Impact of country reimbursement programs on living kidney donations

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Key questions

What is already known?

►There is mixed evidence on the impact of living donor reimbursement programs on the donation rate.

►In the United States, prior literature found no significant impacts of such programs on the donor rates at the state level.

►No prior literature has evaluated the impacts of such programs at the country level.

What are the new findings?

►There is a significant variation in the living kidney donation rate worldwide.

►At the country level, the existence of a reimbursement program has a clear positive association with the living kidney donation rate.

►Social and economic globalizations, as well as limited availability of deceased donor kidneys, are positively correlated with living kidney donation rate.

What do the new findings imply?

►Implementation of a living donor reimbursement program may be an effective policy to alleviate the kidney shortage. Programs are more effective in relatively less developed economies.

►The type of the reimbursement programs and their impacts need to be further researched.

Abstract

Introduction: Living-donor kidney transplantation is the gold standard treatment for end-stage kidney disease patients. However, potential donors ubiquitously face financial as well as logistical barriers. To remove these disincentives from living kidney donations, the governments of 23 countries have implemented reimbursement programs that shift the burdens of non-medical costs from donors to the governments or private entities. However, scientific evidence for the effectiveness of these programs is scarce.

Objectives: The present study investigates whether these reimbursement programs designed to ease the financial and logistical barriers succeeded in increasing the number of living kidney donations at the country level. The study examined within-country variations in the timing of such reimbursement programs.

Method: The study applied the difference-in-difference (two-way panel fixed-effect) technique on the Poisson distribution to estimate the effects of these reimbursement programs on a 17-year long (2000-2016) dataset covering 109 countries where living donor kidney transplants were performed.

Results: The results indicated that reimbursement programs have a statistically significant positive effect. Overall, the model predicted that reimbursement programs increased country-level donation numbers by a factor of 1.12 to 1.16.

Conclusion: Reimbursement programs may be an effective approach to alleviate the kidney shortage worldwide. Further analysis is warranted on the type of reimbursement programs and the ethical dimension of each type of such programs.

I. Introduction

Kidney transplantation is the definitive and gold standard treatment for end-stage kidney disease patients (1). However, access to this treatment is severely hindered by the steadily worsening kidney shortage: While the demand for transplants is continuously rising with the growing prevalence of chronic kidney disease, the supply of kidneys is not increasing at a similar rate (2). In the United States, the median wait time for a kidney transplant is about 4 years, and close to 5,000 patients die every year on the transplant waitlist (3). Worse, this number does not include those patients who are removed from the waitlist due to disease progression and other related complications that make them too sick to receive a transplant (4). As such, end-stage kidney disease patients, transplant centers, policymakers, and other members of the transplant community have a vested interest in increasing kidney donation.

Access to living donor (LD) kidney transplants, which generally provide better outcomes, is hampered by various burdens on donors, including the potential loss of quality of life, possible post-donation complications (such as infections and abdominal problems), and risk of kidney failure or death. The estimated risk involves approximately 3.1 deaths per every 10,000 kidney donors (5,6). Other risks include a potential lack of informed consent and a lack of clarity regarding recovery times and long-term effects, making it hard for donors to fully understand the extent of the risks they are taking and what compensation would be necessary to balance those risks (7). Some of the financial costs, such as costs of recovery or complications, time away from workplace, travel, and accommodations can be eliminated through reimbursement programs. To eliminate some of the disincentives for potential LDs, many countries have initiated some types of reimbursement programs. Most of these programs aim to compensate donors for some of the financial costs.

While these programs have been implemented long enough, more than two decades in the United States, there has been limited literature examining the effectiveness of these policies. Overall, the literature suggests little to no effect of these policies on living kidney donation in the United States (8). For instance, the effects of the state-level tax credit and paid leave laws were studied and are shown to have no impact (8,9). Compensation policies to cover medical, lodging, and wage losses are also known to have no effect (9). At the global scale, so far, there have been no retrospective studies examining the effectiveness of such policies. Thus, the present study constructed comprehensive panel data to quantitatively evaluate the effectiveness of the LD compensation policies worldwide.

