Tram Thi Bich Pham

A CURSE OR A BLESSING:

WILL MORE MONEY MAKE YOUR CHILD HEALTHIER?

EVIDENCE FROM THE ROYALTY PAYMENTS

IN PAPUA NEW GUINEA (PNG)

MA Thesis in Economics and Business.

Central European University Private University

Vienna

June 2021

A Curse or a Blessing: Will More Money Make Your Child Healthier? Evidence from the Royalty Payments in Papua New Guinea (PNG)

by

Tram Thi Bich Pham

(Vietnam)

Thesis submitted to the Department of Economics and Business,

Central European University Private University, Vienna, in partial fulfillment of the

requirements of the Master of Arts degree in Economics and Business.

Accepted in conformance with the standards of the CEU.

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Chair, Examination Committee

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Author’s declaration

I, the undersigned, **Tram Thi Bich Pham**, candidate for the MA degree in Economics and Business declare herewith that the present thesis is exclusively my own work, based on my research and only such external information as properly credited in notes and bibliography. I declare that no unidentified and illegitimate use was made of the work of others, and no part of the thesis infringes on any person’s or institution’s copyright. I also declare that no part of the thesis has been submitted in this form to any other institution of higher education for an academic degree.

Vienna, 02 June 2021

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Abstract

While there has been extensive policy and research focusing on cash transfer and income increase on child health outcomes, there have been conflicting results even for well-known interventions such as Mexico's Progresa (Oportunidades). Moreover, an area that remains relatively understudied is how royalty payments affect child nutritional status. Using the novel data from three districts in Western Province, Papua New Guinea, I examine the causal inference of royalties on infant and young child growth, measured by the 2006 WHO Child Growth Standards. To account for the imbalance in the treatment and comparison groups, propensity score matching (PSM) method is employed. The treatment is shown to bolster the child weight-for-height (WHZ). Royalties, however, do not significantly influence risk factors associated with WHZ. It may be that financial compensation needs to be accompanied by simultaneous education to improve child outcomes.

Keywords: Nutrition, anthropometric measurements, royalties, matching, Papua New Guinea.

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Introduction

Despite substantial investment and improvements in the health sector, more than two million children yearly die before the age of five due to malnutrition (Pham et al., 2021). Many of those who survive suffer from severely impaired growth or weak immune systems. Research has shown that stunting (too short for one's age), underweight (too thin for one's age) and wasting (too thin for one's height) in the first two years of one's life are associated with one's long-term prospects such as health, cognitive ability and employment outcomes (Yoshikawa, 1995; Grantham-McGregor et al., 2007; Heckman and Masterov, 2007). These trends are unacceptably high in many low and middle income countries (Victora et al., 2021). Because of these haunting statistics, the United Nations highlighted the importance of ending hunger, obtaining food security and improving nutrition in the Sustainable Development Goals for 2030.

At the national level, governments have implemented various interventions to break this negative trend, usually through adopting cash transfer programs, either conditionally or unconditionally. The most prominently cited program is Mexico's Progresa (Oportunidades), in which poor rural households' children under five are required to attend nutrition monitoring clinics and their family visit local health centers in order to receive the cash transfers from the government (Gertler and Boyce, 2003). Behrman and Hoddinott (2005) find a positive impact of Progresa on growth and a lower probability of stunting among children less than three years old. However, Aguero, Carter, and Woolard argue that it is ambiguous whether the program demonstrates a "non-zero income elasticity of nutrition", or it is those required conditions that boosted child outcomes (2009, p. 2).

Other countries, on the other hand, implement unconditional cash transfer programs such as the South African Child Support Grants (CSG). Unlike Progresa, CSG provides child assistance without any specific conditions in cash to a parent who cannot rely on the support of the other parent. Aguero, Carter, and Woolard apply continuous treatment methods by exploiting a slow program roll-out to create “eagerness” as an exogenous variable to evaluate CSG’s impacts on a child’s height-for-age z-score (HAZ). Their results show that children who received CSG for two-thirds of their first 36 months of life have 0.20 more HAZ than those receiving cash transfer for only three or four months of their first three years of life (2009, p. 26). In addition, matching methods have often been utilized to analyze the effects of cash transfer programs on child nutritional status in other contexts, such as in Nepal (Powell-Jackson and Hanson, 2012) or Nigeria (Perin et al., 2020).

Another strand of literature has looked at the association between family income and child health (Case, Lubotsky, and Paxson, 2002; Currie and Stabile 2003; Currie, Shields, and Price, 2007). Their findings are mixed. Utilizing the US National Health Interview Survey, Case, Lubotsky, and Paxson (2002) find that children in poorer families had significantly worse health compared to their counterparts. Currie and Stabile (2003) document the same evidence in Canadian contexts. Currie, Shields, and Price (2007), however, find no significant family income/child health gradient by using the Health Survey for England. Despite being influential, these research studies mostly rely on subjective measurements of child health or on blood samples. They also focus on developed countries with rich datasets.

