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Measuring the Affordability of Key Food and Energy Commodities in Pakistan: An Application of Simon Abundance Framework

ABSTRACT

This study applies the Simon Abundance Framework (SAF) to assess food and energy resource affordability in Pakistan from 2007 to 2021. Developed by Tupy and Pooley (2022), the SAF uses the concept of time price, which shows the number of working hours required to purchase a good or service. It serves as an alternative measure of resource affordability, incorporating both prices and the efforts required by labour. By evaluating changes in time prices across 22 essential food and energy items for male and female workers of low and high-skilled categories, the study finds a broad-based improvement in affordability of these items in terms of time price. The findings support the argument made by Julian Simon that human efforts to innovate and find new alternatives can counteract resource scarcity despite population pressure.

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Author's contribution in the article: 1- Conceived and designed the analysis, 2- Reviewed and compiled the literature, 3- Collected the data, 4- Contributed data or analysis tools, 5- Performed the analysis, 6- Wrote the paper, 7- Financial support for the conduct of the study, 8-Other

1. INTRODUCTION

Concerns about resource scarcity have historically dominated economic and environmental debates. The earliest and most influential argument was presented by Malthus (1798), warning that population growth would outpace food production, leading to mass starvation. This pessimistic view was reinforced in the 20th century by Ehrlich (1968) book "*The Population Bomb*" predicted global famines due to overpopulation. The 1972 "Limits to Growth" report by the Club of Rome extended this narrative, suggesting that exponential growth in population and resource consumption would lead to ecological and economic collapse.

However, in a counter argument, Simon (1981) argued that human ingenuity, not natural resources, is the ultimate limiting factor. Simon emphasized that population growth could spur innovation and efficiency, ultimately increasing the availability of resources. Their famous wager with Ehrlich in 1980, involving the prices of selected metals, provided empirical support for this argument. Over ten years, real prices for all five chosen resources declined, indicating increased abundance despite global population growth.

This study contributes to the ongoing debate between scarcity and abundance theorists by applying the Simon Abundance Framework (SAF) developed by Tupy and Pooley (2022) to the context of Pakistan. The SAF replaces traditional money price measures with time price, reflecting the number of hours a person must work to purchase a good. Time price, and its derivatives such as personal resource abundance multiplier (pRAM) and compound annual growth rate (CAGR), offer an alternative and more comprehensive metric to evaluate affordability and abundance.

By analyzing 22 key food and energy resources, we examine how their affordability has evolved across different worker categories (low and high-skilled, male and female) in Pakistan between 2007 and 2021. This period includes significant economic, demographic, and energy market changes, making it a rich ground for analysis.

1.1 Problem Statement

As the global population continues to grow, concerns about the scarcity of essential resources, such as food and energy, have sparked scholarly debate. While many researchers have studied long-term trends in the real prices of resources to assess scarcity, no consensus exists on whether these prices are increasing or decreasing over time (Slade, 1982; Haque, 1994; Erdem & Ünalmış, 2016; Baffes & Kabundi, 2023). This study aims to fill this gap by analyzing the relationship between population growth and resource scarcity using newly developed concepts of the time price of essential food and energy resources and the SAF.

1.2 Objectives of the Study

The main objective of this study is to assess the affordability of food and energy resources in Pakistan using time prices and its derivatives. Specifically, the study aims to calculate the time price and personal resource abundance multiplier (PRAM) for selected food and energy items across male and female workers, disaggregated by skill level (low and high-skilled).

1.3 Organization of the Study

The study is organized as follows: Section 2 covers the literature review. Methodology and data are explained in Section 3. Analysis and results are presented in Section 4, and finally, Section 5 contains the conclusion of the study.

2. LITERATURE REVIEW

The scarcity of resources has been debated in economic literature since its inception. The debate revived in economics when the British Economist Thomas Robert Malthus published the book titled "*An Essay on the Principle of Population*" in 1798. His argument was based on an economic reality of

diminishing returns that presented the concept of absolute scarcity. He assumed that the agricultural land is limited and population increase would put pressure on the fixed amount of available land for more output, thus the diminishing returns of land decrease the availability of food.

