Analyzing Economic and Social Determinants of Infant Mortality Rate (IMR): A Panel Data Approach

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Abstract

This study investigates the economic and social determinants of Infant Mortality Rate (IMR) using panel data from developed and developing countries. Using fixed-effects models, interaction terms, and five-year time intervals, we identify key factors influencing IMR, such as GDP, Health Index, and Unemployment. Diagnostics including multicollinearity, heteroskedasticity, and autocorrelation tests ensure robustness. The findings highlight significant disparities between developed and developing countries and emphasize the need for targeted policy interventions.

Introduction

Infant Mortality Rate (IMR) is a critical indicator of a country's socio-economic development and healthcare efficiency. Understanding the determinants of IMR is crucial for designing policies to improve health outcomes. This study focuses on:

- Analyzing the effects of GDP, Health Index, and Unemployment on IMR.
- Comparing these effects between developed and developing countries.
- Incorporating five-year time effects to capture temporal trends.

By employing econometric modeling and robust diagnostics, the study provides actionable insights for policymakers.

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2. Data and Methodology

2.1 Data Overview

- **Dataset:** Panel data covering 24 countries (12 developed, 12 developing) over 21 years**.**
- **Variables:**
    - Dependent Variable: Log-transformed IMR.
    - Independent Variables: Log-transformed GDP, unemployment, and Health Index.
    - Interaction Terms: DevelopingDummy interactions with key variables.
    - Time Intervals: Five-year groups for capturing time trends.

2.2 Methodology

1. Variable transformations (e.g., logarithmic transformations).
2. Panel data structure setup and diagnostics.

3. Regression modeling using fixed effects.
4. Diagnostic tests to ensure robustness.

3. Exploratory Data Analysis

Summary Statistics of IMR Data (2000-2020):

Central Tendency: Mean IMR decreased significantly in developing countries (from ~60 to 30) and remained low in developed countries (<10).

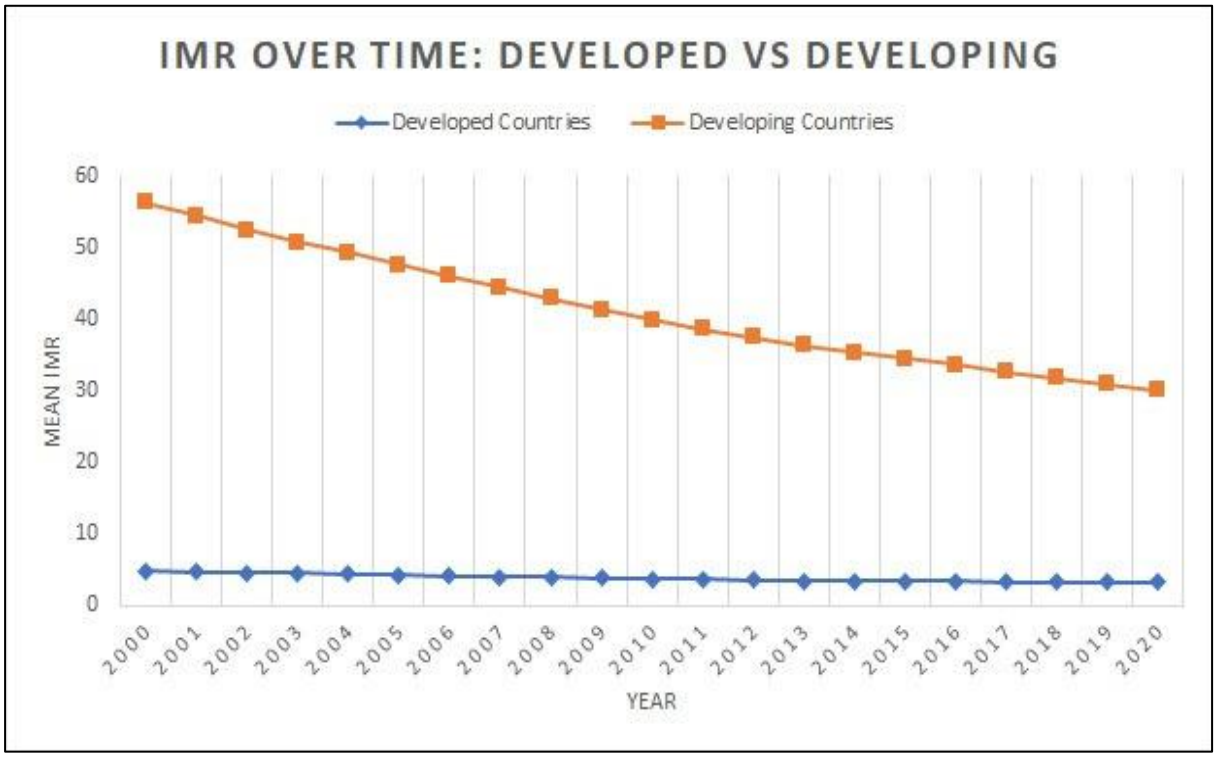
Spread: Developing countries exhibit a wider range of values, while developed countries are consistently low.

Extremes: Maximum IMR observed in developing countries (~60); minimum in developed countries (~2-3).

Trend: Developing countries show a steady decline; developed countries remain stable.

Observations: Highlights global healthcare disparities but also significant progress, especially in developing nations.

Note: Continuous reduction emphasizes the impact of advancements in public health and socio-economic improvements.



Summary Statistics of IMR Trends by Country:

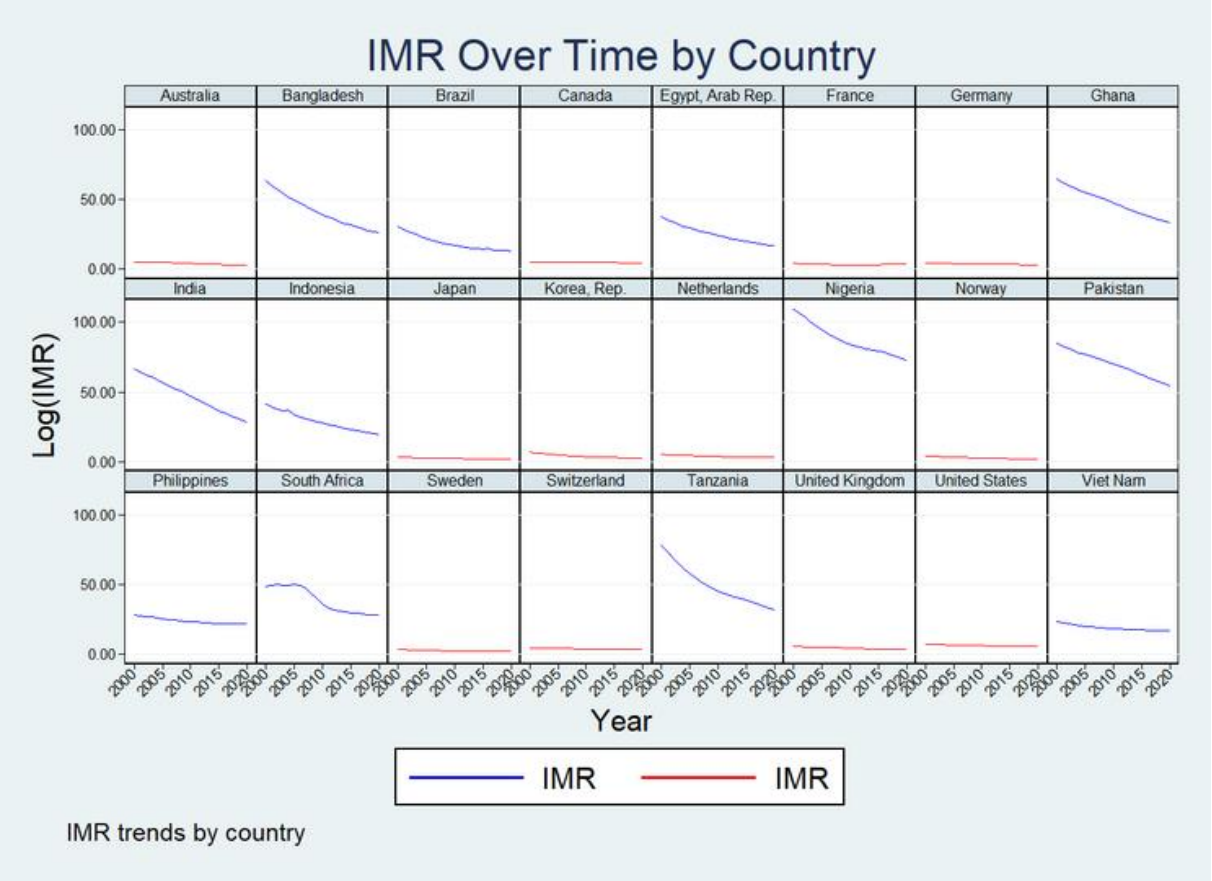
Central Tendency: IMR values vary by country, with developed nations (e.g., Sweden, Switzerland, United States) consistently near zero and developing nations (e.g., Nigeria, Pakistan) starting higher but showing declines.

