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Cost-Effectiveness Analysis of the Pradhan Mantri Ujjwala Yojana (PMUY) in India: A Well-Being Perspective

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Abstract

This brief analyses the Pradhan Mantri Ujjwala Yojana (PMUY), launched in 2016 to provide cooking gas to 80 million poor rural households of India. It uses the 'Well-being Analysis' framework to analyse the scheme beyond traditional economic measures and widen the focus to include improvements in people's overall life. The path-breaking policy initiative was envisioned to reduce dependency on traditional methods of cooking that use polluting fuels like coal and firewood, as well as to mitigate drudgery among women who, because of widely accepted social norms, spend more time in the kitchen. The brief also assesses PMUY's cost-effectiveness through WELLBY (Wellbeing-Years) calculations, showcasing a potential benchmarking for a well-being-driven planning framework for policymakers.

Pradhan Mantri Ujjwala Yojana: Policy Statement and Overview

The Government of India launched the Pradhan Mantri Ujjwala Yojana (PMUY) (Prime Minister's Flagship Scheme) in 2016 to provide clean cooking fuel to rural households who would otherwise rely on polluting options such as coal and firewood, create ancillary employment, and reduce fossil fuel use.¹ The scheme aimed to give free gas connections to 80 million families by 2020 to improve rural women's health and promote their empowerment. Before the scheme's launch, approximately 22 percent of India's population (270 million) were living below the poverty line, 80 percent of them in rural areas,² where cooking relied on coal, firewood, and cow dung cakes. At the time of the scheme's launch, 64 percent of the population had no access to clean cooking sources, compared to the world average of 38 percent.³ Women would walk long distances to collect firewood and spend hours in smoke-filled kitchens, facing health hazards, fire accidents, and a poor quality of life due to the unaffordable cost of gas connections.⁴

Under the programme, the gas connection was issued in the name of an adult woman in the household, ensuring a women-centric and inclusive approach. The scheme was implemented by the Ministry of Petroleum and Natural Gas, with oil marketing companies mandated to provide interest-free loans for the purchase of stoves and gas refills after the initial connection. The entire administrative cost was borne by the government, with state-level monitoring to ensure effective implementation. An initial budget of INR80,000 crore was allocated, and information dissemination camps were organised to raise awareness and train women in the safe handling of stoves and cylinders.

Beyond the target of 80 million gas connections by 2020, the following were the other envisaged outcomes of the PMUY scheme:

- **Protect public health, especially of women:** According to the World Health Organization (WHO), Indian women are routinely exposed to unclean cooking fuels whose health impact is equivalent to smoking around 400 cigarettes per hour.⁵ Polluting fuels cause 0.5 million deaths from non-communicable diseases, with young children bearing the brunt of severe respiratory problems.
- **Empower women and improve their quality of life:** Rural Indian women spend 374 hours per year collecting firewood, affecting their productivity and well-being.⁶
- **Generate employment opportunities:** Expanding the cooking gas supply chain can create ancillary jobs and promote income generation.
- **Reduce environmental impact:** Transitioning from fossil fuels aligns with India's COP26 and COP27 commitments to reduce its CO₂ emissions.

Methodologies and Assumptions

The growing literature on well-being analysis offers various methodologies to assess a policy's cost-effectiveness. For this brief, the WELLBY (Wellbeing-Years) calculation is used. WELLBY is defined as one point of Life Satisfaction (LS) (on a 0–10 Likert scale) for one person for one year. To determine the monetised well-being effect of a policy, the total observed or expected improvement in LS is multiplied by the monetised value of 1 WELLBY. The overall monetised well-being impact per year is calculated by multiplying this figure by the total number of beneficiaries. A policy is cost-effective in well-being terms if its total well-being benefits sufficiently exceed the programme's costs.

To calculate the overall well-being benefits of PMUY, this brief estimates its impact through different channels and quantifies the corresponding LS coefficients. This value is then multiplied by the number of beneficiaries impacted through each channel to avoid double counting. A simple linear equation is used to sum these values, determining the total WELLBYs generated, which is then multiplied by the cost of one WELLBY.

Since India has not set a WELLBY cost, this brief refers to the United Kingdom's HM Treasury Green Book, which estimates one WELLBY at 13,000 pounds.⁷ We are taking GBP 1 \approx INR 100 and considering the lower per capita income of India and lower public expenditure/per person, the cost of 1 WELLBY in India is taken as GBP 130 (INR 13,000) for this analysis. No additional weightage is applied, as all beneficiaries are from poor households. A 1.5-percent discount rate for well-being and 3.5 percent for economic costs is used wherever required while calculating the overall benefits over the years.⁸

Since PMUY achieved its target of 80 million connections by 2019, before the stipulated timeline, this brief calculates the total well-being generated only after this period, excluding the interim implementation period.⁹ The benefits are extrapolated for the succeeding five years, as long-term projections may be influenced by various other factors that may either diminish or enhance LS impacts. This approach is reasonable as well-being research is still nascent in India.

