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PROBLEM STATEMENT

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Executive Summary

This report demonstrates that investing in women's healthcare delivers measurable social and economic returns, drawing on five global datasets covering fertility, maternal mortality, labour participation and health expenditure. The analysis finds that higher health spending is consistently linked to lower maternal deaths and greater female workforce participation, outcomes that directly support the UN Sustainable Development Goals (SDGs) on health, gender equality and economic growth. Although data limitations exist, the evidence clearly indicates that targeted investment in reproductive health and education not only saves lives but also expands economic productivity. The recommendation is clear: prioritising women's health is both a moral responsibility and a high-value economic strategy for sustainable growth.

Introduction & Purpose

The economic performance of a nation is closely tied to its investment in women's health, as healthier women contribute not only to stronger families but also to more resilient and productive societies (Onarheim et al., 2016). Research consistently highlights that improving maternal health outcomes leads to improved educational performance for children, greater female labour participation and long-term economic growth. This issue directly aligns with 3 SDGs: Good Health and Well-Being (SDG 3), Gender Equality (SDG 5) and Decent Work and Economic Growth (SDG 8). Together these goals emphasise the importance of reducing preventable maternal deaths while empowering women to participate fully in social and economic life. Despite progress, many governments underinvest in reproductive health, limiting both women's potential and broader national prosperity. The purpose of this analysis is to examine whether increased healthcare expenditure reduces maternal mortality, enhances labour force participation and generates societal benefits that create strong returns for both communities and investors.

Problem Statement

High maternal mortality and elevated fertility rates remain significant barriers to women's economic inclusion. Poor reproductive health outcomes reduce the number of women able to participate in the workforce, resulting in lower productivity and long-term economic loss. Without targeted investment in healthcare infrastructure and education, these challenges will persist, widening inequalities and limiting growth. To address this, governments and investors must prioritise funding for women's health services and education initiatives, ensuring more women can enter and remain in the workforce. Therefore, driving sustainable GDP growth while advancing global development goals.