Ricardo (1817) and Mill (1848) were also convinced that limited availability of land was a limit to growth, as already expressed by the concern of diminishing of returns of fixed availability of land and further most importantly due to the decline in quality of land in the context of profit maximization and presented the concept of relative scarcity. An influential work by Jevons (1866) on the consumption of coal in the production process of Great Britain, in which he expressed his concern that with the fixed resources of coal, it would not be possible for Britain to maintain its industrial output at a high level indefinitely.

Paul Ehrlich in his book *The Population Bomb* (1968), predicted mass starvation and ecological collapse due to rapid population growth and limited resource availability. He argued that natural systems have strict biological and ecological limits that cannot sustain population pressure.

Similarly, Meadows et al. (1972) projected that the world will come to the physical limits in terms of non-renewable resources, agricultural production, and excessive pollution. The study predicted a new model to make projections about five global variables that include population, food, non-renewable resources, pollution, and industrialization. It concludes that eleven resources will vanish by the end of this century, while Copper, Mercury, Gold, Gas, and Oil are part of those eleven resources. We are still having all the minerals that were projected to disappear by the end of the last century, raising objections about study's accuracy.

Contrary to Paul Ehrlich's arguments, Simon (1981) argued that population growth is not a threat but a catalyst for innovation and abundance. He believed that human intellectual capacity is the ultimate resource; resources may be physically limited, but economically unlimited. Simon's famous bet with Ehrlich in 1980 (Simon wagered that real prices of selected metals would fall over the decade) provided empirical evidence supporting their thesis. Boserup (1965) also presented an argument that labour, not the land, was the limiting factor in agricultural output. Boserup further found a positive impact of population density on poor agrarian societies.

Krautkraemer (2005) concluded that the prices of many commodities, such as corn and wheat, showed relatively constant behaviour from 1800 to 1950. However, an increase in agricultural productivity due to technological innovations led to an increase in food availability and a decrease in prices. Harvey et al. (2010) used data from 1900 to 2003 for a set of twenty-five primary commodity prices, applying time series techniques to estimate the trend function and the existence of possible structural breaks. The results showed that thirteen commodities (Aluminum, Banana, Cotton, Hide, Jute, Lead, Rice, Silver, Sugar, Tea, Wheat, Wool, and Zinc) present a declining trend over the 1900-2003 period, and found that there is no statistical evidence that relative commodity prices have ever trended upwards.

Based on Simon's work, Tupy and Pooley (2022) developed the Simon Abundance Framework, which uses time price as a metric of resource scarcity. Time price reflects the number of working hours required to purchase a good, integrating both wage and price changes. Their framework offers a comprehensive tool to evaluate long-term trends in affordability and human welfare, shifting the scarcity debate from physical limits to economic affordability.

Recently, Janicki (2024) analyzed different human fears like overpopulation, scarcity of resources, climate change, nuclear power, etc., with the help of historical data, and claimed that all these fears are baseless. The primary reason for living a fearless life is that humans have consistently proven to be problem solvers throughout history, rather than problem creators, on average. The ability of the human mind to innovate and solve the problem of resource scarcity has been empirically estimated by

using Simon Abundance Index and the results show that the value between 1980 and 2023 has reached 609.4, which shows that the time price of 50 basic commodities has decreased by 70.4 percent (Tupy, 2022; 2024).

Similarly, Pooley (2025) estimates the time price of gasoline for U.S. blue-collar workers and finds that it has decreased by 35 percent since 1950. The decline in the time price is a result of discoveries and substitutes for gasoline, which confirm human progress through knowledge creation.

3. METHODOLOGY

This study is based on Julian Simon's theory of resource abundance (1981). Contrary to the Malthusian approach, Simon argued that human knowledge, innovation, and the discovery of alternatives—often driven by population growth—are the ultimate resources that lead to long-term welfare improvements. Based on Simon's perspective, Tupy and Pooley (2022) developed Simon Abundance Framework and introduce the concept of time price, a labour-based measure of affordability that better reflects changes in welfare than nominal prices.

