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## Does Earmarking Lead to More per Capita Public Health Spending?

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# Does Earmarking Lead to More per Capita Public Health Spending?

## Abstract

The World Health Organization has advocated the earmarking of health-related taxes to mobilize revenues to be spent on public health spending. While there are certain advantages and disadvantages in the use of earmarked taxes to fund healthcare, its ability to mobilize revenues will depend on whether earmarked taxes are acceptable to voters or not. Earmarking might generate more funding for health care if voters know their tax payments are to be spent on program important to them. However, earmarking might discourage funding if voters are not willing to pay more taxes for health care. Regardless, earmarking will not succeed if government simply replace earmarked taxes for general revenues, leaving public health expenditure untouched. We find that earmarked taxes do not lead to more per capita public health spending in the OECD. If a country has earmarked taxes to support public healthcare, per capita public health spending may decline by over \$800, compared to a country with no earmarked taxes supporting public healthcare. The case for earmarking has to be based on other arguments instead.

JEL-Codes: H200, I180.

Keywords: taxation, earmarking, health financing.

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## 1. Introduction

Private and public healthcare is a major expenditure for countries. In 2019 (a year prior to the COVID pandemic), global healthcare spending as a share of GDP was 9.8 percent, topping at 16.7 percent in the United States, which accounted for nearly 43.5 percent of global health spending (Xu et al. 2022). Global health spending rose rapidly during the 2020 pandemic year, reaching 10.9 percent of GDP on average (ranging from 18.8 percent in the U.S. to 1.7 percent in Monaco).

Our interest is in the types of public financing of healthcare, which accounted for 60 percent of total healthcare spending in 2019 globally (63 percent in 2020). Globally, domestic government spending on health as a share of GDP was 5.9 percent in 2019 (6.9 percent in 2020). With many governments facing rising debt levels and demands for spending on defense, energy transition, and other social services, concerns have been raised as to whether governments will have the wherewithal to fund healthcare sufficiently in the coming years as populations age.

The World Health Organization recommends governments to dedicate taxes to mobilize revenues for the general budget (World Health Organization 2024). Although the WHO focuses on health-related taxes such as tobacco, alcohol and sugar excise taxes, the proposal to earmark revenues is an important consideration and a controversial one as well.

While earmarking might create more public support for new taxes if voters perceive the money will be spent on something valuable to them, they may also resist public spending if they know it becomes a direct cost for them as earmarked taxes. Further, earmarking revenues may only partially fund healthcare. Budgets are fungible, so more earmarked revenues may simply lead to less use of general funding without impacting public health spending, which is determined by other political or economic factors.

The most common form of earmarking is to dedicate payroll and income taxes to fund public health spending. The question we address is whether governments with earmarked revenues spend more on per capita health than those governments without earmarking, using general revenue instead. It is not clear earmarking will mobilize revenues for healthcare.

Using linear and non-linear econometric techniques, we test whether this is the case for OECD countries, taking into account other factors influencing public health spending including population aging, per capita GDP, and the cost of providing healthcare. In general, we find that earmarking has little impact on per capita public health spending with some weak evidence to show lower public spending may result if taxes are earmarked.

We begin our discussion laying out the general theoretical arguments in favour and against earmarking in general. This is followed by a discussion of public health spending in OECD and short review of some countries that have used earmarking, drawing analysis from MacKinnon, Mintz and Khanal (2024). We then undertake an econometric analysis to determine whether a greater share of earmarked revenues to total revenues results in higher per capita health spending. We conclude our paper with general observations.

## **2. Why earmarking**

A critical aspect underlying the use of earmarked taxes is the nature of funded public goods and services. Public goods, like defense or policing, are distinguished by being non-rival in consumption (one's consumption of a public good does not diminish consumption of others) and non-exclusion (inability to limit others from consumption). Private goods are characterized by both rivalry and exclusion. Mixed public goods are those in which either non-rivalry or non-exclusion does not hold. Club goods are provided by excluding non-members, but the consumption is non-rival. Common goods are rival in consumption but cannot exclude others from benefits or costs from provision (e.g. spillovers).

Healthcare is an example of both a private and mixed (common) public good that is rival in consumption but in some case cannot exclude others. The benefits of healthcare services such as knee replacements and cancer surgery only accrue to the person receiving it. However, with vaccination against communicable diseases, the vaccinated person helps prevent the spread of a disease to others.

Governments are not just concerned about the efficient allocation of resources in the economy. They also redistribute income and provide a social safety net. Healthcare can be a major expenditure when someone becomes ill. They may forgo spending on healthcare that could lead to a serious outcome, including death. On the other hand, if they cover required fees, they may face financial hardship over many years. The financing decisions made by government will impact their ability to ensure efficient use of resources in healthcare and the ability to support less well-off parts of the population who get ill.

