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Employment, income and the environment: an analysis for Mato Grosso do Sul, Brazil

Emprego, renda e meio ambiente: uma análise para Mato Grosso do Sul, Brasil

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ABSTRACT

The state of Mato Grosso do Sul (MS) has been one of the states that has registered rates of growth, both GDP and population since 2002. This economic and population growth, in turn, generates constant concerns about the environment, since increasing the income and employment, the pressure on the environment also tends to grow generating, for example, higher emissions of greenhouse gases. In this sense, the objective of this research was to measure the employment and income multipliers for MS state and to associate the results to the sectors of CO2 emissions. The method consisted of using the input-output matrix (MIP) of MS of the year 2010 and, from this matrix, find the income and employment multipliers of the State. The MIP used was of 32 × 32-dimension (sectors) and was aggregated based on the MS energy balance sectors thus creating a new 14 x 14 (sectors) matrix. The results show that there is a reversal in the results, with the income multiplier presenting greater power of externalities (positive or negative) to the environment, while the employment multiplier generates fewer externalities, due to the main activities that cause impacts multiplication.

Keywords: Input-output; Job; Income; Mato Grosso do Sul; Emission of CO2

RESUMO

O estado de Mato Grosso do Sul (MS) tem sido um dos estados que tem registrado taxas de crescimentos, tanto do PIB quanto populacional a partir do ano 2002. Esse crescimento econômico e populacional gera, por sua vez, constantes preocupações relativas ao meio ambiente, uma vez que, aumentando renda e emprego, a pressão sobre o meio ambiente também tende a crescer gerando, por exemplo, maiores emissões de gases de efeito estufa. Nesse sentido, o objetivo deste trabalho de pesquisa foi o de mensurar os multiplicadores de emprego e renda para o MS e associar os resultados aos setores de emissões de CO2. O método consistiu em utilizar a matriz insumo-produto (MIP) de MS do ano de 2010 e, a partir de dessa matriz encontrar os multiplicadores de renda e emprego do Estado. A MIP utilizada era de dimensão 32 x 32 (setores), e foi agregada com base nos setores do balanço energético de MS criando, assim, uma nova matriz 14 x 14 (setores). Os resultados apontam existir uma inversão nos resultados, sendo que o multiplicador de renda se apresenta com maior poder de externalidades (positivas ou negativas) ao meio ambiente, enquanto que o multiplicador de emprego gera menos externalidades, em função das principais atividades que causam impactos de multiplicação.

Palavras-chave: Insumo-produto; Emprego; Renda; Mato Grosso do Sul; Emissão de CO2

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1 INTRODUCTION

The state of Mato Grosso do Sul (MS) over the last 13 years (2002-2014) has presented growth rates of gross domestic product (GDP) on average of 14% per year, an average increase of per capita GDP of 15% per year and population growth, on average, 2% per year, as data extracted from the State Department for the Environment, Economic Development, Production and Family Agriculture (SEMAGRO, 2016).

Of course, if GDP grows, the pressure on other variables such as, for example, the environment, shall receive the externalities of this movement of growth, either positive or negative externality.

It is possible to suppose that the increase of income and wealth in the State has been converted into acquisitions in order to satisfy the primary needs, whether for consumption of goods or services, requiring greater processing of natural resources, both in the condition of raw materials as a condition of waste receptor (Freitas, 2014).

Identifying the key sectors of a given economy can provide subsidies for the implementation of public policies that can be directed to the development of the region and the protection of the environment (FACHINELLI *et al*., 2015). Thus, since the end of the decade of 1960, the use of MIP and its extensions of multiplier effects have been extended to explain the relationship of the generation of environmental pollution and industrial activities (MILLER AND BLAIR, 2009)

One way to think of the environment is to imagine an asset that produces considerable services for humans and non-human bodies, knowing that the ability to produce such services may, over time, having to degradation processes, reducing the value of the asset (FIELD AND FIELD, 2014).

According to the report of the World Commission on the Environment (CMMD, 1987), due to the increase in the consumption of energy, greater risks and uncertainties related to the environment incur as, for example, climate change (CARVALHO AND PEROBELLI, 2009). In this context, the employment and income become two major strands within the economic and environmental analyzes. The higher levels of incomes than the normal may generate negative externalities on the

environment. Therefore, knowing the emissions of CO_2 is an essential step for an in-depth analysis of environmental impacts derived from consumption (MOTTA, 2002).

