In the Pursuit of Windfalls: Internal Migration and Natural Resources in Indonesia

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Abstract

Internal migration has become an important feature of economic development. However, little research has been done to establish convincing causal effects of natural resource wealth on population mobility. This paper examines how the endowment of oil and gas affects the pattern of internal migration in Indonesia. Our identification strategy is to exploit exogenous variation in the possession of the non-renewable resources across Indonesian districts and applies a modified dose-response approach to the latest disaggregated census data on recent and lifetime migration. We find that the rate of internal migration is consistently higher in resource-rich districts than their resource-poor counterparts. The results also highlight stronger effects of the natural resource treatment variables on lifetime migration. Interestingly, the plots of the modified dose-response function exhibit an inverted U-shaped, suggesting that mediocre levels of oil-gas abundance are associated with the highest inflow of migrants. Further exercises show that the rural population and the male group are more responsive to the availability of oil and gas.

Keywords: internal migration, recent migration, lifetime migration, natural resource.

JEL Classification Codes: J61, O15, Q32.

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1. Introduction

The widespread increase in migration rates within a country has been an important feature of the development process. It is the workhorse of Harris and Todaro in 1970 which provides fundamental explanations why people move from one location to another. Their eminent model of rural-urban migration assumes that an individual is rational and thus posits that the migration decision is primarily driven by economic considerations. According to the thesis, however, a person undertakes migration especially to improve his employment prospects and take advantage of higher expected earnings in the chosen destination. Instead, the contemporary literature looks at migration as the instrument of reducing income risks due to the presence of imperfect insurance markets (Stark and Bloom, 1985).

Drawing on the above theoretical insights, de Janvry et al. (1997) derive testable predictions of the role of environmental factors on migration. The authors highlight two main channels through which environmental conditions may affect the movement of people. In line with the conventional theoretical framework, higher expected income differentials and greater employment opportunities in natural resource-rich environments provide strong incentives to migrate. Furthermore, according to the new notion, the availability of natural resources is supposed to increase the opportunity cost of capital and provide additional protection against market failures, implying additional gains from migration. In other words, this migration-environmental model suggests that the endowment of natural resources is a magnetic factor of migration.

The main objective of this paper is to give further empirical evidence on the magnetic effect of natural resource wealth on internal migration in Indonesia. This country is an ideal laboratory for our current study. As the world's largest archipelagic nation and one of the most populous countries, Indonesia has experienced uneven population distributions for many decades where the country's population is highly concentrated in Java and Bali Islands. The government of Indonesia, however, has made a serious attempt to reduce this disparity. While the effort to migrate people from Java to the other islands was formally initiated after gaining its independence, the most substantial plan to population redistribution by far was the introduction of the transmigration program by the New Order regime during 1967-1997. Apart from the purpose of allocating the population more evenly, the policy, indeed, was intended to reduce poverty by providing land resources to poor landless migrants and to foster the agricultural potential in the outer islands of Java (Tirtosudarmo, 2009).

Another distinct aspect is the geographical spread of natural resources, particularly oil and gas, across Indonesian provinces. While there are only four provinces (i.e. East Kalimantan, Riau Island, Riau, and West Papua) that are consistently considered as the major oil and gas producing regions, the income from oil and gas itself is reasonably imperative, accounted for around 20% of the central government revenue in 2010 (Agustina et al., 2012). Intriguingly, Hill et al. (2008) also report that the mobility rate in these resource-abundant provinces together with Jakarta is relatively higher than the other provinces.

It is the recent ethnographic work of Jäger (2014) that explicitly studies how the migration pattern in western Kazakhstan is determined by the growth of the oil and gas industry in the aftermath of the Soviet era. The article describes that higher salaries in this industrial sector are able to attract more migrants. Yet, uncertainties in finding employment opportunities and poor working conditions in oil and gas extraction activities seem to offset the positive effect of offered salaries on migration. We extend this work by exploiting exogenous variation in the natural resource endowment across Indonesian districts and employing a modified dose-response approach with many zero observations. The idea is to examine whether migrants respond differently to the varying degrees of the availability of oil and gas in a respective district. This strategy is well-suited for our current study since only few districts (about 13% of the entire districts) in Indonesia are considered as the oil-gas producing regions, and therefore we need to relax the normality assumption which is principally embedded in the used method. Because the design of the dose-response function signifies a counterfactual outcome, our estimated results also offer a more credible causal interpretation.

In doing so, we add to the literature on the migration-environment nexus which has received little attention thus far. The understanding of the dynamic interplay between migration and environmental factors is a nontrivial task. Environmental conditions may determine migration and this in turn may change the environment. The influx of migrants, however, may increase local environmental degradation and reduce the ability of local people to migrate. This is precisely explained by the so-called migration hump hypothesis (Martin and Taylor, 1996; de Haas, 2006). Additionally, the growing interest in the importance of environment is due to the fact that the livelihoods of people, particularly in rural developing countries, are heavily dependent on the conservation of nature and natural resources.

In the estimated model, we also include a range of local amenity variables to signify the influence of the public provision of goods and services on migration decisions.

For this reason, we also speak to a certain extent the merit of fiscal decentralization in which it can improve the supply of local public goods. As suggested by the Tiebout migration hypothesis, if people are allowed to move freely from district to district, an individual will be more likely to move to a district that closely matches his preferences for the given fiscal menus.

Finally, we believe this paper further contributes to the debate on public policy interventions aimed at promoting the development agenda through changes in the migration pattern. When an economy experiences the development of natural resource-based industries, some initiatives to reallocate labors to these sectors would become the best option. On the contrary, integrated plans to detain migration should be taken into account, while the major target of development actions is to decrease the tragedy of the commons resulting from overexploitation of natural resources.

The rest of the paper proceeds as follows. Section 2 gives an overview of the dose-response method. Section 3 describes the data and the characteristics of the sample. Section 4 presents the main empirical findings and some robustness checks. The final section concludes.

2. Identification Strategy

The main focus of this paper is to examine the causal effect of natural resource endowments on internal migration. Following the literature of program evaluation, we treat the varying levels of natural resource availability across districts in Indonesia as an exogenous continuous treatment variable and assume that migrants will have different reactions to this treatment. It follows that our strategy closely resembles dose-response functions which are commonly adopted in epidemiology studies. The idea of our modified dose-response model summarized from Cerulli (2014) is presented in the following discussion.

Assume there are two potential migration outcomes for district i: y_{1i} if it is considered as the resource-abundant district and y_{0i} if the district to be poor in natural resources. We define r_i, the ownership of natural resources, as a binary treatment variable which is equal to one for the resourcefully treated district and zero otherwise, and $x_i = (x_{1i,} x_{2i,} \dots, xK_i)$ as a vector of K exogenous and observable characteristics for district $i = 1,2, \dots, n$. Thus, the total number of districts in the analysis can be stated as $n = n_0 + n_1$, where n_0 is the number of non-resource districts and n_1 is the number of resource-rich districts.

We express the responses of district i to the vector of x_i into the functions of $g_0(x_i)$ for the untreated and $g_1(x_i)$ for the treated. Let μ_0 and μ_1 be two scalars,

e_0 *and* $e_1 \sim N(0, \sigma^2)$. We also have a continuous treatment indicator $t_i \in [0, .., 100]$, whereas the derivable function of this variable is $h(t_i)$.

The possible outcomes for a given population, thus, can be formulated as:

$$\begin{cases} r = 1: y_1 = \mu_1 + g_1(x) + h(t) + e_1 \\ r = 0: y_0 = \mu_0 + g_0(x) + h(t) + e_0 \end{cases} \tag{1}$$

where the function of $h(t)$ for the treated district is different from zero.

If the treatment effect of natural resource availability is measured by $TE = (y_1 - y_0)$, the average treatment effect for the population (ATE) conditional on x and t is estimated in the following way:

$$ATE(x; t) = E(y_1 - y_0 | x, t) \tag{2}$$

$$ATT(x; t > 0) = E(y_1 - y_0 | x, t > 0)$$

$$ATU(x; t = 0) = E(y_1 - y_0 | x, t = 0)$$

where ATE denotes the total average treatment effect, ATT and ATU are the average treatment effects on the treated and untreated districts respectively.