### **2.1 Arguments in favour of earmarking**

Earmarking taxes or revenues has several benefits: better decision-making by governments, matching benefits and taxes in the interest of fairness and efficiency, and a “double dividend” argument if health taxes are dedicated to health spending. To the extent these arguments are persuasive for governments and voters, they will result in greater mobilization of revenues for healthcare spending.

#### ***Preference Revelation and Earmarking***

Buchanan (1963) argues that earmarking allows taxpayers to reveal their preferences for public goods (leading to an optimal allocation of resources when public goods are fully funded by benefit taxes). The argument rests on pricing, in which taxpayers voting for spending on a public goods also know that they pay a contribution to cover for a share of the costs. However, when public decisions are based on other criteria, such as supporting vulnerable parts of the population, the provision of free public goods has a redistributive impact, supporting vulnerable parts of the population (those facing bankruptcy from illness or those unable to cover the cost of medical procedures charged by earmarked taxes).

Earmarking is, thus, supportable as an approach leading to greater preference revelation for public services. It has also been argued to be more democratic by enabling taxpayers to have more direct influence over budget decision-making. It can constrain politicians or bureaucracies from “wasting” revenues on pet projects (Niskanen 1968).

### ***The Benefit Principle***

The strongest argument in favor of earmarking is that it can effectively implement the benefit principle of taxation: people should be taxed in proportion to the benefits they receive from goods and services provided by the government. As Richard Bird (1997) explained, the relationship between earmarking and the benefit principle “solves in a fair and efficient way the two most important problems in public finance: deciding how much of a public service to supply and who should pay for it.” However, how does this idea square with the argument that a universal health system requires “a financing system that collects revenue based on ability to pay and redistributes it across risk and income groups,” which means moving away from the benefit principle is “critical for equity and sustainability” (Bird 1997).

### ***Double Dividend Argument***

Taxing products that are harmful can produce better outcomes as well as raise revenue. A double dividend can be realized by discouraging harmful behaviour through taxation (such as tobacco, alcohol, cannabis and sugar taxes), and using that revenue to finance healthcare. Earmarking taxes that are deemed harmful to one’s health or the economy are sometimes used by countries in which tax compliance is a problem with the goal of increasing compliance.

In some cases, governments want to dedicate a specific revenue source to some form of care spending to protect it “from competing political interests” and exempt it from “budgetary constraints” (Brett and Keen 2000). For example, in low- and lower-income countries earmarking can be used to help expand healthcare coverage, with the goal of laying the foundations for universal healthcare coverage (Hanson et al. 2022). More generally, taxpayers are more amenable to paying a tax that is dedicated to what is considered a worthwhile purpose, rather than taxes which are used for a wide array of spending initiatives. In countries that are federations, some central governments use earmarking to ensure that sub-national levels of government maintain a certain level of spending on a public healthcare.

## **2.2 Arguments against earmarking**

Earmarking can distort spending budgetary decisions leading to excessive or deficient spending on a spending program. Initially, earmarked tax rates are set so that spending and earmarked revenues are in balance. However, in later years, earmarked revenues might grow more (less) quickly than spending needs, artificially leading to excessive (deficient) spending. Thus, there are several issues that need to be considered in assessing the effectiveness of earmarking revenue. For example, is the earmarking for a specified time frame, with regular reviews of its effectiveness, and is there flexibility to change the tax or the time frame in which the funds are to be spent? (Bird 1997). In terms of outcomes, critical questions include: “whether earmarking leads to an efficient or optimal allocation of public funds” and “does earmarking make any difference to expenditure patterns”? (Bird 1997; Cashin, Sparkes, and Bloom 2017).

Further, if a public program is funded by a mix of earmarked taxes and general revenues, earmarked revenues are fungible i.e., any increase in earmarked revenues may have little impact on spending as government redirect non-earmarked taxes to other programs. In other words, taxpayers are deceived since earmarked taxes become virtue signaling without any discernible effect on budgetary decisions.

A study by the World Health Organization found that earmarking revenue for healthcare led to an increase in funding for healthcare in the short-term (Cashin, Sparkes, and Bloom 2017). However, it also found that “the findings are less clear on whether earmarking for health spending can bring a sustained increase in government revenues allocated to the health sector, particularly as a relative share of total government spending.” As the study pointed out, budgets are “fungible” and earmarking funding for one revenue source is likely to be offset by cuts in other sources. The study also pointed out that “it is impossible to know the counterfactual scenario in which earmarking policies have not been pursued” (Cashin, Sparkes, and Bloom 2017, 27). That is, it is difficult to prove the link between earmarked funding for healthcare and an increase in funding for healthcare. Did healthcare funding increase because of the earmarking or would it have increased anyway?

Also, an earmarked tax could lead to the underfunding of a mixed public good if the earmarked tax is less than the cost of public good provision. Taxpayers only internalize the benefits and the cost they incur, forgetting that a subsidy is needed to cover the public cost in providing the public good or service.