We structured our paper in the following manner. The next section describes the data and the method. Section III presents the results. Section IV further discusses the results in light of prior research in this area. Section V and Section IV provide the limitations and the conclusion of the present study respectively.

II. Data and Method

Data

The country-level panel data from 109 countries was constructed for the period between 2000 and 2016. The information on LD compensation policies was gathered from various sources. Sickand, et al. (2009) provided the information of reimbursement programs in 40 countries: whether they have any government and non-government reimbursement programs and, if they do, the program's eligibility criteria, duration, types of expenses reimbursed, and reimbursement mechanism (10). These programs mainly facilitated reimbursement to LDs for non-medical expenses such as travel, accommodation, meal, lost-income, childcare, etc. The Google search of government, nephrology, and transplantation foundations' websites, as well as policy papers, identified an additional 45 countries without reimbursement programs. For the other 24 countries, no information on the LD compensation policy was available. These countries were considered to have no compensation policy because the lack of online information would most likely hinder public awareness about the policy even if it existed, which would de facto mean the non-existence of such a program. The final dataset contained 23 countries that have implemented some type of compensation program for the living kidney donors.

The outcome (dependent) variable, i.e., the total number of living kidney donors in the country, was extracted from the Global Observatory on Donation and Transplantation (GODT) and the International Registry on Organ Donation and Transplantation (IRODaT) databases. In addition to the presense of a reimbursement program in the country, we collected data on various other factors potentially affecting the number of living donors. Those included the country-level demographic, financial, health, and political-related factors. For demographic and economic variables, we explored the population size, GDP per capita, and the GDP growth rate. A larger population increases the pool of potential donors, and thus possibly a larger number of living donors. A higher GDP is likely to reduce various challenges associated with living donation. For health-related variables, we explored the ratio of public and private health expenditure to GDP and the average out-of-pocket health expenditure. Higher health expenditure is, in general, an indication of a relatively advanced healthcare system or infrastructure. The advanced system may reduce the fear associated with living donation, or it could mean that the country has a more advanced deceased donor transplant system which may, in turn, reduce the overall incentive or need for LD transplants. We also controlled for the number of deceased donors, which may encourage living donation if deceased kidney donation promotes the overall donation culture. Or the presense of such an alternative may reduce the incentive for living donation. Other control variables included were the county's political globalization, social globalization, and financial globalization indices. Political globalization is associated with the government's ability to impose tax and change policies (11). Financial globalization reflects FDI, portfolio investment, international debt, international reserves, and international income payment (11). Social

globalization captures different factors of information, culture, internet usage, migration, transfers, tourism, and others (11). The globalization indices were taken from the Swiss economic institute Konjunkturforschungsstelle (KOF) index. These composite indices are standard controls included in the literature using country-level panel regression analyses to compensate missing values/variables in the data of some countries or years (12,13). Appendix II presents more information about these globalziaiton indices.

Patient and Public Involvement

There were no patient or public involvement. This restospective study was performed only using publicly available/downloadable country-level data.

Statistical Analysis

We applied time averages to interpolate the values for missing years where data exhibited a clear time trend. This increased the number of observations from 1,453 to 1,519 in the balanced panel. No data extrapolation was performed. For the regression, a nonlinear model was applied to accommodate the outcome variable, i.e., the number of living kidney donors, which takes on count/discrete values. The model incorporated country and year fixed effects to control for time-invariant country-level observable and non-observable confounders and country-wide secular trends in donations. We specifically used a Poisson model as opposed to a negative binomial model since the conditional fixed-effects negative binomial model for count panel data does not control for individual fixed effects unless a very specific set of assumptions are met (14,15). To estimate the program effect on the outcome variable, we took the difference and difference (DiD) approach with a dummy variable reflecting the presence of a compensation program. The approach exploits the fact that different countries have introduced compensation programs at different points in time, thereby capturing the program effects both within and across the countries over the study period. Our main interest lies in within-country variation since we aim to make an inference about the causality of a reimbursement program instead of the simple association between the program existence and the number of LDs.