Using the law of iterated expectations, the unconditional version of the above equation becomes:

$$ATE = E_{(x;t)}\{ATE(x; t)\} \tag{3}$$

$$ATT = E_{(x;t>0)}\{ATE(x; t > 0)\}$$

$$ATU = E_{(x;t=0)}\{ATE(x; t = 0)\}$$

where $E_z(\cdot)$ is the mean operator capturing a vector of variable z. Supposed that the parametric equations of $g_0(x) = x\delta_0$ and $g_1(x) = x\delta_1$ are linear in parameters. We can rewrite the conditional form of the average treatment effect as:

$$ATE(x, t, r) = r \cdot [\mu + x\delta + h(t)] + (1 - r) \cdot [\mu + x\delta] \tag{4}$$

where $\mu = (\mu_1 - \mu_0)$ and $\delta = (\delta_1 - \delta_0)$.

Referring to Equation (1), the unconditional average treatment effect can also be rewritten as:

$$ATE = p(r = 1) \cdot \left(\mu + \overline{x}_{t>0}\delta + \overline{h}_{t>0}\right) + p(r = 0) \cdot (\mu + \overline{x}_{t=0}\delta) \tag{5}$$

where $p(\cdot)$ denotes a probability and $\overline{h}_{t>0}$ indicates the average response function for all $t > 0$. Again, from the iterated expectations theorem, we obtain that $ATE = p(r = 1) \cdot ATT + p(r = 0) \cdot ATU$. Therefore,

$$\begin{cases} ATE = p(r = 1)\left(\mu + \overline{x}_{t>0}\delta + \overline{h}_{t>0}\right) + p(r = 0) \cdot (\mu + \overline{x}_{t=0}\delta) \\ ATT = \mu + \overline{x}_{t>0}\delta + \overline{h}_{t>0} \\ ATU = \mu + \overline{x}_{t=0}\delta \end{cases} \tag{6}$$

The dose-response function is the average of $ATE(x, t)$ over x, or:

$$ATE(t) = \begin{cases} ATT + \left(h(t) - \overline{h}_{t>0}\right), \ \forall \, t > 0 \\ ATU, \forall t = 0 \end{cases} \quad (7)$$

Because the basic parameters of our potential migration outcomes are derived from ATEs and the dose-response equation, our challenge is to produce a consistent estimator of these parameters. To answer this, we first return to the Rubin causal model, that is, $y_i = y_{0i} + r(y_{1i} - y_{0i})$ and the outcomes expressed in Equation (1) to obtain the following random-coefficient regression:

$$y_i = \mu_0 + r_i \cdot ATE + x_i\delta_0 + r_i \cdot (x_i - \overline{x})\delta + r_i \cdot \left(h(t_i) - \overline{h}\right) + \eta_i \quad (8)$$

where $\eta_i = e_{0i} + r_i \cdot (e_{1i} - e_{0i})$

The next identifying assumption is to hold the Conditional Mean Independence (CMI) hypothesis such that both r and t are exogenous, given the series of observable variables x. Accordingly, we can express the estimated regression function as:

$$E(y_i | r_i, t_i, x_i) = \mu_0 + r_i \cdot ATE + x_i\delta_0 + r_i \cdot (x_i - \overline{x})\delta + r_i \cdot \left(h(t_i) - \overline{h}\right) \quad (9)$$

The last step is to meet the parametric assumption when estimating $h(t)$ or:

$$h(t_i) = \alpha t_i + \beta t_i^2 + \gamma t_i^3 \quad (10)$$

where $\alpha, \beta,$ and γ are obtained from (9).

If the consistent OLS estimators based on Equation (9) are $\hat{\mu}_0, \hat{\delta}_0, A\hat{T}E, \hat{\delta}, \ \hat{\alpha}, \hat{\beta},$ and $\hat{\gamma}$ respectively, the consistent estimation of the dose-response function is given by:

$$A\hat{T}E(t_i) = r\left[A\hat{T}T + \hat{\alpha}\left(t_i - \frac{1}{N}\sum_{i=1}^{N} t_i\right) + \hat{\beta}\left(t_i^2 - \frac{1}{N}\sum_{i=1}^{N} t_i^2\right) + \hat{\gamma}\left(t_i^3 - \frac{1}{N}\sum_{i=1}^{N} t_i^3\right)\right] + (1 - r)A\hat{T}U \quad (11)$$

where $A\hat{T}T(t_i) = A\hat{T}E(t_i)_{t_{i>0}}$. Indeed, our final goal is to estimate Equation (11) and examine the statistical significance of our treatment variables at each level of the dose t.

3. Data Sources and Descriptive Analysis

This paper extracts large datasets from several sources during the period 2009-2010. Given the availability of the data, the analysis is carried out at the district level which covers 497 districts in total. The data on internal migration come from the 2010 Population Census published by Statistics Indonesia (BPS). It should be noted that our measure of migration represents the inflow (in) of internal migrants from a district or a province to a certain district. Specifically, this consists of two measures: lifetime migration and recent migration. The former is measured by the proportion of people who reside in a different region than their birth region, whereas the latter is identified as the fraction of people who live in a different region than their residential places five years previously.

The disaggregated data files on the treatment variables enable us to generate two indicators: the fraction of oil produced by each district and the district share of total gas production. The data were collected from the Ministry of Energy and Mineral Resources, and basically they are estimated from the lifting of crude oil and natural gas by Pertamina or other contractors through production sharing contract systems with the aforementioned state-owned energy company.

We also include the socio-economic variables that are supposed to be important to migration decisions. Chief among them is the local amenity variables that comprise the share of households with access to safe drinking water and basic sanitation facilities. The inclusion of these indices will also allow us to examine the existence of the Tiebout hypothesis, stating that people tend to sort themselves into regions that provide a mix of public expenditures. The detailed explanations of the used variables can be found in Appendix 1.

< Table 1>

Table 1 presents summary statistics of the key variables by the treatment status. According to the table, there are only 12.12% (61) districts are considered as the producing regions. Those producing districts, however, are geographically concentrated in Sumatra and Kalimantan (Figure 1). Moreover, the kernel density plots in Figure 3 indicate that the distributions of oil and gas production are not normally distributed but heavily right skewed.

< Figure 1>

< Figure 3>

Together with the visual inspection in Figure 2, it is also clearly revealed that the rate of migration in the resource-rich districts is higher than the resource-poor districts, where the remarkable difference between the two groups is for lifetime migration (18.88% versus 27.31% respectively). Looking at the housing amenities, while fewer households in the producing areas have access to safe drinking water, the level of access to basic sanitation in this group is higher than the other group. Besides, these rich-resource districts are characterized with a healthier fiscal position as well. When it comes to the rate of morbidity, it is recorded that this number is lower in the producing regions. In 2010, about 30.67% households in the producing areas, on average, reported that they were unhealthy, whereas it was 33.68% in the non-producing areas.

< Figure 2>

As compared to the resource-poor regions, the other characteristics of the treated areas are having a bigger share of married population, longer school years, more poor people, a higher level of income per capita, better employment opportunities in both agriculture and manufacturing sectors, a higher level of prices. Finally, the statistic informs us that there are approximately over a quarter of the resource-poor districts are located in Java and Bali, while the corresponding value for the resource-rich districts is 22.95%.

4. Empirical Results and Discussion

4.1 Baseline Results

Our main results are presented in the first column of Table 2-5. The analysis is split up by the two types of internal migration and the used treatment variables. We begin by examining the effect of the oil endowment on internal migration. As seen in Table 2 and 3, the estimated coefficients are positive and statistically significant for both measures of migration. However, the impact of oil resources is stronger for lifetime migration rates. The coefficient indicates that the rate of lifetime migration is increased by 6.12% on average. Likewise, the average result for recent migration is only around 1.02%.