### **3. Earmarking for healthcare globally and in the OECD**

Globally, eighty countries earmark taxes for health spending (Bloom 2022; Ozer et al. 2020). The most common form of earmarking is to use income or payroll taxes to fund health spending (62 countries). Four countries use dedicated value-added taxes. Another commonly used form is to earmark taxes on products that are deemed to be unhealthy: 35 countries earmark all or a portion of revenues from tobacco taxes, nine earmark all or a portion of revenues from taxes on alcohol sales, and 10 earmark revenue from taxes on other goods that can negatively affect health, notably sugar-sweetened beverages (Ozer et al. 2020, 3). Another eight countries earmark a portion of transfers from the national level or earmark revenue generated at the subnational level for health spending (Ozer et al. 2020). Finally, two countries earmark lottery funding, and one uses a levy on foreign personal money transfers and mobile phone company revenues (Cashin, Sparkes, and Bloom 2017, 14).

A systematic review of over 100 health taxes around the world found that taxes on unhealthy products increases government revenue (Wright, Smith, and Hellowell 2017). Other studies find earmarked taxes positively impacting public health spending (Studnicki et al. 2007; Honoré et al. 2011). These taxes also improve public health outcomes. Taxes on unhealthy products have shown to reduce demands for such products (Wright, Smith, and Hellowell 2017). Mortality rates associated with various diseases lowered as a result of earmarked health taxes in Florida (Studnicki et al. 2007). Similar results were seen in a study of 720 counties in the Mississippi Delta Region (Honoré et al. 2011).

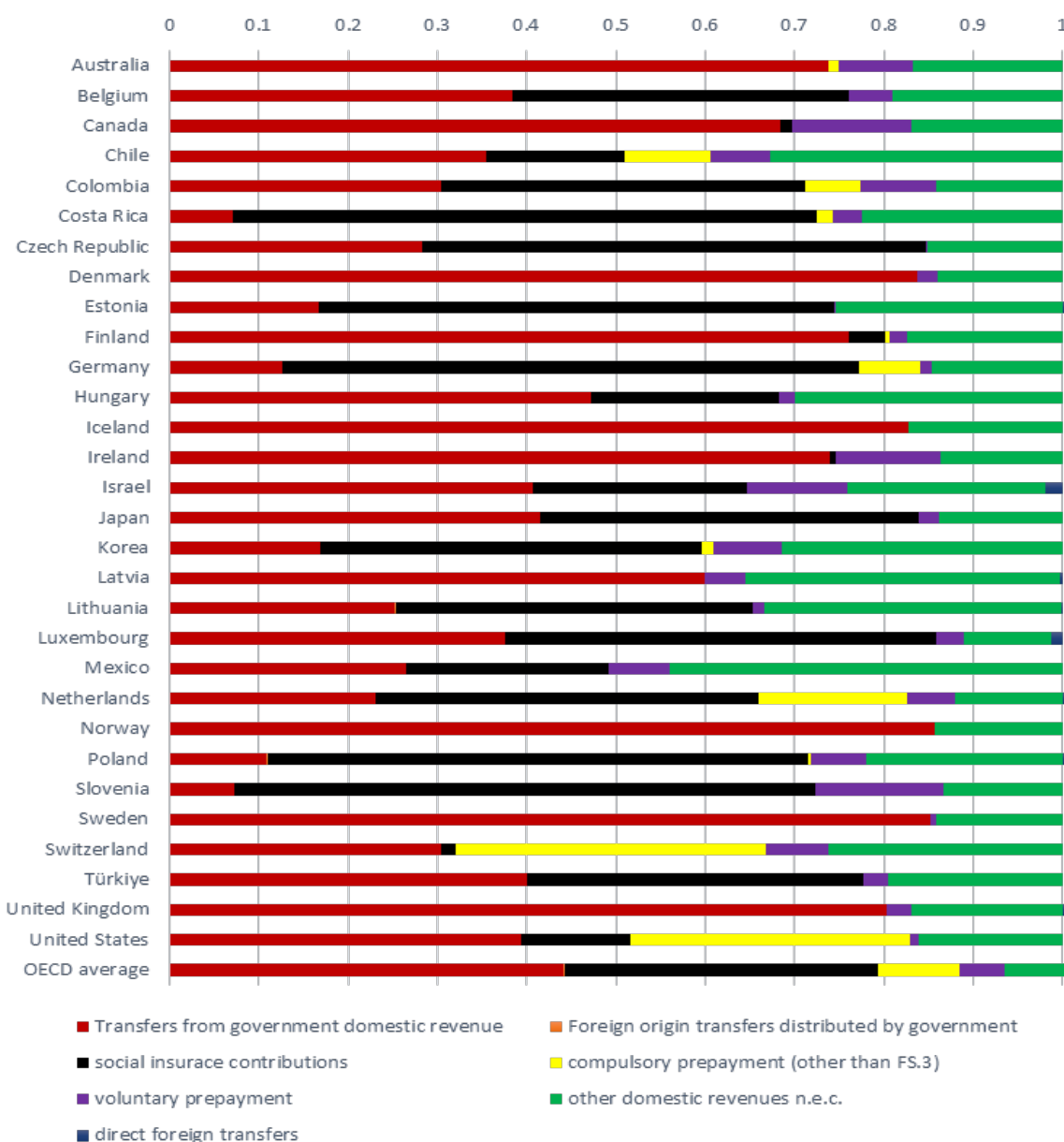
However, public health outcomes as a result of earmarked taxes vary across demographics and income. A region with greater proportion of aging population may not observe significant impact, while improved health outcomes occur as a result of earmarked taxes only if a region is already relatively well-off. For example, in the Mississippi Delta Region, earmarked taxes improved public health outcomes in counties where per capita income exceeded \$28,000 while