The basic setup of the DiD regression model involves: countries with a reimbursement program (i = 1) and those countries without (i = 0), and two time periods representing pre- (t = 0) and post-program (t = 1) implementation. In the Poisson setup, it is specified as follows:

$$\log(E(Y_{it}|X_{it}) = \beta_0 + \beta_1 ReimProg_i + \beta_2 Post_t + \beta_3 ReimProg_i * Post_t + \beta_4 \mathrm{X}_{it} + \varepsilon_{it} \ldots \text{(i)}$$

where Y_{it} is the number of LDs in country i at time t, $ReimProg_i$ is an indicator variable for the countries with a reimbursement program, $Post_t$ represents the post-program time period, and $ReimProg_i * Post_t$ is the interaction term between the post-program period and the countries with a reimbursement program. X_{it}

is the country-level covariates and ε_{it} is the error term. Our primary interest is β_3, which is the estimator for the average effect of the country-level reimbursement programs.

III. Results

Descriptive analysis

There were 23 countries that implemented a LD reimbursement program during the study period. Of those, 12 countries had a program throughout the 17 years, while 10 countries implemented a program after 2000 (Figure 1). None of these countries ceased their reimbursement programs during the period. The figure presents the (cumulative) evolution of the reimbursement programs worldwide. The reimbursement programs covered five broad categories of non-medical expenses such as travel, accommodation, meal, income loss, and childcare. There was limited variation in the reimbursement components seen across the countries, i.e., if a country had a reimbursement program, it tended to have all of these components with a few exceptions. While the full picture of the program was not available for all countries, we noted that at least Denmark, France, Netherlands, Israel, Philippines, Saudi Arabia, Norway, Singapore, Sweden, Switzerland had all of the five components. In Appendix I, we provided the list of the countries included in the analysis and the known status of the program implementation.

Table 1 presents the summary statistics of the variables used in the analysis. The mean number of LDs was 7.56 per million population (pmp). There was a large variation in the donation rate worldwide. The donation rate for 2015, for instance, varied from less than 1 to more than 40 per million (Figure 2). In the figure, the countries colored in yellow to green represent those countries with a relatively high donation rate, while the countries colored in orange to red correspond to those with a relatively low donation rate. The countries with a relatively high level of donation included all (low-, middle-, and high-) economy levels. Similarly, the countries with a relatively low level of donation included high- and middle-income countries (Greece, Germany, Austria, France, etc.). In absolute numbers, only India and the United States had more than 5,000 donors annually.

Figure 1. Evolution of Country Reimbursement Program: (2000-2016)

Table 1: Descriptive statistics of key variables used in the analysis

Variable	Mean or %	No. of observations	S.D.	Min.	Max.
No. of living donors per million population*, mean	7.56	1,453	8.46	0	64
No. of deceased donors per million population*, mean	8.21	1,451	8.99	0	44
Presence of reimbursement programs, %	10%	2,975	29%	10%	29%
Population growth rate, mean	1.52	2,970	1.55	-3	16
Population size (per million), mean	37.58	2,903	137.27	0	1394
GDP growth rate	4.04	2,940	6.06	-62	179

GDP per capita (thousand)	12.93	2,921	18.26	0.19	111.97
Health expenditure / GDP, mean	6.22	3,712	2.77	1	27
Health expenditure per capita, mean	813.14	3,724	1482.20	3	10005
Share (%) of out of pocket health expenditure, mean	35.18	3,706	19.00	0	97
Social globalization, mean	56.64	2,846	18.95	11	91
Financial globalization, mean	61.47	2,778	19.34	15	100
Political globalization, mean	63.43	2,846	22.00	6	100
Poverty head count ratio at $3.2 a day, mean	29.51	1,859	29.90	0	99

* The numerator (the number of donors) reflects the interpolated values.