< Table 2>

< Table 3>

Moving on the role of natural gas, the results in Table 4-5 also suggest sizeable effects. Again, a larger effect of the gas endowment is to be found in lifetime migration as compared to recent migration. The point estimate indicates that the districts endowed with natural gas receive roughly 5.48% higher inflow of lifetime migrants. In the same vein, the marginal effect of gas (0.71) is obtained in the level of recent migration.

< Table 4>

< Table 5>

We plot the dose-response functions for the four above migration outcomes with their respective 95% confidence intervals in Figure 4-7. The charts exhibit an inverted U-shaped form for the three migration measures. The exceptional case is for the relationship between the inflow of recent migration and the dose of the ownership of crude oil, showing a U-shaped pattern. The general impression from these findings is that high and low levels of natural resource endowments do not appear to give a substantial stimulus for the inflow of migrants. Conversely, a mediocre dose of natural resource wealth is associated with the largest inflow of migrants.

< Figure 4>

< Figure 5>

< Figure 6>

< Figure 7>

The next interesting results are related to our local amenity variables. As predicted by the Tiebout migration model, migrants are more likely to move to regions with adequate provisions of local amenities. A recent study in Nepal by Fafchamps and Shilpi also signifies this hypothesis. Our present result confirms that the better access to basic sanitation facilities seems to be able to attract more migrants. However, the estimated coefficients vary between 0.02% and 0.07%. Surprisingly, the access to safe drinking water enters the models with a negative sign, and they are all statistically distinguishable from zero at the 1% level. This implies that the lack of access to a good quality of drinking water is associated with the higher level of migration. One possible explanation for the findings is due to negative externalities from unsustainable practices of oil and gas industries themselves.

Because a district's fiscal capacity is measured based on its own-source revenue and revenue sharing (including the sharing of natural resources revenue with the central government), this variable is expected to go hand in hand with the oil and gas production. Our results suggest the important role of this fiscal measure on migration inflows. All of the coefficients turn to be positive and are not distinguishable from zero at any conventional level of significance. Intuitively, we read these findings as an indication that the producing districts associated with sound fiscal capacities are able to offer attractive fiscal menus and thus become a magnet for potential migrants.

Focusing on the remaining coefficients, the estimates of marital status are noticeably large and significant at the 1% level in the case of lifetime migration. A one percent increase in the proportion of married adults leads up to 0.56% increase in the rate of lifetime migration. In contrast, marriage does not significantly affect recent migration. Although we do not have exact data showing that marriage is one of the main reasons to migrate, this econometric exercise offers prima facie evidence about the relevance of marriage migration in Indonesia. That the primary goals of migration are to join the spouse and to form a family. Research on internal migration and marriage is small indeed. An outstanding contribution to this field is the paper of Rosenzweigh and Stark in 1989, arguing that internal migration in India, especially female migration, is an instrument to smooth the consumption of households against negative income shocks.

Having longer schooling years substantially boosts migration. The magnitude of the coefficients is large, close to the half of our treatment effect variables. If schooling is deemed to be a rational device to secure jobs and obtain better income, prospective migrants will overinvest in education prior to migrating (Kochar, 2004). We also note the triviality of our health variable.

While the rate of poverty does not show statistically significant results, income per capita, however, plays a substantial positive role on the process of internal migration. The largest estimated coefficient is for the lifetime migration outcome regression and its relationship with natural gas resources which suggests that the rate of internal migration is significantly raised by 3.55%. The next economic variable is employment opportunities in both agriculture and manufacturing sectors. Overall, we find that high levels of employment opportunities in the district of origin are inversely related to migration rates. Yet, the evidence provided in this paper clearly confirms only employment in the agriculture sector does matter for migration. This reflects that migration is essentially determined by economic considerations. Consistent with the Harris-Todaro model, people tend to move to a locality where there is a good job opportunity and a higher expected income.

All else equal, our estimates display that the proxy of living costs has the expected sign and significant though the size of the coefficients is small. This is theoretically appealing evidence, that expensive districts attract more migrants. If the high level of human capital accumulation is the major source of a district's aggregate productivity growth, this leads not only to higher skill premia but also to higher price levels via the Balassa-Samuelson effect, giving the incentive for high-skilled migrants to entry (Giannetti, 2003). In fact, the prediction of this two-location overlapping generation model is consistent with our previous discussion that more educated individuals are more mobile.

Surprisingly, the dummy for Java-Bali provides intriguing results as the rate of internal migration in these two islands seems to be lower than the other islands. Nevertheless, Hill et al. (2008) highlight that Java and Bali experienced slow population growth between 1971 and 2000, whereas Sumatra and Kalimantan exhibited the opposite trend. The authors further emphasize that this demographic pattern is partly explained by raising net migration to the resource-rich/frontier regions (including the southern part of Sumatra, East and Central Kalimantan, and Papua) for the purpose of socio-economic improvement.

4.2 Robustness Tests

4.2.1 Explaining Rural-Urban Differentials

Although economists have spurred research on population mobility for over the last half century, the canonical study of internal migration was initiated by Ravenstein during the 1880s. In his fourth migration law, Ravenstein posits that the rural population is far more mobile than the urban population to take advantage of appealing qualities of urban areas (Greenwood and Hunt, 2003). This idea is simple, but through this analysis, the rural-urban migration theory of push-pull factors is developed later on.

To examine this hypothesis, we split our sample into two different parts and rerun our baseline specification separately for rural and urban samples. The results of this experiment are presented in Columns 2 and 3 of Table 2-5. As clearly seen from the tables, our treatment variables are still positive and keep strongly affecting lifetime migration. A notable differential finding is larger point estimates for the rural sample as compared to the urban sample, corroborating that of Ravenstein's thesis.

The fact that larger proportions of movers are residents of rural areas is not unexpected. The most plausible reason for this is the rapid growth of urbanization. World Bank (2012), however, reports the level of urbanization in Indonesia is very impressive. It increased by 200% during 1970-2007. The persistence of the higher GRDP per capita in urban regions somehow becomes a pull factor for the rural population to move to these areas. Moreover, structural changes in the Indonesian economy from agriculture toward manufacturing and services have also amplified the rate of urbanization.

4.2.2 Assessing the Role of Gender

A final concern is to understand whether migration flows are reliant on gender composition. Despite a large body of literature on migration has recorded that working-age males are predominantly labor migrants, migration among the female group has been growing rapidly (see, for example: Enchautegui, 1997; Liang and Chen, 2004; Faggian, McCann and Sheppard, 2007). In addition to marriage and other family-related reasons, this can be explained by the increasing demand for female labors as a result of the raising education attainment of women and the expansion of service and export-oriented labor industries (de Haan, 2000).

The last two columns of Table 2-5 show the dose-response function estimates for migration rates by gender. In agreement with our earlier finding, we also find a positive impact of oil and gas endowments on internal migration, and this effect is nontrivial in determining the inflow of lifetime migration. In support to the existing literature, our point estimates reveal that male migrants are particularly susceptible to natural resource wealth than their female migrant counterparts. Certainly, these results are not difficult to explain. Perhaps gender segregation in the oil and gas industries would attract productive males to work in a resource abundant district.

5. Concluding Remarks

In this paper, we have studied the causal effect of natural resource endowment on internal migration in Indonesia. We take advantage of the geographical spread of oil and gas wealth across Indonesian districts and introduce a modified dose-response function model to estimate the outcome of interest. In general, our results show that the inflow of migrants to oil and gas producing districts is larger as compared to non-producing districts. The causal effects are substantially greater on the rate of lifetime migration. The graphical representations of the function display a nonlinear relationship between the availability of natural resources and the rates of migration, indicating that migrants react differently to the varying degrees of oil-gas abundance. These findings are robust across subsamples, suggesting that the rural population and the male group are mostly to be affected.