In this paper, I fill in this gap in the extant literature by addressing the question of whether financial compensation affects child growth. Specifically, I exploit the royalty payments for landowners in Papua New Guinea (PNG), whose economy is export-oriented (ADB, 2021). These royalties are provided to families affected by the operation of mining, oil, gas and forestry companies. In the words of Bena, one of the societies in PNG, “the payment of compensation is an admission of liability by the offending party” (Burton et al., 1997, p.51). Due to its versatile functions, royalty payments in PNG can fit into a wide scope of literature on child nutritional status. They can either be considered as a form of cash transfer, though not from the government and not based on conditions, or offer a chance to analyze the impacts of a windfall gain (or increase in a family's income) on child nutritional status. Moreover, the data enables me to expand the analysis about the impacts of income on child health compared to the existing literature in three ways. First, I can look at the children's anthropometric measurements instead of subjective measurements. Second, the holistic indices of child anthropometric measurements will be analyzed: height-for-age (HAZ), weight-for-age (WAZ), weight-for-height (WHZ). Third, I can investigate whether the children and families' nutrition intake and morbidity affect child outcomes.

To address the research question, I leverage the novel dataset collected last year (2020) by the University of Papua New Guinea and World Vision, assessing infant and young child feeding and growth in Western Province in PNG. The data provides detailed information to analyse the causal inference of royalties on child growth and the pathways that nutrition intake affects child outcomes.

I begin my empirical strategy by painting a picture of the current child nutritional status in Western Province. I document that the sample's prevalence of stunting, underweight and wasting among children under two is 12.1%, 17.3% and 18.8% respectively. The wasting rate is critical for public health significance based on WHO's prevalence cut-off (WHO, 2010). I then compare the means characteristics of the children, caregivers and families between the treated and control groups. Preliminary t-tests show that children from royalty-receiving families are more likely to be stunted, while less likely to be wasted than their counterparts. These differences are statistically significant. The classification between the two groups also reveals that the caregivers in the treated group tend to be slightly younger, less likely to partake in farming or personal/family business and more likely to use contraception.

Having established these statistics about the child outcomes and background, I move to analyzing the causal inference of royalties on child growth. Not being a randomized experiment like Progresa, the treatment and control groups from PNG are not easily compared due to their various unobserved characteristics that may be associated with their probability of receiving the royalties and the targeted outcomes. Hence, I apply a propensity score matching (PSM) method to evaluate the effects of the royalties on child nutrition. My analysis shows that having access to royalty payments does not significantly improve child nutritional status or the causal inference is very weak. In other words, children from royalty-receiving families have slightly higher weight-for-height z-score (WHZ) than those in without-royalty families. More closely focusing on nutrition pathways that lead to the previous outcomes, I find that the royalty status has similar effects on risk factors associated with wasting among the treated and control group. It may be either because the treated group do not fully utilize facilities provided by the mining companies or they spend their cash windfalls on nutrients that do not significantly improve child outcomes.

The remainder of the paper is structured as follows. Section 2 describes the background and data. Section 3 presents the empirical strategy. Section 4 and 5 discuss the main findings and heterogeneity in impacts. Section 6 looks at the associations between royalties and risk factors with child outcomes; Section 7 concludes the paper.

II. Background and Data

In this section, I first present a picture of the current child nutritional status in PNG and introduce the royalty payments scheme. I then describe the summary statistics and prevalence of undernutrition and morbidity among the children in the sample.

1. The Nutritional Status of Children under 2 Years Old in PNG

PNG is a lower-middle income country in the South Pacific region. It is classified as a "fragile and conflict-affected" developing country (ADB, 2021). Around 85% of its 9 million citizens live in rural areas and rely on resources from mining industries (Pham et al., 2021, p.2). Despite significant improvement in economic development in the last 20 years, "PNG is facing a nutrition crisis" (Save the Children, 2017). Around 36% of children's deaths in PNG were caused by malnutrition in 2012 (Aipit S, Aipit J, Laman M., 2014). Save the Children (2017) also reports that one in two children in PNG are stunted, which ranks PNG as having the fourth highest in child stunting rate in the world. Alarmingly, the stunting rate in the country has worsened throughout time: 43.5% in 2005 to 49.5% in 2015 and it is prevalent in all income distribution quantiles (2017). As Figure 1 reveals, stunting, wasting and malnourishment are common in all regions in PNG. Stunting is the most serious issue, with around 45% of children under five being stunted and more than 20% severely stunted. Despite this frightening situation, not enough attention has been paid to understanding the causes and solutions to child malnutrition in PNG, mostly due to the unavailability of data (Miyoshi et al., 2015).

Pham et al. argue that nutrition transition and changes in dietary behaviors may affect the child nutritional status of the country. Besides macro environmental factors, micro factors such as household wealth can also influence the nutrition choice and consumption (2021, p. 2-3). As a windfall or compensation, royalty payments can also be characterized as one of the micro factors contributing to this nutrition transition.