The environmental impact of inequality in the distribution of income has been the object of many theoretical and empirical studies that seek to describe how the interaction between the level of income and the generation of environmental externalities happen (SOMMER AND KRATENA, 2017).

The work developed by Kureski *et al*. (2008) describes that for every 1 million reais of increase on aggregate demand in the sugar industry 27 jobs and 264.1 thousand reais in income are created. In the state of Rio Grande do Sul, from the analysis of the estimated MIP, regarding the effect on employment, the largest multipliers were: public administration (21.33), trade (19.23), services rendered to families (LEIVAS and FEIJÓ, 2014).

With the objective to analyze the effects on employment and income, from the reduction in the use of chemical inputs, Lima and Lenhardt (2007) showed that for a variation of less than 1 million reais with expenditures of chemical inputs, 18 jobs were generated and still increases the gain of income in 97 thousand reais. In MS Fagundes *et al*. (2014) carried out a comparison of reduction of aliquot of ICMS via MIP for the sector of agriculture, and concluded that, with the reduction of the aliquot, the employment level increases by 6.66%.

According to the data of the system of Estimates of Emissions and Removals of Greenhouse Effect Gases **(SEEG), which** produces annual estimates of greenhouse gas emissions in Brazil, according to the guidelines of the Intergovernmental Panel on Climate Change (IPCC), historically, 62% of emissions of CO_2 in MS occurred in function of the farming sector, while the use of the land appears as second sector with greater stimulus for emissions of CO_2. The energy sector is the third sector that emitted CO_2 the most along the historic series (Table 1).

Chart 1. Estimation of emission of CO_2 per sector in MS

Sector	Emission of CO^2 in %
Energy	10%
Use of land	25%

Agriculture	62%
Wastes	3%
Industry	1%

Source SEEG (2018)

Upon disaggregating the data of MS of the sectors regarding the emission of CO_2, the change of land use for agricultural production represents 83.6% of the total agricultural sector, being the main source of induction for emission of CO_2 in the State. In the sector of agriculture, the enteric fermentation (digestive process that happens in the rumen), holds 72.3% of the sector. In the case of the energy sector, the transport activity represents 60.7% of the total of the sector.

The average estimated emissions of CO_2 of the group change of land use is 53.459 million tons (MtCO2e) and the energy sector 8,873 (MtCO2e). Industrial processes and wastes have an average of 571 (MtCO2e) and 2.05 (MtCO2e) respectively. With the record of emissions in 2015 and 2016, MS is in 14th place in the ranking of the states emitters of CO_2.

The crux of the discussion of this work consists, therefore, of examining the effect of employment and income, and what their impact on the day-to-day is (MONTONYA AND PASQUAL, 2015). This concern gains prominence to the extent that the productive activities are advancing on the conservation units of MS, being that this State has three biomes and strong vocation for agriculture and, more recently, for agribusiness, aiming to reconcile development of these activities with the preservation of the environment.

For this reason, this study proposes to analyze the effect of the multipliers of employment and income, considering the productive structure of the state of MS, and its relationship with the emission of greenhouse gases (GHG), notably the carbon dioxide (CO_2).

2 MATERIAL AND METHODS

For the construction of indicators, the MIP of MS was used for the year 2010, size 32 x 32 (sectors). Based on the energy balance of MS a new aggregation of industries was done by reducing the MIP for an array with 14 x 14 (sectors) using the criterion the National Classification of Economic Activities (CNAE) in version 2.0. In table 2 are the 14 aggregated sectors in the new MIP.

Chart 2. Sectors of the economy of MS of the year 2010 used in this work.

Number	Sectors of the economy of Mato Grosso do Sul
1	Agriculture
2	Mineral extraction
3	Food and Beverages
4	Textiles
5	Other industries
6	Pulp and paper products
7	Miscellaneous services
8	Alcohol
9	Chemical Products
10	Rubber and plastic articles
11	Non-metallic minerals
12	Manufacture of steel and derivatives
13	Metal Products - exclusive machinery and equipment
14	Public Administration

Source: Own elaboration

It is presented in table 1 the input-output matrix with 14 sectors of the economy of Mato Grosso do Sul, which serves as the basis for the calculation of the multipliers of employment and income.