Although the results of this research can be used to identify policy interventions that are intended to either foster or deter migration flows to resource-rich regions, several issues leave aside for future work. First, the used data do not allow us to exactly indentify sending and receiving districts. In fact, the closer distance between origins and destinations is supposed to boost migration since migrants will incur lower travel costs.

While this paper explicitly assumes the exogeneity of natural resources, it would be worthwhile to model the causal of interest under treatment endogeneity. The idea is that the increasing rate of net migration may adversely affect the availability of natural resources. This is very plausible case because migrants may extract resources from the environment for their livelihoods, and this finally influences the quality and quantity of the existing natural resources.

Moreover, we limit the analysis to two treatment variables thus far. Utilizing other types of natural resources would be beneficial in order to test whether the current findings can be extrapolated under different settings and to provide an answer to classes of resources that are more attractive to migrants.

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Figure 1 Oil and Gas Production Areas

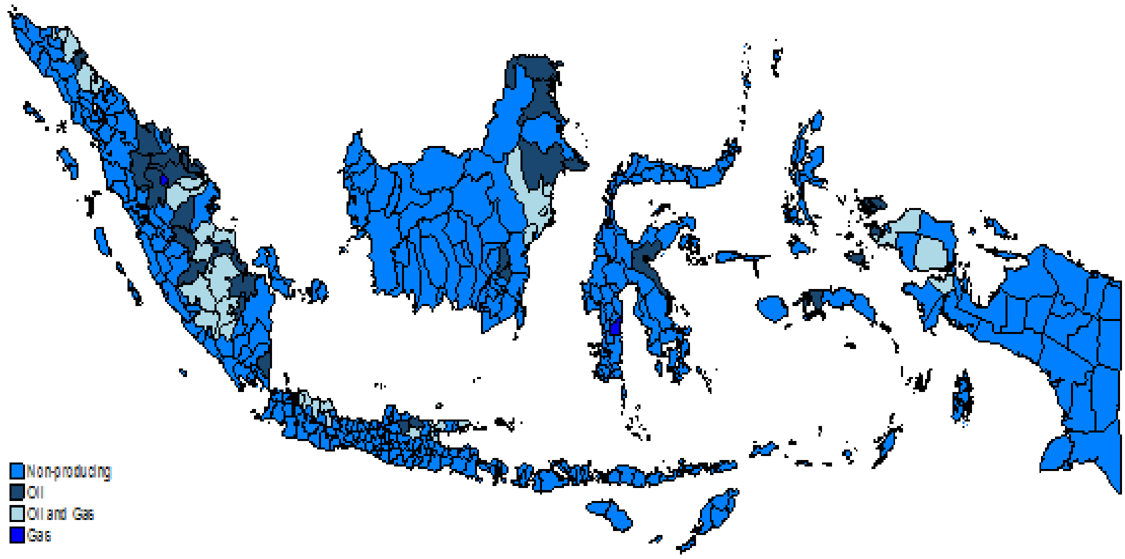


Figure 2 Kernel Density Distributions of Internal Migration Rates

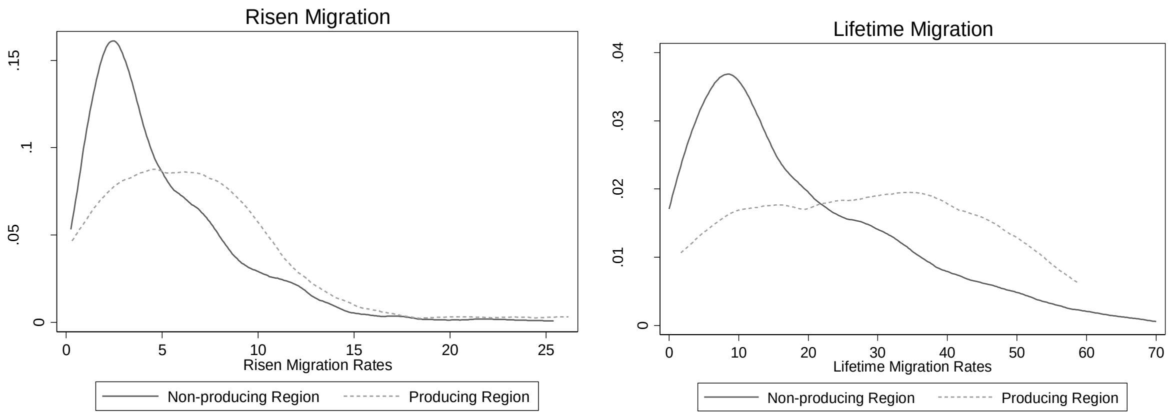


Figure 3 Kernel Density Distributions of Oil and Gas Production

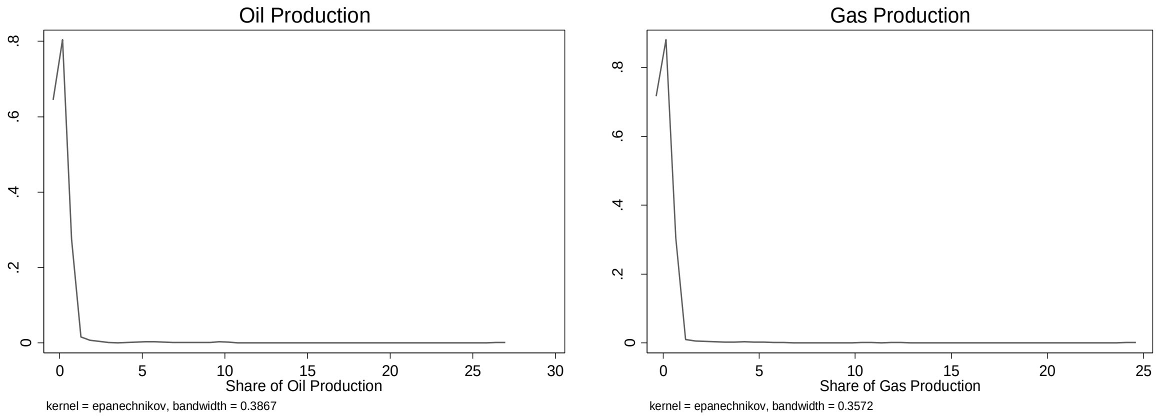


Table 1 Summary Statistics of the Sample

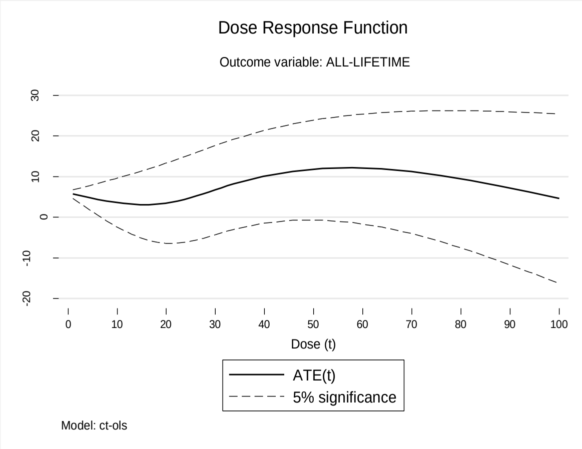
	Non-producing districts		Producing districts	
	Mean	Std. Dev.	Mean	Std. Dev.
lifetime	18.8835	14.7609	27.3122	16.6575
recent	5.0143	3.9794	6.1011	4.0671
water	44.2437	16.9967	42.4397	14.1960
sanitation	48.2757	23.6943	51.1349	18.3291
morbidity	33.6750	9.0419	30.6718	7.8263
FCI	1.1128	1.6504	1.5394	2.2129
married	58.7739	4.7074	60.5620	3.3758
schooling	7.7791	1.6204	7.8844	1.2014
lnpoor	10.4576	1.0447	10.8582	1.0294
lypcp	1.7258	0.7462	2.2959	0.8230
agriculture	51.1986	26.1286	52.7961	21.3881
manufacturing	13.2168	9.2735	14.6958	9.6653
CPI	95.9085	14.0375	101.5743	36.7770
Java-Bali	0.2592	0.4387	0.2295	0.4240
Observations	436		61	

