Introduction

The study examines the impact of economic growth, trade openness, financial development, and technological innovation on energy consumption in Pakistan. The proposed analysis has massive implications for Pakistan due to two reasons. Firstly, the last two decades have shown a rapid increase in demand for energy in Pakistan. The primary energy consumption increased from 1.74 quadrillions Btu in 1998 to 3.37 quadrillions Btu in 2017, with an annual average growth rate of 3.6% in Pakistan (EIA, 2019). The energy intensity reduced from 5.54 MJ per dollar of GDP in 2000 to 4.42 MJ per dollar of GDP in 2015, reflecting the efficient use of energy in Pakistan (EIA, 2019). Due to the exponential increase in urbanization and population growth, it is expected that the energy demand, especially electricity, would be 19 times higher in 2050 than in 2015 in Pakistan (Javid and Qayyum, 2014; Nawaz et al., 2014a). The growing energy demand led to an energy crisis in Pakistan (Irfan et al., 2019; Valasai et al., 2017). The electricity shortage touches 6000 megawatts, causing forced blackouts (Awan et al., 2019).

Secondly, we observe cyclical patterns of macroeconomic fundamentals in Pakistan. The economic growth declined from around 6% in the early 1970s to less than 4% during the 2020s. Apart from the declining economic growth trend, Pakistan observes cyclical economic growth patterns: a high growth period followed by low economic growth (Iqbal et al., 2008). Other macroeconomic factors, such as trade and financial inclusion, also show cyclical patterns (see Figure 1 to Figure 4). These facts compel us to investigate the nexus between macroeconomic fundamental and energy consumption in Pakistan.

The policymakers are continuously reviewing energy policy to ensure an uninterrupted supply of energy and meet the future energy needs in Pakistan (Malik et al., 2020). The continuous supply of energy is essential to achieve inclusive development and promote economic well-being (Mohamed and Lee, 2006; Nawaz and Iqbal, 2020; Perera, 2019). The global projections show that energy consumption is expected to grow by 50% between 2018 and 2050 worldwide, mainly in developing countries, including Pakistan, due to strong economic growth (EIA, 2019). The extensive use of energy causes environmental degradation, such as air pollution and adverse climate change. It is also a key contributor to global warming (Akhmat et al., 2014; De Cian and Wing, 2019). Given the significant contribution and widening supply-demand energy gap, a growing body of literature has sought to understand the determinants of energy consumption (Awan et al., 2019; Raza et al., 2020; Shahbaz et al.,