UNDERLYING TRENDS IN EMPLOYMENT-OUTPUT EQUATION: THE CASE OF JORDAN

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Abstract: The underlying employment trend (UET) is investigated in Jordanian economy over the period 1989- 2004 using structural time series model (STSM). This approach allows to modelling the trend in its stochastic form introduced by Harvey (1989). The results show that a stochastic trend is preferred to deterministic trend. In addition, the inclusion or exclusion of the conventional deterministic trend leads to overestimated output elasticity. Furthermore, the UET is found to be non-linear, down downward sloping.

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Introduction

The quest for the truth never ends, researchers choice often cross procedures and techniques. Often technical progress and productivity are modelled using a simple deterministic time trend. The cointegration approach that is well documented in (Hendry and Juselius 2000 and 2001) has had a considerable effect on wide range econometric studies including employment functions. This approach allows modelling technical progress and productivity via a simple deterministic trend.

Harvey (1997) criticises heavily the cointegration approach as being unnecessary and/or misleading or both. From his point of view there is no reason to keep individual series moving together in the long run. Moreover, Harvey (1997) asserts that this is a general shortcoming of pure time series techniques and in general such models may have poor statistical properties.

Therefore, Harvey et al. (1986) argued that "a stochastic trend offers an intuitively more appealing way of modelling variables like technical progress and productivity, and offers a way out of the problems caused by constraining them to be deterministic". Moreover, as noted by Henry (1979) and O'Brien (1983) the inclusion of the deterministic time trend in employment-output equations often failed to predict employment satisfactorily.

Given the arguments above on the importance of the inclusion of the stochastic trend when modelling technical progress and productivity in employment equation, this study utilises structural time series model (STSM) introduced by Harvey (1989). This approach allows modelling the trend in its stochastic form (non-linear). In addition, for the sake of comparing the results, this paper introduces the deterministic trend in employment-output equation as a proxy for technical progress and productivity. And hence, we can gauge its effect on the estimate, hence investigating any biases in output elasticity estimate.

Methodology

Harvey (1989) argues that "the level of employment is determined by current and past level of output, by employment in the previous time period and by capital stock and technical progress. These two factors are not only difficult to measure, but are also difficult to separate conceptually. If they could be measured, their combined effect would yield a measure of productivity" (pp. 4-5). Therefore, productivity is one of the determinants of employment level, but hence it cannot be measured directly, then its effect could be proxied by a trend component and it may be stochastic as specified below. More details of economic theory and the derivation of employment-output equation can be found in Harvey et al (1986).

Therefore, drawing on Harvey et al. (1986), this paper combines both the STSM with an autoregressive distributed lag (ADL) model to estimate the employment output function. This specification allows a stochastic trend in which the level and slope are allowed to vary over time when estimating output elasticity of employment output function. Therefore, in the present context, the study proposes the model to be:

$$A(L)n_t = \mu_t + B(L)q_t + \varepsilon_t , \qquad (1)$$

where $A(L)$ is the polynomial lag operator $1-\phi_1 L - \phi_2 L^2 ....\phi_P L^P$ and $B(L)$ is the polynomial lag operator $\delta_0 + \delta_1 L + \delta_2 L^2 ....\delta_p L^p$. n_t is the natural logarithm of employment for the specific sector, q_t is the natural logarithm of output of the specific sector. $B(L)/A(L)$ represents the long run output elasticity.

The trend component μ_t is assumed to have the following stochastic process:

$$\mu_t = \mu_{t-1} + \beta_{t-1} + \eta_t \qquad (2)$$

$$\beta_t = \beta_{t-1} + \zeta_t , \qquad (3)$$

where $\eta_t \sim NID(0, \sigma^2_\eta)$ and $\zeta_t \sim NID(0, \sigma^2_\zeta)$.

Equations (2) and (3) indicate the level and the slope of the trend, respectively. The shape of the underlying trend depends upon the variances σ^2_η and σ^2_ζ, (also known as the hyperparameters), the larger the variances the greater the stochastic movements in the trend. In the limiting case, when the variances are equal to zero, the model collapses to a conventional deterministic time trend regression. There are a number of alternatives to estimate the stochastic trend depending on the values of the hyperparameters, as illustrated in Harvey (1989) and in a separate literature as in Hunt et al (2003b).