Data Sourcing and Preparation

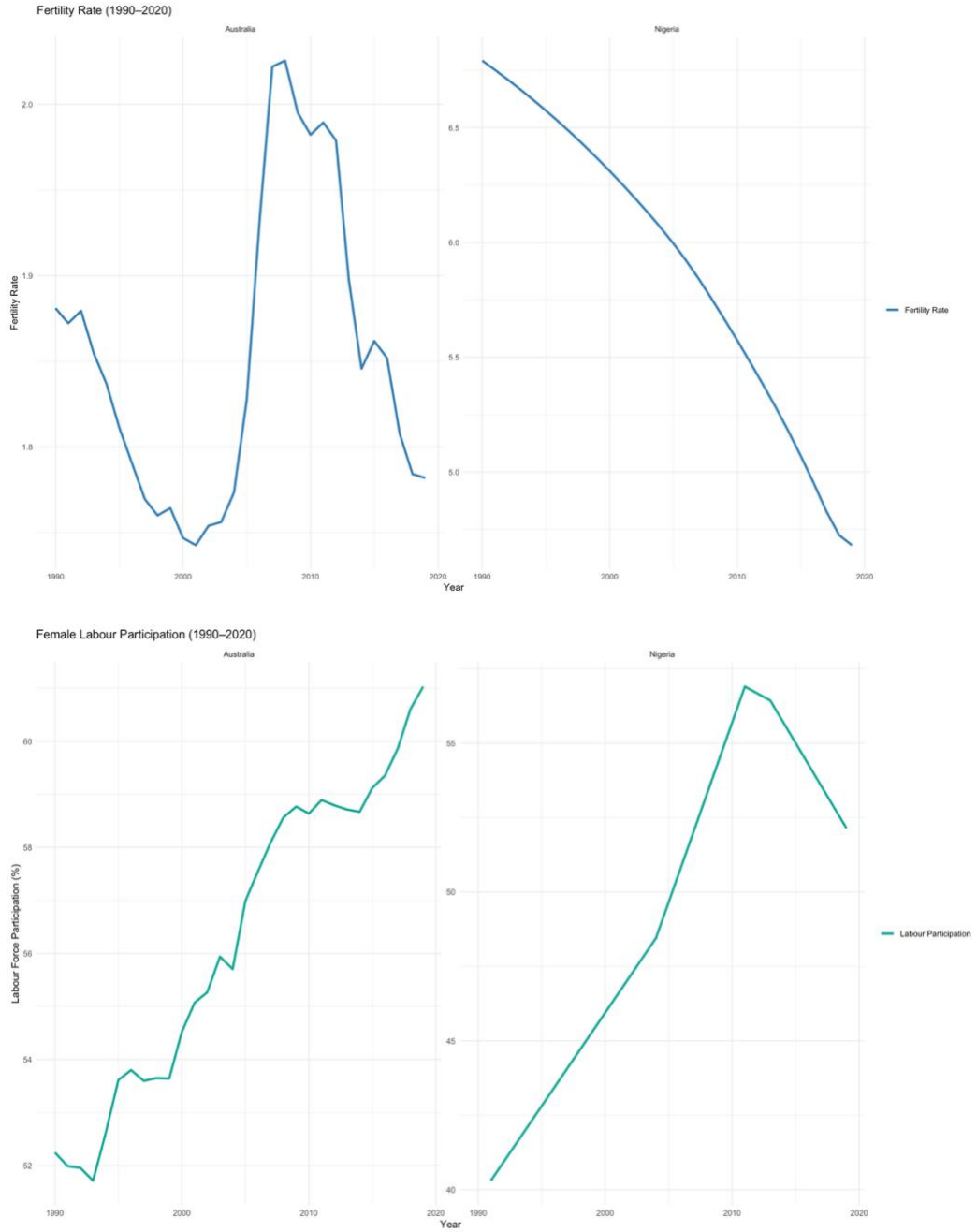
This analysis draws on five publicly available datasets selected for their direct relevance to reproductive health and its economic impact. The IHME Fertility Estimates (1950–2019) capture the total fertility rate, a critical indicator of women's reproductive burden and a driver of both maternal mortality and labour market exclusion. Accompanying this, the UN Maternal Mortality datasets for 2000 and 2010 provide internationally comparable figures on maternal deaths per 100,000 live births, offering a measure of the most severe outcome of inadequate health investment. The World Bank Female Labour Force Participation dataset (1990–2020) links reproductive health outcomes to economic productivity by showing the proportion of women engaged in the workforce. Finally, the World Bank Health Expenditure per Capita dataset (2000–2020) provides insight into the scale of financial investment in healthcare across countries, allowing analysis of the relationship between spending and women's survival outcomes.

To ensure comparability, the data was filtered to cover the years 1990–2020, and country names were standardised and merged across sources. Missing values in the labour dataset were addressed through na.approx interpolation, which improved continuity but introduced some estimation bias. Health expenditure values were capped to reduce distortion from extreme outliers, enabling more meaningful cross-country comparison. Maternal mortality data, available for only 2000 and 2010, limits the ability to track progress beyond those years and may understate longer-term improvements in survival. Furthermore, the health expenditure dataset reflects total per capita spending rather than reproductive specific investment, meaning its effects on women's health outcomes are indirect. Despite these limitations, each dataset is a vital contribution to understanding how healthcare investment shapes maternal health, fertility and women's participation in the economy.