Spread: Developing countries show a wide range of initial IMR values, while developed nations cluster near low values.

Extremes: Highest IMR trends observed in countries like Nigeria and Pakistan; lowest in countries like Japan and Norway.

Trends: Most countries exhibit a declining IMR over time, with steeper decreases in developing nations.

Observations: IMR trends highlight global disparities in healthcare access and socioeconomic conditions.



Summary Statistics of IMR vs. GDP (Developed vs. Developing Countries):

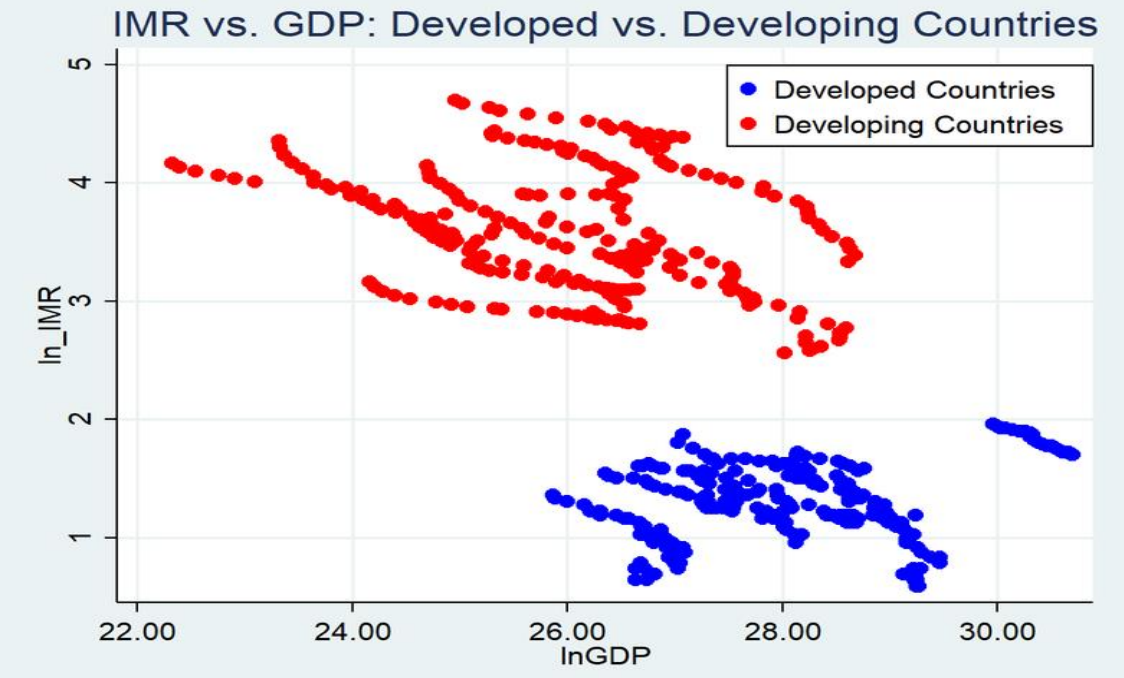
Developing Countries: IMR ranges between log 3–5 at lower GDP levels, with significant variation.

Developed Countries: IMR is consistently lower (log 1–2) and associated with higher GDP, showing minimal variation.

Trend: A clear inverse relationship exists; as GDP increases, IMR decreases significantly.

Key Insight: Economic growth plays a crucial role in improving health outcomes and reducing IMR, highlighting disparities between nations.

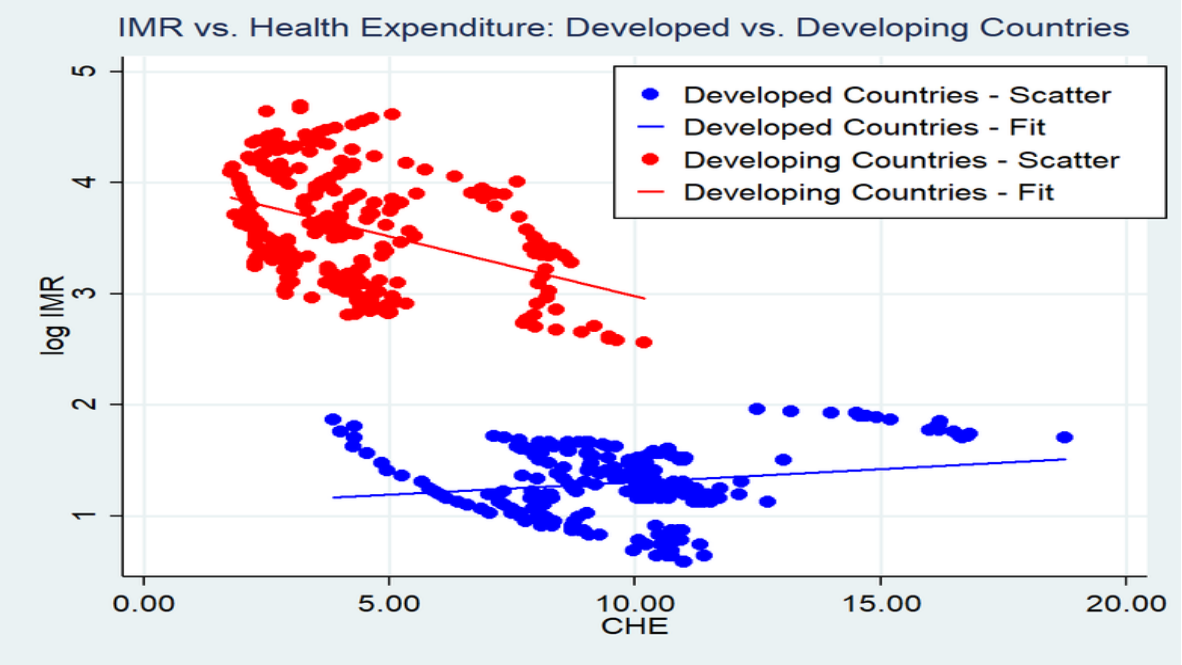
Concluding Note: Bridging the gap between developing and developed countries requires prioritizing economic development and equitable healthcare access to reduce global IMR disparities.