Figure 2. Donations per million by country in 2015

Note: Authors' recreation of the map based on the data from GODT and IRODaT

Regression results

Table 2 presents the regression results of the 5 models, each with a different set of independent variables. The overall goodness of fit was acceptable (wald_chi2=14209, $p<0.001$), and there was no multicollinearity observed in the model (VIF=2.19). The reported coefficients are the log of expected counts in all models. The Model 1 results show the DiD estimates with only 1 control, i.e., the number of deceased donors, and the country and year fixed effects. The coefficient of the reimbursement program was positive and statistically significant ($p<0.01$), indicating that the expected log count is approximately 0.05 units higher for the countries with a reimbursement program than the countries with no reimbursement program. In the incidence rate ratio (IRR) term, this indicates that, ceteris paribus, the number of LDs would be expected to increase by a factor of 1.05 ($=e^{0.054}$) or 5% in the presence of a reimbursement program. The coefficient became larger (Model 2: IRR= $e^{0.149}$ =1.16; Model 3: IRR= $e^{0.114}$ =1.12; Model 4: IRR= $e^{0.138}$ =1.15) with added controls (the ratio of health expenditure to GDP and out of pocket health expenditure in Model 2, GDP per capita, GDP growth, population size, and population growth rate in Model 3, and the levels of financial, political, and social globalization in Model 4), and remained consistently positive and statistically significant ($p<0.01$) across the 5 models. Most of the control variables were consistently statistically significant. The number of deceased donors (measured in thousand)was negatively associated with the number of LDs. While the health expenditure ratio to GDP was negatively associated with LDs, the out of pocket health expenditure was positively associated. Similarly, financial and social globalization levels and other economic variables (GDP and GDP per capita growth) were positively associated with living donation relatively consistently, but political globalization was negatively associated ($p<0.01$). Population size was negatively correlated with donations ($p<0.01$) but its growth rate did not affect the donation level ($p>0.05$) in any model. Model 5 excludes Iran and India from the data over a concern of unique patterns of living donations which may drive our findings. In Iran, the higher number of living donations is presumably driven

by monetary compensation which is legal (16). The higher living donations in India may be associated with a history of certain exploitation which might have resulted into some non-altruistic donors (17). After excluding these two countries, the coefficient was larger and the association was more statistically significant. The coefficient increased from 0.138 in Model 4 to 0.156 in Model 5, which means that introducing a reimbursement program increases the living donation by a factor of 1.17 or 17%.

Table 2: Difference in difference estimation

	No. of LD	**No. of LD**	**No. of LD**	**No. of LD**	**No. of LD (after excluding Iran and India)**
	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)
Donor reimbursement program	0.054***	0.149***	0.114***	0.138***	0.156***
	(0.009)	(0.010)	(0.011)	(0.011)	(0.011)
No. of deceased donors (thousand)	-0.302***	-0.342***	-0.196***	-0.214***	0.029***
	(0.004)	(0.006)	(0.007)	(0.007)	(0.008)
Health expenditure/GDP		-0.065***	-0.068***	-0.042***	-0.012***
		(0.003)	(0.003)	(0.004)	(0.004)
Out of pocket health expenditure		0.007***	0.008***	0.005***	0.000
		(0.001)	(0.001)	(0.001)	(0.001)
GDP per capita (thousand USD)			0.007***	-0.002	-0.034***
			(0.002)	(0.002)	(0.002)
GDP growth rate			0.013***	0.015***	0.018***
			(0.001)	(0.001)	(0.001)
Population size (in million)			-0.012***	-0.012***	-0.033***
			(<0.001)	(<0.001)	(0.001)
Population growth rate			0.007	0.006	-0.006
			(0.007)	(0.007)	(0.007)
Financial globalization				0.007***	0.002***
				(<0.001)	(0.000)
Social globalization				0.035***	0.038***
				(0.001)	(0.001)
Political globalization				-0.022***	-0.002*
				(0.001)	(0.001)
Country FE	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Number of observations	1,346	1,224	1,214	1,198	1,178
Number of countries	109	106	105	104	102

Note: *** p<0.01, ** p<0.05, * p<0.1. The outcome variable is total number of living kidney donations. Standard errors are in parenthesis. The reported coefficient is the log of expected count for all independent variables. The IRR for reimbursement program is 1.06 in model 1, 1.16 in model 2, 1.12 in model 3, 1.15 in model 4, and 1.17 in model 5. Model 5 excludes data of Iran and India.