such taxes lowered the public health outcomes in poorer counties (Honoré et al. 2011). Other scholars have observed similar results elsewhere: additional taxation imposed on an already poor population to support public health funding does not lead to improved public health outcomes (Meheus and McIntyre 2017).

Among the OECD countries (Figure 1 below), a variety of revenue sources are used to fund healthcare, including general revenue transfers, social insurance contributions, involuntary payments, voluntary compulsory prepayment schemes, and prepayments (e.g. medical expense accounts).

**Figure 1: How Public Healthcare is Funded in OECD Countries in 2019**



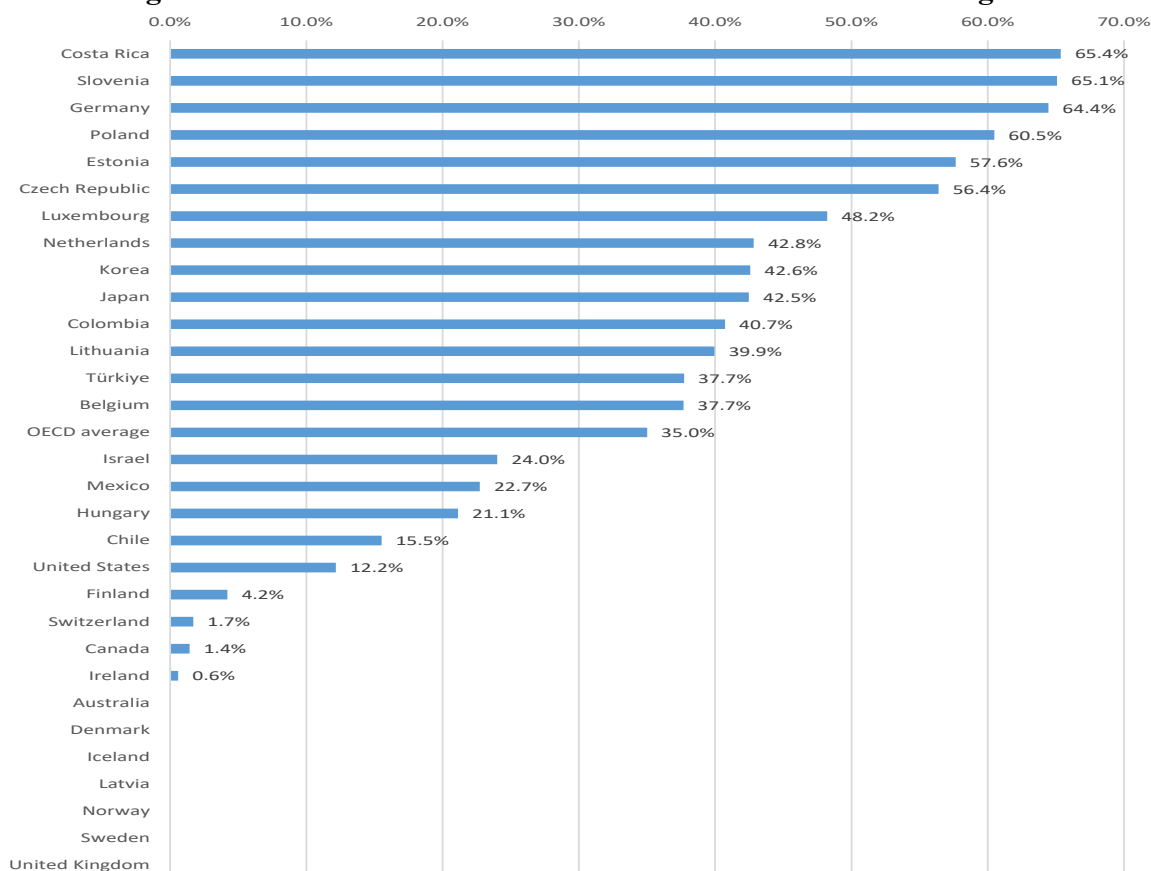
Source: OECD Health Statistics

The Anglo-countries (except the United States) primarily use general revenues to finance healthcare (Australia, Canada, Ireland, New Zealand, and the United Kingdom). Denmark uses general revenues to fund over half of healthcare costs, although Denmark once used payroll taxes to fund social security but were replaced by income taxes after 2010 to encourage labour supply (Larsen 2010). Belgium, Colombia, Japan, and Luxembourg have healthcare systems funded mainly through two sources: government transfers and social contributions. Chile, Colombia, Hungary, Israel, Korea, Lithuania, Mexico, Netherlands, Switzerland, Turkey, and the United States have health systems that could be called diversely funded.

