains if the residuals of the M equations are correlated. We, therefore, apply a two-step approach which explicitly accounts for cross-equation residual correlation. The weighting matrix V^S in two-step efficient GMM estimation is defined as;

$$V^s = N^{-1} \sum_{i=1}^{N} Z^{S\,'}_i \ddot{e}_i \ddot{e}_I' Z^S_i \quad (19)$$

And the vector of first step error terms $\ddot{e}_i = (\ddot{e}_{i1},\ldots, \ddot{e}_{iM})'$ is derived from 2SLS estimation. The system GMM estimator in the context of the PVAR(1) can then be written as:

$$\ddot{\Phi}_{GMM} = (S'_{ZX}(V^S)^{-1}S_{ZX})^{-1}\, S'_{ZX}(V^S)^{-1}S_{Zy}, \quad (20)$$

Where

$$S_{ZX} = \begin{bmatrix} \frac{1}{N}\sum_{i=1}^{N} Z'_{i1}\, x_{i1} & & \\ & \ddots & \\ & & \frac{1}{N}\sum_{i=1}^{N} Z'_{iM}\, x_{iM}\end{bmatrix} \quad (21)$$

$$S_{Zy} = \begin{bmatrix} \frac{1}{N}\sum_{i=1}^{N} Z'_{i1} y_{i1} \\ \vdots \\ \frac{1}{N}\sum_{i=1}^{N} Z'_{iM} y_{iM} \end{bmatrix}. \quad (22)$$

Empirical Results

In this section, we apply Arellano and Bond's estimation method to estimate the effects of productivity on output both in logarithmic and growth form.

First, we look at the estimation output and post-estimation tests. Instruments both in levels and differences used to estimate the relationships. One of the tests done is the determination of how our estimators are consistent or efficient. Sargan (1958), and Hansen (1982), over-identification test applied using Arelano and Bond's GMM estimator, to see how they are identified or over-identified. Acceptance of H0 indicates that the instruments used in our estimations were accurate and true, whereas rejection indicates the necessity of revision of instruments set. Impulse responses and variance decompositions indicate how one unit affect different variables in production and therefore causes and strengthens our results of the negative effect of NAIRU and its fluctuations on both productivity and economic growth.

Estimation results of PVAR for models in level and growth form are shown in table (1) and table (2). Estimations include different lags of variables considered as explanatory variables and all the variables considered as endogenous in order to study how they behave in front of other variables. All variables are significant with confidence intervals and standard errors, and p-values of acceptance levels. Sargan test of over-identification provides the criteria for testing our instruments accuracy. Results show the proper identification of all estimated models.

Panel VAR results consisted of all variables considered as independent variables, which are reflected in tables (1) and (2). In the final model, it is shown NAIRU has a negative impact on economic growth. Increasing workers with low productivity and inefficiency increase unemployed labour force as a major input in production function. Increasing labour with low productivity will cause the production level to diminish and negatively affects it as the sign. Coefficients of the logarithm of NAIRU and fluctuations of NAIRU are negative for OECD countries and for the effect of fluctuations or NAIRU Intensity, it is equal to -0.0882 in the investigation period and one percent increase in economic growth caused NAIRU to vary more about 0.00882. This can be construed from the direct hiring behaviour of firms in order to boost up their output in response to increase in demand and causing unemployment to change more. The difference in productivity positively affects economic growth which is a result of an increase in labour productivity in EU countries from 1997 to 2009. Productivity variation (increasing trend in the period under investigation), decreased changes in NAIRU caused negative force against its fluctuation which based on results, numerically amounted to -0.0272. Increasing labour productivity decreased disguised unemployment in the workplace and caused a change in hiring policies of firms in countries under analysis in order to maintain current employees which can be done by extending work agreements. The upward trend of labour productivity induced more production increased output levels and brought more stability to NAIRU in a specified period. Monetary reform executed in 1999 to establish unanimous currency throughout the European Union has a positive impact on both economic growth and productivity and negatively influences the variation of NAIRU. The new currency changed the effectiveness of policies by smoothing ordering path from monetary authorities to policy makers in each country's territory and other nations. Fast responding to policies and easing facility provided by Euro in European countries increased productivity and growth and shrunk fluctuations of NAIRU and in effect resulted in more stability.