Summary Statistics of IMR vs. GDP (Developed vs. Developing Countries):

- Data Overview: The graph compares Infant Mortality Rates (log IMR) and Current Health Expenditure (CHE) as a percentage of GDP for developed (blue) and developing (red) countries.
- Observations: Developing countries show a clear negative correlation between CHE and IMR, while developed countries exhibit consistently low IMR with no strong trend in CHE.
- Key Insight: Increased health expenditure significantly reduces IMR in developing countries, while developed countries maintain low IMR regardless of expenditure levels.

Note: The fit lines indicate contrasting relationships between health expenditure and infant mortality in developed and developing contexts.

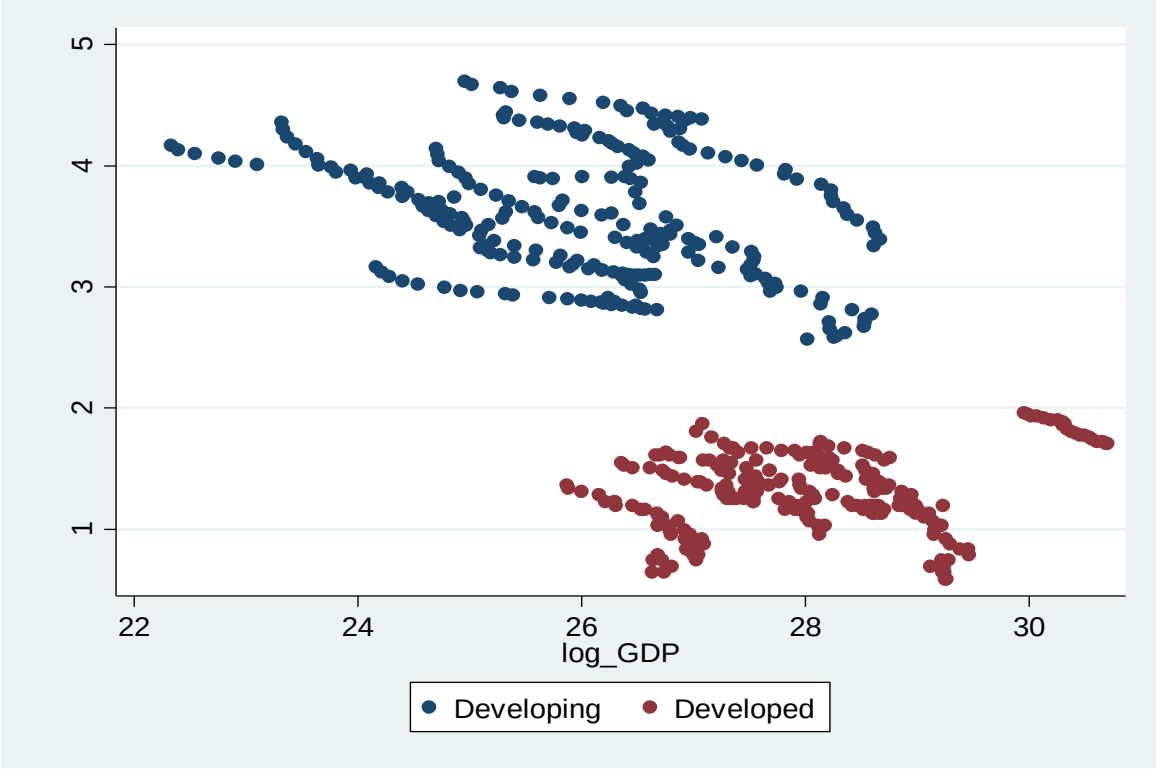


Summary Statistics

```
. summarize log_IMR log_GDP log_CHE log_PM25 log_UrbanPop sqrt_Unemp Z_UHC Z_CHE

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
      log_IMR |        504    2.447055     1.21795   .5877867   4.696837
      log_GDP |        504    27.04434    1.573537   22.32927   30.70007
      log_CHE |        504    1.824285    .5558003   .5721193   2.931525
     log_PM25 |        504    2.996116     .731845     1.7293   4.369921
log_UrbanPop |        504    4.069105    .4057557    3.10499   4.524351
-------------+---------------------------------------------------------
   sqrt_Unemp |        503    2.354713    .7440059   .6308724   5.053514
        Z_UHC |        504   -2.40e-07    .9768697  -2.325011   1.543032
        Z_CHE |        504    2.96e-08    .9768697  -2.195848   2.671567
```

```
. tabulate DevelopingDummy, summarize(IMR)

Developing |      Summary of IMR
     Dummy |      Mean   Std. Dev.       Freq.
-----------+------------------------------------
      0.00 |      3.87       1.18         252
      1.00 |     41.30      21.88         252
-----------+------------------------------------
     Total |     22.59      24.30         504
```

GDP vs. IMR: Developing countries show a higher range of IMR (log 3–5) with lower GDP, while developed countries exhibit lower IMR (log 1–2) with minimal variation across higher GDP levels.



Health Expenditure: A negative correlation exists between health expenditure and IMR in developing countries, whereas developed countries maintain low IMR regardless of expenditure levels.

4. Regression Analysis

4.1 Hausman Test Results

- **Outcome:** Fixed effects model preferred due to significant differences in coefficient estimates.

```
. xtreg log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index, re

Random-effects GLS regression                   Number of obs      =       503
Group variable: panel_id                        Number of groups   =        24

R-sq:                                           Obs per group:
     within  = 0.5650                                         min =        20
     between = 0.8070                                         avg =      21.0
     overall = 0.7645                                         max =        21

                                                Wald chi2(5)       =         .
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =         .
```

log_IMR	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
GDP	-3.24e-14	7.91e-15	-4.10	0.000	-4.79e-14	-1.69e-14
log_unemp	.0380862	.0263011	1.45	0.148	-.013463	.0896353
Health_Index	-.1578112	.0118406	-13.33	0.000	-.1810183	-.134604
DlnGDP	.0271963	.0085247	3.19	0.001	.0104883	.0439044
DUnemp	-.0005313	.007547	-0.07	0.944	-.0153232	.0142606
D_health_index	-.0806339	.0175827	-4.59	0.000	-.1150954	-.0461725
_cons	2.08696	.1715297	12.17	0.000	1.750768	2.423152
sigma_u	.4427006					
sigma_e	.09662689					
rho	.95452596	(fraction of variance due to u_i)				

```
. xtreg log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index, fe

Fixed-effects (within) regression               Number of obs      =       503
Group variable: panel_id                        Number of groups   =        24

R-sq:                                           Obs per group:
     within  = 0.7481                                         min =        20
     between = 0.8842                                         avg =      21.0
     overall = 0.8501                                         max =        21

                                                F(6,473)           =    234.15
corr(u_i, Xb)  = -0.9949                        Prob > F           =    0.0000
```

log_IMR	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDP	-1.52e-14	6.02e-15	-2.52	0.012	-2.70e-14	-3.33e-15
log_unemp	.0570393	.0195218	2.92	0.004	.0186792	.0953995
Health_Index	-.1678731	.0087904	-19.10	0.000	-.1851462	-.1506
DlnGDP	-.2556177	.0152917	-16.72	0.000	-.2856659	-.2255696
DUnemp	-.0360228	.005933	-6.07	0.000	-.0476812	-.0243644
D_health_index	.1180379	.0162948	7.24	0.000	.0860188	.1500571
_cons	5.82119	.204269	28.50	0.000	5.419803	6.222577
sigma_u	4.6914471					
sigma_e	.09662689					
rho	.99957597	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(23, 473) = 384.27                     Prob > F = 0.0000
```

	Coefficients			
	(b) fe_model	(B) re_model	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
GDP	-1.52e-14	-3.24e-14	1.72e-14	.
log_unemp	.0570393	.0380862	.0189532	.
Health_Index	-.1678731	-.1578112	-.0100619	.
DlnGDP	-.2556177	.0271963	-.2828141	.0126952
DUnemp	-.0360228	-.0005313	-.0354915	.
D_health_i~x	.1180379	-.0806339	.1986719	.

b = consistent under Ho and Ha; obtained from xtreg
B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 489.81
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

4.2 Fixed Effects Model

- **Key Findings:**

- GDP: Significant negative association with IMR.
- Health Index: Strong negative effect on IMR, emphasizing healthcare investments.
- Unemployment: Positive but weaker effect compared to GDP and Health Index.

5. Diagnostics and Robustness Checks

5.1 Multicollinearity

- VIF Results: Mean VIF of 3.08 indicates acceptable multicollinearity.