Table 1. Input-product Matrix of Mato Grosso do Sul

Sector	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	957 075	38	2 511 295	896	6 124	119 168	22 029	184 508	54	614	90	0	228	7 416
2	86 456	31 004	3 036	0	116 129	7 241	477	1 085	519	5	3 311	33 675	3 426	687
3	940 361	46	1 436 185	89	5 097	4 690	327 051	13 349	198	1	2	0	0	86 836
4	22 337	1 914	2 382	70 577	15 380	12 999	53 865	938	25	1 144	278	0	102	3 072
5	76 109	39 996	858 044	44 764	2 483 071	95 899	868 184	57 835	2 853	23 359	15 506	22 972	42 551	563 968
6	16 140	2 233	90 971	517	69 658	238 621	81 773	2 559	220	3 549	569	437	5 659	16 926
7	260 909	142 044	699 707	8 365	867 684	117 192	2 227 526	46 131	1 680	8 549	4 106	24 379	29 776	1 676 800
8	298 151	9 821	60 618	623	129 986	13 994	440 504	4 580	785	2 347	1 673	2 015	1 792	61 884
9	80 773	1 070	13 731	283	24 898	15 061	11 969	167	550	4 892	259	1 173	3 328	28 838
10	13 392	1 195	36 582	171	46 969	7 636	43 488	1 560	73	1 633	49	416	2 866	517
11	1 986	1 301	6 145	0	204 178	670	4 523	386	29	12	1 476	702	459	3 140
12	0	624	2 947	0	128 842	195	3	1	2	648	286	12 514	41 829	0
13	22 618	7 375	46 883	0	101 928	12 133	2 569	3 084	87	558	149	5 000	12 760	12 627
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Own elaboration

From the coefficients generated of MIP it is possible to estimate the impact of changes in income and employment of determined economy and industry. This impact can be both direct and indirect. The direct effect seeks to measure the impact on the income and employment from variation of final demand, while the indirect effect is the variation in income and employment based on secondary changes in the economy. The sum of these two effects (direct and indirect) creates the total multiplier (GUILHOTO and SESSO FILHO, 2010; FEIJÓ, 2013). The direct multiplier reveals the changes at the first round of variation of final demand in relation to the sectors and multipliers while the indirect multiplier registers changes in the following rounds through the primary alteration (GUILHOTO, 2011).

The method for measuring the multiplier effect of employment consists of associating the Leontief-inverse matrix of the coefficients of employment in the sectors of the economy, which provide the number of jobs generated directly and indirectly to a variation of final demand as shown in equation 1 (NABERG and IKEDA, 1999).

$$GV_j = \sum_{i=1}^{n} b_{ij}\, v_i \qquad j=1,2,3,\ldots,n \qquad (1)$$

Where: GV_j is the total impact, direct and indirect, on the variable *j* in question; $b_{ij,}\,(i,\ j=1,2,3,\cdots,n)$ are the technical coefficients fixed measures of relations between the production of a sector *i* and their inputs j, i.e., is *ij*- th element of the array Leontief-inverse and v_i is the direct coefficient of the variable *i* in question.

Based on Guilhoto (2009), the multiplier of jobs is given by equation 2.

$$MV_i = \frac{GV_i}{v_i} \qquad (2)$$

Where MVi would represent the multiplier of the variable in question and the other variables are defined as done previously.

The multiplier of production is defined by equation 3.

$$MP_j = \sum_{i=1}^{n} b_{ij} \qquad (3)$$

Where *MPj* is the multiplier of production of the *j-th* sector and the other variables are defined as expressed earlier. The mathematical procedure for calculating the employment multiplier, is given by equation 4 (KURESKI *et al*., 2008).

$$I_j = \frac{e_j}{x_i} \qquad (4)$$

Where: *lj*= coefficient of direct employment; *ej* = number of employees of the activity *j*; *xj* = gross value of production of activity *j.*

As the number of rounds in the economy is infinite, from the previous round new increase is generated in purchase of inputs, creating the indirect jobs that are calculated from the equation 5:

$$MEI = L(I - A)^{-1}.Y \qquad (5)$$

Where: MEI = employment multiplier of type I (direct jobs); L = multiplier of direct employment; I = identity matrix; A = matrix of direct multipliers; Y = final demand.