Figure 3 plots the coefficients of the covariates including year fixed effects. The figure demonstrates that the impact of a reimbursement program is positive and comparatively large. As to the year fixed effects, later years have a larger impact on the donation level than the earlier years, presumably because of the overall advancement in medical systems and technologies worldwide as well as possible

"spillover effect" where the act of donation in a country or an individual positively influence other individuals/countrie over time.

Figure 3. Coefficient Plots

Note: The coefficient plots were created using estimates of model 4 in Table 2

In order to see if the above results vary depending on the level of economic development, we also ran regressions with the subsets of data divided into 2 (GDP per capita below or above $50,000) and 5 (with the GDP per capita cut-offs at $5,000, $10,000, $30,000 and $50,000) classes. We found that reimbursement programs contributed to a higher level of living donations in relatively less developed economies. The impact was statistically insignificant among higher income economies. These results were confirmatory in the regression with the 5 classes (Table 3).

Table 3: Disaggregated results by economic development

	GDP per capita<$5,000	GDP per capita<$10,000	GDP per capita<$30,000	GDP per capita<$50,000	GDP per capita>$50,000
Coefficient of reimbursement program	0.302***	0.490***	.068***	.132***	-.004
P-value	0.009	<0.001	0.010	<0.00	0.966
Number of obs.	295	523	836	1,090	108
Number of countries	38	60	80	99	11

Note: *** p<0.01, ** p<0.05, * p<0.1. We estimated model 4 in Table 2 where all control variables and country and year FE are included.

Finally, to examine the robustness of the results, we ran separate regressions with additional controls such as physicians per 1,000 people, the poverty headcount ratio at $3.5 a day, economic inequality measures (Gini coefficient), measures for education achievement, and human development index. These variables were not statistically significant (p>0.10) and did not alter the findings presented above. We also performed the analogous regressions without interpolating missing observations and confirmed that the findings hold true. Similarly, the regression excluding the countries with no documentation on reimbursement programs did not alter the results. The regression without the country and year fixed effects revealed that the reimbursement program impact is larger than what we reported above. Such coefficients would inevitably be susceptible to heterogeneity bias, and thus are not presented here.

IV. Discussion

The present study suggests that implementation of a reimbursement program has a positive impact on the country's living kidney donation level, adjusting for various conceivable covariates. The result demonstrates a stark difference from the findings of prior US-based studies that report almost no evidence

that these policies were effective: Venkataramani, et al. (2012) found no statistically significant effect of tax policies on the living kidney donation level in the United States where 15 states passed tax deductions and 1 state passed a tax credit policy between 2004 and 2008 to help defray potential medical, lodging, and wage losses (9). Chatterjee, et al. (2015) also found that state-level policies designed to increase living kidney donation and transplantation during the past two decades had little to no effect (8). Wellington & Sayre (2011) drew similar conclusions based on their quantitative analyses that examined the effects of state-level tax deduction and paid leave laws (18). Lacetera, N. et al. (2014) examined the impact of legislative efforts to alleviate the kidney and bone marrow shortages. They found that, while neither legislations had impacts on the level of kidney donation, paid-leave legislation was effective in increasing bone marrow donation (19). Direct payments to kidney donors have been prohibited by law everywhere in the world except in Iran (16,20,21). At the same time, prior research indicates that the burden on living donors is so substantial that significant increase in the number of donors would be possible if some of these burdens were removed (22,23). The global effort to comply with the law in the presence of various burdens faced by the donors has sparked a debate over whether kidney donors should be compensated. Some experts in this area strongly oppose to the idea due to the risk of possible exploitation of the poor, excessive motivations generating a semi-market for the kidneys, adverse selection, and commercialization of the human body (24–26). Others have strong reservations, due to the fundamental concern whether an ethical compensation program is indeed designable and implementable (7). Other experts are more amenable to the idea of direct monetary payments for kidney donation. Becker & Elias (2007) estimates that for a kidney, an amount of $15,000 and for a liver, an amount of $38,000 would enable markets to function (22,27). Other scholars claim that some form of non-cash, in-kind benefits could help reduce the shortage of human organs and tissue, thereby reducing the wait time for a transplant and improving quality of life among patients (19,22–24,28,29) At the societal level, the economic benefit of a reimbursement program is rather well established. The cost effectiveness of a reimbursement program is achieved from treating more patients with a transplant rather than with a more costly treatment modality, i.e., dialysis (22)