Not included in Figure 1 are user charges and incentive-based (co-payment) systems. These payments are naturally earmarked to fund specific health services. Instead, they are classified as part of out-of-pocket expenses on a cost-shared basis with the government, which are not separately reported.

Of countries that use social security payroll contributions earmarked to fund healthcare, most are European with payroll taxes (Figure 2). A half or more of healthcare system financing in Costa Rica, Slovenia, Germany, Poland, Estonia, and Czech Republic are through social insurance contributions. So, citizens directly majority-fund these healthcare systems through social insurance contributions.

**Figure 2: Social Insurance Contributions to Healthcare Funding in 2019**



Source: OECD Health Statistics

Most OECD countries also get significant financing through voluntary prepayments, while Switzerland and the United States' healthcare systems (and to an extent the Netherlands) stand out for their large shares of healthcare financing coming from compulsory prepayment.

#### **4. Some case studies**

In our Tax Notes International paper (Mackinnon, Mintz, and Khanal 2024), we presented detailed case studies of how six countries (the Philippines, South Korea, South Africa, France, Germany, and Brazil) use earmarking to fund healthcare.

The Philippines used to collect excise taxes from harmful products like tobacco and alcohol, and earmarked such taxes to fund healthcare. The Sin Tax Reform Act of 2012 made that earmarking permanent (Cashin, Sparkes, and Bloom 2017). By 2020, 50 percent of taxes on sugar-sweetened beverages, 20 percent of taxes on tobacco, 100 percent of taxes on tobacco and vaping products, 40 percent of Philippine Charity Sweepstakes Office profit, and 50 percent of Philippine Gaming Corporation profits were earmarked to fund healthcare (Ozer et al. 2020, 5).

While the Philippines earmarks its tax revenue to fund healthcare, Brazil and South Africa engage in expenditure earmarking. South African national government earmarks 20 percent of its expenditure to healthcare (Cashin, Sparkes, and Bloom 2017, 38). After various attempts at revenue earmarking for healthcare in the past failed, Brazil resorted to expenditure earmarking for healthcare in 1996: the federal government was required to maintain its current level of funding at that time and adjust it accordingly based on GDP changes, while states were required to spend at least 12 percent and municipalities at least 15 percent of their respective budgets on healthcare (Massuda et al. 2020).

Germany and South Korea earmark payroll taxes for healthcare. In 2020, Germany set the payroll contributions at 3.05 percent of gross wages, with additional 0.25 percentage point contribution required from those aged 23 years and older (Blumel and Busse 2020, 88). Germany also sets aside 0.1 percent of contributions annually, which is accessible in 2035 to cover aging baby boomers (Blumel et al. 2020, 182). In addition to payroll taxes, healthcare funding in South Korea also comes from government subsidies and tobacco surcharges. Unlike Germany's decentralized system, healthcare in South Korea is centralized and less complex, which results in lower administrative costs and better efficiency (Kwon, Lee, and Kim 2015).

In 1998, France stopped funding healthcare exclusively with payroll taxes. In 2017, 53 percent of funding still came from payroll taxes, 34 percent from earmarked income taxes, 12 percent from alcohol, tobacco, and pharma taxes plus voluntary health insurance, and the remaining 1 percent from state subsidies (Durand-Zaleski 2020, 72-73).

In our analysis of these country cases, we found that earmarking did not mobilize healthcare spending, except in the case of the Philippines and long-term care insurance in Germany. Revenues from earmarked taxes were often used to reduce other revenues used to fund healthcare rather than increase health spending. While France and Germany restrain spending to align with revenue, there is no regular review of the basic organization and funding of their

health systems. Local authorities have key decision-making powers in Brazil, South Africa, and Germany. The decision-making is fragmented in the Philippines. The social insurance funding model has problems of efficiency (controlling spending is difficult) and equity (contributions do not depend on ability to pay). We found that the German model of mandatory basic long-term care insurance is noteworthy and should be replicated in more countries.

## **5. Econometric analysis**

The basic proposition we now turn to is whether earmarking, as generally defined, results in greater mobilization of revenues to be spent on public healthcare spending. We turn to an econometric approach to determine if earmarking mobilizes revenues for health spending. We focus on the industrialized countries in the OECD, which has the most complete data that are needed to test our proposition.