From the increase of production, one also has effects on income, called income-effect. From the perspective of analysis of endogenization, in particular the consumption of households, it is possible to calculate the income effect of type 2 (KURESKI *et al*., 2008):

$$MCE = L(I - A)^{-1}.Y \qquad (6)$$

Where: MEI = employment multiplier of type I (direct jobs); L = multiplier of direct employment; I = identity matrix; A = matrix of direct multipliers; Y = final demand. For the calculation of the income effect, one must decrease from type 2 the multiplier type 1, obtaining the equation 7.

$$ER = MEII - MEI \qquad (7)$$

Where: ER = income effect on employment; MEII = Type II multiplier; MEI = Type I multiplier.

The multiplier of direct income is defined by equation 8.

$$cr_j = \frac{s_j}{x_j} \quad (8)$$

Where: cr_j = direct income multiplier; s_j = value of wages of activity j;

X_j = gross value of production of activity j. With the equation 8, the technical coefficients of direct income are obtained. To obtain the technical coefficients of direct and indirect income, equation 9 is applied.

$$CWI = CR\ (I - A)^{-1}.Y \quad (9)$$

Where: CWI= type I income multiplier; CR- direct income multiplier; I = identity matrix; A = matrix of direct multipliers; Y = final demand. In order to obtain the income effect on wages, it is also necessary to work with the endogenized Leontief matrix, equation 10.

$$CWII = CR\ (I - \bar{A})^{-1}\ f \quad (10)$$

Where: CWII= type II income multiplier; CR= direct income multiplier; I = identity matrix; A = matrix of direct multipliers; Y = final demand. With the aim of measuring the impact of the income effect on wages, when there is variation in final demand, equation 11 is used.

$$ER = CW - MCR \quad (11)$$

Where: ER = income effect in the generation of new income; CW = type I income multiplier; MCE = type II income multiplier.

From the data of employment and income of the matrix input-product, it is presented in the next section the multipliers of impact on employment and income, considering variation of R$ 1 million in the final demand.

3 RESULTS

Based the method described in the previous section, it was possible to identify the multipliers of the impact of employment and income for variation in final demand of the economy of Mato Grosso do Sul. The construction instrument of the multipliers was developed based on published works and countersigned in world literature as, for example, Miller and Blair (2009).

In table 2 the classification was carried out by the productive sector of the multiplier effects of employment and income. From this, the secondary sector is the main one when it comes to effects on employment and, also, of the impacts on income. The tertiary sector is the second most important both for the generation of employment and income and the primary sector is in the third position in relation to the capacity to affect employment and income.

Table 2. Multiplier of employment and income, by sector, in Mato Grosso do Sul, in 2010.

Sector	Employment. (job)	Income R$
Primary	22	0.47
Secondary	193	2
Tertiary	53	0.90

Source: Own elaboration

Table 3, from equations 4, 5 and 6, shows that the main activity generating employment is the activity of generation of chemicals, with a technical coefficient of 35 jobs in total. The second place is occupied by the sector of miscellaneous services and the textile industry. In those last two, it is noteworthy that they are intensive activity in the labor force and, therefore, stand at the end of the generation of employment.

Traditional activity of the economy of Mato Grosso do Sul state, agriculture is only the sixth activity in the item total effect of employment generation, possessing

the capacity of 22 jobs. The sector of public administration is in seventh place with medium power to effect on the generation of jobs for Mato Grosso do Sul, as well as the pulp and paper products sector, this being one of the most recent inductors of the state economy, which is in the twelfth place.

