May 5, 2022

Econometrics – 1

End-semester exam (Winter 2022)

Maximum marks: 100

Instructions: This is an open notes, open book exam. Please manage your time wisely. Institute's plagiarism policy will apply as-is.

Q. You are hired by Kingdom of Arendelle as their principal economic advisor to analyze factors that drive quarterly GDP levels during 1961-2020. You are further informed that crops harvested during third quarter of each year are critical to the nation's economy. The Kingdom wants to evaluate whether tractor sales (i.e., number of tractors sold) in a quarter drive GDP higher than volume of exports (in tons), or vice-versa. Please answer the following questions.

A. Which among the following models is more appropriate for your above assignment and why? Provide a clear interpretation of all parameters in the most appropriate model.

$$G_{q(y)} = \alpha + \beta T_{q(y)} + \eta E_{q(y)} + \lambda D_{q(y)} + u_{q(y)} \quad (1)$$

$$\ln\left(G_{q(y)}\right) = \alpha + \beta T_{q(y)} + \eta E_{q(y)} + \lambda D_{q(y)} + u_{q(y)} \quad (2)$$

Where $G_{q(y)}$ represents GDP measured in dollars in quarter q of year y. Note that there are four quarters in each year and $y = 1961, 1962, ..., 2020$. Further, $T_{q(y)}$ represents tractor sales in quarter q of year y; $E_{q(y)}$ represents ~~tractor sales~~ vol. of exports in quarter q of year y; and $D_{q(y)} = 1$ for third quarter three in each year ($q(y) = 3(y)$). $u_{q(y)}$ is random model error with $E(u) = 0$; $V(u) = \sigma_u^2$; $Cov(u_{q(y)}, u_{q(y')}) = 0$; $Cov(u_{q(y)}, u_{q'(y)}) = 0$. α, β, η and λ are model parameters (to be estimated).

B. You suspect that the nation' GDP might be heteroskedastic due to its crop harvesting cycle. That is,

$$\sigma_u^2 = V(u_{q(y)}) = \theta_0 + \theta_1 D_{q(y)} \quad (3)$$

In class we developed an FGLS strategy to reconcile heteroskedasticity as specified in equation (3), where we ran the following OLS regression in Step 2 of FGLS: $\hat{u}^2_{q(y)} = \theta_0 + \theta_1 D_{q(y)} + \varepsilon_{q(y)}$.

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B1. Claim: $\hat{\sigma}^2_u$ **may not** be positive for all quarters across years 1960-2020. True/False. Explain.

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B2. Due to the above suspicion you decided to employ an alternative strategy for reconciling heteroskedasticity in GDP levels. That is, we specify

$$\sigma^2_u = V(u_{q(y)}) = \exp\left[\theta_0 + \theta_1 D_{q(y)}\right] \qquad (4)$$

Note that $\hat{\sigma}^2_u$ will always be positive. Write down the steps for FGLS estimation of parameters in model (1) using the heteroskedastic structure specified in equation (4).

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C1. Provide a t-statistic to test H_o: $\lambda = 0$ vs. H_a: $\lambda \neq 0$ and outline the steps for conducting inference.

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C2. Testing H_o: $\lambda = 0$ vs. H_a: $\lambda \neq 0$ can be conducted by using a F-statistic. True/False. Explain.

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C3. Outline the steps for conducting inference on the following test: H_o: $\theta_1 = 0$ vs. H_a: $\theta_1 \neq 0$.

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D1. Assume $u_{q(y)} \sim N(0, \sigma^2_u)$ *s.t.* $\sigma^2_u = \theta_0 + \theta_1 D_{q(y)}$ and $Cov(u_{q(y)}, u_{q(y')}) = Cov(u_{q(y)}, u_{q'(y)}) = 0$. Setup a maximum likelihood estimation algorithm for estimating model parameters $\alpha, \beta, \eta, \lambda, \theta_0$ and θ_1. Clearly outline all the steps in the estimation process.

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BONUS QUESTION (to be graded only after questions A-D are duly attempted)
Based on the panel conducted during RIISE 2022 suggest a regression model for the estimation of demand for electric vehicles in New Delhi. Support your model with at least five explanatory variables. Discuss plausible issue(s) in obtaining causal inference from your model, if any.

Be aware of the practical aspects of your model, for example, two-wheelers are likely to have a different demand structure relative to three-wheelers and four-wheelers; similar arguments will hold for private and public vehicles. Please ensure the proposed explanatory variables are measurable and a researcher can expect to find data to conduct an analysis.