Methodologies and Assumptions

However, there are constraints that must be acknowledged. First, LS has not been recorded at the national level in India, with only a few studies available. Since there is no available baseline LS score, this brief relies on the *World Happiness Report (2023)*, which ranks India 126th with a score of 4.036 (on a scale of 0 to 10).^a The second and biggest constraint is quantifying the impact (estimated LS coefficients) of different channels in the absence of related coefficients for India, as there are only limited studies available. To address this, this brief primarily uses the coefficients suggested by Clark (2018), based on a study conducted in Britain, and some coefficients from the Canadian Database of Happiness Coefficients, which are reasonably well-defined.¹⁰ While this extrapolation¹¹ may not be perfectly accurate, it remains the best available approach in the absence of India-specific coefficients. Third, as defined above, the value of one WELLBY for India will be taken as INR 13,000. Finally, while 80 million households have benefitted overall, the number of beneficiaries affected by different channels shall be based on approximations derived from available global or national estimates.

a The author does not agree with India's happiness score on account of various methodological and cultural issues, such as the small sample size of 1,000 respondents which cannot truly represent a country as diverse as India. The Happiness index also fails to account for cultural differences in understanding the term 'Life Satisfaction' as concepts of happiness/satisfaction vary across cultures. A more inclusive and culturally sensitive approach is needed for accurate inter-country comparisons and conclusions. For lack of a better alternative, however, the brief uses this value in order to understand the magnitude of change in LS after the implementation of this scheme.

Channels Impacting Well-being and Its Estimation

Before examining the individual channels that will impact the well-being of the population through this scheme, there is an overall validation of its objectives, based on existing literature. Providing affordable clean cooking fuel is an important prerequisite for improving the quality of life in developing countries. As outlined in the envisaged outcomes of the PMUY, the well-being benefits will primarily be quantified through four channels: improved health; enhanced empowerment of women; increased employment opportunities; and reduced CO₂ emissions. While some omitted variables may exist, these channels are the scheme's core impact areas.

Health Benefits

The PMUY is expected to reduce mortality and illnesses caused by household air pollution, including respiratory issues, cataracts, tuberculosis, and heart disease. Several studies have established that solid fuel use is associated with high mortality risk.¹² Studies in India show that users of smokeless fuel experience better physical, psychological, social, and environmental well-being, with a reduced burden of ophthalmic and asthmatic disorders. However, the literature review does not provide a specific coefficient to quantify the impact of these illnesses on overall well-being.

Layard (2023) highlighted that physical health impacts an individual's well-being, while Clark (2018) estimated that physical health problems negatively affect LS with a coefficient of -0.22. In the absence of an India-specific coefficient, this brief adopts the same value.

PMUY has benefited 80 million households, impacting around 360 million.^b However, for the sake of conservative evaluation, this brief pegs the number of beneficiaries at 80 million.

Globally, 2.7 billion people rely on biomass as their primary fuel. The use of biomass is found to contribute to 4.3 million deaths annually with a massive associated disease burden.¹³ In the Indian context, reporting is limited, but a reasonable assumption is that one woman in every fourth household (i.e., 20 million women) would have been adversely impacted with related disease burden in the absence of this scheme.

The number of WELLBYs generated on account of reduced physical illness would be:
 $0.22 * 20 \text{ million} = 4.4 \text{ million per year.}$

^b This assumes an average family size of 4.5.

Women Empowerment

PMUY aimed to uplift poor women not just by reducing physical illness but also through better financial access, improved socio-economic status, and reduced drudgery, leading to increased productivity. Studies show that shifting to gas cooking may save up to 1.5 hours/day for women and girls, giving them more time for education, self-employment, and participation in community activities. Various studies in India¹⁴ have established that PMUY has led to positive behavioural changes in women and has also improved women empowerment variables.¹⁵ Various intertwined factors such as free time, improved social engagements, and increased productivity contribute to the socio-economic empowerment of women through PMUY. However, an extensive literature review did not yield a single definitive coefficient for this impact.

To estimate this effect, reference is taken from where:

- Social capital through increased time with friends has a coefficient of 0.017;
- Increased time with family has 0.051;
- Part-time employment has 0.080; and
- Increased financial satisfaction has 0.194.

With a rough estimation, this brief assumes an average coefficient of 0.12 to quantify the well-being impact of this channel. This implies that women freed from domestic drudgery may indulge in social engagements, economic participation, or experience better subjective well-being with increased leisure time. Since respective numbers cannot be estimated for these micro channels of impact, an overall coefficient of 0.12 is adopted for women's empowerment effects. Even if 25 percent of PMUY beneficiaries (i.e., 20 million) experience positive outcomes through this channel, the impact remains substantial.

*The number of WELLBYs generated on account of women empowerment benefits would be: $0.12 * 20 \text{ million} = 2.4 \text{ million}$.*

Employment Benefits

PMUY has expanded LPG coverage to 98 percent across India, strengthening the network of bottling plants, distributors, and LPG sales. As per estimates by the Government of India, this scheme has led to ancillary employment for 0.10 million people and has created business opportunities worth INR10,000 crore.¹⁶

While unemployment has a ‘scarring’ impact on families, this analysis focuses solely on direct quantification.^c Further, for conservative analysis, only the 0.10 million direct employment opportunities will be considered, excluding business growth, as its impact is difficult to quantify in numerical or well-being terms.