In PNG, the royalties' distribution process is usually handled by the State. Based on section 73 of the Land Act, landowners were prohibited from directly dealing with mining investors (Polume-Kiele, 2014). However, the introduction of the new Mining Act 1992 allowed landowners to discuss and get involved in the compensation process through development forums (2014). Tony Power in "Landowner Compensation: Policy and Practice," highlights the compensation process as follows. For mining and petroleum projects, the State tries to secure the best revenue for the country by setting tax rules and sharing mechanisms with investing companies. Then the provincial governments receive royalties as provincial government budgets, together with special support grants (SSG) given for provincial infrastructure development. Following the procedure, landowner groups receive "at least 20 per cent" of the royalties provided to the provincial government (Burton et al., 1997, p.86). The landowners then divide the royalties within themselves and distribute them to individual households. This process, however, needs further studies (Callan, 2013).

For forestry projects, the State controls the forest extraction and sale. The forest exporting tax paid to the State is from 20-46 percent. Landowners receive royalties, while the provincial government receive around 1.25 percent of the export amount (Burton et al., 1997, p.88).

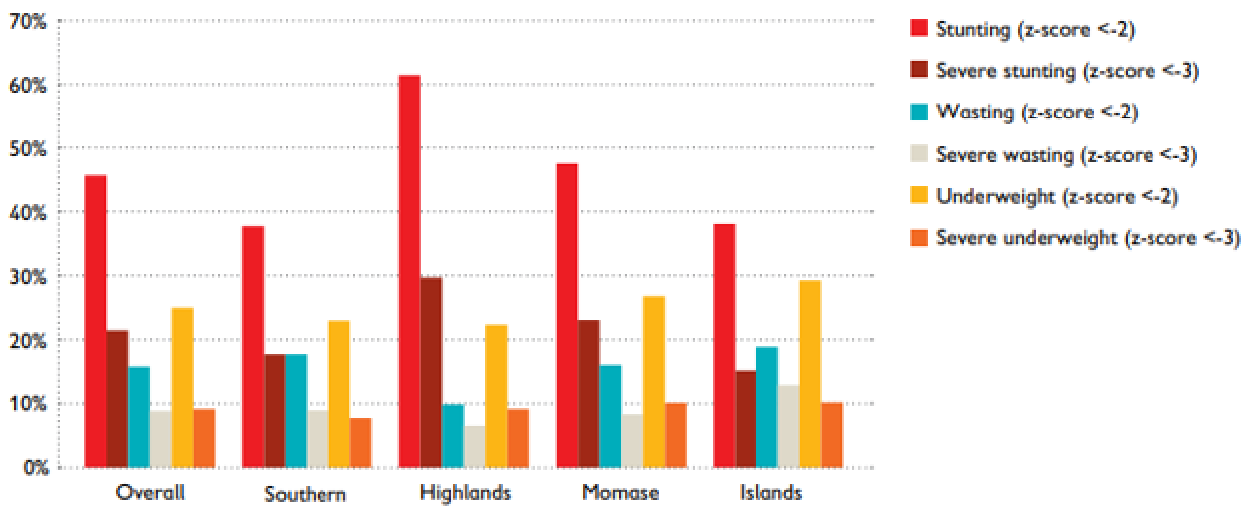

Figure 1. Severe Stunting, Wasting and Underweight Rates in PNG (Source: Save the Children, 2017)

2. Data and Sample Characteristics

a. Sample Location

In 2020, The University of Papua New Guinea, particularly the School of Medicine and Health Sciences, collaborated with World Vision to conduct a cross sectional study titled “An Assessment of Infant and Young Child Feeding and Growth in TB-affected communities in Western Province” with the aim to assess infant and young child feeding and growth and caregivers’ nutrition knowledge. The study recorded anthropometric measurements of 752 children under two and interviewed their caregivers’ about the children’s nutrition intakes and the caregivers’ knowledge and practices regarding nutrition. The questionnaire covered basic demographic characteristics and the question about whether the families receive the royalties from local mining, forestry, fishing or other companies.

Western Province, the study site, is the largest province in PNG by area, with its three districts: North Fly, Middle Fly and South Fly. The main economic income comes from the OK Tedi Mine, operated by Ok Tedi Mining Limited (OTML). As demonstrated in Figure 2, Western Province health performance lay below the national average in 2016. Among 22 provinces, Western Province’s health worker to population ratio is 0.6, while the average ratio in the country is 0.9.

b. Child Growth Indicators

Anthropometric measurements have been widely recognized as indicators for child nutritional status and growth (WHO, 2010). Height-for-age (HAZ) reflects the effects of the nutritional status and infections before and after birth, thus it indicates living conditions and long-term growth faltering. Weight-for-height (WHZ), on the other hands, reflects “proper body proportion or the harmony of growth” (Prakash, Shetty). Weight-for-age (WAZ) is a synthesis of HAZ and WHZ, so it is used to detect underweight. Based on the 2006 WHO Child Growth Standard, children with HAZ, WAZ, WHZ below minus two are identified as stunted, underweight and wasted, respectively. Those with z-scores below minus three are considered severely stunted, underweight and wasted (WHO, 2017).