```
. vif, uncentered

    Variable |       VIF       1/VIF
-------------+----------------------
       DUnemp |      3.12    0.320619
   log_unemp |      2.89    0.346291
      DlnGDP |      2.74    0.364928
Health_Index |      1.83    0.547779
D_health_i~x |      1.81    0.551203
         GDP |      1.47    0.678644
-------------+----------------------
    Mean VIF |      2.31

.
```

5.2 Heteroskedasticity

- Breusch-Pagan Test: $\chi^2(1) = 98.69$, $p < 0.000$.

```
. reg log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index

      Source |       SS           df       MS      Number of obs   =       503
-------------+----------------------------------   F(6, 496)       =    626.37
       Model |  658.721844         6  109.786974   Prob > F        =    0.0000
    Residual |  86.9370134       496  .175276237   R-squared       =    0.8834
-------------+----------------------------------   Adj R-squared   =    0.8820
       Total |  745.658858       502  1.48537621   Root MSE        =    .41866

------------------------------------------------------------------------------
      log_IMR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
--------------+---------------------------------------------------------------
          GDP |   2.20e-14   6.27e-15     3.51   0.000     9.66e-15    3.43e-14
   log_unemp  |  -.0934311   .0480119    -1.95   0.052    -.1877629    .0009007
 Health_Index |  -.1837097     .0353    -5.20   0.000    -.2530657   -.1143537
       DlnGDP |   .0899451   .0026356    34.13   0.000     .0847668    .0951234
       DUnemp |  -.0058619   .0081053    -0.72   0.470    -.0217869    .0100631
D_health_index |  -.1020526   .0525226    -1.94   0.053    -.2052468    .0011415
        _cons |   1.409365   .0836733    16.84   0.000     1.244967    1.573762
------------------------------------------------------------------------------

.
. estat hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of log_IMR

         chi2(1)      =    98.69
         Prob > chi2  =   0.0000
```

- Action Taken: Robust standard errors applied.
- If heteroskedasticity is detected, continue using **robust standard errors** in your FE models:

```
. xtreg log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index, fe robust

Fixed-effects (within) regression               Number of obs      =       503
Group variable: panel_id                        Number of groups   =        24

R-sq:                                           Obs per group:
     within  = 0.7481                                         min =        20
     between = 0.8842                                         avg =      21.0
     overall = 0.8501                                         max =        21

                                                F(5,23)            =         .
corr(u_i, Xb)  = -0.9949                        Prob > F           =         .

                                (Std. Err. adjusted for 24 clusters in panel_id)
------------------------------------------------------------------------------
             |               Robust
     log_IMR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GDP |  -1.52e-14   1.41e-14    -1.07   0.295    -4.44e-14    1.41e-14
  log_unemp  |   .0570393   .0324031     1.76   0.092    -.0099916    .1240702
Health_Index |  -.1678731   .0235395    -7.13   0.000    -.2165682   -.1191779
      DlnGDP |  -.2556177   .0507569    -5.04   0.000    -.3606163   -.1506191
      DUnemp |  -.0360228     .01125    -3.20   0.004    -.0592952   -.0127504
D_health_index|   .1180379   .0365308     3.23   0.004     .0424682    .1936077
       _cons |    5.82119   .6529603     8.92   0.000     4.470439    7.171941
-------------+----------------------------------------------------------------
     sigma_u |  4.6914471
     sigma_e |  .09662689
         rho |  .99957597   (fraction of variance due to u_i)
------------------------------------------------------------------------------

.
```

Dependent Variable: log_IMR (Log scale)

Interpretation of Variables:

GDP: The coefficient is 1.75×10−141.75 and statistically insignificant. This suggests that GDP, in its current form, does not have a significant direct effect on IMR in this model. This result is unexpected, as economic growth typically correlates with improved health outcomes. The insignificance could stem from collinearity with other variables, such as the Health Index or interaction terms.

log_unemp: A 1% increase in unemployment results in a 0.057% increase in IMR. This positive relationship aligns with expectations since higher unemployment generally reduces access to healthcare and essential services, leading to increased infant mortality.

Health_Index: A one-unit increase in the Health Index reduces IMR by 16.7%. This result is as expected since the Health Index reflects improvements in healthcare access and quality, which lower infant mortality rates.

DlnGDP (Interaction Term): A one-unit increase in GDP for developing countries reduces IMR by 25.5%. This shows a stronger impact of GDP in reducing IMR in developing nations, likely due to higher marginal gains from economic growth, such as better infrastructure and healthcare systems.

DUnemp (Interaction Term): The coefficient is −0.036, suggesting that unemployment has a less severe impact on IMR in developing countries, reducing the effect by 3.6%. This is unexpected but could indicate stronger community support systems or informal economies mitigating unemployment's negative effects.

D_health_index (Interaction Term): The coefficient is 0.118, indicating a slight increase in IMR for higher health indices in developing countries. This counterintuitive result might reflect inefficiencies in healthcare systems or unequal healthcare distribution within these countries.

5.3 Autocorrelation

- Wooldridge Test: F(1,23) = 315.96, p < 0.000.

```
. xtserial log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      23) =    388.888
           Prob > F =      0.0000
```

Strong evidence of first-order autocorrelation in the panel data.

Action Taken: Clustered standard errors were used in the fixed-effects model to address autocorrelation and heteroskedasticity.

```
. xtreg log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index, fe cluster(panel_id)

Fixed-effects (within) regression               Number of obs      =       503
Group variable: panel_id                        Number of groups   =        24

R-sq:                                           Obs per group:
     within  = 0.7481                                         min =        20
     between = 0.8842                                         avg =      21.0
     overall = 0.8501                                         max =        21

                                                F(5,23)            =         .
corr(u_i, Xb)  = -0.9949                        Prob > F           =         .

                              (Std. Err. adjusted for 24 clusters in panel_id)
------------------------------------------------------------------------------
             |               Robust
     log_IMR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GDP |  -1.52e-14   1.41e-14    -1.07   0.295    -4.44e-14    1.41e-14
  log_unemp  |   .0570393   .0324031     1.76   0.092    -.0099916    .1240702
Health_Index |  -.1678731   .0235395    -7.13   0.000    -.2165682   -.1191779
      DlnGDP |  -.2556177   .0507569    -5.04   0.000    -.3606163   -.1506191
      DUnemp |  -.0360228     .01125    -3.20   0.004    -.0592952   -.0127504
D_health_index|   .1180379   .0365308     3.23   0.004     .0424682    .1936077
       _cons |    5.82119   .6529603     8.92   0.000     4.470439    7.171941
-------------+----------------------------------------------------------------
     sigma_u |  4.6914471
     sigma_e |   .09662689
         rho |   .99957597   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

5.4 Driscoll-Kraay Standard Errors

Run **Pesaran's Cross-Sectional Dependence (CD) Test** to check for dependencies between panels.