Visualisation 1: Fertility vs Maternal Mortality (2000 & 2010)

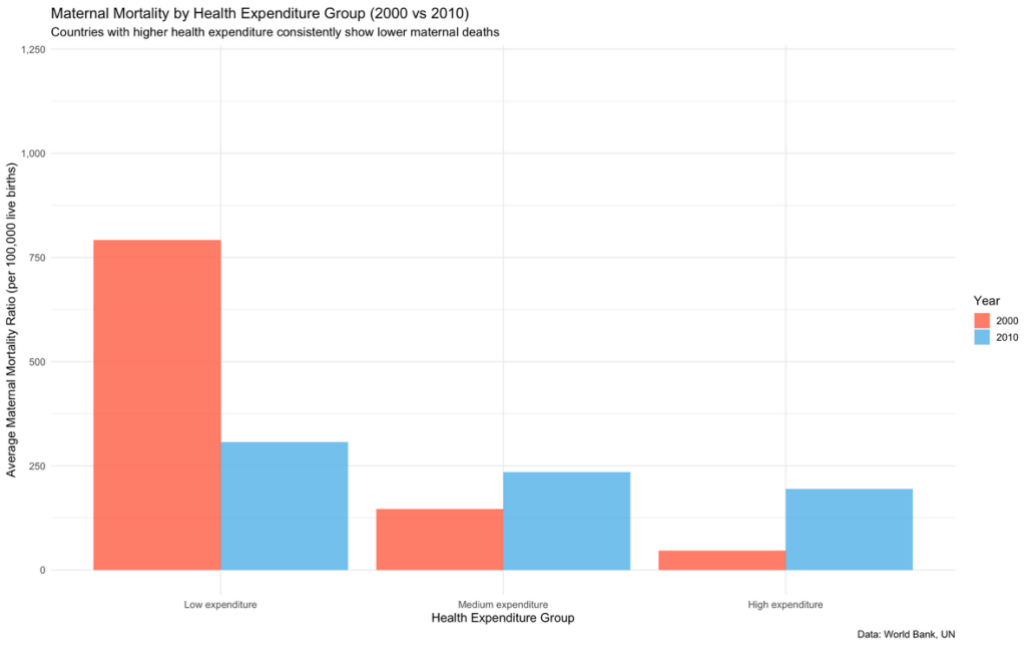
Cleveland and McGill (1984) highlight that positioning values along a common scale is one of the most effective ways to compare two quantitative variables. Hence, a scatterplot provides an appropriate method for examining the relationship between fertility and maternal mortality. The visual clearly identifies that countries with higher fertility consistently experience higher maternal deaths thus, reinforcing the strong link between reproductive health and survival outcomes. The downward shift of the 2010 trend line relative to 2000 suggests measurable global progress. This explains that even in high fertility contexts, improvements in healthcare access, education and maternal services ultimately reduced mortality. This shift is not just descriptive; it highlights the effectiveness of targeted investment and demonstrates how structural change can break the cycle of poor health outcomes. However, there are limitations as the maternal mortality data is only available for 2000 and 2010 hence, preventing analysis of whether this trend continued in the last decade, while fertility data extends to 2019. Despite this, the insight for investors is clear: funding reproductive health education and infrastructure reduces both fertility and maternal deaths. Therefore, creating long-term economic and social benefits by enabling more women to participate safely in the workforce and contribute to GDP growth.

Visualisation 2: Fertility Rate & Female Labour Participation (1990–2020, Australia vs Nigeria)



Munzner (2014) highlights that line graphs are highly effective for showing temporal change thus, making them the most appropriate technique for comparing fertility and labour force participation trends between Australia and Nigeria. These countries were deliberately chosen to contrast a developed and a developing nation, exposing how reproductive health directly shapes women's economic opportunities. In Australia, stable and relatively low fertility rates are accompanied by steady growth in female labour participation, emphasising the structural advantages created by accessible healthcare, education and family planning. In contrast, Nigeria's persistently high fertility rates are strongly associated with lower and more unpredictable female labour force participation, outlining how limited access to reproductive healthcare perpetuates economic exclusion. These patterns highlight an underlying driver of gender inequality as high fertility acts as a structural barrier that prevents women from pursuing education and employment. However, access to reproductive healthcare enables women to delay or reduce childbearing and integrate into formal labour markets. Furthermore, a key limitation is that labour participation data required interpolation for missing years, which may obscure short-term fluctuations. Nevertheless, the long-term divergence between Australia and Nigeria remains clear. Investing in reproductive health and education in high-fertility contexts can open access to a largely untapped labour force, helping to drive both gender equality and sustainable economic growth.