The trend of earmarking for public health spending grew while countries' public health spending grew faster than government revenue (Glied 2008), thereby causing a funding shortage. While earmarked health taxes often face consumer opposition and the associated revenue stream is volatile, earmarking revenue from health taxes for a specific purpose arguably increases public and political support for such taxes (Wright, Smith, and Hellowell 2017). On the other hand, earmarked taxes may not grow as quickly as other revenues sources to fund healthcare. Political resistance, tax evasion, and fairness concerns might limit their application. Thus, it is unclear whether more earmarking mobilizes revenues for healthcare spending. That is what we wish to test.

Countries finance their public health spending with “transfers from the government, social insurance contributions, voluntary or compulsory prepayments (such as insurance premiums), other domestic revenues and revenues from abroad (for example, as part of development aid)” (OECD 2021). However, there are issues in identifying and estimating public health financing data, even across the OECD. For example, “institutional prevention” financing data in France includes national programs but excludes many activities at the local level, such as complementary funding provided by local governments (Rechel et al. 2018, 64). Similarly, it is difficult to estimate public health financing data in Italy because public health costs and general healthcare costs are intertwined and dispersed with national and regional funding sources (Rechel et al. 2018, 63). Using national estimates also poses policy concerns since there are variations across regions within a country, and the national aggregate data often fails to capture and highlight that variation.

### **5.1 Econometric modeling**

In light of the above findings, our literature review in earlier parts of this paper, and the findings from the case studies paper, we identified several variables for our econometric analysis. The objective of our analysis is to determine whether earmarked taxes<sup>1</sup> have an impact on public health spending per capita in the OECD.

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<sup>1</sup> The OECD breaks down revenue sources for healthcare into 7 components, each calculated as percentage of total current health expenditure. “Earmarked taxes” is the sum of two components: social insurance contributions and compulsory prepayments.

The literature review tells us income levels and poverty levels affect public health spending and its outcomes. Therefore, we include Gross Domestic Product per capita in international PPP dollars and poverty rate<sup>2</sup> in our analysis. Since rising prices for healthcare service makes healthcare more expensive (Rechel et al. 2018), we include healthcare price level<sup>3</sup> in our analysis to observe what kind of impact it has on public health spending. Finally, because the general population is getting older and may be increasing the demand for public health expenditure, we include population aging<sup>4</sup> to observe its impact on public health spending.

Therefore, the dependent variable in our econometric analysis is the public healthcare spending on per capita international PPP dollars. The independent variables are earmarked taxes as share of public health spending, per capita GDP in international PPP dollars, elderly population as a share of total population, healthcare service price level index, and the poverty rate. Except for the healthcare service price level index, which is obtained from a 2017 OECD survey, the OECD statistical data for all other variables are for 2019. Because some of the data were unavailable for some of the countries, we end up with 27 OECD countries in our cross-sectional analysis. Although we had data available for 2020 and later years, we perform the analysis for 2019 in order to avoid COVID-related distortions in the data.

**Table 1: Descriptive statistics**

<b>Variables</b>	<b>Mean</b>	<b>Median</b>	<b>Standard Deviation</b>	<b>Minimum</b>	<b>Maximum</b>
Public Current Health Expenditure Per Capita, PPP \$	3,210	3,701	1,613	542	6,055
Earmarked Taxes (%)	31.2%	37.7%	25.2%	0.0%	71.3%
GDP per capita, PPP \$	50,908	49,289	20,810	20,224	119,542
Healthcare Price Level Index	86	94	40	20	172
Elderly population (%)	17.5%	18.6%	4.5%	7.4%	28.4%
Poverty rate (%)	11.8%	10.9%	4.1%	5.6%	19.9%

In 2019, Mexico (\$542) had the lowest public health spending per capita while Norway (\$6,055) spent the most. Denmark, Latvia, Norway, Sweden, and the UK had no earmarked taxes supporting public health spending, while most of Germany's public health spending came from earmarking (71.3%). Luxembourg (\$119,542) had the largest GDP per capita and Mexico (\$20,224) had the lowest. With healthcare price level index of 172, Switzerland had the highest costs of procuring healthcare services, and Turkey (20) was the cheapest. Elderly as a proportion of the population was highest in Japan (28.4%) and lowest in Mexico (7.4%). Poverty rates were highest in Costa Rica (19.9%) and lowest in the Czech Republic (5.6%).

In our analysis, as discussed below, we are concerned about two particular statistical issues: (i) endogeneity (e.g. earmarked taxes and per capita public health spending are both related to the same factor such as incomes), and (ii) multicollinearity between variables (e.g. higher poverty rates in countries with lower per capita GDP).

<sup>2</sup> The OECD poverty rate used in our analysis is the ratio of the number of people whose income falls below the OECD poverty line (half the median household income of total population). See: OECD (2023b).

<sup>3</sup> The healthcare sector price level index is from a 2017 OECD survey report. The OECD average is set as 100, and countries are given index scores that are their price level index. The higher the index, the more expensive the healthcare is in that country. Please see: OECD (2020).

<sup>4</sup> The OECD defines the elderly as aged 65 years and older. Please see: OECD (2023a).