Table 2 Dose-response Function Estimates of Lifetime Migration - Oil

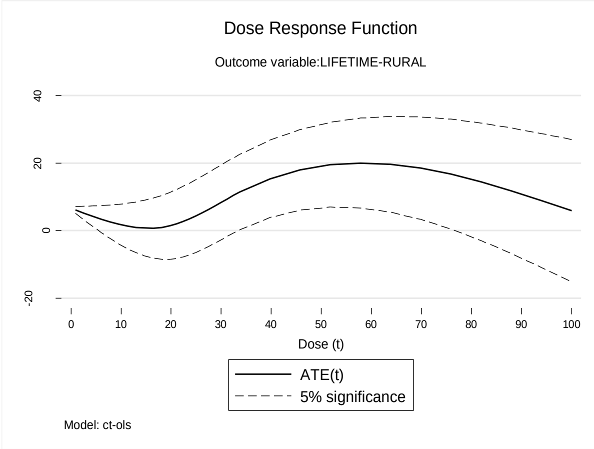
	ALL	RURAL	URBAN	MALE	FEMALE
oil	6.1193**	6.9144***	6.1537**	3.4110***	2.7082**
	(1.9144)	(1.9597)	(2.1009)	(1.0295)	(0.8948)
water	-0.1023***	-0.0275	-0.1090**	-0.0527**	-0.0497***
	(0.0301)	(0.0330)	(0.0338)	(0.0162)	(0.0140)
sanitation	0.0651	0.0530	0.0646	0.0287	0.0364*
	(0.0356)	(0.0377)	(0.0390)	(0.0191)	(0.0166)
FCI	1.0603**	1.2960**	1.1869*	0.7151***	0.3452*
	(0.3722)	(0.4220)	(0.4783)	(0.2001)	(0.1739)
morbidity	0.0501	0.0627	0.1178	0.0239	0.0261
	(0.0546)	(0.0566)	(0.0621)	(0.0294)	(0.0255)
married	0.5275***	0.7597***	0.3145*	0.2869***	0.2406***
	(0.1144)	(0.1228)	(0.1320)	(0.0615)	(0.0535)
schooling	2.9997***	1.3990*	3.2371***	1.4642***	1.5355***
	(0.5594)	(0.5899)	(0.6415)	(0.3008)	(0.2615)
lnpoor	-0.2850	0.4453	-0.0523	-0.1020	-0.1830
	(0.6709)	(0.7705)	(0.7502)	(0.3608)	(0.3136)
lypcp	3.3212***	3.6814***	2.1993*	1.8654***	1.4558***
	(0.7796)	(0.8338)	(0.8831)	(0.4193)	(0.3644)
agriculture	-0.1992***	-0.0920	-0.0661	-0.0966***	-0.1026***
	(0.0451)	(0.0488)	(0.0493)	(0.0242)	(0.0211)
manufacturing	-0.1371	-0.2402*	0.0286	-0.0509	-0.0862*
	(0.0882)	(0.0983)	(0.0959)	(0.0474)	(0.0412)
CPI	0.0559**	0.0077	0.3019***	0.0298**	0.0261**
	(0.0169)	(0.0173)	(0.0350)	(0.0091)	(0.0079)
Java-Bali	-9.0029***	-13.5911***	-7.3617***	-5.0837***	-3.9192***
	(1.6350)	(2.0138)	(1.8113)	(0.8793)	(0.7642)
$\hat{\alpha}$	-0.5513	-1.1324	-0.9893	-0.3022	-0.2491
	(0.7213)	(0.7305)	(0.7824)	(0.3879)	(0.3371)
$\hat{\beta}$	0.0245	0.0506	0.0364	0.0126	0.0120
	(0.0298)	(0.0303)	(0.0323)	(0.0160)	(0.0139)
$\hat{\gamma}$	-0.0002	-0.0004	-0.0003	-0.0001	-0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
constant	-31.0165*	-47.2224***	-49.2916**	-17.3043*	-13.7122*
	(12.8437)	(14.2214)	(15.2645)	(6.9072)	(6.0031)
Adj. R-squared	0.5353	0.4162	0.4519	0.5197	0.5509
Observations	497	460	474	497	497

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

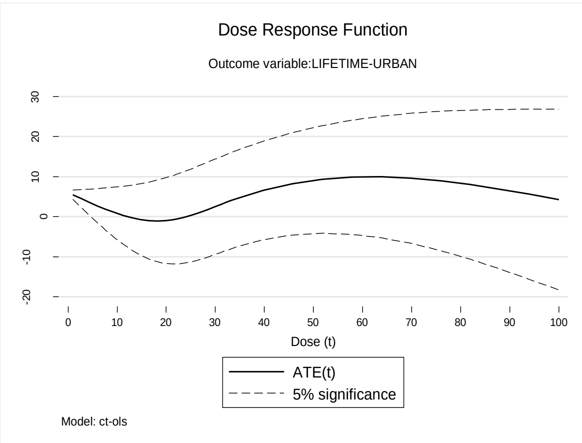
Figure 4 Dose-response Function Plots of Lifetime Migration and 95% CI - Oil