Visualisation 3: Maternal Mortality by Health Expenditure Group (2000 vs 2010)



A bar chart was chosen because, as Cleveland and McGill's hierarchy of graphical perception explains, length is a clear and effective way to compare discrete categories. This makes it well suited to highlight how maternal mortality differs across expenditure groups and over time (Cleveland & McGill, 1984).This provides a more gender focused lens, linking health expenditure directly to maternal mortality outcomes. Countries in the low expenditure group recorded alarmingly high maternal mortality ratios in 2000 but saw sharp reductions by 2010 as spending increased. Meanwhile, high-expenditure countries consistently maintained very low maternal mortality rates across both years. This demonstrates a clear, evidence-based relationship where higher health spending not only saves lives but also reduces the long-term economic and social costs associated with maternal deaths. This is a critical insight where relatively modest increases in health investment in low and middle-income regions can produce disproportionately large improvements in maternal survival, contributing to good health and equality while also driving broader economic productivity.

Recommendation

Based on the analysis, it is evident that targeted investment in reproductive health education and access is essential for driving both social and economic change. Educating women on preventive healthcare, alongside improving access to safe and affordable treatment, addresses systemic gaps that currently undermine health and economic inclusion. A major barrier remains the persistent gender bias in medical research, which has historically prioritised male health outcomes and left women's reproductive health underfunded and under researched (Regensteiner et al., 2025). This lack of investment results in delayed diagnoses of common reproductive conditions, creating long-term health and productivity costs (Pino et al., 2023).

Aligning with the SDGs of Good Health and Gender Equality, this recommendation highlights that improved women's health outcomes not only save lives but also unlock greater economic participation, directly contributing to the SDG Decent Work and Economic Growth. Prevention and treatment together form the most effective pathway to reduce maternal mortality, lower fertility rates and empower women to participate more in the labour force. For investors, the case is clear: funding women's health research and education is not a cost but a high return investment, generating long term societal benefits, reducing future healthcare expenditure and driving sustainable economic growth.