As Aguero, Carter, and Woolard argue, z-score measurements for stunting, wasting and underweight status could represent two potential threats. First, the failure to identify a causal inference of an income increase on HAZ, WAZ, WHZ can suggest two interpretations. It is either because of zero income elasticity of nutrition or the inability of transforming nutrition intakes into health status. Second, those z-scores may suffer from measurement error (2009, p. 7-8). In the PNG dataset, these measurements are taken twice to reduce such errors.

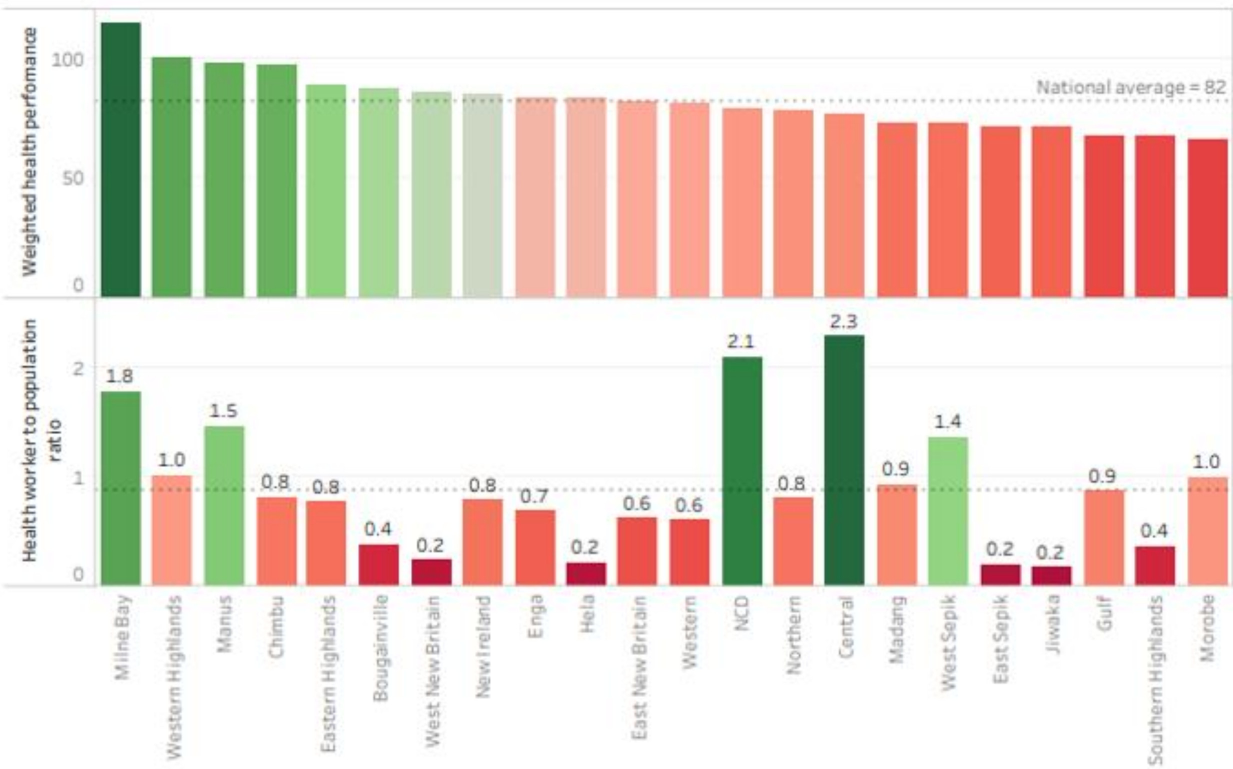

Figure 2. Western Province Health Indicators Ranking (Source: National Health Information System, 2016)

c. Summary Statistics

Table 1 presents the summary statistics of relevant characteristics of children, their caregivers and families based on the royalty payment status. As can be seen, there are a number of significant differences between the children from royalty-receiving families and their counterparts. On average, they are more likely to be stunted and less likely to be wasted, compared to children from without-royalty families.

Regarding the caregiver's characteristics, the mean age of the caregiver (95% of them are the children's biological mother) is 26.4 years old (standard deviation of 6.4). Also, while the majority of the caregivers in the treated group stay at home and do household work, more than half of those in the control group get involved in farming or personal/family business.

Moreover, the percentage of using contraceptives is much higher in the treated group compared to the control group (55% vs. 32%). As identified by the interviewers, some royalty payments are given to people residing along the Fly River with good transport situation, whereas those in more remote areas are less likely to receive the royalties. This may explain the reasons why those in the treatment group have better access to family planning methods than their counterparts.

Family's income is not recorded in the dataset. I, however, present other family characteristics such as food shortage, drinking water sources, toilet types and handwashing facilities. Around two-thirds, 66%-68% of the households in the sample, experienced food shortage in the last 12 months. The most common drinking water source and sanitation facilities are tank (50% and 40% in the control and treated group, respectively) and pit latrine (78% in the control and 54% in the treated group). Nearly 31% of the households in the treated group still defecate outdoors.

Around 39% of the families in the control group has no access to handwashing facilities, while 35% of those in the treated group share the same experience. Their mean difference is not statistically different, however. This significant proportion of handwashing facilities shortage may explain the high rate of diarrhea observed in the sample.