## 5.2 Correlation analysis

In statistics, correlation describes how closely associated two variables are. Correlation tests give us correlation coefficients, which can range from -1 to +1, showing not only the magnitude of the association but also the direction. For example, a correlation coefficient close to +1/-1 indicates a strong positive/negative relationship between two variables, while a coefficient close to zero indicates no relationship. Therefore, a positive correlation means both variables increase at the same time, and a negative correlation means one variable increases while another decreases (James 2023). The presence of correlation, however, does not imply causality between dependent and independent variables.

**Table 2: Correlation Test of dependent and independent variables**

	Public Health Spending	Earmarked Taxes	GDP per capita	Healthcare Price Level Index	Elderly Population	Poverty Rate
Public Health Spending	1					
Earmarked Taxes	-0.25	1				
GDP per capita	0.76	-0.14	1			
Healthcare Price Level Index	0.66	-0.35	0.63	1		
Elderly Population	0.36	-0.01	0.13	-0.01	1	
Poverty Rate	-0.43	0.16	-0.42	-0.16	-0.41	1

We find per capita public health spending is strongly correlated with GDP per capita and healthcare price level index, and moderately correlated with elderly population and poverty rate. Among the independent variables, per capita GDP and healthcare price level index are strongly correlated; poverty rate is moderately correlated with GDP per capita and elderly population; and healthcare price level index is moderately correlated with earmarked tax. Because correlation analysis assumes linear relationship between variables, the negative or positive signs indicate the direction of the relationship, which we can see as downward sloping or upward sloping trendlines on scatterplots.

## 5.3 Cross-section regression estimation

For the five explanatory variables we have identified plus the dependent variable, we have complete data for 27 OECD countries for the year 2019 (except the healthcare price level index, which comes from a 2017 OECD survey). Table 3 shows the result of a cross-section regression of these variables.

**Table 3: Cross-section regression result**

Regression Statistics					
Multiple R	0.85				
R Square	0.73				
Adjusted R Square	0.66				
Standard Error	934.94				
Observations	27				
ANOVA					
	df	SS	MS	F	Significance F
Regression	5	49278051.7	9855610.34	11.28	2E-05
Residual	21	18356322.97	874110.6179		
Total	26	67634374.67			
	Coefficients	Standard Error	t Stat	P-value	
Intercept	-1252.92	1416.86	-0.88	0.39	
GDP per capita	0.04	0.01	3.09	0.01	
Healthcare price level index	12.51	6.33	1.98	0.06	
Earmarked tax	-391.82	793.68	-0.49	0.63	
Elderly population	10009.49	4464.38	2.24	0.04	
Poverty rate	-1959.83	5499.56	-0.36	0.73	

In the cross-section regression model, the p-values tells us that three of the five independent variables we identified are significant at a minimum 10 percent significance level: per capita GDP, healthcare price index, and the elderly population. The poverty rate and the all-important earmarked tax variables are not significant, indicating little relationship between them and per capita public health spending. The R-squared is 0.73, which means this set of explanatory variables explain 73 percent of the variance in the per capita public healthcare spending in the OECD. Compared to the R-squared, we have a lower adjusted R-squared of 0.66, which tells us that our regression has one or more explanatory variables that hurt the estimation efficiency i.e., identifying and removing a “useless” variable will improve the estimation power of this regression model.

A correlation test (Table 4) shows the independent variables are not correlated to the residuals of the regression (their correlation coefficients are all zeros or close to zero). Therefore, the regression does not have endogeneity issues. However, given several strong and moderate correlations between independent variables (see Table 2), we cannot rule out multicollinearity issues.

**Table 4: Correlation between regression residuals and explanatory variables**

	Residuals	GDP per capita	Healthcare Price Level Index	Earmarked tax	Elderly Population	Poverty Rate
Residuals	1					
GDP per capita	0.00	1				
Healthcare Price Level Index	0.00	0.63	1			
Earmarked tax	0.00	-0.14	-0.35	1		
Elderly Population	0.00	0.13	-0.01	-0.01	1	
Poverty Rate	0.00	-0.42	-0.16	0.16	-0.41	1

Multicollinearity does not affect the regression model's efficacy and predictive prowess (Gujarati 2009). However, a plot of the residuals from the cross-section regression shows a U-shaped pattern, which tells us that a linear model is not appropriate for our data. Therefore, we will attempt a non-linear regression estimation for better results. In the next section, we achieve that with the use of quadratics and logs to standardize our variables in an attempt to reduce the issue of multicollinearity. We also use lags of variables to further improve our model.

#### 5.4 Non-linear regression estimation

To address non-linearity, we re-run the cross-section regression utilizing several approaches:

- Instead of the earmarking tax variable, we use a tax dummy to deal with any possible endogeneity.
- We use per capita public health spending or alternatively the log of per capita public health spending.
- We use the quadratic for per capita GDP and alternatively the log of per capita GDP.
- We use the quadratic for healthcare price level index.
- We also test using lagged variables for GDP and earmarked tax.