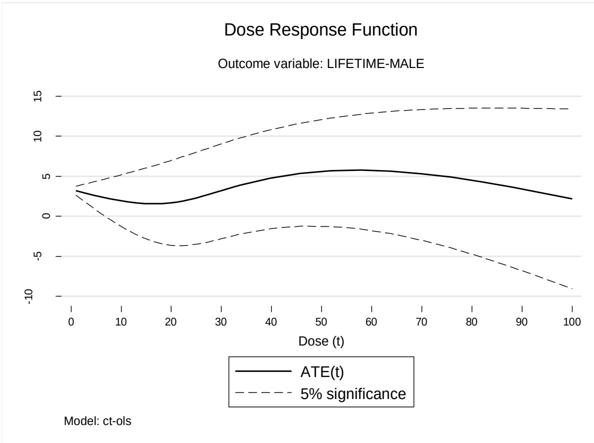
(A) All



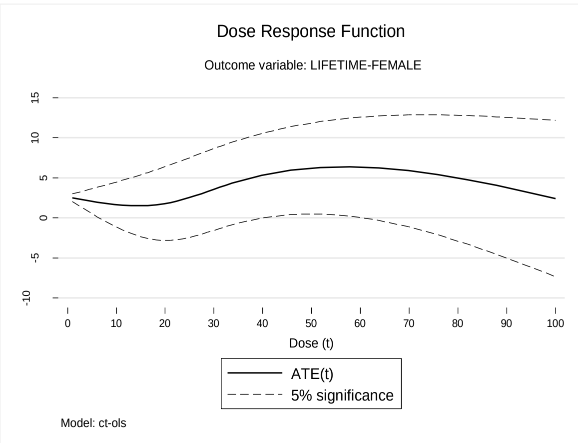
(B) Rural



(C) Urban



(D) Male



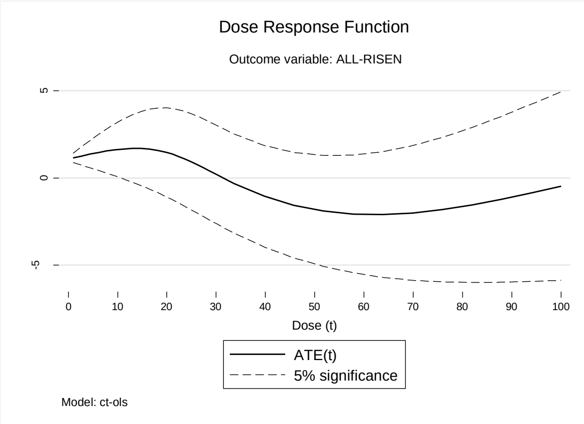
(E) Female

Table 3 Dose-response Function Estimates of Recent Migration - Oil

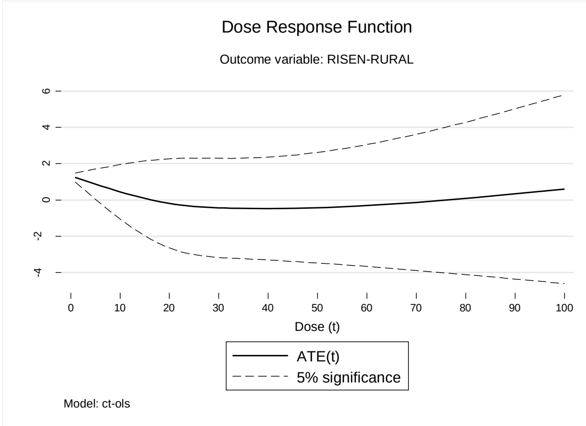
	ALL	RURAL	URBAN	MALE	FEMALE
oil	1.0231*	1.2956**	0.4812	0.6443*	0.3789
	(0.4960)	(0.4841)	(0.8432)	(0.2767)	(0.2259)
water	-0.0265***	-0.0129	-0.0490***	-0.0134**	-0.0132***
	(0.0078)	(0.0081)	(0.0136)	(0.0043)	(0.0035)
sanitation	0.0206*	0.0110	0.0212	0.0098	0.0109*
	(0.0092)	(0.0093)	(0.0157)	(0.0051)	(0.0042)
FCI	0.6577***	0.7955***	0.6421***	0.4323***	0.2254***
	(0.0964)	(0.1042)	(0.1923)	(0.0538)	(0.0439)
morbidity	0.0351*	0.0345*	0.0636*	0.0173*	0.0178**
	(0.0141)	(0.0140)	(0.0249)	(0.0079)	(0.0064)
married	-0.0020	0.0399	-0.0979	0.0004	-0.0024
	(0.0296)	(0.0303)	(0.0530)	(0.0165)	(0.0135)
schooling	0.6795***	0.3542*	0.6063*	0.3154***	0.3641***
	(0.1449)	(0.1457)	(0.2579)	(0.0809)	(0.0660)
lnpoor	-0.4098*	-0.1441	-0.6332*	-0.1893	-0.2206**
	(0.1738)	(0.1903)	(0.3023)	(0.0970)	(0.0792)
lypcp	0.0554	0.4439*	-0.4341	0.0456	0.0098
	(0.2020)	(0.2060)	(0.3545)	(0.1127)	(0.0920)
agriculture	-0.0499***	-0.0120	0.0005	-0.0222***	-0.0278***
	(0.0117)	(0.0120)	(0.0198)	(0.0065)	(0.0053)
manufacturing	-0.0119	-0.0324	0.0373	0.0017	0.0136
	(0.0228)	(0.0243)	(0.0385)	(0.0127)	(0.0104)
CPI	0.0194***	0.0077	0.0946***	0.0102***	0.0092***
	(0.0044)	(0.0043)	(0.0141)	(0.0024)	(0.0020)
Java-Bali	-1.4474***	-1.4458**	-1.0173	-0.8943***	-0.5530**
	(0.4236)	(0.4974)	(0.7270)	(0.2363)	(0.1929)
$\hat{\alpha}$	0.1541	-0.1178	0.2457	0.0728	0.0813
	(0.1869)	(0.1804)	(0.3140)	(0.1043)	(0.0851)
$\hat{\beta}$	-0.0078	0.0023	-0.0113	-0.0042	-0.0036
	(0.0077)	(0.0075)	(0.0130)	(0.0043)	(0.0035)
$\hat{\gamma}$	0.0001	-0.0000	0.0001	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0000)
constant	3.4110	-2.1797	4.7972	1.4000	2.0110
	(3.3273)	(3.5129)	(6.1445)	(1.8566)	(1.5157)
Adj. R-squared	0.5476	0.4072	0.3139	0.5220	0.5725
Observations	497	460	473	497	497

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

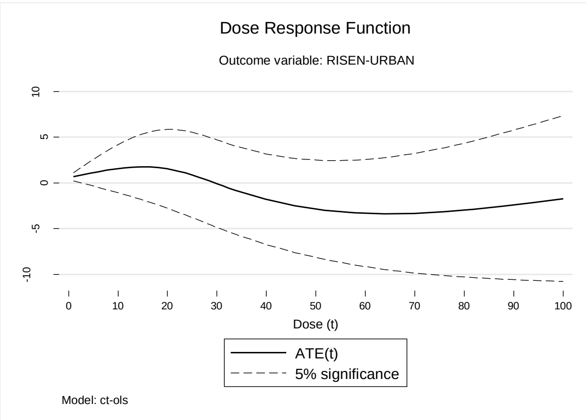
Figure 5 Dose-response Function Plots of Recent Migration and 95% CI - Oil