Table 1. Descriptive Statistics based on Royalty Payments Status

	Mean Royalty=0	N	Mean Royalty=1	N	Difference	t-Statistic
Child characteristics						
HAZ	-0.038	417	-0.339	333	0.301*	1.923
WAZ	-0.860	417	-0.690	333	-0.170	-1.485
WHZ	-1.105	417	-0.641	333	-0.464***	-3.711
Female	0.465	417	0.456	333	0.009	0.239
Caregiver characteristics						
Education	8.087	379	7.804	311	0.283	1.480
Spouse education	8.878	311	8.996	243	-0.118	-0.528
Age	26.855	366	26.014	285	0.841*	1.667
Marital status	0.851	417	0.862	333	-0.011	-0.408
Job: household chore	0.403	417	0.553	333	-0.150***	-4.121
Job: business	0.540	417	0.399	333	0.140***	3.851
Job: student	0.010	417	0.012	333	-0.002	-0.320
Job: work outside	0.046	417	0.036	333	0.010	0.651
Contraception	0.319	417	0.553	333	-0.234***	-6.611
Family characteristics						
Food concern:						
Running out of food	0.662	417	0.676	333	-0.014	-0.398
Worry about food	0.700	417	0.604	333	0.097***	2.781
Water source:						
Dug hole	0.259	417	0.219	333	0.040	1.264
Pipe	0.060	417	0.273	333	-0.213***	-8.385
Surface (river, dam, pond)	0.173	417	0.096	333	0.077***	3.029
Tank	0.504	417	0.411	333	0.092**	2.523
Toilet type:						
Open	0.146	417	0.306	333	-0.160***	-5.373
Flush	0.046	417	0.096	333	-0.051***	-2.741
Pit latrine	0.775	417	0.535	333	0.240***	7.160
Composing	0.007	417	0.006	333	0.001	0.198
Bucket	0.022	417	0.051	333	-0.029**	-2.196
Handwashing facility						
Basin	0.118	417	0.135	333	-0.018	-0.724
Tank	0.091	417	0.042	333	0.049***	2.638
Plastic container	0.302	417	0.402	333	-0.100***	-2.878
Tippy tap	0.096	417	0.072	333	0.024	1.161
None	0.393	417	0.348	333	0.045	1.264

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

d. Prevalence/proportion of child outcomes and morbidity

Table 2 depicts that 10% and 15% of the children in the control and treated group are stunted (HAZ < -2), respectively. In the control group, prevalence of stunting is significantly higher in boys than girls (14% in boys and 6% in girls). On the contrary, the number of wasted children is higher in the control group than the treated group (22% vs. 15%). Also, more than 20% of the children in the sample suffered from diarrhea in the last two weeks, even though the difference between the two groups is not significant.

The gap in the child anthropometric measurements between the two groups is ambiguous. It is unclear whether the gap comes from the royalty payments status or the differences in the caregiver and household characteristics. To resolve this puzzle, I apply PSM to extract the causal inference of the royalties.

Table 2. Prevalence of Undernutrition and Morbidity among the Children in the Sample

		Prevalence (Royalty=0)	Prevalence (Royalty=1)	Difference	p-value	Public-health significance[†]
Stunting	HAZ < -2	0.103	0.144	-0.041*	0.087	Low
Underweight	WAZ < -2	0.189	0.153	0.036	0.192	Medium
Wasting	WHZ < -2	0.218	0.150	0.068**	0.018	Critical
Overweight	WHZ > 2	0.014	0.027	-0.013	0.219	Low
Morbidity[††]						
Diarrhea		0.247	0.204	0.043	0.165	

[†] WHO, 1995

[††] Disease history in the past two weeks

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

III. Empirical Strategy

In case of a randomized control trial, it is common to evaluate the impact of a binary treatment by ordinary least square (OLS). However, a selection bias may arise in the case of the royalties in PNG because the treated and control groups are not selected randomly. Hence, PSM method is applied to balance the treated and control groups for my research. In this section, I briefly introduce the Propensity Score Matching (PSM) method and mention covariates I apply to estimate the propensity score.

1. Propensity Score Matching (PSM)

The main idea behind any matching method is to "equate the distribution of covariates in the treated and control groups" (Stuart 2010, p. 2). In particular, PSM tries to balance the probability of receiving the treatment between the two groups. For the context of this research, the binary treatment, T_i, is whether the child i lives in a household receiving the royalty payment or not. The propensity score is defined as the conditional probability of receiving the royalty, given the covariates X_i. According to Rosenbaum and Rubin (1983), it can be seen that:

$$0 < \Pr(T_i = 1 | X_i = x) < 1 \text{ for any } x \in X$$

Also, if the conditional independence assumption, or unconfoundedness is assumed, i.e.

$$\{Y_i(1), Y_i(0)\} \perp\!\!\!\perp T_i | X_i$$

then the treatment is "ignorable," conditional on the true propensity score $\pi(X_i)$ (Imai and Ratkovic, 2014).

$$\{Y_i(1), Y_i(0)\} \perp\!\!\!\perp T_i | \pi(X_i)$$

This helps to reduce the curse of dimensionality by conditioning on only the propensity score, instead of the whole covariate vector X_i. When those two conditions hold, the estimates are the average treatment effect on the treated.