Using the combination of these approaches, we run several cross-section regressions, removing any explanatory variable and their lags if they are shown to be statistically insignificant (p-value greater than 10%). We then re-run the regressions. We keep the earmarked tax in our regressions no matter its significance because we are interested in observing what kind of impact it always has in determining public health spending. After performing these steps, we arrive at four promising non-linear regression models (see Table 5).

**Table 5: Regression results**

	Estimation 1	Estimation 2	Estimation 3	Estimation 4
	Dependent variable	Dependent variable	Dependent variable	Dependent variable
	Log per capita public healthcare spending	Log per capita public healthcare spending	Per capita public healthcare spending	Per capita public healthcare spending
R square	0.94	0.94	0.85	0.90
Adjusted R square	0.92	0.92	0.82	0.86
F statistic	64.3 ***	50.3 ***	24.6 ***	24.1 ***
	Coefficient	Coefficient	Coefficient	Coefficient
Intercept	-41.17 (-5.4) ***	-41.92 (-5.31) ***	-4654.88 (-4.7) ***	-1991.17 (-1.4)
Healthcare price level index	0.009 (5.62) ***	0.01 (4.63) ***	57.56 (3.8) ***	48.22 (3.4) ***
Healthcare price level index squared	-0.00005 (-5.27) ***	-0.00004 (-4.24) ***	-0.31 (-3.8) ***	-0.29 (-3.9) ***
Log per capita GDP	17.76 (5.44) ***	18.08 (5.35) ***		
Log GDP squared	-1.77 (-5.06) ***	-1.80 (-4.99) ***		
Earmarked tax dummy	-0.06 (-1.48)			-831.71 (-2.6) **
Earmarked tax		-0.27 (-1.17)	-297.09 (-0.5)	
Earmarked tax squared		0.47 (1.31)		
Per capita GDP			0.16 (5.3) ***	0.21 (4.3) ***
Per capita GDP squared			-0.000001 (-4.0) ***	-0.000001 (-3.5) ***
Elderly population				-35951.74 (-1.8) *
Elderly population squared				99152.91 (1.9) *

\*\*\* significant at 1%

\*\* significant at 5%

\* significant at 10%



We start with regression estimations based on log of per capita public health spending as the dependent variable. We end up with two promising models: estimation #1 and estimation #2. However, residual plots of both these regressions show U-shaped patterns persist, suggesting that the two models still do not give us the best fit to the data.

We then re-run the estimations with per capita public health spending as the dependent variable. This gives us two other promising regression models: estimation #3 and estimation #4. The residual plots of these two regressions show no clear pattern, suggesting that these two regressions clearly give us better fit to the data than the previous regressions. Between these two regression estimates, however, estimation #4 gives us residuals that are closer and tighter, suggesting it is the better of the two models.

Therefore, estimation #4 is the best model we have, given the set of explanatory variables we identified. GDP per capita and healthcare services price level index are significant at 1 percent level. Earmarked tax dummy is significant at 5 percent level, while the elderly population is significant at 10 percent level. Poverty rate is insignificant (hence, removed from the regression model). The adjusted R-squared of 0.86 is slightly lower than the R-squared of 0.90, which tells us we may still have an extra explanatory variable that is lowering the regression model's predictive prowess. However, the adjusted R-squared tells us this model still manages to explain 86 percent of variation in public healthcare spending per capita in the OECD. The F-statistic is large and significant at 1 percent level, suggesting that the combination of explanatory variables in estimation #4 accounts for much of the variance in the dependent variable and does an excellent job of it. The F-statistics tells us we have a very useful model to explain the variance in public healthcare spending per capita in the OECD.

The results in estimation #4 show that for every 1-unit worsening of health services price level index (i.e., prices for healthcare services getting more expensive), the country's public healthcare spending per capita increases by \$48. Similarly, a \$1 increase in per capita GDP increases public health spending per capita by \$0.21.

Most importantly, we find that earmarked taxes do not lead to more per capita public health spending in the OECD. Instead, if an OECD country has earmarked taxes to support public healthcare, per capita public health spending in that country actually lowers by around \$831, compared to a country that has no earmarked taxes supporting public healthcare.

## **6. Conclusion**

The World Health Organization has advocated the earmarking of health-related taxes to mobilize revenues to be spent on public health spending. While there are certain advantages and disadvantages in the use of earmarked taxes to fund healthcare, its ability to mobilize revenues will depend on whether earmarked taxes are acceptable to voters or not. It also depends on whether earmarked revenues ultimately lead to more health spending – it will not succeed if government simply replace earmarked taxes for general revenues, leaving public health expenditure untouched.

We find that earmarked taxes do not lead to more per capita public health spending in the OECD. If a country has earmarked taxes to support public healthcare, per capita public health spending may decline by over \$800, compared to a country with no earmarked taxes supporting public healthcare. The case for earmarking has to be based on other arguments instead.

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