Within this framework, a decline in time prices indicates an increase in abundance, and vice versa. This change is quantified through various indicators, including the personal resource abundance multiplier (pRAM), the compound annual growth rate (CAGR), and the doubling time of resources. Collectively, these measures constitute the Simon Abundance Framework (SAF).

Applying the SAF, this study measures the affordability and resource abundance of Pakistan's essential food and energy commodities between 2007 and 2021. These items are selected based on their data availability and relatively higher weights in the current basket of CPI in Pakistan. The framework requires data on nominal prices and nominal hourly wages. Wage data for different worker categories were obtained from ILOSTAT (International Labour Organization Statistics), while prices data were sourced from the Pakistan Bureau of Statistics. To achieve our objectives, we have measured the following indicators.

3.1 Time Price

Time price (TP) denotes the amount of time that a buyer needs to work to earn enough money to be able to buy something. The time price of a good or service is measured in hours and minutes.

$$Time\ Price = Nominal\ Money\ Price\ \div Nominal\ Hourly\ Incom \quad (1)$$

3.2 Percentage Change in Time price

Equation 2 below shows the formula to calculate percentage change in time price over the period:

$$PCTP = (Time\ Price_{end\ year} - Time\ Price_{start\ year}) \div\ Time\ Price_{Start\ year} \quad (2)$$

3.3 Personal resource abundance multiplier (pRAM)

It is the ratio between the start year time price to end year time price, and it tells us how much more or less of an item we can buy with the same amount of labour. The relevant calculation here is as follows in equation 3:

$$pRAM = Time\ Price_{start\ year} \div Time\ Price_{end\ year} \quad (3)$$

3.4 Compound annual growth rate (CAGR) of pRAM

This measure helps to measure the speed at which the personal resource abundance multiplier is growing.

$$CAGR = (pRAM^{1/years} - 1) \quad (4)$$

3.5 Doubling Time

This indicator shows how much time is required for a resource to double in its affordability. for this purpose, the Simon Abundance framework used the following formula

$$Doubling\ Time = 70 \div CAGR \quad (5)$$

4. ANALYSIS AND RESULTS

The results summarized in Table 1 reveal a consistent trend of declining time prices (TP) and increasing personal resource abundance (pRAM) for both male and female workers, across both low and high-skilled categories, over the period 2007–2021. This is despite the fact that key global economic shocks like oil price surge and Covid-19 pandemic happened during the study period. On average, time prices declined by 28.1% for low-skilled females, 24.8% for high-skilled females, 26.4% for low-skilled males, and 23.2% for high-skilled males. These reductions imply that fewer work hours are needed in 2021 to purchase the same essential items compared to 2007, indicating improved affordability and economic efficiency. Similarly, pRAM increased by 47.2% for low-skilled females and 40.6% for high-skilled females, with similar trends among males (45.6% and 38.6%, respectively). The compound annual growth rate (CAGR) of pRAM ranged from 2.04% to 2.43%, while the years to double pRAM ranged from 37 to 44 years, with faster doubling among low-skilled workers.

Table 1: Summary of Results

Indicator	Female Low-Skilled	Female High-Skilled	Male Low-Skilled	Male High-Skilled
Average % Change in Time Price (TP)	-28.1%	-24.8%	-26.4%	-23.2%
Average pRAM (2021)	1.49	1.41	1.47	1.39
Average % Change in pRAM (2007–2021)	+47.2%	+40.6%	+45.6%	+38.6%
Average Compound Annual Growth Rate (CAGR)	2.43%	2.12%	2.36%	2.04%
Average Years to Double pRAM	37 years	43 years	37 years	44 years

Source: Authors' own calculations

Overall trends in Appendix A and Appendix B, given in the annexure, show that time prices of selected food and energy items are higher for female workers than for their male counterparts. These differences primarily stem in gender wise wage differences in Pakistan, where female workers on average earn less than that of male workers both in low and high skilled categories. Consequently, when the nominal prices of goods are same for both male and female workers, lower wages lead to higher time prices for female workers in Pakistan. However, further insights show that a higher decline has been observed in the time prices of food and energy items for female low-skilled workers between 2007 and 2021. This trend shows that the food and energy resources are becoming more affordable for low-skilled workers, particularly female workers. The doubling period is also relatively shorter for low-skilled female workers compared to their male counterparts.