2. Covariates for Estimating the Propensity Score

In "Some Practical Guidance for the Implementation of Propensity Score Matching," Caliendo and Kopeinig suggest including only variables that simultaneously affect the treatment status and the outcome to estimate the propensity score (2005, p.6). In this research, I include available demographics characteristics that are expected to influence the probability of receiving the royalties as well as the child growth. These covariates cover dummies indicating whether the caregiver or spouse complete primary school, respectively. As PNG is facing a great challenge to achieve the universal primary education goal (Rena, 2011), graduating from primary school is one of the milestone in one's education. I also include the caregiver's age and age square, the number of children in the household and village variables. Proxies for household wealth (drinking water sources, toilet types and handwashing facilities) are also covered. Food shortage is omitted in estimating the propensity score due to reverse causality. In other words, food shortage may be affected by the program participation. Previous studies have shown that royalty-receiving families invest less than 1% on agricultural activities and about 6% in nonagricultural enterprises (ADB, 2008, p.7). The majority of the royalties may go to food.

IV. Econometric Results

1. Ordinary Least Squares Estimation

Table 3 shows the effect of royalty on child nutritional status using OLS method. In column 1, estimates without any covariates reveal that royalties significantly decrease the wasting among the children, but not stunting or malnourishment. Once controlling for the caregiver and family characteristics, children in royalty-receiving families have 0.47 more WHZ than those in without-royalty families. This statistical significance, however, only exists among female children.

When classifying the caregiver's occupations into groups, the findings suggest that royalties significantly improve the child WAZ and WHZ if their caregivers get involved in farming or personal/ family business, compared to those whose caregivers only do household chores. These findings make sense, intuitively. Once the caregivers only get involved in household chores, they may be financially inferior compared to their counterparts. They may also have fewer contacts and narrower information exposure, which can explain the gap in their children's outcomes. Similarly, there is an improvement in weight-for-age and weight-for-height for children in the treated group, once the standard is clustered at district level.

Table 3. Effects of Royalties on Child Outcomes by OLS

HAZ	-0.301	-0.190	-0.0818	-0.371	-0.0458	-0.198	-0.190
	(0.157)	(0.182)	(0.259)	(0.280)	(0.244)	(0.290)	(0.147)
WAZ	0.170	0.240	0.252	0.134	0.0490	0.456*	0.240*
	(0.115)	(0.134)	(0.169)	(0.225)	(0.194)	(0.208)	(0.043)
WHZ	0.464***	0.472**	0.349	0.538*	0.175	0.737**	0.472*
	(0.125)	(0.145)	(0.200)	(0.221)	(0.195)	(0.263)	(0.093)
N	750	651	349	302	297	318	651
Covariates	No	Yes	Yes	Yes	Yes	Yes	Yes
Child gender			Male	Female			
Caregiver's job					HH chores	Business	
Robust std.		Yes	Yes	Yes	Yes	Yes	No
Cluster std.		No	No	No	No	No	Yes

Note: Standard errors in parentheses. Cluster at district level
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Covariates include caregiver's education (dummy), spouse education (dummy), caregiver's age, age square, number of children, village, toilet types (dummies), handwashing facilities (dummies), drinking water sources (dummies)

2. Effectiveness of Matching Implementation

OLS estimates are likely to be biased because of the endogeneity from non-random selection of the treated and control group. This section presents how matching methods can reduce this imbalance.

From Table 1, it seems that the caregivers in the comparison group are slightly older and more likely to partake in farming or personal/family business than those in the treated group. Their families also tend to worry more about food shortage. My goal would be to "balance" the two groups and reduce the bias on observables as much as possible (Powell-Jackson and Hanson, 2012, p. 276). I use logistic regression to estimate the propensity score of receiving the treatment, and graphically demonstrate the balance of propensity score in the two groups in Figure 4 below. As shown, PSM equalizes the probability of receiving the treatment among the two groups, even though not perfectly.