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Appendix

Appendix 1: R Code

```
# Load packages

library(tidyverse); library(zoo); library(dplyr); library(tidyr); library(sf);

library(rnaturalearth); library(rnaturalearthdata); library(countrycode)

# Load data

fertility <- read_csv("Fertility.csv") %>% select(Country=location_name, Year=year_id, TFR=val)

mortality <- read_csv("Mortality.csv") %>% filter(Subgroup=="Total") %>%

  select(Country=`Country or Area`, Year, MMR=Value) %>% mutate(Year=as.integer(Year))

labour <- read_csv("Labour.csv", skip=4) %>%

  pivot_longer(cols=`1960`:`2024`, names_to="Year", values_to="LabourRate") %>%

  select(Country=`Country Name`, Year, LabourRate) %>% mutate(Year=as.integer(Year))

expenditure <- exp_raw %>% pivot_longer(cols=`1990`:`2024`, names_to="Year", values_to="Healthexp") %>%

  mutate(Year=as.integer(Year), Healthexp=as.numeric(Healthexp)) %>%

  select(Country=`Country Name`, Year, Healthexp)

# Clean datasets

exp_clean <- expenditure %>% filter(Year>=2000 & Year<=2020) %>%

  group_by(Country) %>% filter(sum(!is.na(Healthexp))>=15) %>% ungroup()

labour_clean <- read_csv("Labour.csv", skip=4) %>%

  pivot_longer(cols=`1960`:`2024`, names_to="Year", values_to="LabourRate") %>%

  select(Country=`Country Name`, Year, LabourRate) %>%

  mutate(Year=as.integer(Year), LabourRate=as.numeric(LabourRate)) %>%

  filter(Year>=1990 & Year<=2020) %>%

  group_by(Country) %>% mutate(LabourRate=na.approx(LabourRate, Year, na.rm=FALSE)) %>% ungroup()

fertility_clean <- fertility %>% filter(Country!="Global", Year>=1990 & Year<=2020) %>% select(Country, Year, TFR)

mortality_clean <- mortality %>% select(Country, Year, MMR)

# Merge

master <- fertility_clean %>%

  left_join(mortality_clean, by=c("Country","Year")) %>%

  left_join(labour_clean, by=c("Country","Year")) %>%

  left_join(exp_clean, by=c("Country","Year"))

# Add Mortality 2000 dataset

mortality2000 <- read_csv("Mortality2000.csv") %>%

  select(Country=`Country or Area`, Year, MMR=Value) %>% mutate(Year=as.integer(Year))

mortality_clean <- bind_rows(mortality2000, mortality) %>% arrange(Country, Year)

master <- fertility_clean %>%

  left_join(mortality_clean, by=c("Country","Year")) %>%
```

```
  left_join(labour_clean, by=c("Country","Year")) %>%
  left_join(exp_clean, by=c("Country","Year"))
# --- Visualisation 1: Fertility vs Mortality
fert_mort <- master %>% filter(Year %in% c(2000,2010)) %>% select(Country,Year,TFR,MMR) %>% drop_na()
ggplot(fert_mort, aes(x=TFR, y=MMR, color=factor(Year))) + geom_point(alpha=0.6) +
  geom_smooth(method="lm", se=FALSE) + scale_y_log10() +
  scale_color_manual(values=c("2000"="tomato","2010"="steelblue")) +
  labs(title="Fertility vs Maternal Mortality (2000 vs 2010)",
       x="Total Fertility Rate (Children per Woman)",
       y="Maternal Mortality Ratio (Deaths per 100,000, log scale)", color="Year") +
  theme_minimal()
# --- Visualisation 2: Fertility & Labour Trends (Australia vs Nigeria)
fert_labour_trend <- master %>% filter(Country %in% c("Australia","Nigeria"), Year>=1990 & Year<=2020) %>%
  select(Country, Year, TFR, LabourRate)
ggplot(fert_labour_trend, aes(x=Year)) + geom_line(aes(y=TFR, color="Fertility Rate"), size=1.2) +
  facet_wrap(~Country, scales="free_y") + scale_color_manual(values=c("Fertility Rate"="#2C7BB6")) +
  labs(title="Fertility Rate (1990–2020)", x="Year", y="Fertility Rate", color="") + theme_minimal()
ggplot(fert_labour_trend, aes(x=Year)) + geom_line(aes(y=LabourRate, color="Labour Participation"), size=1.2) +
  facet_wrap(~Country, scales="free_y") + scale_color_manual(values=c("Labour Participation"="#00A896")) +
  labs(title="Female Labour Participation (1990–2020)", x="Year", y="Labour Force Participation (%)", color=NULL) +
  theme_minimal()
# --- Visualisation 3: Health Expenditure vs Mortality
mort_summary <- exp_mort_groups %>% group_by(SpendGroup, Year) %>%
  summarise(mean_MMR=mean(MMR, na.rm=TRUE), .groups="drop")
ggplot(mort_summary, aes(x=factor(SpendGroup, levels=c("Low expenditure","Medium expenditure","High expenditure")),
y=mean_MMR, fill=factor(Year))) +
  geom_col(position="dodge", alpha=0.85) +
  scale_y_continuous(labels=scales::comma, limits=c(0,1200)) +
  scale_fill_manual(values=c("2000"="tomato","2010"="#56B4E9")) +
  labs(title="Maternal Mortality by Health Expenditure Group (2000 vs 2010)",
       subtitle="Countries with higher health expenditure consistently show lower maternal deaths",
       x="Health Expenditure Group", y="Average Maternal Mortality Ratio (per 100,000 live births)",
       fill="Year", caption="Data: World Bank, UN") +
  theme_minimal(base_size=13) + theme(legend.position="right"
```

Appendix 2: Global Health Expenditure Map (2000 vs 2020)