Tong (2014) conducted interviews of 110 transplant nephrologists and surgeons from 43 transplantation programs in 12 countries in Europe, Australasia, and North America, and compiled their opinions on financial remunerations and kidney donations. The study revealed that a majority of the respondents consider that minimizing disincentives support equity and justice in living kidney donation, and prioritizing the removal of disincentives for living donors is acceptable. However, direct financial incentives were considered entirely unjustifiable because of the potential moral consequences and uncertain feasibility (30). These studies together suggest that specifying the types of ethically acceptable compensations and close examination of the effectiveness of each of such compensations are warranted. Also important is that the system in place is free of corruption or inefficiencies in implementing the policies.

That being said, the present study is only the first rigorous attempt to grasp a full-picture of what constitutes an effective reimbursement program.

The reimbursement programs included in the present study exhibited significant variations in terms of the reimbursement mechanism, eligibility criteria, duration, and types of expenses reimbursed. For example, in France and Denmark, reimbursements provided by hospitals often stipulate no eligibility criteria while, in the United States, eligibility criteria vary by state or program: Some programs focus on the reimbursement to low-income individuals, while state-level policies limit the reimbursement to state employees only (10). Similarly, while Saudi Arabia offers long-term medical insurance to donors for future medical care, Israel protects donors from the potential loss of work and/or earning after surgery (10). The positive impact reported in this study is the average effect of the presence, or lack thereof, of the program. Analyzing whether such differences in the program implementation protocols can make some programs more successful or not is an important quession to be pursued, although it is beyond the scope of the current study

For the deceased donations, there have been programs that reimburse the costs related to kidney donation including funeral expenses to the family of the deceased individual (31). While the effectiveness of such programs has not been measured, existing research suggests that such an endeavor needs to take a comprehensive approach and be accompanied by educational initiatives, public policy endeavors, and clinical protocols (32). This may apply to living donor programs where education for donor candidates and clinical practice such as kidney paired exchange could be performed in conjunction with the cost reimbursement to donors.

Our results indicated that the number of deceased kidney donations has a negative impact on the number of donations. The finding may reflect the fact that living donors are more prevalent in the countries such as Korea (donor pmp=38.41 in 2015) and Japan (donor pmp=14.76 in 2015) where deceased donor kidneys are unavailable or unutilized due to cultural and/or other historical reasons (33,34). Clinically speaking, the unavailability of deceased donor transplants in these countries has led them to develop some advanced techniques to enable living donor transplants more efficiently. For instance, clinical knowledge and expertise in performing ABO incompatible transplants are far more established in these countries (35–37). The Western countries are yet to fully incorporate such techniques to the existing living donation programs including kidney paired donation (38).

In terms of the globalization impact on living donations, the social globalization and economic variables (GDP-related variables and financial globalization) had positive impacts on the donation level, presumably indicating that the donation level tends to go up as a nation becomes more socially and economically open, and richer. However, the main roles of these variables are as controls and the gist of the findings is that a reimbursement program has a positive impact on the donation level even after adjusting

for the country's globalization and economic growth levels. The population size had a negative impact on the donation level presumably because some of the most populated countries had the relatively low levels of donation (donor pmp in China=1.87 and donor pmp in India=5.87 in 2015). The population growth was positively associated with the donation level possibly because some of the countries with the highest population growth rate (predominantly in Middle East) had a relatively high donation level. Similarly, the data revealed that Middle Eastern countries tend to have a high out of pocket health expenditures and donation levels. These countries at the same time had a relatively low ratio of private and public health expenditure to GDP, which produced a negative correlation between the variable and the donation level. Concurrently, the countries with a relatively high ratio of private and public health expenditure to GDP (Europe, Japan and United States) exhibited a relatively high donation level.