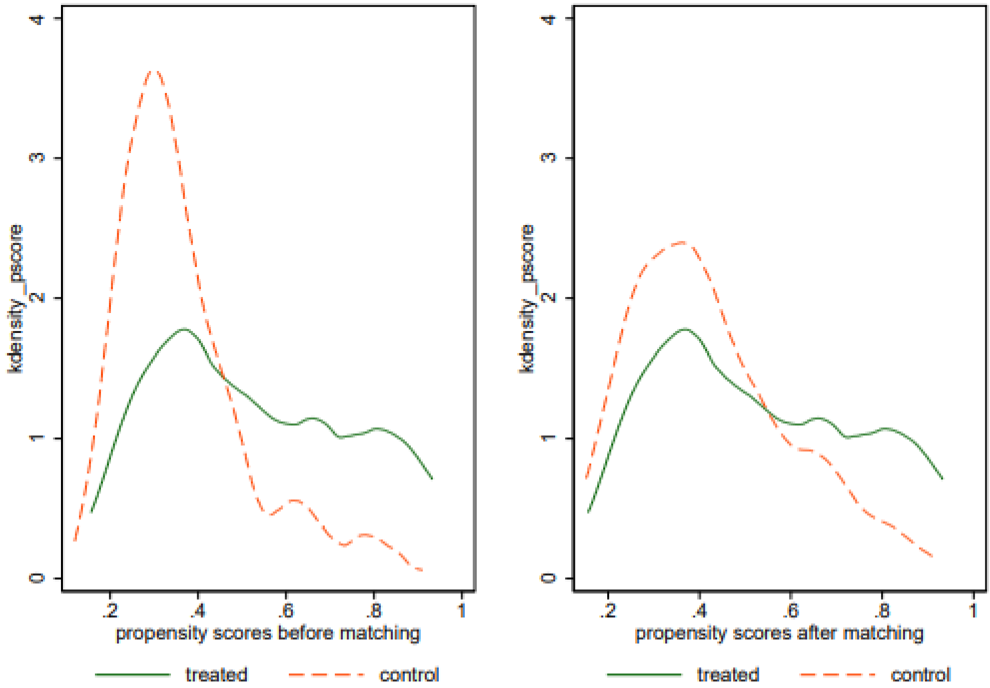

Figure 3. Density of Propensity Scores for the Treated Group and Control Group

3. Estimated Average Treatment Effect for the Treated (ATT)

Table 4 presents the ATT estimates for different child nutrition outcomes with the corresponding standard deviation and statistically significant level. There seems to be no substantial differences in the estimates across four propensity score matching methods.

The matched estimates indicate that royalties, for those they are provided to, statistically influence the child weight-for-height z-score. A child receiving treatment, on average, has 0.32 to 0.39 higher WHZ than a child without treatment, across different matching methods. Moreover, the stratification matching method shows a significant improvement in weight-for-age z-score among children receiving the treatment. All of these effects are significant at only 10 percent level of significance.

Table 4. Impact of the Royalty Payments on Child Nutrition Status by PSM

	HAZ	WAZ	WHZ
Nearest Neighbor	-0.110	0.197	0.348*
	(0.200)	(0.178)	(0.168)
Radius	-0.186	0.126	0.329*
	(0.180)	(0.122)	(0.134)
Kernel	-0.0283	0.280	0.393*
	(0.209)	(0.148)	(0.164)
Stratification	0.0892	0.312*	0.324*
	(0.252)	(0.149)	(0.152)
N	750	750	750

Note: Standard errors in parentheses. First, pscore is used to estimate the propensity score with common support. Then, attnd, attr, attk, atts are applied to estimate ATT for different matching methods.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

V. Heterogeneity in Impacts

There has been ample evidence suggesting that children's anthropometric measurements (z-scores) in low-income and middle-income countries are usually the best at birth and falter slightly in early infancy and bottom out by 24 months (Victora et al., 2010; Roth et al., 2017). This section analyzes variation in the impact of royalties on WHZ for different child age-groups. Specifically, I divide the sample into three different age groups following evidence from Victora et al. (2010): 1-to-2-month group, 3-to-9-month group and the rest.

Table 5 shows the results from the OLS. From column 2, I include a full set of covariates used in previous estimations. As can be seen, the impacts of royalties on wasting seem to be the largest for children aged 1 to 2 months. However, the significance is only observed for those between 2 and 9 months old.

Table 5. Impact of the Royalties on Wasting by OLS, based on Age Groups

	WHZ	WHZ	WHZ	WHZ
Royalty	0.464***	1.693	0.612**	0.0725
	(0.125)	(1.211)	(0.209)	(0.162)
N	750	62	243	346
Covariates	No	Yes	Yes	Yes
Age group		1-2 month	2-9 months	9-24 months
Robust std.		Yes	Yes	Yes

Note: Standard errors in parentheses. Cluster at district level
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Covariates include caregiver's education (dummy), spouse education (dummy), caregiver's age, age square, number of children, village, toilet types (dummies), handwashing facilities (dummies), drinking water sources (dummies)

However, a different picture is shown once PSM is applied. The results in Table 6 show that most of the impacts of royalties focus on children aged 1-2 months. The treatment bolsters their WHZ dramatically through different specifications. However, due to the limited observations in this age group, it is hard to draw a solid conclusion.

Table 6. Impact of the Royalties on Wasting by PSM, based on Age Groups

Nearest Neighbor	3.212**	0.325	0.152
	(0.987)	(0.274)	(0.237)
Radius	1.921*	0.281	0.120
	(0.842)	(0.198)	(0.151)
Kernel	2.889***	0.355	0.0316
	(0.765)	(0.230)	(0.170)
Stratification	2.856	0.522*	0.0819
	(1.525)	(0.253)	(0.158)
N	62	243	346

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

VI. Impact of Royalties on Risk Factors Associated with Wasting

As royalties have been shown to slightly affect the child WHZ throughout different specifications, this section sets out to understand the pathway through which it channels the effect. Together with royalties, OK Tedi has claimed to bring other benefits to the mine-area communities such as "modern amenities," "aid post and … access to the Tabubil Hospital services," and "road and air transport access…to Tabubil" (ADB, 2008, p. 5-6). My aim is to understand whether royalties and these additional benefits lead to improvements in nutrition habits or practices that boost child WHZ.