Conclusion

NAIRU, as stable inflation rate regarding unemployed workers in an economy is a subject of major concern to many economic researchers in order to determine the factors responsible for the reason why it does not attain optimum stability on the long run and advise countries to change their economic target function in such a way that will allow policy regulation. Gregory Mankiw and Laurence Ball (2002), insist on the role of productivity in the behaviour of NAIRU and its variation during periods for US economy. The concern of this study was to estimate a model which catches the effects of NAIRU and its fluctuation on output as well as factors that may influence a change in these effects. One of such under consideration is productivity, which has caused much of the variance of NAIRU. We attempt to apply data from OECD countries to our model of economic growth which strongly approved our premise of the intensely decaying negative impact of oscillation in NAIRU on output by increasing productivity. NAIRU Intensity or coefficient of Fluctuations of NAIRU in economic growth model is an indicator of how intensely, unstable NAIRU decreases economic growth.

Labour productivity is the main factor in a firm's decision to extend the work agreement period and new investment plans due to monetary policy, which will, directly and indirectly, decrease disguised unemployment and in turn change NAIRU. Productivity caused NAIRU to diminish and besides, bring more stability to its path in the Long-run period by preventing further movements. The monetary Reform done in 1999 is a point of significant effect in the result of our model. Fluent path of monetary policy from policy makers to policy takers as a most important consequence of unanimous currency was positive to economic growth by increasing efficiency and leading to lower level of Intensity of NAIRU.

International Journal of Contemporary Economics and Administrative Sciences
ISSN: 1925 – 4423
Volume :7, Issue:1-2, Year:2017, pp.160-173

References

Arellano, M., Bond, S, (1991). “Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations”., Review of Economic Studies, 58, 277-297.

Barro, J., Robert, “Human Capital and Growth”, (pp. 12-17), American Economic Review: Vol. 91 No. 2, (May 2001).

Blundell, R., Bond, S, (1998). “Initial conditions and moment restrictions in dynamic panel data models”, Journal of Econometrics, 87, 115-143.

Braninger, Micheal, Pannendberg, Markus, “Unemployment and Productivity Growth, An Empirical analysis within the Augmented Solow Model”, Economic Modeling, 19 (2002), 105-120, 2000, March.

Eli’as, J., Victor “The Role of total productivity on economic growth”, National University of Tucuma’n, World development Report 1991, World Bank.

Hatton, J., Timothy, “Can Productivity Growth Explain NAIRU? Long-run Evidence from Britain, 1871-1999”, Econometrica, (2007), 74, 475-491.

Holtz-Eakin D., W., Newey, H.S, Rosen, (1988). “Estimating vector autoregressions with panel data”. Econometrica, 56, 1371-1395.

Komijani, Akbar, Mohebi, Mehdi, “NAIRU Fluctuations and Economic Growth: Evidences from Developing Countries”., European Journal of Scientific Research, 98, no. 3 (2013): 310.

Mankiw, Gregory, Ball, M., Laurence, “NAIRU in theory and practice”, Journal of Economic Perspective, 2002.

Mitze, Timo, “A Panel VAR Approach for Internal Migration Modelling and Regional Labour Market Dynamics in Germany”, Lecture Note in Economics and Mathematical System 657, Empirical Modelling in Regional Science, Springer-Verlag Berlin Heidelberg 2012.

Roodman D., (2009). "How to do xtabond2: an introduction to difference and system GMM in Stat". Stata Journal, 9(1), 86_136.

Sheffrin, M., Steven, O'Sullivan, Arthur, "Economics: Principles and Tools", Prentice Hall 2003-712.

Zicchino, Lea, Love, Inessa, "Financial development and dynamic investment behaviour: Evidence from panel VAR", The Quarterly Review Of Economics And Finance., (2005)