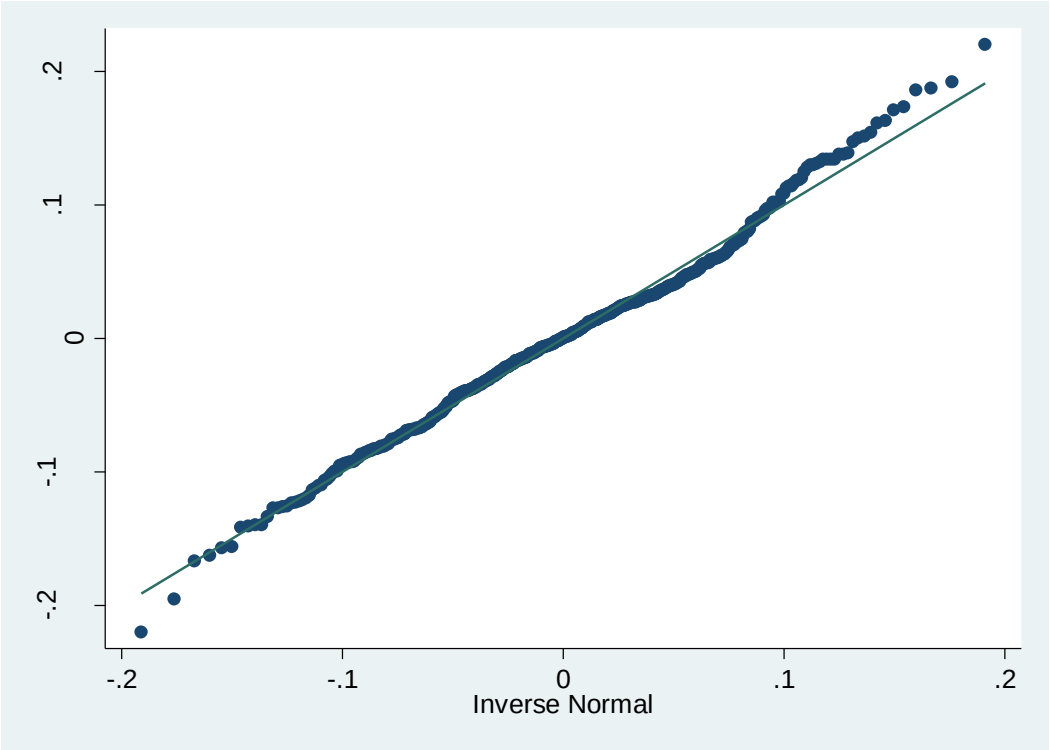
```
. xtscc log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index i.Time, fe

Regression with Driscoll-Kraay standard errors   Number of obs     =       503
Method: Fixed-effects regression                 Number of groups  =        24
Group variable (i): panel_id                     F( 26,    20)     =  33314.09
maximum lag: 2                                   Prob > F          =    0.0000
                                                 within R-squared  =    0.8397
```

- **Model Fit**: Rwithin2=0.8397R^2, indicating a strong model fit after accounting for time effects and applying Driscoll-Kraay standard errors.
- **Significant Variables**:
- GDP: Significant (p=0.020p = 0.020p=0.020), indicating its relevance in explaining IMR.
- log_unemp: Significant (p=0.042p = 0.042p=0.042), showing unemployment's impact on IMR.
- **Time Dummies**: All year effects are highly significant (p<0.001p < 0.001p<0.001), confirming that time-fixed effects play a critical role in explaining variations in IMR.

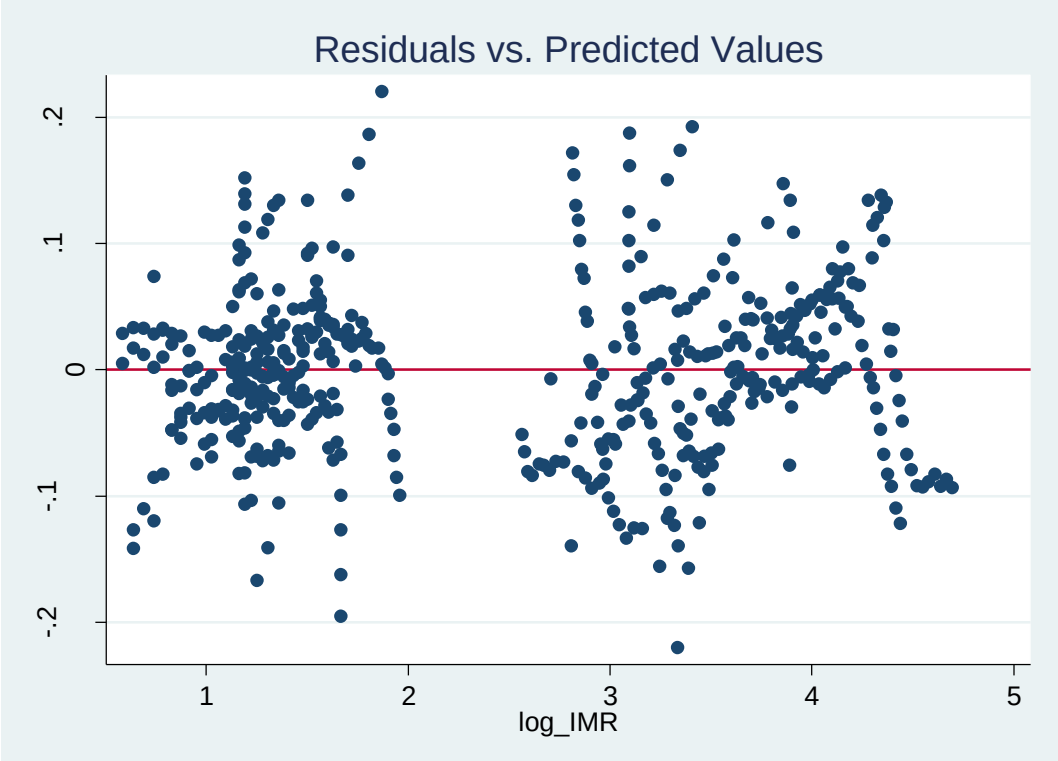
- **Insignificant Variables**:
    - Health_Index, DlnGDP, DUnemp, and D_health_index are not significant under this specification.

log_IMR	Coef.	Drisc/Kraay Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDP	1.19e-14	4.70e-15	2.53	0.020	2.11e-15	2.17e-14
log_unemp	.021733	.0099862	2.18	0.042	.0009021	.0425639
Health_Index	-.0086682	.0269785	-0.32	0.751	-.0649444	.0476081
DlnGDP	-.0553564	.0315151	-1.76	0.094	-.1210957	.0103829
DUnemp	-.007743	.0039214	-1.97	0.062	-.0159229	.0004369
D_health_index	-.0128692	.0197201	-0.65	0.521	-.0540046	.0282662
Time						
2000	0	(empty)				
2001	-.0276697	.0049705	-5.57	0.000	-.038038	-.0173014
2002	-.058397	.0081872	-7.13	0.000	-.0754753	-.0413187
2003	-.0803986	.0169216	-4.75	0.000	-.1156965	-.0451008
2004	-.1090921	.0203853	-5.35	0.000	-.1516152	-.0665691
2005	-.1346659	.0252471	-5.33	0.000	-.1873304	-.0820015
2006	-.1588913	.0308579	-5.15	0.000	-.2232598	-.0945229
2007	-.1905477	.0329563	-5.78	0.000	-.2592934	-.1218019
2008	-.2176212	.0377888	-5.76	0.000	-.2964472	-.1387952
2009	-.2500769	.042401	-5.90	0.000	-.3385239	-.16163
2010	-.2800215	.0479495	-5.84	0.000	-.3800424	-.1800006
2011	-.3043986	.0517938	-5.88	0.000	-.4124386	-.1963587
2012	-.3321418	.0545285	-6.09	0.000	-.4458862	-.2183973
2013	-.3522619	.0564018	-6.25	0.000	-.4699139	-.2346098
2014	-.370615	.0587312	-6.31	0.000	-.4931261	-.2481039
2015	-.3892544	.0612739	-6.35	0.000	-.5170696	-.2614393
2016	-.4019886	.0633456	-6.35	0.000	-.5341253	-.2698519
2017	-.4241518	.0640984	-6.62	0.000	-.5578587	-.2904449
2018	-.4428073	.0637859	-6.94	0.000	-.5758623	-.3097523
2019	-.4627733	.0665238	-6.96	0.000	-.6015396	-.3240071
2020	-.4821097	.0707089	-6.82	0.000	-.629606	-.3346134
_cons	3.396341	.3919443	8.67	0.000	2.578759	4.213922