TABLE 1. THE ESTIMATED RESULTS FOR EMPLOYMENT OUTPUT EQUATION

Variables	Model 1	Model 2	Model 3
n_{-1}	0.51*	0.77**	1.07*
q	1.40**	1.42*	0.50*
q_{-1}	-0.48*	-0.74**	0.62**
Type of the trend	Stochastic	Deterministic	No trend
Growth rate at the end of the period	-1.54% p.a	-1.23% p.a.	None
Long-run estimate			
Output Q	1.88	2.96	16.00
Diagnostics equation residual			
Standard error	0.01	0.01	0.01
Normality	0.70	1.45	2.62
Heteroscedasticity	F(4,4) = 0.90	F(4,4) = 0.71	F(5,5) = 0.36
r(1)	-0.11	-0.04	0.25
r(8)	0.20	$r_{(6)}$= 0.13	$r_{(6)}$=-0.10
DW	2.00	2.0	1.30
Box- Ljung Q	$Q_{(8,6)}$=4.21	$Q_{(6,6)}$=3.30	$Q_{(6,6)}$=4.90
R2	0.98	0.99	0.97
R2D	0.66	0.81	0.37
Auxiliary residuals			
Irregular			
Normality	0.15	0.09	1.80
Kurtosis	0.01	0.06	0.33
Skewness	0.14	0.03	1.47
Level			
Normality	0.36	n/a	n/a
Kurtosis	0.35	n/a	n/a
Skewness	0.01	n/a	n/a
Slope			
Normality	0.41	n/a	n/a
Kurtosis	0.40	n/a	n/a
Skewness	0.01	n/a	n/a
Estimated Hyperparameters			
Irregular	0.008	0.004	n/a
Level	0.003	0.00	n/a
Slope	0.003	0.00	n/a
LR tests			
Test $\chi_{(1)}$	4.3**	n/a	n/a
Estimation period	1989-2004	1989-2004	1989-2004

Notes: ** indicates significant at 1% level and * indicates significant at the 5%. Normality is the Bowman-Shenton statistic, approximately distributed as $\chi^2_{(2)}$. Kurtosis statistic is approximately distributed as $\chi^2_{(1)}$. Skewness statistic is approximately distributed as $\chi^2_{(1)}$. The heteroscedasticity, distributed approximately F(h,h). r(τ) the residual autocorrelation at lag τ , distributed approximately as N(0, 1/T). DW-Durbin-Watson statistic, distributed approximately as N(2,4/t). Q(p,d)- Box-Ljung Q statistic based on the first P residuals autocorrelations and distributed approximately as χ^2_d . R^2 is the coefficient of determination.

In addition, following Harvey and Koopman (1992), the initial model to be estimated therefore consists of equation (1) with (2) and (3). All the disturbances are assumed to be independent and uncorrelated with each other. The estimation is carried out by maximum likelihood and the hyperparameters are obtained from a smoothing algorithm using the Kalman filter. For model selection, equation residuals are estimated (similar to those from ordinary regression), in addition to a set of auxiliary residuals. The auxiliary residuals include irregular residuals, level residuals and slope residuals. Of course, level and slope residuals are estimated if the trend components are non-zero. The final preferred specifications for employment output equation is found by testing down from the initial general model by eliminating insignificant variables, provided that the equation passes an array of diagnostic tests, which are described in more detail in the results section below.

In addition to the stochastic model specified above, two other models were estimated to check the appropriate specification of the trend that reflects the technical progress or productivity. The trend specifications of the estimated three models are summarised as follows.

Model 1: A stochastic trend that relies at least either $\sigma^2_\eta \neq 0$ or $\sigma^2_\xi \neq 0$.

Model 2: A deterministic linear trend that specified $\mu_t = \alpha + \beta t$

Model 3: No trend that specified $\mu_t = \alpha$.

Models 2 and 3 are limiting case of model 1 and they are familiar conventional models with and without a time trend respectively which can be estimated by OLS. However, model 1 cannot be estimated by OLS and Kalman filter is used instead.

In addition, a likelihood ratio (LR) test is undertaken to test the restriction of a deterministic trend against the estimated stochastic trend. [1]

Data description

The data used in this paper are yearly over the period 1989 to 2004. The Jordanian employment data, N, represents number of workers (in thousands) in the whole economy from various issues of the Statistical Year Book, Department of Statistics (DOS). The period starts from 1989 and the data on employment before this year is calculated with a constant growth rate and therefore it has no fluctuations. Q refers to Gross Domestic Product (GDP) at constant price 1994=100 from different issues of the Central Bank of Jordan (CBJ). Further, n and q represent the natural logarithm of N and Q respectively.