WHO and previous studies in PNG have listed associated risk factors that influence the wasting status for children under two. They are food insecurity, high incidence of infectious diseases, especially diarrhea, and the timing of introducing the first food (WHO, 2010; Miyoshi et al., 2015; Pham et al., 2021).

Leveraging the detailed information in the dataset, I perform regressions analyzing how the child WHZ is affected by those associated risk factors. Namely, I look at dummies indicating whether the household experiences food shortage in the last 12 months, whether the child suffers from diarrhea in the last two weeks, whether (s)he was breastfed within the first hour after birth as studies have shown that putting newborns to the breast within the first hour after birth can increase the probability of babies being breastfed and experiencing exclusive breastfeeding (UNICEF, 2018). I also include a dummy of whether the child receives vitamin A supplement in the last six months, because vitamin A deficiency can worsen the chance of infection from diarrhea (WHO, 2010).

The argument is that royalties with their additional "modern amenities" such as quality water and toilets can reduce the chance of being infected by diarrhea. Also, the extra health support can raise the caregivers' awareness about breastfeeding and increase the chance of babies receiving vitamin A. In other words, these associated risk factors are not "distributed" randomly; they, instead, are assumed to come together with the royalty status. Hence, PSM method would be appropriate to extract the causal inference of the royalty status on these associated risk factors.

Table 7 demonstrates associations between royalties and the probability of food insecurity, suffering from diarrhea, breastfed within the first one hour after birth and receiving vitamin A, respectively. These factors are not significantly influenced by the treatment, even though most of the estimates are in the expected direction: royalties decrease the chances of experiencing food shortage and diarrhea infection, while boosting the probability of being breastfed in the first hour after birth and receiving vitamin A.

Based on the findings, there is no evidence suggesting that the royalty status boosts the child weight-for-height through influencing the common risk factors. This result is likely to reflect an important fact in remote and impoverished contexts like PNG: the existence of financial compensation and infrastructure needs to go hand in hand with education. It is important to persuade people to trust benefits of modern amenities so that they can take full advantage of infrastructures and facilities they may be provided with. They should also be educated in investing in specific food with nutrients significantly boosting child growth. Future efforts may deeply focus on evaluating the pathways through which royalties affect the child WHZ.

Table 7. Impact of the Royalties on Risk Factors Associated with Wasting by PSM

	Food shortage	Diarrhea	Breastfeeding	Vitamin A
Nearest Neighbor	-0.0281	-0.0474	0.0526	0.0351
	(0.0535)	(0.0481)	(0.0476)	(0.0527)
Radius	0.0254	-0.0533		-0.0436
	(0.0372)	(0.0330)		(0.0379)
Kernel	-0.0000825	-0.0310	0.0737	0.0174
	(0.0452)	(0.0351)	(0.0528)	(0.0410)
Stratification	-0.0257	-0.0371	0.0537	0.0244
	(0.0447)	(0.0306)	(0.0531)	(0.0452)
N	750	750	750	750

Note: Standard errors in parentheses. First, pscore is used to estimate the propensity score with common support. Then, attnd, attr, attk, atts are applied to estimate ATT for different matching methods.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

VII. Concluding Remarks

Besides presenting an update on the child growth and household socioeconomic characteristics in Western Province in PNG, the evidence from this paper adds to the contentious debate about the impacts of cash transfer programs as anti-poverty programs. While many interventions have modeled on or modified Mexico's Progresa program (i.e. Brazil, Nicaragua, Honduras, Malawi, and Nepal), the royalty scheme in PNG offers a new perspective of cash transfer as compensation for resource development from private companies. I find that the royalty status slightly improves the child weight-for-height. However, little is understood about the channels by which royalties affect this outcome. That is, royalties are not shown to significantly influence risk factors associated with wasting such as food shortage, diarrhea infection, the timing of breastfeeding after birth and vitamin A deficiency. Further research about the pathways that royalties are translated to the improvement on weight-for-height would be a valuable addition to the field.

Although this study is good at extracting the effect of biasedness in OLS due to endogeneity, there are several issues future research can improve upon. First, due to unavailable data, this study is limited to a cross-sectional study. The panel data could also evaluate the impact of royalty payments on long-term human capital outcomes. Moreover, the data do not cover the duration and amount of royalties, which might imply variations in impacts. Lastly, the data are not nationally representative, so I cannot interpret the results as national impact estimates. Having said that, the paper has attempted to be the first in quantifying the causal impact of royalties on child growth in a context of limited data like PNG.

Nevertheless, this research opens a new direction about the implementation of financial compensation in remote and impoverished contexts. Namely, future research can address whether additional training programs should be implemented in parallel with cash transfer so that the treated group can and know how to maximize the benefits of their cash windfalls.

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