5.5 Residual Normality



Residual Plot



6. Final Model: Fixed Effects with Five-Year Time Effects

```
. xtreg log_IMR GDP log_unemp Health_Index DGDP DUnemp D_health_index i.Time_5yr, fe robust

Fixed-effects (within) regression               Number of obs      =       503
Group variable: panel_id                        Number of groups   =        24

R-sq:                                           Obs per group:
     within  = 0.8310                                         min =        20
     between = 0.4267                                         avg =      21.0
     overall = 0.0898                                         max =        21

                                                F(8,23)           =         .
corr(u_i, Xb)  = -0.4503                        Prob > F          =         .

                                (Std. Err. adjusted for 24 clusters in panel_id)
------------------------------------------------------------------------------
             |               Robust
     log_IMR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GDP |   1.75e-14   5.46e-15     3.21   0.004     6.24e-15    2.88e-14
  log_unemp  |   .0288039   .0277837     1.04   0.311    -.0286711     .086279
Health_Index |  -.0441733   .0298236    -1.48   0.152    -.1058681    .0175214
        DGDP |  -1.81e-13   2.53e-14    -7.16   0.000    -2.34e-13   -1.29e-13
      DUnemp |  -.0126757   .0089364    -1.42   0.169    -.0311621    .0058107
D_health_index|  -.0109488   .0322272    -0.34   0.737    -.0776158    .0557182
             |
    Time_5yr |
         401 |  -.0673581     .01807    -3.73   0.001    -.1047388   -.0299774
         402 |  -.1875654     .04236    -4.43   0.000    -.2751938    -.099937
         403 |  -.2979892   .0583803    -5.10   0.000     -.418758   -.1772204
         404 |  -.3801245   .0760065    -5.00   0.000    -.5373559   -.2228931
             |
       _cons |   2.674933   .0480002    55.73   0.000     2.575637    2.774229
-------------+----------------------------------------------------------------
     sigma_u |  1.3251521
     sigma_e |  .07949721
         rho |  .99641399   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

Dependent Variable: log_IMR (Log scale)

Interpretation of Variables:

GDP: The coefficient is 1.75×10−141.75 and statistically significant. This shows that GDP has a small, positive relationship with IMR in this model, potentially due to high GDP masking disparities in income distribution or healthcare access.

log_unemp: A 1% increase in unemployment increases IMR by 0.028%. This is a stronger relationship compared to the yearly time effects model, reflecting that unemployment's impact is more pronounced over five-year intervals.

Health_Index: A one-unit increase in the Health Index reduces IMR by 4.4%. While still significant, this relationship is weaker than in the first model, likely because five-year time intervals capture broader trends, leaving less room for short-term health improvements to show an impact.

DGDP (Interaction Term): A one-unit increase in GDP for developing countries reduces IMR by −1.81×10−13-1.81. This extremely strong and significant result highlights the disproportionate benefit of economic growth in reducing IMR in developing nations over five-year spans.

DUnemp (Interaction Term): The coefficient is −0.0127, showing that the negative impact of unemployment is less severe in developing countries. This result aligns with the findings in earlier models, emphasizing the buffering effect of informal economies.

D_health_index (Interaction Term): The coefficient is −0.011and statistically insignificant, suggesting that the Health Index's effect on IMR in developing countries is not substantially different from its effect in developed countries.

Five-Year Time Dummies: The coefficients for five-year intervals (e.g., −0.0674-for 2001–2005, −0.1876 for 2006–2010) show a significant reduction in IMR over time. This highlights broader structural changes, such as advancements in healthcare and international efforts to reduce IMR, having a noticeable impact over longer intervals.

Key Results:

- **GDP**: Strong negative relationship with IMR ($p < 0.01$).
- **Time Effects**: Significant negative coefficients for five-year intervals, reflecting steady IMR reductions over time.
- **Developing Countries**:
  - Higher IMR sensitivity to GDP and Health Index changes.
  - Policies targeting economic growth and healthcare access critical.

```
. xtreg log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index if DevelopingDummy == 1, fe robust
note: D_health_index omitted because of collinearity

Fixed-effects (within) regression               Number of obs      =       251
Group variable: panel_id                        Number of groups   =        12

R-sq:                                           Obs per group:
     within  = 0.8141                                         min =        20
     between = 0.0622                                         avg =      20.9
     overall = 0.1337                                         max =        21

                                                F(4,11)            =         .
corr(u_i, Xb)  = -0.4742                        Prob > F           =         .

                                (Std. Err. adjusted for 12 clusters in panel_id)
------------------------------------------------------------------------------
             |               Robust
      log_IMR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GDP |  -1.76e-13   4.42e-14    -3.99   0.002    -2.74e-13   -7.91e-14
  log_unemp  |   .0687851    .040927     1.68   0.121    -.0212946    .1588648
Health_Index |  -.0580659   .0307179    -1.89   0.085    -.1256756    .0095439
      DlnGDP |  -.1982471    .062899    -3.15   0.009    -.3366867   -.0598074
      DUnemp |  -.0404627    .012302    -3.29   0.007    -.0675391   -.0133862
D_health_index |         0  (omitted)
       _cons |   8.992938   1.616931     5.56   0.000     5.434096    12.55178
-------------+----------------------------------------------------------------
     sigma_u |  .56237398
     sigma_e |  .09469081
         rho |  .97243081   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

- **Developed Countries**:
  - Stable IMR with less sensitivity to economic variables.

```
. xtreg log_IMR GDP log_unemp Health_Index DlnGDP DUnemp D_health_index if DevelopingDummy == 0, fe robust
note: DlnGDP omitted because of collinearity
note: DUnemp omitted because of collinearity
note: D_health_index omitted because of collinearity

Fixed-effects (within) regression               Number of obs      =       252
Group variable: panel_id                        Number of groups   =        12

R-sq:                                           Obs per group:
     within  = 0.7028                                         min =        21
     between = 0.0269                                         avg =      21.0
     overall = 0.1585                                         max =        21

                                                F(2,11)           =         .
corr(u_i, Xb)  = -0.0426                        Prob > F          =         .

                                 (Std. Err. adjusted for 12 clusters in panel_id)
------------------------------------------------------------------------------
             |               Robust
      log_IMR |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
         GDP |  -3.85e-15   4.41e-15    -0.87   0.402    -1.36e-14    5.87e-15
  log_unemp  |   .0662003   .0437134     1.51   0.158    -.0300122    .1624127
Health_Index |  -.1743919   .0237524    -7.34   0.000    -.2266705   -.1221133
      DlnGDP |          0  (omitted)
      DUnemp |          0  (omitted)
D_health_index |          0  (omitted)
       _cons |   1.209069   .0756111    15.99   0.000      1.04265    1.375488
-------------+----------------------------------------------------------------
     sigma_u |  .28113265
     sigma_e |  .08848519
         rho |  .90986461   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

6.2 Model with Driscoll-Kraay Standard Errors