4.1 Male Low-Skilled Workers

The time price of all food and energy resources, given in Appendix A, has decreased for low-skilled workers between 2007 and 2021. However, the time price of Moong pulse has increased from 2007 to 2021. This increase may be due to its climate vulnerability and high import dependency in Pakistan. One of the most important food items, cooking oil, has shown a decline of the time price from 15.77 hours to 7.74 hours, that is around a 51% decline between 2007 and 2021. In the case of energy resources, the most essential resource is petrol, which has shown a decline of about 52% from 2.55 hours in 2007 to 1.23 hours in 2021. The personal resource abundance calculations for low-skilled workers show that almost all the food and energy resources have become more abundant between 2007 and 2021. The values reveal the fact that the low-skilled worker can afford more food and energy resources with the same amount of labour between the two time periods. The more abundant food item is cooking oil, which has become about 104% more affordable with the same labour effort.

The low-skilled workers can have 107% more affordability of petrol resources during the same period. The speed at which these two food and energy items are becoming more affordable annually is 4.86 and 4.96, respectively. By looking at the speed of affordability of food and energy items, cooking oil and petrol are projected to double in affordability within around 14 years for low-skilled workers.

4.2 Male High-Skilled Workers

Appendix A in the annexure shows that the high-skilled workers have also experienced a decline in time prices during 2007 and 2021, however, food items like Moong pulse and Gur have shown an increase in their time prices. This may be due to the reasons that Gur is often produced in small and traditional setups with limited economies of scale. The personal resource abundance estimation shows that cooking oil and petrol seem to have the highest increase in resource abundance of about 94% and 96% respectively. The speed at which these items are becoming more available can be observed with the estimated value of compound annual growth rate, which is 4.5% and 4.6%. The estimated doubling time period of cooking oil is 16 years, and for petrol is 15 years showing greater affordability in future.

4.3 Female Low-Skilled Workers

Appendix B, in the annexure, reveals that the low-skilled workers have experienced a decline in the time prices of all food and energy items from 2007 and 2021. The highest decline of 67% can be seen in the time price of cooking oil from 28.26 hours in 2007 to 10.77 hours in 2021. In the category of energy, the time price of petrol has shown a substantial decline in the time price 62% from 4.56 hours to 1.71 hours from 2007 to 2021. The affordability of cooking oil and petrol with the same labour work between 2007 and 2021 is 162% and 166% respectively. Further, both goods are becoming cheaper compared to early basis with the same rate of about 7%, which will lead to double the resources within 10 years.

4.4 Female High-Skilled Workers

The time prices of almost all food and energy resources, given in Appendix B, have declined for high-skilled female workers between 2007 and 2021. Cooking oil and petrol have shown a substantial decline in its time prices among different food and energy items. Both resources are becoming cheaper at the same rate of around 6%, which may lead them to become double available within 12 years.

These findings resonate strongly with the empirical results of Tupy and Pooley (2022), which shows that as societies grow more productive, time prices for essential goods tend to fall. The current study also shows that despite differences in income levels, low-skilled workers experienced greater relative gains in affordability, reflecting more equitable improvements in purchasing power. This indicates a form of inclusive productivity growth, where even the least skilled are gaining better access to necessities due to either rising real wages or stable goods prices.

5. CONCLUSION AND POLICY IMPLICATIONS

This study uses the Simon Abundance Framework to assess changes in the affordability of food and energy resources in Pakistan between 2007 and 2021. The findings consistently show that time prices have declined for most essential items, particularly for low-skilled and female workers, indicating growing resource abundance. The most notable improvements are seen in cooking oil and petrol, which have become significantly more affordable across all demographic groups. The application of time price as a metric reveals important insights not captured by traditional monetary prices. It underscores that the standard of living, especially for economically vulnerable groups, has improved in terms of resource affordability. The results support the view that human capital, productivity growth, and technological advancement can overcome resource scarcity. This suggests that policy efforts should continue focusing on increasing income, skill development, and innovation to sustain and accelerate this trend. The study also opens new areas of research to measure the cost of living,

inequality in terms of time price and time inequality in Pakistan. In future, studies can be conducted to analyze the determinants of time prices through econometric techniques.