V. **Limitations**

One of the advantages of applying a fixed effects model is that the method corrects bias due to both observed and unobserved heterogeneity that are time-invariant. That is, if there are country specific traits that are time-invariant, we do not need to control for those variables, and the estimators in the model are free of heterogeneity bias. However, this also means that the model is not suitable for measuring the impacts of some theoretically important variables. In many cases, these are cultural variables associated with the donation rate. For instance, a relatively high donation rate among female in India is cultural (39), and may be an important factor in explaining India's donation rate. Similarly, a high donation rate in Saudi Arabia may be attributable to the donations to unrelated recipients, which might partially reflect living donor transplants involving immigrant donors (40). The fixed effects model used in the current study cannot demonstrate the impacts of these factors. However, these factors were were controlled in the FE estimates.

We also acknowledge that some of the known predictors were excluded from the model. For instance, religion is a known predictor for the willingness to donate (41,42). However, composition of religious structure do not change much over time, and thus the effect of such time-invariant fixed effects cannot be measured. In conclusion, our approach compromised these known country specific heterogeneities and time invariant predictors to be taken into account for the sake of obtaining the unbiased estimate for the key predictor, i.e., adoption of a reimbursement program(s) in the 17-year long panel data. Further investigation of the effects of such traits may be warranted although such investigation will need to be undertaken using a different dataset with a shorter coverage of time period or in a cross sectional study without focusing on the policy changes within countries. It is also important to note that some of the variables that are likely to be critical in determining the living donation level were not available. For instance, the number of transplant programs or trained transplant surgeons per country per year were not available. While we made effort to accommodate the impacts of such variables using the globalization measures, we acknowledge that the use of such composite measures neither fully accommodates the variable effects nor allows us to delineate

concrete policy recommendations.

As mentioned in the discussion section, the current study did not analyze what type of reimbursement program is effective. In our data, the number of the countries with a reimbursement program was relatively small compared to the number of countries without, and most of the countries with a program appeared to have a similar set of reimbursement components. This made us impossible to disentangle the effects of different types of programs. Further data collection and concomitant analysis are needed to discern the types of reimbursement programs that are effective at the global level. To complement the research using aggregated data, small-scale prospective trials of various types of donor reimbursement programs could be pursued and be comparatively evaluated to examine the feasibility and the effectiveness of individual programs.

Most importantly, we recognize that the data compiled here answers only half the question of whether a program of donor compensation should be implemented. The question has two parts: (1) will it work as far as increasing the number of transplants; and (2) will it be fair to all concerned, including donors. The first question is necessarily of preliminary concern. If compensation doesn't increase the number of transplants, then there is no need to look into question (2), so our study lays the fundamental groundwork for further analysis. We also recognize that the data compiled for the present study had comparatively high donation rates in some of the Low-to-Middle-Income Countries (LMICs) including Egypt (donor pmp=40.40) and Jordan (donor pmp=31.84), compared to some of the developed countries with a consistently high donation rate such as Korea (donor pmp=38.40) and the Netherlands (donor pmp=30.59) (based on the 2015 figures). The global database on organ donation is compiled using individual countries' organ transplant data. Thus, it is possible that some of the LMIC countries erroneously count kidneys that were purchased in the black market and other unethical transplants perfomed overseas as a donation. This would inflate the size of the outcome variable for these countries, thereby distorting the coefficients as well as the significance of the covariates that are correlated with the development stage of the countries. There was a related discussion on the donation statistics on Saudi Arabia (40), and it seems that our number on Saudi Arabia does not appear to include the living donor transplants that might have performed overseas. However, there are no references that we can use to check the accuracy of the statistics for the statistics in other countries.