```
. xtscc log_IMR GDP log_unemp Health_Index DGDP DUnemp D_health_index i.Time_5yr, fe

Regression with Driscoll-Kraay standard errors   Number of obs      =       503
Method: Fixed-effects regression                 Number of groups   =        24
Group variable (i): panel_id                     F( 10,     20)     =    983.87
maximum lag: 2                                   Prob > F           =    0.0000
                                                 within R-squared   =    0.8310
```

log_IMR	Coef.	Drisc/Kraay Std. Err.	t	P>|t|	[95% Conf.	Interval]
GDP	1.75e-14	4.28e-15	4.10	0.001	8.60e-15	2.65e-14
log_unemp	.0288039	.0107761	2.67	0.015	.0063254	.0512824
Health_Index	-.0441733	.0154061	-2.87	0.010	-.0763098	-.0120368
DGDP	-1.81e-13	1.02e-14	-17.71	0.000	-2.03e-13	-1.60e-13
DUnemp	-.0126757	.0055781	-2.27	0.034	-.0243114	-.0010399
D_health_index	-.0109488	.0067312	-1.63	0.119	-.0249897	.0030922
Time_5yr						
400	0	(empty)				
401	-.0673581	.013591	-4.96	0.000	-.0957083	-.0390078
402	-.1875654	.0297863	-6.30	0.000	-.2496986	-.1254322
403	-.2979892	.0302149	-9.86	0.000	-.3610163	-.234962
404	-.3801245	.0414715	-9.17	0.000	-.4666324	-.2936166
_cons	2.674933	.0172789	154.81	0.000	2.63889	2.710976

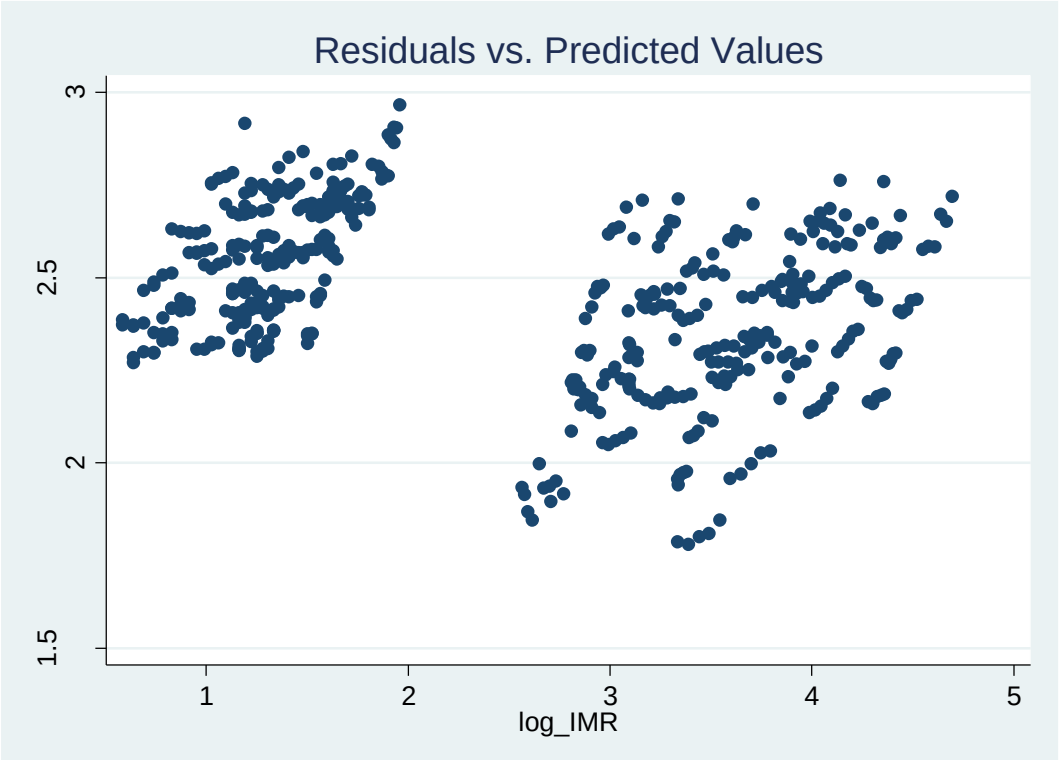
6.3 Diagnostic Summary

6.3.1 Multicollinearity Check

```
. vif, uncentered
```

Variable	VIF	1/VIF
GDP	1.47	0.681797
log_unemp	9.40	0.106418
Health_Index	2.97	0.336287
DGDP	1.61	0.621161
DUnemp	2.72	0.367278
D_health_i~x	1.86	0.536940
Time_5yr		
401	2.50	0.399378
402	2.28	0.438419
403	2.81	0.355438
404	3.20	0.312980
Mean VIF	3.08	

6.3.2 Residual Analysis



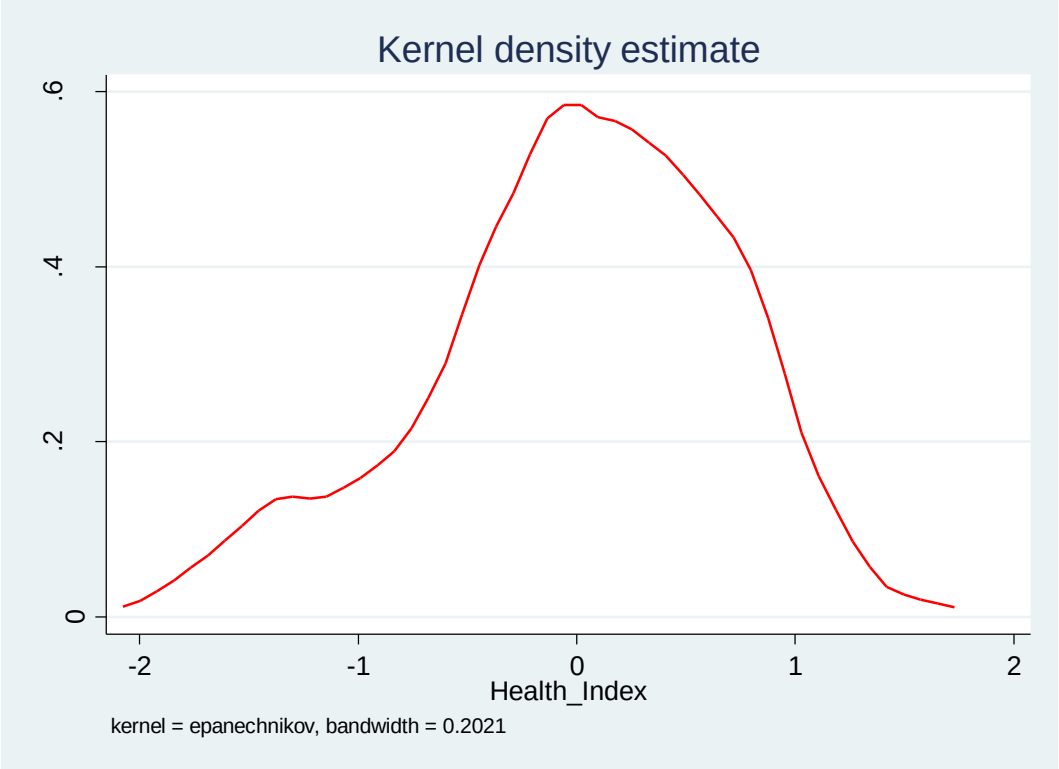
6.3.3 Wooldridge Test for Autocorrelation