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Appendix A: Time Price and Personal Resource Abundance for Male Workers

Sr. No.	Items	Low Skilled			High Skilled			Personal Resource Abundance Multiplier (pRAM)				Compound Annual Growth Rate (pRAM)		Years to double (pRAM)	
		Time Price	Time Price	% Δ in Time Price	Time Price	Time Price	% Δ in Time Price	Low Skilled	High Skilled	% Δ Low Skilled	% Δ High Skilled	Low Skilled	High Skilled	Low Skilled	High Skilled
		2007	2021		2007	2021									
1	Wheat Flour	8.57	5.38	-37.27	3.04	2.01	-33.99	1.59	1.51	59.41	51.5	3.16	2.81	22	25
2	Rice	1.81	1.01	-44.08	0.64	0.38	-41.16	1.79	1.7	78.83	69.95	3.95	3.6	18	19
3	Chicken	3.98	2.55	-35.89	1.41	0.95	-32.54	1.56	1.48	55.97	48.23	3.01	2.66	23	26
4	Milk	1.37	1.19	-12.66	0.48	0.45	-8.1	1.14	1.09	14.5	8.82	0.91	0.56	77	124
5	Eggs	2.33	1.87	-20.02	0.83	0.7	-15.84	1.25	1.19	25.02	18.82	1.5	1.16	47	61
6	Mustard Oil	5.41	2.94	-45.62	1.92	1.1	-42.78	1.84	1.75	83.89	74.76	4.14	3.79	17	18
7	Cooking Oil	15.77	7.74	-50.92	5.59	2.89	-48.35	2.04	1.94	103.73	93.62	4.86	4.5	14	16
8	Vegetable Gee	14.8	7.82	-47.16	5.25	2.92	-44.4	1.89	1.8	89.26	79.86	4.34	3.99	16	18
9	Masoor Pulse	3.03	1.74	-42.41	1.07	0.65	-39.41	1.74	1.65	73.65	65.03	3.75	3.4	19	21
10	Moong Pulse	2.33	2.62	12.22	0.83	0.98	18.08	0.89	0.85	-10.89	-15.31	-0.77	-1.1	-91	-64
11	Mash Pulse	3.14	2.84	-9.54	1.11	1.06	-4.82	1.11	1.05	10.55	5.06	0.67	0.33	104	212
12	Gram Pulse	2.05	1.6	-21.77	0.72	0.6	-17.68	1.28	1.21	27.82	21.48	1.65	1.31	42	54
13	Potato	0.69	0.46	-32.71	0.24	0.17	-29.19	1.49	1.41	48.6	41.23	2.68	2.33	26	30
14	Onion	0.78	0.46	-41.33	0.28	0.17	-38.27	1.7	1.62	70.44	61.98	3.62	3.27	19	21
15	Tomatoes	1.4	0.74	-46.96	0.5	0.28	-44.19	1.89	1.79	88.53	79.17	4.32	3.96	16	18
16	Sugar	1.28	1.04	-19.32	0.45	0.39	-15.11	1.24	1.18	23.95	17.8	1.44	1.1	49	64
17	Gur	1.46	1.45	-0.74	0.52	0.54	4.44	1.01	0.96	0.75	-4.25	0.05	-0.29	1410	-242
18	Tea	3.03	2.75	-9.1	1.07	1.03	-4.35	1.1	1.05	10.01	4.55	0.64	0.3	110	236
19	Electricity	0.05	0.05	-11.28	0.02	0.02	-6.64	1.13	1.07	12.71	7.11	0.8	0.46	87	152
20	Gas	2.5	1.61	-35.86	0.89	0.6	-32.51	1.56	1.48	55.91	48.17	3.01	2.66	23	26
21	Petrol	2.55	1.23	-51.62	0.9	0.46	-49.09	2.07	1.96	106.69	96.44	4.96	4.6	14	15
22	Firewood	8.8	8.4	-4.57	3.12	3.13	0.41	1.05	1	4.79	-0.41	0.31	-0.03	224	-2555