The number of WELLBYs generated on account of employment benefits would be:
 $0.70 * 0.10 \text{ million} = 0.07 \text{ million per year.}$

Environmental Gains

PMUY has led to environmental benefits by reducing CO₂ emissions.¹⁷ A number of studies have also observed that clean cooking mitigates climate change by reducing carbon emissions in a cost-effective manner. Furthermore, a large portion of conventional cooking fuels comes from forests; therefore, large-scale deforestation could be diminished by shifting to cleaner options.

A review of the literature could not identify a specific Indian coefficient for the well-being impact of reduced carbon emissions. This brief takes recourse to the Canadian coefficient which estimates air pollution impact on life satisfaction at 0.02.¹⁸ Reduced carbon emissions will also have a substantial positive impact on future generations but for lack of quantifying mechanism, this analysis adopts a conservative approach by using the 0.02 coefficient.

The total beneficiaries of PMUY are approximately 360 million (based on 80 million households). Even if half of them experienced the benefits of reduced air pollution, this would account for 180 million beneficiaries.

The number of WELLBYs generated on account of environmental benefits would be:
 $0.02 * 180 \text{ million} = 3.6 \text{ million per year}$

^c The estimation of employment effect on LS is recorded at 0.70.

Cost-effectiveness analysis (in terms of well-being) is defined as follows:

$$\text{Net Benefits} = \text{Total Well-being Benefits} - \text{Total Costs}$$

The total costs of PMUY is calculated as follows:

- INR1,600 per gas connection/household was directly spent for 80 million households, reaching a total of $1,600 \times 80 \text{ million} = \text{INR}12,800 \text{ crore}$.
- Adding administrative costs and additional benefits provided, the total expenditure is estimated at INR14,000 crore, approximately (spent by the Government in five years).
- There is no recurring cost envisaged in the scheme, as refilling¹⁹ is primarily borne by the beneficiaries.

Thus, the total cost of PMUY is INR14,000 crore.

The total well-being benefits of PMUY can be calculated as follows:

WELLBYs generated through PMUY = $LS1 \times \text{No. of beneficiaries impacted by better health} + LS2 \times \text{No. of beneficiaries impacted through women empowerment variables} + LS3 \times \text{No. of beneficiaries impacted by increased employment} + LS4 \times \text{No. of beneficiaries impacted by improved environment}$ (Where LS is the estimated coefficients of the respective channels)

= $4.4 \text{ million} + 2.2 \text{ million} + 0.07 \text{ million} + 3.6 \text{ million} = 10.27 \text{ million WELLBYs per year in total}$.

Monetisation of WELLBYs

Multiplying this figure by the assumed cost of one WELLBY (assumed here as INR13,000)

$$10.27 \text{ million} \times 13000 = \text{INR}1,33,510 \text{ crore per year.}$$

As stated in the assumptions, the impact will be calculated for five years, using a discount rate of 1.5 percent (although the benefits may persist for longer with the same effect). The table represents the discounted WELLBY-based benefits of PMUY over last five years.^d

^d A discount rate of 1.5 percent, as explained previously, is widely accepted and used in such analysis to account for general uncertainties of the future.

Cost-Effectiveness Analysis

Years	Year 1	Year 2	Year 3	Year 4	Year 5
Benefits (in crore)	₹1,33,500	₹1,31,500	₹1,29,500	₹1,27,600	₹1,25,700

Summing up the above discounted five-year benefits:

$$\text{INR}1,33,500 + \text{INR}1,31,500 + \text{INR}1,29,500 + \text{INR}1,27,600 + \text{INR}1,25,600 = \text{INR}6,47,800 \text{ crore}$$

Thus, the total Well-being benefits of PMUY is INR6,47,800 crore.

$$\text{Net benefits of PMUY scheme} = \text{Total Well-being Benefits of PMUY} - \text{Total Costs of PMUY}$$

Thus, Net Well-being benefit of PMUY is:

$$\text{INR}6,47,800 \text{ crore} - \text{INR}14,000 \text{ crore} = \text{INR}6,33,810 \text{ crore.}$$

Estimating an overall change in LS scores, this scheme would roughly lead to an approximate increase of one point (zero to 10 scale), which, when compared to the base score of 4.036 for the average Indian, would be considered a huge impact.

Conclusion

This brief finds that PMUY is highly cost-effective in quantified well-being terms, as it helps achieve targets in improved health outcomes, enhanced women's productivity, increased employment, and the protection of the environment. PMUY produces three times the benefits compared to the costs incurred, even when using conservative estimates.

Beyond reducing misery and enhancing overall life satisfaction, PMUY represents the maximum value for investment. Often referred to as India's 'Blue Revolution', this scheme has had transformational long-term impacts, now substantiated through this well-being analysis. [ORF](#)

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