The First Demographic Dividend and Public Education Expenditure in Brazil: A relationship derived from around 5,000 municipalities in 2014

**Eduardo Rios-Neto**

Bruno Melo

INTRODUCTION

- Coale and Hoover (1958): Fertility decline induced a declining young dependency rate, reducing education expenditure, and favoring rising savings rate and per-capita income

- Assumption: Full coverage, direct relation between school-aged population and enrollment

- Schultz (1987) criticized Coale and Hoover, there were adjustments in costs, and government expenditure in education (budget) did not follow the demographic dynamic in the short run

- Miller et al. (2008) and Manabu (2015) derived a formula for the education expenditure share in GDP

- We will replicate this formula here

DEPENDENCY RATIO – SAP/WAP

- **Dependency Ratio–SAP/WAP = Pop 6-17/Pop 18-64**
  - **SAP – School Age Population**
  - **WAP – Working Age Population**
- **Brazilian Estimated Dependency Ratio Following UN – Population Division Projections**

Dependency Ratio - (6-17/18-64) - Brazil - 1950-2040
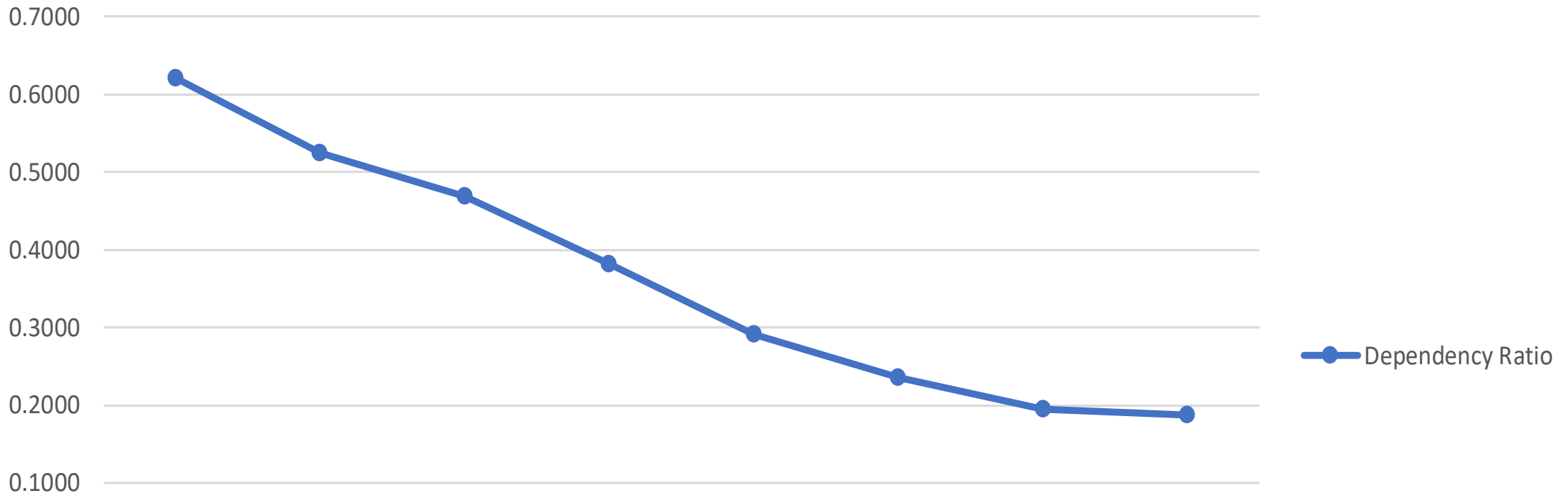
	1970	1980	1990	2000	2010	2020	2030	2040
Dependency Ratio	0.6206	0.5249	0.4694	0.3816	0.2907	0.2357	0.1948	0.1874

YEARS

Dependency Ratio

DATA SOURCE AND VARIABLES

- Year 2014
- 5,564 municipalities
- Dependency Ratio – Cedeplar's Demographic Projection by Municipalities
- Municipal GDP – 2014 - Source IBGE
- Enrolled Students – Education Census – 2014 - INEP
- Teachers – Education Census – 2014 – INEP
- Teachers' Salary – INEP – 2014 – Matching – RAIS – Labor Ministry