Table 3. Direct employment multipliers, indirect and total for MS, in 2010

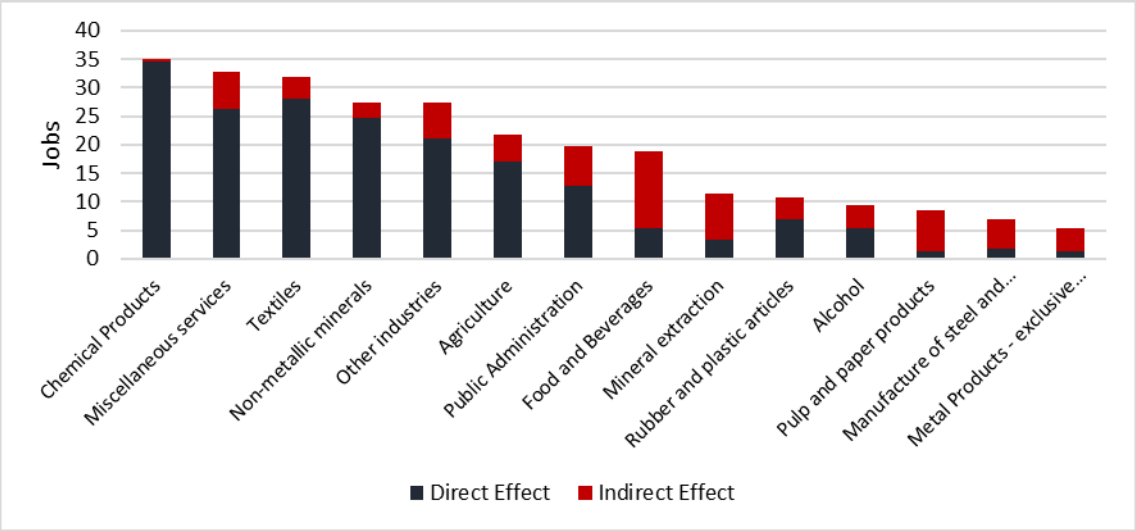
Activity	Multipliers		
	Direct	Indirect	Total
Chemical Products	34.62	0.41	35
Miscellaneous services	26.23	6.64	33
Textiles	28.02	3.95	32
Non-metallic minerals	24.75	2.73	27
Other industries	21.17	6.20	27
Agriculture	17.01	4.87	22
Public Administration	12.76	7.05	20
Food and Beverages	5.46	13.29	19
Mineral extraction	3.35	8.02	11
Rubber and plastic articles	6.84	3.95	11
Alcohol	5.35	4.11	9
Pulp and paper products	1.27	7.20	8
Manufacture of steel and derivatives	1.77	5.20	7
Metal Products - exclusive machinery and equipment	1.32	4.14	5

Source: Own elaboration

The sectors of metal products (excluding machinery and equipment), Manufacture of steel and derivatives and the pulp and paper industry are the sectors that have less capacity to generate employment, considering the base year of 2010 MIP.

Figure 1 shows the direct and indirect multipliers for employment in the state of MS, by sector, based on the year of 2010.

Figure 1. Direct and indirect multipliers for employment, in MS, by sector, in 2010



Source: Own elaboration

According to Figure 1, the chemicals industry has greater capacity for generation of direct jobs than indirect jobs in the productive chain, followed by the services sector, textiles, non-metallic minerals and agriculture. Whereas the other sectors have greater indirect capacity to impact the level of employment.

Considering the emission estimates of CO_2 to the main activities, it is possible to interpret that, in the case of employment, the activities of greater power to effect of multiplication are not considered activities of major environmental externalities.

Based on equations 8, 9 and 10, in relation to the effect on income, public administration consolidates itself as the main activity (Table 4). For the state of MS this is an important sector, being one pays the best pay on average of activities. In the second place, the sector of agriculture presents itself as one of the main sectors, followed by the services sector.

The pulp industry, important economic sector in recent years, is in seventh place with power to generate 24 cents for each variation of R$ 1.00 in final demand. Another important consideration in the state sector, mainly from the perspective of export, mineral extraction, is in sixth place in relation to the capacity of the effects of income.

Still, in the case of the effect of income, the textile industry and the chemical production sector does not have a role of major significance as it is the case of employment.

Table 4. Direct Income multipliers, indirect and total for MS, in 2010.