Source: Author's own calculations

Appendix B: Time Price and Personal Resource Abundance for Female Workers

Sr. No.	Items	Low Skilled			High Skilled			Personal Resource Abundance Multiplier (pRAM)				Compound Annual Growth Rate (pRAM)		Years to double (pRAM)	
		Time Price Year 2007	Time Price Year 2021	% Δ in Time Price	Time Price Year 2007	Time Price Year 2021	% Δ in Time Price	Low Skilled	High Skilled	% Δ Low Skilled	% Δ High Skilled	Low Skilled	High Skilled	Low Skilled	High Skilled
1	**Wheat Flour**	15.36	7.48	-51.28	4.27	2.31	-45.73	2.05	1.84	105.24	84.28	4.91	4.16	14	17
2	**Rice**	3.24	1.41	-56.57	0.90	0.44	-51.63	2.30	2.07	130.24	106.72	5.72	4.96	12	14
3	**Chicken**	7.13	3.55	-50.20	1.98	1.10	-44.54	2.01	1.80	100.82	80.30	4.76	4.01	15	17
4	**Milk**	2.45	1.66	-32.17	0.68	0.51	-24.45	1.47	1.32	47.42	32.36	2.62	1.89	27	37
5	**Eggs**	4.18	2.60	-37.88	1.16	0.80	-30.81	1.61	1.45	60.97	44.53	3.22	2.49	22	28
6	**Mustard Oil**	9.69	4.09	-57.76	2.69	1.27	-52.96	2.37	2.13	136.76	112.58	5.91	5.16	12	14
7	**Cooking Oil**	28.26	10.77	-61.88	7.85	3.33	-57.54	2.62	2.36	162.31	135.51	6.64	5.88	11	12
8	**Vegetable Gee**	26.52	10.88	-58.96	7.37	3.37	-54.29	2.44	2.19	143.67	118.78	6.12	5.36	11	13
9	**Masoor Pulse**	5.42	2.43	-55.27	1.51	0.75	-50.19	2.24	2.01	123.58	100.75	5.51	4.76	13	15
10	**Moong Pulse**	4.18	3.64	-12.84	1.16	1.13	-2.93	1.15	1.03	14.73	3.01	0.92	0.20	76	353
11	**Mash Pulse**	5.62	3.95	-29.74	1.56	1.22	-21.75	1.42	1.28	42.34	27.80	2.38	1.65	29	42
12	**Gram Pulse**	3.67	2.23	-39.24	1.02	0.69	-32.33	1.65	1.48	64.58	47.77	3.38	2.64	21	27
13	**Potato**	1.24	0.65	-47.73	0.34	0.20	-41.79	1.91	1.72	91.33	71.78	4.42	3.67	16	19
14	**Onion**	1.41	0.64	-54.43	0.39	0.20	-49.25	2.19	1.97	119.45	97.03	5.38	4.63	13	15
15	**Tomatoes**	2.51	1.03	-58.80	0.70	0.32	-54.12	2.43	2.18	142.73	117.94	6.09	5.33	11	13
16	**Sugar**	2.30	1.44	-37.34	0.64	0.45	-30.21	1.60	1.43	59.59	43.29	3.17	2.43	22	29
17	**Gur**	2.62	2.02	-22.91	0.73	0.62	-14.14	1.30	1.16	29.72	16.47	1.75	1.02	40	69
18	**Tea**	5.43	3.83	-29.40	1.51	1.19	-21.37	1.42	1.27	41.64	27.17	2.35	1.62	30	43
19	**Electricity**	0.09	0.06	-31.09	0.03	0.02	-23.25	1.45	1.30	45.12	30.29	2.51	1.78	28	39
20	**Gas**	4.49	2.24	-50.18	1.25	0.69	-44.52	2.01	1.80	100.74	80.24	4.76	4.01	15	17
21	**Petrol**	4.56	1.71	-62.42	1.27	0.53	-58.15	2.66	2.39	166.12	138.94	6.74	5.98	10	12
22	**Firewood**	15.76	11.68	-25.88	4.38	3.61	-17.45	1.35	1.21	34.92	21.14	2.02	1.29	35	54

Source: Author's own calculations