REGRESSIONS

- $\log(E/S) = \log(SAP/WAP) + e$
  - Average Student Cost = E/S = WB/ S = θwt
  - WB = Wage Bill Teachers = wt*T
  - wt = Average Wage Teachers
  - T = Number of Teachers
  - θ = T/S = Teacher-Student Ratio
- $\log(Y/WAP) = \log(SAP/WAP) + e$
- $\log(T/S) = \log(SAP/WAP) + e$
- $\log(wt) = \log(SAP/WAP) + e$
- $\log(Pass) = \log(SAP/WAP) + e$
  - Pass = Passing Initial Year (5th Grade) or Final Year (9th Grade)
- $\log(Test) = \log(SAP/WAP) + e$
- Average Test Score from 0 to 10 – Portuguese and Math – IY or FY

Table 1 – Regression model to explain log of cost-student

	OLS			Spatial Error Model		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-value
Intercept	6.753	0.019	0.000	6.830	0.021	0.000
log educacional dependency ratio	-0.625	0.016	0.000	-0.559	0.017	0.000
				Wald stat.: 316.57, p-val.: 0.000		
Obs.: 5132	Adj. R²: 0.238			Log likelihood: 71.770		
				Sigma sq.: 0.056		
				AIC: -135.54		

Source: Own elaboration.

Table 2 – Regression model to explain log of productivity

	OLS			Spatial Error Model		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-valu
Intercept	8.493	0.040	0.000	8.943	0.047	0.000
log educacional dependency ratio	-1.356	0.034	0.000	-0.968	0.039	0.000
				Wald stat.: 851.39, p-val.: 0.0		
				Log likelihood: -4492.88		
Obs.: 5564		Adj. R²: 0.224		Sigma sq.: 0.281		
				AIC: 8993.8		

Source: Own elaboration.

Table 3 – Regression model to explain the number of teacher per student

	OLS			Spatial Error Model		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-valu
Intercept	0,033	0,001	0,000	0,023	0,001	0,000
log educacional dependency ratio	-0,029	0,001	0,000	-0,025	0,001	0,000
				Wald stat.: 155.18, p-val.: 0.0		
Obs.: 5564	Adj. R²: 0.145			Log likelihood: 15174.78 Sigma sq.: 0.000 AIC: -30342		

Source: Own elaboration.

Table 4 – Regression model to explain the teachers' average salary

|	OLS			Spatial Error Model		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-val
Intercept	1851,870	36,920	0,000	1867,900	41,625	0,0(
log educacional dependency ratio	-271,320	31,020	0,000	-256,930	34,465	0,0(
				Wald stat.: 631.33, p-val.: 0.000		
Obs.: 5135	Adj. R²: 0.014			Log likelihood: -38812.32 Sigma sq.: 207840 AIC: 77633		

Source: Own elaboration.

Decomposition of Average Student Cost

Table 5: Teacher-Student Ratio in Brazil - 1970-2040

Year	Teacher/Student	Student/Teacher
1970	0.049	20.474
1980	0.052	19.104
1990	0.055	18.241
2000	0.060	16.745
2010	0.067	14.962
2020	0.073	13.721
2030	0.079	12.680
2040	0.080	12.480

Decomposition of Average Student Cost

Figure 2:

**Teacher's Salary and Teacher/Student Ratio Brazil - 1970-2040**
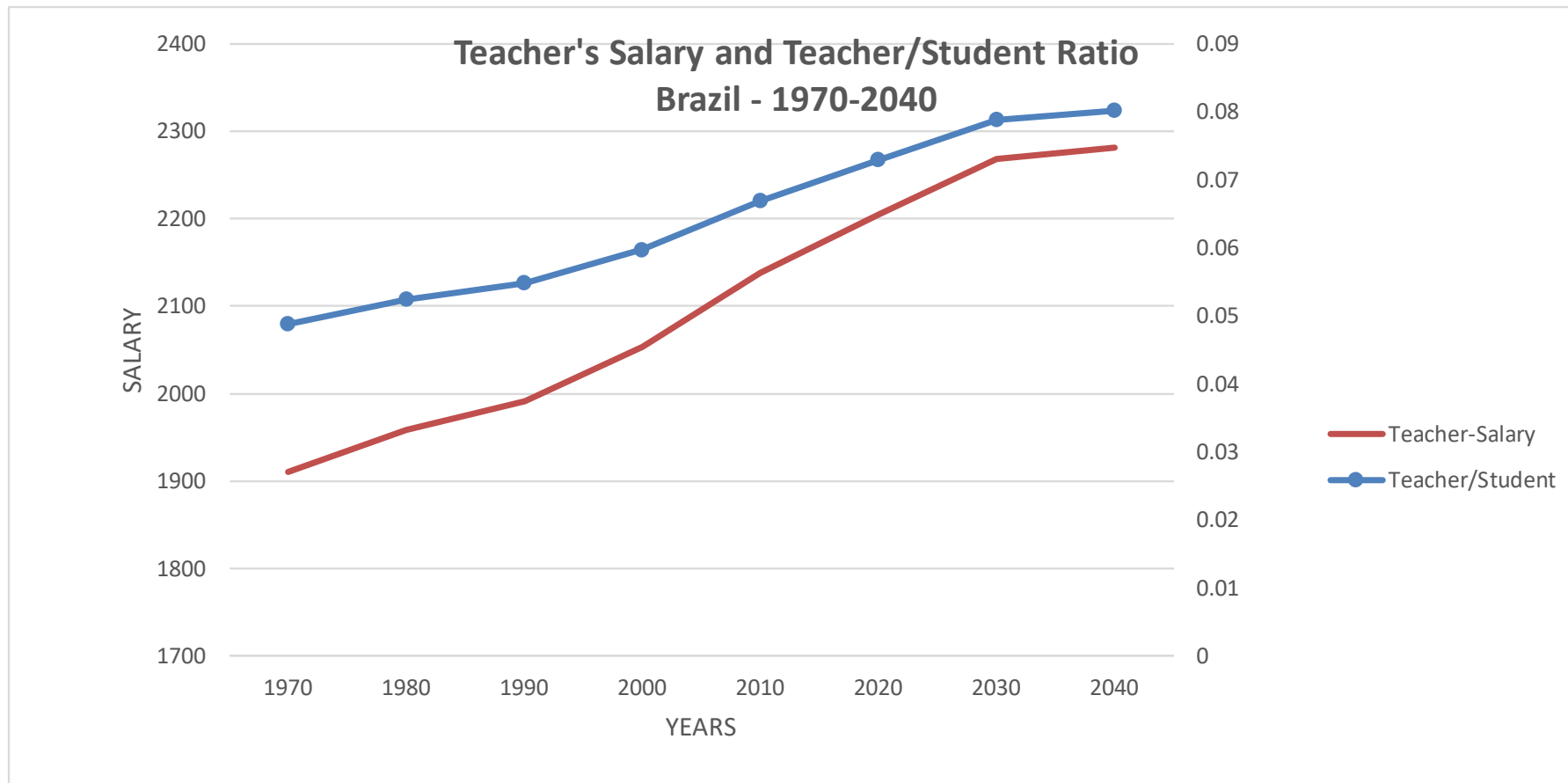
Decomposition of Average Student Cost

Table 6: Decomposition Average Student Cost Variation

YEAR	Teacher/Student	Teacher-Salary	Interaction
1970-80	72.7%	25.5%	1.8%
1980-90	71.2%	24.0%	4.7%
1990-00	69.6%	22.5%	7.9%
2000-10	67.1%	20.4%	12.5%
2010-20	64.8%	18.4%	16.8%
2020-30	62.9%	17.0%	20.1%
2030-40	61.8%	16.2%	22.0%