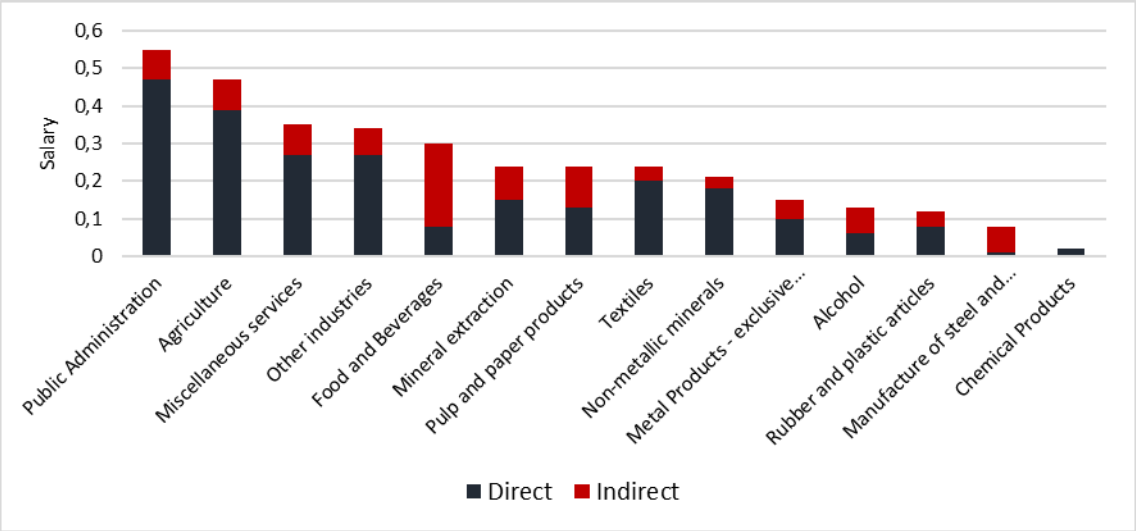
Activity	Multipliers		
	Direct	Indirect	Total
Public Administration	0.47	0.08	0.55
Agriculture	0.39	0.08	0.47
Miscellaneous services	0.27	0.08	0.35
Other industries	0.27	0.07	0.35
Food and Beverages	0.08	0.22	0.31
Mineral extraction	0.15	0.09	0.25
Pulp and paper products	0.13	0.11	0.24
Textiles	0.20	0.04	0.24
Non-metallic minerals	0.18	0.03	0.21
Metal Products - exclusive machinery and equipment	0.10	0.05	0.15
Alcohol	0.06	0.07	0.13
Rubber and plastic articles	0.08	0.04	0.12
Manufacture of steel and derivatives	0.01	0.07	0.08
Chemical Products	0.02	0.00	0.02

Source: Own elaboration

The sectors with the lowest capacity to generate income, in this case derive from the secondary sector (industry), which are chemical products, Manufacture of steel and derivatives and articles made of rubber and plastic. For the purpose of income, the main activities with the power of the multiplier effect are the main emitting sources of CO_2 from the estimates of SEEG, generating this way, greater externalities.

Figure 2 shows the direct and indirect multipliers of incomes in the state of MS, by sector, in the year of 2010.

Figure 2. Direct and indirect multipliers of income, in MS, by sector, in 2010



Source: Own elaboration

Figure 2 shows that the public administration has a greater capacity for direct impact on income and, secondly, the agriculture, followed by miscellaneous services. At this point, the other sectors have a median ability to impact on income, both directly and indirectly.

4 CONCLUSION

From the multipliers presented in this study it was possible to estimate for the sectors of the productive chain of MS the number of employees and income by component of final demand. The results indicate there is a reversal between the multipliers of employment and income, because the areas of greatest prominence in the generation of employment do not stand in the increase of income and vice versa.

In the case of the multiplier effect of employment, sectors popularly known in the state economy showed weak dynamism in relation to generating employment as, for example, the agriculture, the extractive industry and the public sector. In compensation, the miscellaneous services sector stands on this request and has important multiplier effect of employment in the state productive chain.

For the multiplier effects on income, the traditional sectors of the economy of Mato Grosso do Sul state have a prominent role. The public administration, agriculture and miscellaneous services lead the ranking, in this case.

From the multipliers presented herein, it is possible to make the analogy that the sectors that have more intense activities in the use of energy and labor are those that emit more CO_2 into the atmosphere, and they cause, broadly speaking, increased pollution and externalities to the state environment.

In this sense, it was concluded that for employment, the main activities of the multiplier effect do not generate greater environmental externalities, however, the multiplier effect of income that is reversed, and the main activities, have higher potential of pollution to the environment.

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