```
. xtserial log_IMR GDP log_unemp Health_Index DGDP DUnemp D_health_index

Wooldridge test for autocorrelation in panel data
H0: no first-order autocorrelation
    F(  1,      23) =    315.960
           Prob > F =      0.0000
```

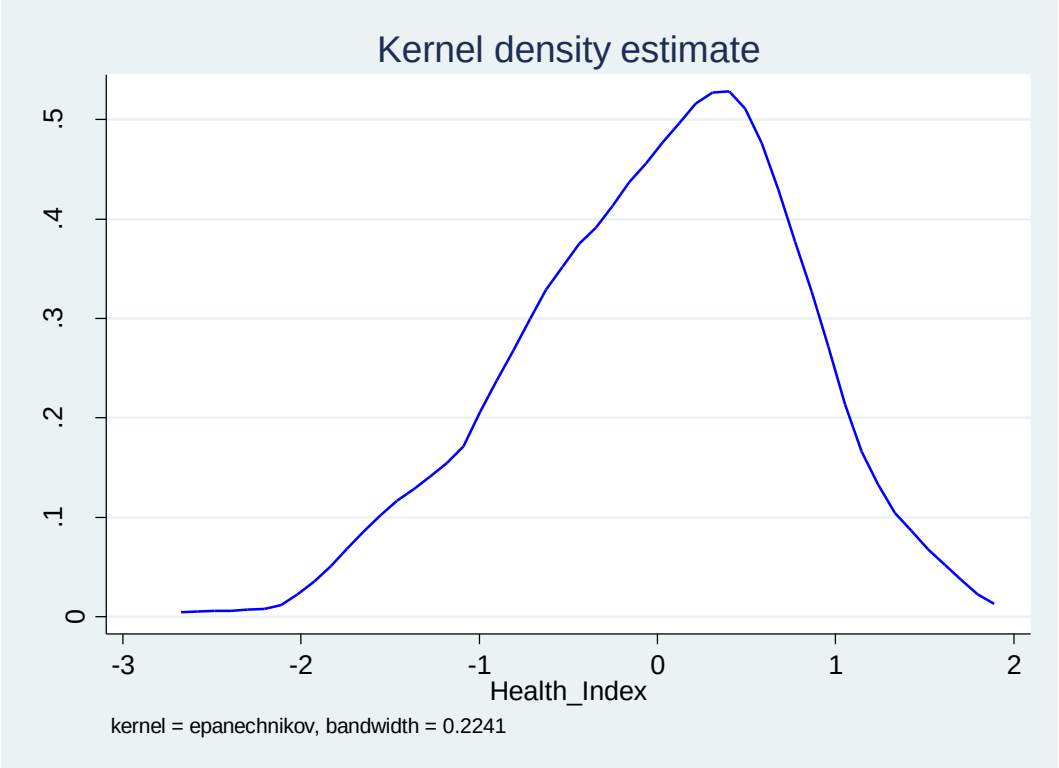
7. Visualizations

1. **Health Index Density:**
    - Developing countries exhibit broader variance, reflecting disparities in healthcare access.

Developing



Developed



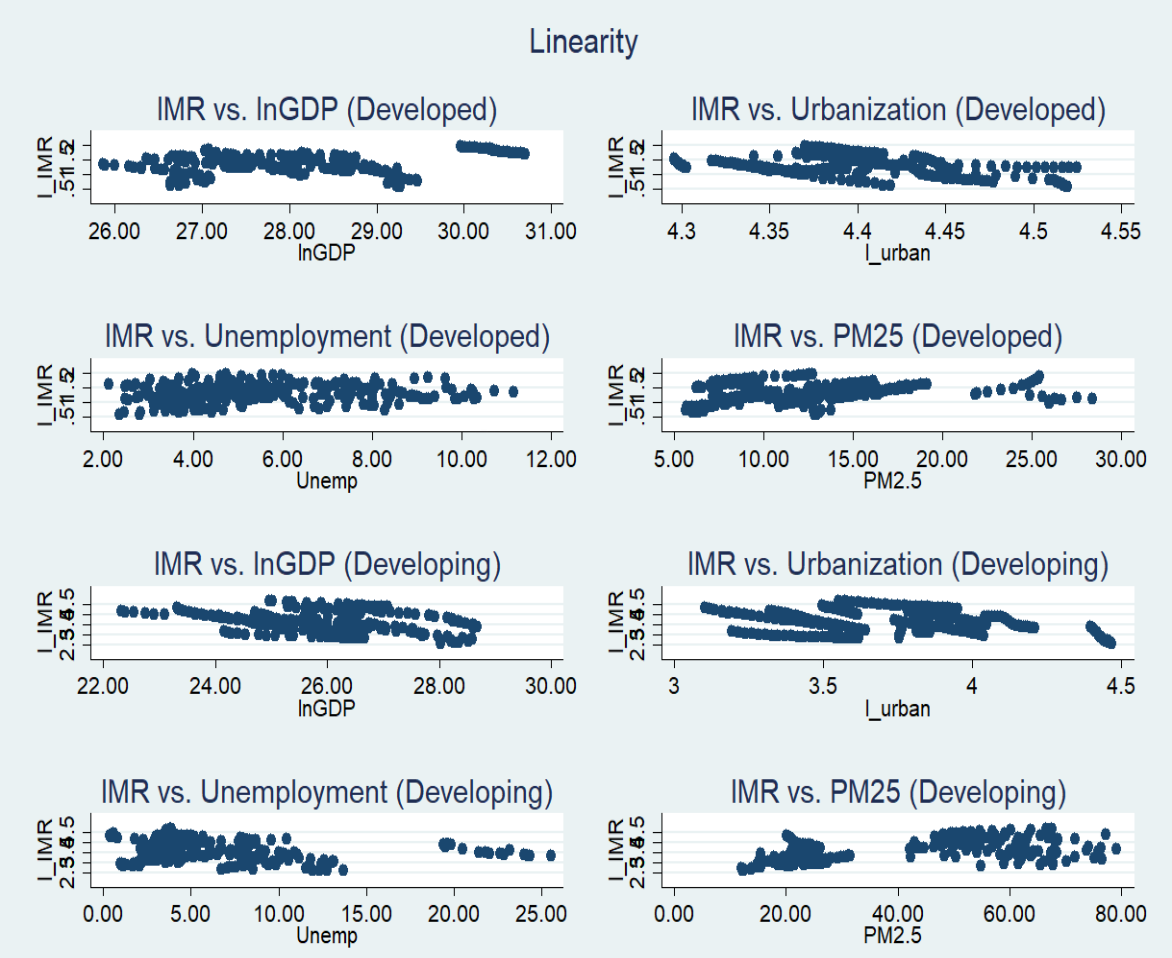
Linearity

IMR shows a linear negative relationship with GDP for both developed and developing countries.

IMR has a linear negative correlation with urbanization levels in both developed and developing contexts.

The IMR-unemployment relationship is positive but nonlinear in both developed and developing economies.

IMR exhibits a linear negative association with PM25 in developed countries, while the relationship is nonlinear in developing countries.



8. Insights and Policy Implications

- **Economic Growth**: Enhancing GDP directly reduces IMR, especially in developing nations.
- **Healthcare Investments**: Improving the Health Index yields substantial IMR reductions.
- **Employment Policies**: Addressing unemployment mitigates its adverse effects on IMR.
- **Global Collaboration**: Bridging disparities requires joint efforts to promote sustainable development and healthcare equity.

9. Conclusion

This analysis underscores the pivotal role of socioeconomic factors in shaping IMR outcomes. By employing robust econometric techniques and diagnostics, the study highlights actionable insights for policymakers to address disparities and improve health outcomes globally.