Decomposition of Educational Spending divided by GDP
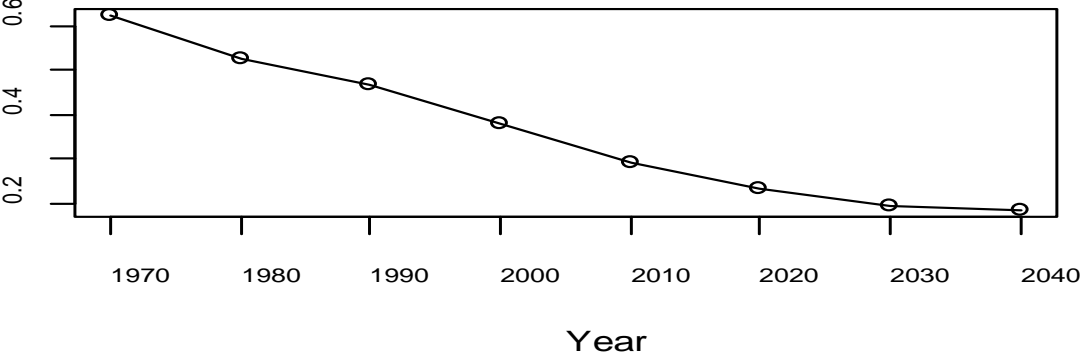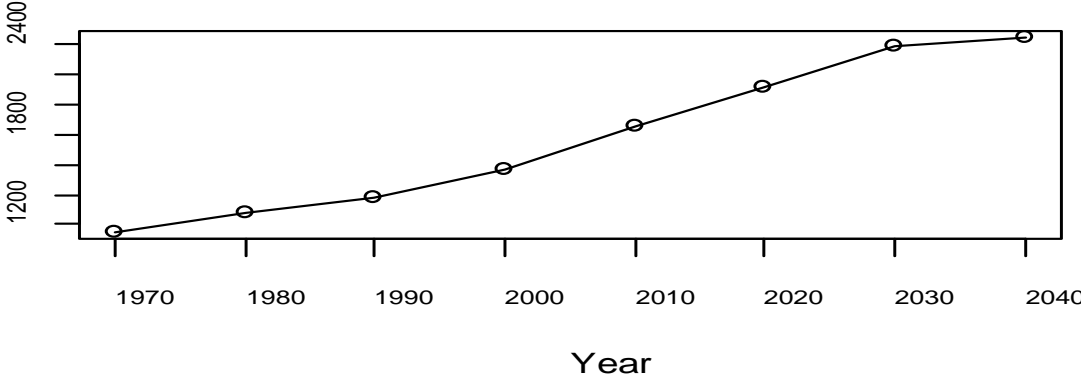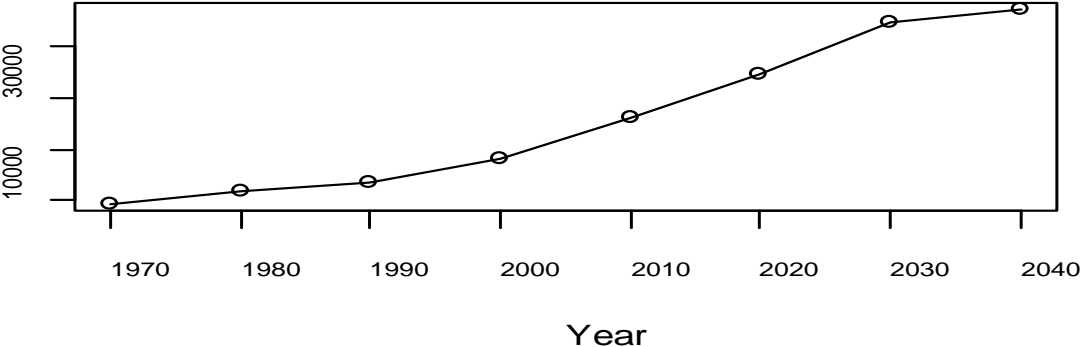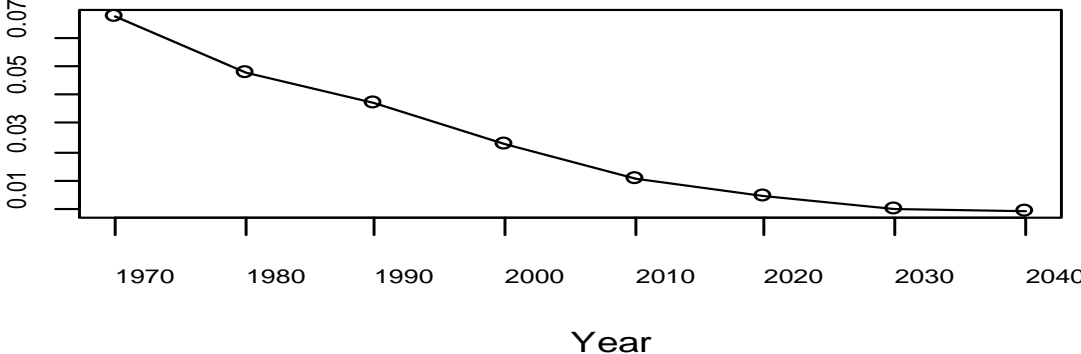
Decomposition of Educational Spending divided by GDP