VI. Conclusion

In this evaluation study of country-level living donor reimbursement programs implemented globally between 2000 and 2016, the impact of such a program on overall donation numbers was substantial. We predict that living kidney donation would increase by a factor of 1.16 as a result of a reimbursement program. The result indicates that a reimbursement program has a potential to bring substantial economic and welfare benefits through improved access to kidney transplantation. This is a fundamental first step in

determining the future direction of research endeavor, which should include not only the type of reimbursement programs that is effective in increasing donation rates but also the content of the programs that is fair and just in other respects.

Figure legends:

Figure 41. Evolution of Country Reimbursement Program: (2000-2016)

Figure 52. Donations per million by country in 2015

Figure 63. Coefficient Plots

Appendix I

Country	Reimbursement program (Year)	Country	Reimbursement program (Year)	Country	Reimbursement program (Year)
Albania	No	Ghana	No	Pakistan	No
Algeria	No	Greece	No	Panama	No
Argentina	No	Guatemala	No	Paraguay	No
Armenia	No	Honduras	No	Peru	No
Australia	Yes (2013)	Hungary	No	Philippines	Yes (2000)
Austria	No	Iceland	No	Poland	No
Azerbaijan	No	India	No	Portugal	No
Bahrain	No	Indonesia	No	Qatar	No
Bangladesh	No	Iran	Yes (2000)	Republic of Korea	No
Belarus	No	Ireland	Yes (2014)	Republic of Moldova	No
Belgium	Yes (2000)	Israel	Yes (2008)	Romania	No
Bolivia	Yes (2011)	Italy	No	Russian Federation	No
Bosnia and Herzegovina	No	Japan	No	Saudi Arabia	Yes (2007)
Brazil	No	Jordan	No	Serbia	No
Brunei Darussalam	No	Kazakhstan	No	Singapore	Yes (2009)
Bulgaria	No	Kenya	No	Slovakia	No
Canada	Yes (2000)	Kuwait	No	Slovenia	No
Chile	Yes (2000)	Latvia	No	South Africa	No
China	No	Libya	No	Spain	No
Colombia	No	Lebanon	No	Sudan	No
Costa Rica	No	Lithuania	No	Sweden	Yes (2000)
Croatia	No	Malaysia	No	Switzerland	Yes (2000)
Cuba	No	Malta	No	Syrian Arab Republic	No
Cyprus	No	Mauritius	No	Tajikistan	No
Czech Republic	Yes (2013)	Mexico	No	Thailand	No
Denmark	Yes (2000)	Mongolia	No	Trinidad and Tobago	No
Dominican Republic	No	Montenegro	No	Tunisia	No
Ecuador	No	Morocco	No	Turkey	Yes (2000)
Egypt	No	Myanmar	No	Ukraine	No
El Salvador	No	Nepal	No	United Arab Emirates	No
Estonia	No	Netherlands	Yes (2000)	United Kingdom	Yes (2004)

Ethiopia	No	New Zealand	Yes (2015)	USA	Yes (2004)
Finland	No	Nicaragua	No	Uruguay	No
France	Yes (2000)	Nigeria	No	Uzbekistan	No
Georgia	No	Norway	Yes (2000)	Venezuela	No
Germany	Yes (2007)	Oman	No	Viet Nam	No

Appendix II

Financial globalization	The index of financial globalization consists of financial de facto such as foreign direct investment, international reserves and dept, portfolio investment, and international income payments and financial de jure such as investment restrictions and capital account openness.	Swiss economic institute Konjunkturforschungsstelle (KOF)
Social globalization	The index of social globalization consists of social de facto such as migration, international tourism, trade in cultural goods and high technology, patent etc. and social de jure such as press and civil freedom, gender parity, internet user, television, etc.	Swiss economic institute Konjunkturforschungsstelle (KOF)
Political globalization	The index of political globalization consists of political de facto such as number of embassies, UN peace keeping missions, and international NGOs and political de jure such as international organization, international treaties, and number of partners in investment treaties. The index range 1 to 100, higher value indicates higher level of globalization.	Swiss economic institute Konjunkturforschungsstelle (KOF)

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