Results

The model described in Equation (1) is estimated employment equation on aggregate level and for three different specifications of the trend. Table 1 reports the estimated results and diagnostic tests of each model.

Model 1, with a stochastic trend, passes array of diagnostic tests. In specific, the equation residuals were diagnosed for the presence of non-normality, serial correlation, heteroscedasticity, etc. Besides, where applicable, the auxiliary residuals were diagnosed to ensure there were no significant outliers and/or structural breaks. The number of lagged variables is small with just a one-year lag on employment and output. The output elasticity is estimated of 1.88. The variations in the underlying trend come from the slope and the level, hence $\sigma_\eta^2 \neq 0$ and $\sigma_\xi^2 \neq 0$.

The estimated UET growth at the end of the estimation period is -1.54% p.a, indicating that after controlling for the output effect the employment fall by 1.54% each year.

Model 2 with a deterministic linear trend fits the data as Model 1. On the statistical grounds the model passes all the diagnostic tests as detailed in Table 1. In addition, the number of lagged variables is small that similar to Model 1. However, the estimated output elasticity is 2.96 that is higher than the one found in Model 1. The estimated UET growth rate at the end of the estimation period is -1.23% p.a, suggesting that after holding the output constant the employment fall by 1.23 each year. Comparing Model 1 and Model 2 it seems that the inclusion of the of the deterministic time trend lead to overestimate the output elasticity hence the UET is not incorporated in the model in its stochastic form. Moreover, it is useful to test for the restriction of the deterministic trend on the stochastic trend via the LR. The LR test clearly indicates that the restriction is not valid. Therefore, the preferred specification is Model 1. Moreover, it seems that Model 3 produces output elasticity of 16.0 indicating that ignoring the effect of technical progress or productivity in output-employment equation leads to implausible output elasticity.

Conclusion

The paper attempts to estimate the effect of productivity on employment in Jordanian economy and hence to estimate accurately the output elasticity. To achieve this, we demonstrated the need to model the underlying employment trend (UET) adequately. Therefore, we adopted Harvey's structural time series model. The empirical work shows that the stochastic trend for the employment-output equation of Jordan produces more plausible output elasticity compared with the other two specified models. In addition, the UET is a nonlinear downward sloping, indicating that the demand curve for employment in Jordan has been shifting to the left over the estimation period. However, there is a need to investigate whether the employment and economic activity are procyclical and/or countercyclical. Hence investigating the cycles of the series is interest subject in this paper.

[1] The software package STAMP 6.3 (Koopman et al, 2000) is used for the estimation.

References

Central Bank of Jordan (CBJ), Annual report, Different issues.

Department of Statistics (DOS), Statistical Year Book, Jordan, different issues.

Harvey, A., 1989. Forecasting, structural time series models and the Kalman filter, Cambridge University Press, Cambridge.

Harvey, A., 1997. "Trend, cycles and autoregression", The Economic Journal 107 (440), 192- 201.

Harvey, A., Henry, S., Wren-Lewis, S., 1986. "Stochastic trend in dynamic regression models: An application to the employment-output equation", The Economic Journal, 96 (384), 975-985.

Harvey, A., Koopman, S., 1992. "Diagnostic checking of unobserved components time series models", Journal of Business and Economic Statistics 10 (4), 377-389.

Hendry, D., Juselius, K., 2000. "Explaining cointegration analysis: Part I", Energy Journal, International Association for Energy Economics, Vol.21, pp. 1-42.

Hendry, D., Juselius, K., 2001. "Explaining cointegration analysis: Part II", Energy Journal, International Association for Energy Economics, Vol.22, pp.75-120.

Henry, S., 1979. "Employment equations for the U.K.", Paper presented to the SSRC Econometric Modelling Group LSE.

Koopman, S., Harvey, A., Doornik, J. and Shephard, N., 2000. Stamp: structural time series analyser, modeller and predictor, London: Timberlake Consultants Press.

O'Brien, P., 1983. Employment in systematic econometric comparison. London: NIESR.