The Projection of education expenditure with respect to GDP between 1970 and 2040 follow the equation below

$$E/Y = \frac{(\frac{SAP}{WAP}) \times (\frac{S}{SAP}) \times (\frac{E}{S})}{Y/WAP}$$

E/Y = spending on education in relation to GDP

SAP/WAP = educational dependency ratio

S/SAP = rate of coverage of the school system

E/S = student cost

Y/WAP = productivity of the economic system

Decomposition of Educational Spending divided by GDP

Table 7: Counterfactuals Projections of Each Factor Holding Other Factors Constant

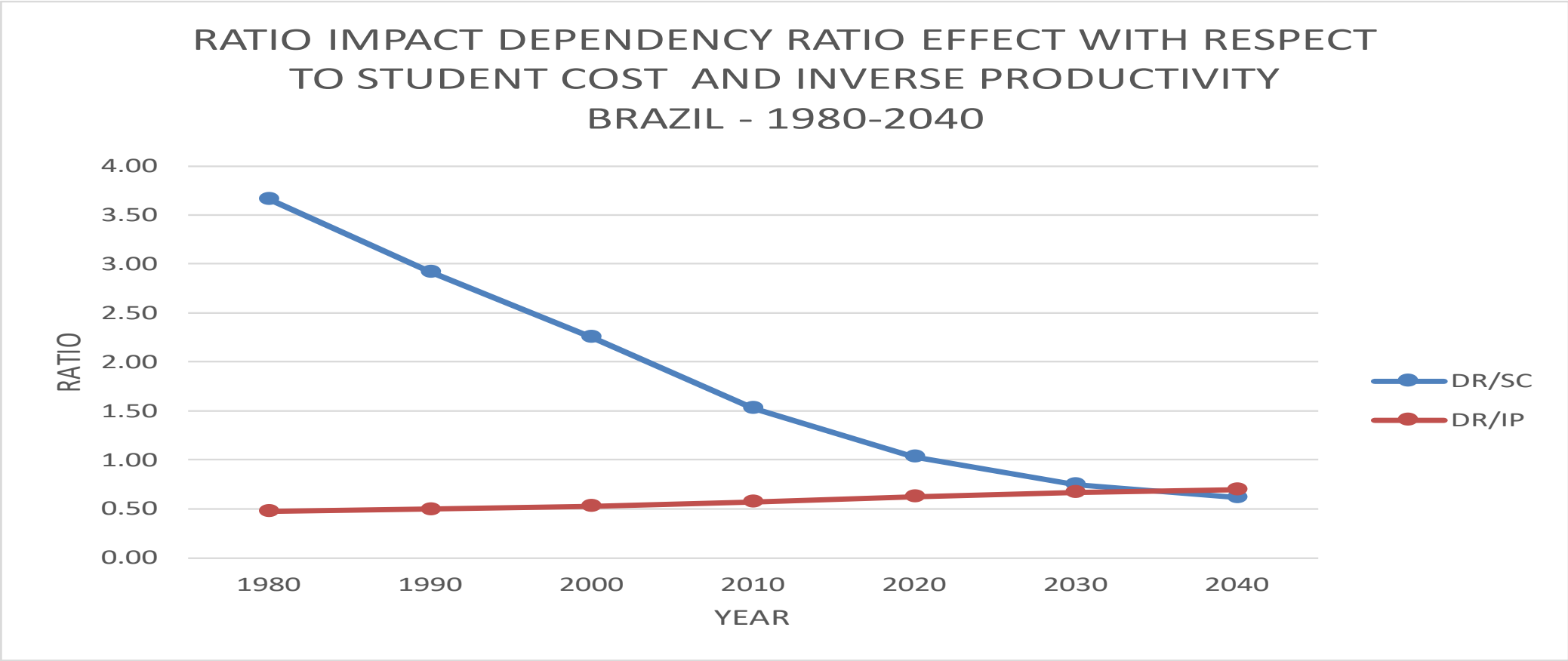| YEAR	Educ.Spend/GDP	Factor DR	Factor Stud. Cost	Factor Inv Prod
1970	0.07685	0.04278	0.01632	0.06896
1980	0.05750	0.03618	0.01812	0.05495
1990	0.04739	0.03235	0.01943	0.04722
2000	0.03312	0.02630	0.02211	0.03567
2010	0.02067	0.02003	0.02622	0.02466
2020	0.01439	0.01625	0.02988	0.01856
2030	0.01034	0.01342	0.03367	0.01433
2040	0.00967	0.01292	0.03448	0.01360