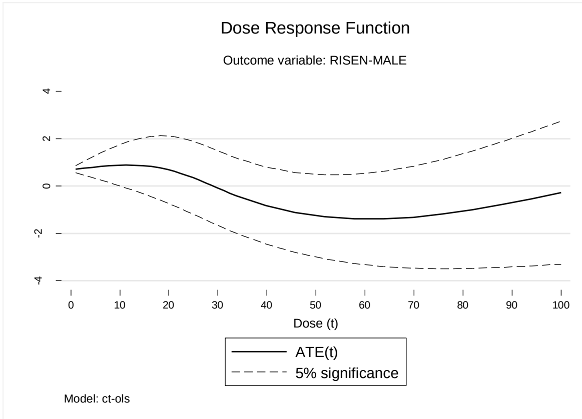
(A) All



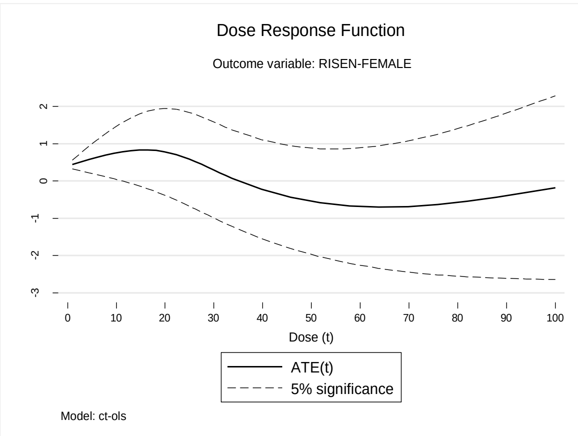
(B) Rural



(C) Urban



(D) Male



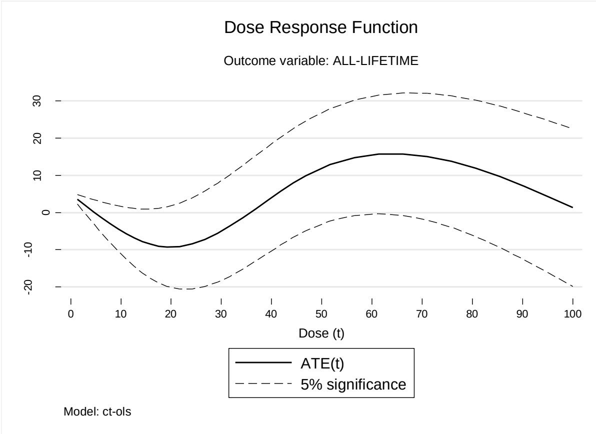
(E) Female

Table 4 Dose-response Function Estimates of Lifetime Migration - Gas

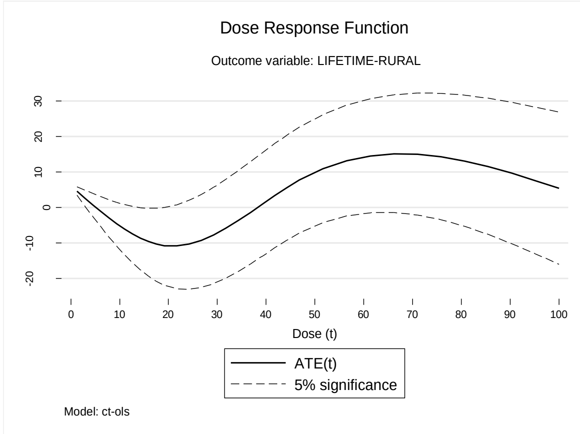
	ALL	RURAL	URBAN	MALE	FEMALE
gas	5.4841*	6.6302**	5.0590*	2.9590*	2.5252*
	(2.3549)	(2.4067)	(2.5399)	(1.2657)	(1.1012)
water	-0.1051***	-0.0349	-0.1107**	-0.0544***	-0.0508***
	(0.0302)	(0.0331)	(0.0338)	(0.0162)	(0.0141)
sanitation	0.0712*	0.0637	0.0700	0.0321	0.0391*
	(0.0357)	(0.0377)	(0.0390)	(0.0192)	(0.0167)
FCI	1.4486***	1.8652***	1.5352**	0.9225***	0.5261**
	(0.3671)	(0.4117)	(0.4748)	(0.1973)	(0.1717)
morbidity	0.0386	0.0551	0.1050	0.0175	0.0211
	(0.0548)	(0.0568)	(0.0621)	(0.0294)	(0.0256)
married	0.5610***	0.8047***	0.3438**	0.3049***	0.2560***
	(0.1145)	(0.1226)	(0.1316)	(0.0615)	(0.0535)
schooling	3.0124***	1.4355*	3.2216***	1.4741***	1.5382***
	(0.5614)	(0.5913)	(0.6421)	(0.3017)	(0.2625)
lnpoor	0.2384	1.2495	0.4340	0.1745	0.0639
	(0.6658)	(0.7589)	(0.7441)	(0.3578)	(0.3113)
lypcp	3.5457***	3.8705***	2.4236**	1.9619***	1.5837***
	(0.7791)	(0.8327)	(0.8794)	(0.4187)	(0.3643)
agriculture	-0.1829***	-0.0754	-0.0530	-0.0877***	-0.0952***
	(0.0449)	(0.0486)	(0.0490)	(0.0241)	(0.0210)
manufacturing	-0.1377	-0.2479*	0.0278	-0.0508	-0.0869*
	(0.0885)	(0.0986)	(0.0960)	(0.0475)	(0.0414)
CPI	0.0501**	0.0022	0.2899***	0.0265**	0.0236**
	(0.0170)	(0.0173)	(0.0352)	(0.0091)	(0.0079)
Java-Bali	-9.5825***	-14.4914***	-8.0270***	-5.3792***	-4.2033***
	(1.6303)	(2.0085)	(1.7996)	(0.8763)	(0.7624)
$\hat{\alpha}$	-1.7822**	-1.9996**	-1.8868**	-0.9978**	-0.7844**
	(0.6051)	(0.6139)	(0.6556)	(0.3252)	(0.2830)
$\hat{\beta}$	0.0598**	0.0634**	0.0594**	0.0345**	0.0253**
	(0.0206)	(0.0209)	(0.0224)	(0.0111)	(0.0097)
$\hat{\gamma}$	-0.0004**	-0.0004**	-0.0004*	-0.0002**	-0.0002*
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)
constant	-38.8294**	-59.0308***	-55.4320***	-21.4182**	-17.4112**
	(12.7188)	(13.9773)	(15.1092)	(6.8359)	(5.9476)
Adj. R-squared	0.5326	0.4138	0.4516	0.5175	0.5478
Observations	497	460	474	497	497

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

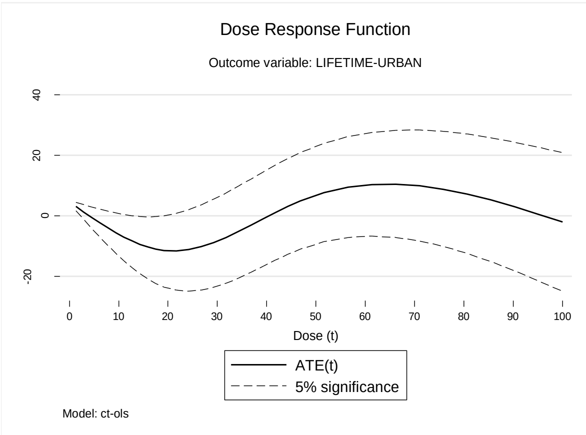
Figure 6 Dose-response Function Plots of Lifetime Migration and 95% CI - Gas