Decomposition of Educational Spending divided by GDP

Table 8: Decomposition of Educational Spenditure/GDP - Brazil

YEAR	Tot. Eff	Dep.Rat.Eff	Stud. Cost Eff	Inv.Prod.Eff	Pred.Tot.Eff	% DR	% Stud. Cost	% Inv. Prod	% Pred. Tot
1970-80	-0.01935	-0.00660	0.00180	-0.01401	-0.018808	35.1%	-9.6%	74.5%	100.0%
1980-90	-0.01011	-0.00382	0.00131	-0.00772	-0.010238	37.4%	-12.8%	75.4%	100.0%
1990-00	-0.01427	-0.00605	0.00268	-0.01155	-0.014919	40.5%	-18.0%	77.4%	100.0%
2000-10	-0.01245	-0.00627	0.00410	-0.01101	-0.013183	47.6%	-31.1%	83.5%	100.0%
2010-20	-0.00628	-0.00378	0.00366	-0.00609	-0.006214	60.9%	-58.9%	98.1%	100.0%
2020-30	-0.00405	-0.00282	0.00379	-0.00423	-0.003273	86.3%	-115.7%	129.4%	100.0%
2030-40	-0.00066	-0.00050	0.00082	-0.00073	-0.000414	121.7%	-196.8%	175.0%	100.0%

Decomposition of Educational Spending divided by GDP

Figure 3:

RATIO IMPACT DEPENDENCY RATIO EFFECT WITH RESPECT TO STUDENT COST AND INVERSE PRODUCTIVITY BRAZIL - 1980-2040

Educational Dependency Ratio and the Quality of Education

Table 9 – Regression model to explain the log of average student Initial Years proficiency

	OLS			Spatial Lag Model		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-value
Intercept	1,240	0,008	0,000	0,817	0,021	0,000
log educational dependency ratio	-0,433	0,007	0,000	-0,344	0,007	0,000
				Wald stat.: 495.32, p-val.: 0.00		
				Log likelihood: 4610.351		
Obs.: 5286	Adj. R²: 0.456			Sigma sq.: 0.010		
				AIC: -9212.7		

Source: Own elaboration.

Educational Dependency Ratio and the Quality of Education

Table 10 – Regression model to explain the log of average student Final Years proficiency

	OLS			Spatial Lag Model		
	Coef.	Std. Error	p-value	Coef.	Std. Error	p-value
Intercept	1,240	0,007	0,000	0,989	0,021	0,000
log educational dependency ratio	-0,305	0,006	0,000	-0,269	0,006	0,000
				Wald stat.: 158.03, p-val.: 0.00		
				Log likelihood: 5157.779		
Obs.: 5247	Adj. R²: 0.356			Sigma sq.: 0.008		
				AIC: -10308		

Source: Own elaboration.

CONCLUDING REMARKS

- We conclude that the educational dependency ratio has a negative effect on the share of education expenditure in GDP.

- The increase in labor productivity due to the declining dependency ratio is an indirect determinant of this declining share of GDP.

- The average student cost rises with the declining educational dependency ratio due to rising teacher's salaries and rising teacher-student ratio.

- This rising average student cost correlates with an increasing quality of education, but it is not enough to counteract the declining share of education expenditure in GDP.

- We also found that the educational dependency ratio affects school quality negatively as measured by a joint score test in Math and Portuguese.

CONCLUDING REMARKS

- We suggest a future empirical exercise to decompose the share of education expenditure in GDP. We will estimate a structural equation model in which we can derive the direct effect of the educational dependency ratio and the indirect effect through student costs and labor productivity.

- In another line of research, we will relate this paper's findings with the discussion found in Lee and Mason (2010). They found an elasticity of –1.0 of total fertility rate in the share of public and private expenditures in health and education divided by the wage bill. This result confirms the proposed trade-off between child quantity and quality.

- Ronald Lee and Andrew Mason (2010). Fertility, human capital, and economic growth over the demographic transition. *European Journal of Population*, 26:159-182.

THANK YOU!!!