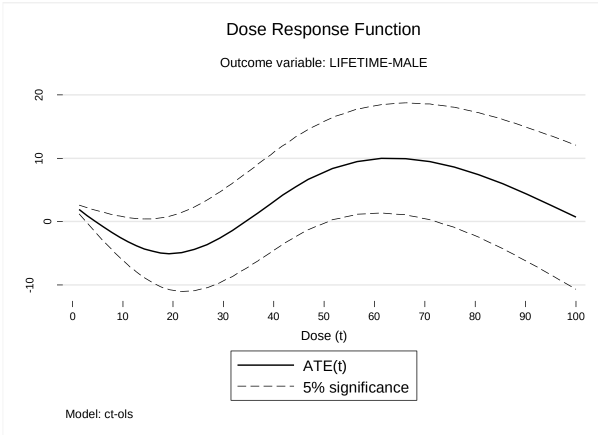
(A) All



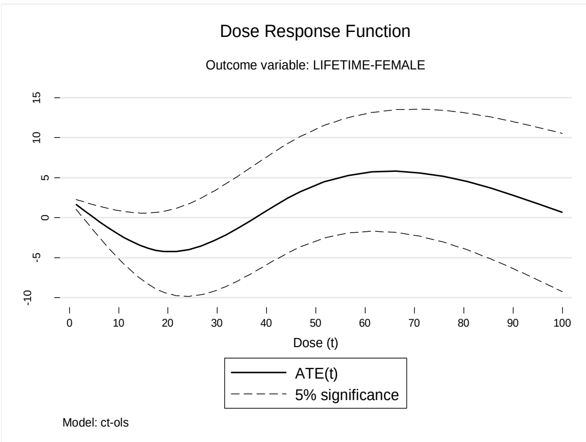
(B) Rural



(C) Urban



(D) Male



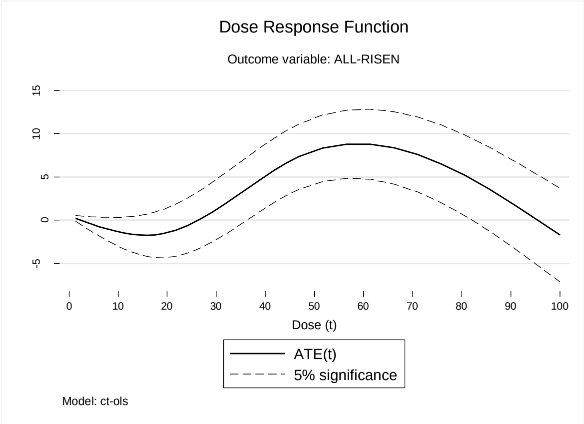
(E) Female

Table 5 Dose-response Function Estimates of Recent Migration - Gas

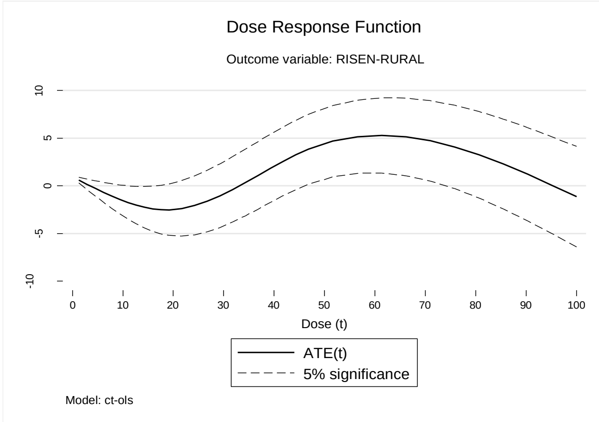
	ALL	RURAL	URBAN	MALE	FEMALE
gas	0.7109	1.0872	0.5076	0.4464	0.2645
	(0.6026)	(0.5911)	(0.9997)	(0.3347)	(0.2760)
water	-0.0276***	-0.0145	-0.0505***	-0.0141**	-0.0136***
	(0.0077)	(0.0081)	(0.0133)	(0.0043)	(0.0035)
sanitation	0.0214*	0.0132	0.0211	0.0103*	0.0111**
	(0.0091)	(0.0093)	(0.0153)	(0.0051)	(0.0042)
FCI	0.7199***	0.8786***	0.7209***	0.4679***	0.2520***
	(0.0939)	(0.1011)	(0.1872)	(0.0522)	(0.0430)
morbidity	0.0308*	0.0319*	0.0573*	0.0147	0.0161*
	(0.0140)	(0.0139)	(0.0244)	(0.0078)	(0.0064)
married	0.0053	0.0483	-0.0950	0.0045	0.0008
	(0.0293)	(0.0301)	(0.0518)	(0.0163)	(0.0134)
schooling	0.6985***	0.3636*	0.6380*	0.3272***	0.3712***
	(0.1437)	(0.1452)	(0.2532)	(0.0798)	(0.0658)
lnpoor	-0.3205	-0.0106	-0.5616	-0.1407	-0.1798*
	(0.1704)	(0.1864)	(0.2941)	(0.0946)	(0.0780)
lypcp	0.0416	0.4247*	-0.5602	0.0256	0.0160
	(0.1994)	(0.2045)	(0.3462)	(0.1107)	(0.0913)
agriculture	-0.0462***	-0.0087	0.0038	-0.0200**	-0.0262***
	(0.0115)	(0.0119)	(0.0193)	(0.0064)	(0.0053)
manufacturing	-0.0109	-0.0317	0.0384	0.0024	-0.0134
	(0.0226)	(0.0242)	(0.0378)	(0.0126)	(0.0104)
CPI	0.0178***	0.0064	0.0872***	0.0092***	0.0086***
	(0.0043)	(0.0043)	(0.0139)	(0.0024)	(0.0020)
Java-Bali	-1.4788***	-1.5905**	-0.9991	-0.9061***	-0.5727**
	(0.4172)	(0.4933)	(0.7084)	(0.2317)	(0.1911)
$\hat{\alpha}$	-0.4404**	-0.4821**	-0.6503*	-0.2771**	-0.1633*
	(0.1548)	(0.1508)	(0.2581)	(0.0860)	(0.0709)
$\hat{\beta}$	0.0197***	0.0176***	0.0313***	0.0125***	0.0072**
	(0.0053)	(0.0051)	(0.0088)	(0.0029)	(0.0024)
$\hat{\gamma}$	-0.0002***	-0.0001***	-0.0003***	-0.0001***	-0.0001**
	(0.0000)	(0.0000)	(0.0001)	(0.0000)	(0.0000)
constant	2.0863	-4.0795	4.6536	0.6925	1.3938
	(3.2545)	(3.4327)	(5.9645)	(1.8077)	(1.4904)
Adj. R-squared	0.5561	0.4115	0.3399	0.5353	0.5760
Observations	497	460	473	497	497

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

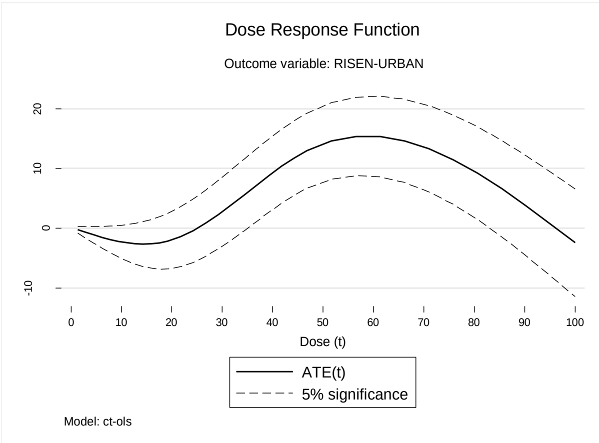
Figure 7 Dose-response Function Plots of Recent Migration and 95% CI - Gas



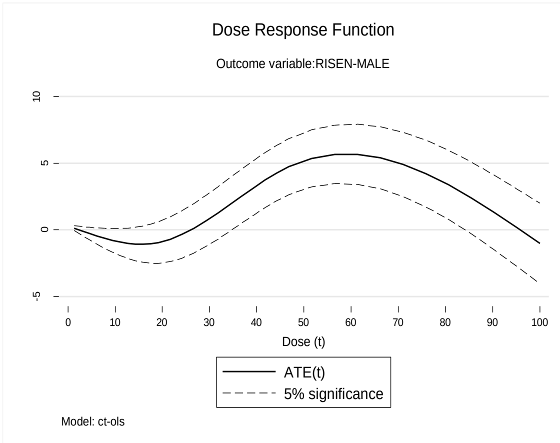
(A) All



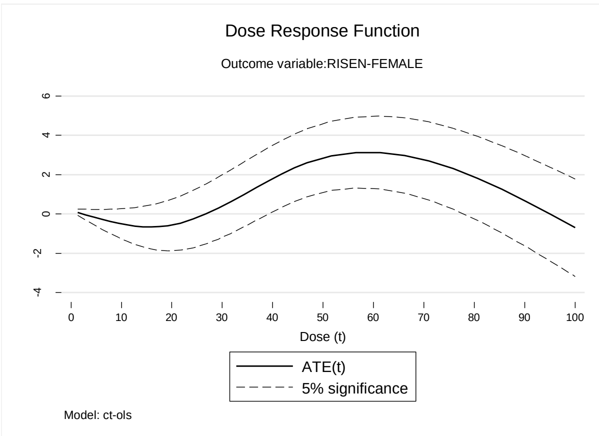
(B) Rural



(C) Urban



(D) Male



(E) Female

Appendix 1 Description of the Variables

Variable	Description	Source
lifetime	proportion of people who reside in a different region (province or district) than their place of birth	Population Census of BPS, 2010
recent	proportion of people who reside in a different region (province or district) than their residential places five year earlier	Population Census of BPS, 2010
water	proportion of households with access to safe drinking water	Population Census of BPS, 2010
sanitation	proportion of households with access to basic sanitation facilities	Population Census of BPS, 2010
FCI	fiscal capacity index, measuring the ability of a district to raise revenue from its own sources. The possible values are: ≥2 for a very high fiscal capacity district, 1≤FCI<2 for a high fiscal capacity district, 0.5≤FCI<1 for a medium fiscal capacity district, and <0.5 for a low fiscal capacity district.	Map of Regional Fiscal Capacity by the Ministry of Finance, 2009
married	proportion of married adults	Population Census of BPS, 2010
schooling	years of schooling	Human Development Index, 2010
lnpoor (in logs)	number of poor households	Data on Poverty by District in Indonesia by BPS, 2010
lypcp (in logs)	real GRDP per capita by industrial origin, including oil and gas (2000)	District GDP of Indonesia in 2009-2013 by BPS, 2014
agriculture	proportion of the population (age ≥ years) working in agriculture	Population Census of BPS, 2010
manufacturing	proportion of the population (age ≥ years) working in manufacturing	Population Census of BPS, 2010
CPI	Construction Price Index, measuring the price differentials across Indonesian districts.	Construction Price Index by Province and District by BPS, 2010

Variable	Description	Source
oil	proportion of oil production in a district	Crude Oil and Natural Gas Producing Regions by the Ministry of Energy and Mineral Resources, 2010
gas	proportion of natural gas production in a district	Crude Oil and Natural Gas Producing Regions by the Ministry of Energy and Mineral Resources, 2010
Java-Bali	dummy, taking a value of 1 if a district is located in either Java or Bali Islands.	