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MADAGASCAR – An Evaluation of the Welfare Impact of Higher Energy Prices in Madagascar

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Abstract

In this paper we estimate the effect of a rise in petroleum prices on living standards in Madagascar combining information on expenditure patterns from the *Enquete Aupres des Menages* 2005 with an input-output model describing how petroleum price increases propagate across economic sectors. We identify both a *direct* welfare effect (heating and lighting one's house become more expensive) and an *indirect* effect (the price of food and anything else which has to be transported from factory to shop rises). We find that, a 17 percent rise in oil prices produces, on average, a 1.75 percent increase in household expenditures (1.5 percent for high-income households, 2.1 for the households in the bottom expenditure quintile). Circa 60 percent of the increase in expenditures is due to the indirect effect, mostly *via* higher food prices. Although energy price increases hurt the poor more in percentage terms, subsidizing would involve a substantial leakage in favor of higher income households. This raises the issue of identifying more cost-effective policies to protect the poor households against energy price increases.

JEL classification system: D57, H2, Q4, R2.
Key Words: energy prices; oil; price subsidies; input-output analysis; Madagascar.

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An Evaluation of the Welfare Impact of Higher Energy Prices in Madagascar

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1. INTRODUCTION

Typical analyses of the economic impact of oil price movements treat them as macroeconomic supply shocks affecting inflation and output. Not less important is their distributional impact on different segments of the population, operating through relative prices and real incomes. A rise in petroleum prices is not simply bad news for the economy as a whole, but is particularly bad news for poorer households.

Over the past few years, Madagascar has experienced a substantial increase in oil prices. The relatively low price of international crude oil of USD 29.8 a barrel in December 2003, has increased by about 150 percent, to reach USD 62 a barrel by December 2006. To make things worse, the local currency, the Ariary has depreciated considerably during the period 2003-2005. A US dollar bought 1,277 Ariary in January 2003, which became 2,488.5 Ariary by mid 2004. Beginning in the second half of 2004 the Ariary showed some tendency to appreciate to reach 2,013 at the end of December 2006. The exchange rate has since stabilized around 2,050 to the US dollar. Fiscal regimes did not help. Oil products are subject to specific taxes (TPP, *Taxes sur les Produits Pétroliers*), while petroleum products are subject to VAT. The oil tax rates were adjusted upward in 2002 and 2006. Diesel was affected the most by a 230% increase in TTP in 2002 and 179% in the budget law 2006.

Given the dynamics of *(i)* international crude oil prices, *(ii)* the exchange rate, and *(iii)* the fiscal regimes, it comes as no surprise that domestic prices of petroleum products increased significantly between 2003 and the first half of 2006. Prices of gasoline, diesel and kerosene increased on average by 145 percent between December 2003 and December 2006.

Higher energy prices have adverse consequences for the poor. Real income losses may be substantial, as higher oil prices not only imply higher prices for petroleum products directly consumed by households, but also higher prices of other goods which use petroleum as an intermediate good in the production process. In fact, previous studies show that the latter, indirect effect is just as important or more so than the direct effect.[1] With the goal of shielding the purchasing power of poor households, governments may consider subsidizing petroleum prices. However, the introduction of price subsidies raises a number of issues that need careful consideration.

First, the introduction of price subsidies is not neutral from the distributive standpoint. The key questions here are: *(i)* Are the poor the real beneficiaries of the price subsidies?; *(ii)* What is the exact extent of their benefit,?, and *(iii)* Is the overall effect progressive or regressive?

Second, there is a concern about the consequences of price subsidies in terms of allocational efficiency. Are subsidies the most effective/efficient way of protecting the real income of the poor? In the presence of binding budget constraints, subsidies are likely to divert resources from other social expenses, which may be more effective in reaching the poor. Moreover, by altering the structure of relative prices, subsidies may affect the incentives for households to use their energy efficiently.

Third, there are fiscal considerations. Even if price subsidies are not financed by reductions in other social expenditures, they may eventually cause fiscal distress (increase in budget deficit and debt). Thus, it can be argued, that they may lead to adjustment policies, *e.g.* increases in taxes with offsetting effects.

[1] See Coady and Newhouse (2005), Kpodar (2006).

To begin addressing the above issues in the context of Madagascar, this paper analyzes how higher petroleum prices impact households, focusing most of the attention on the poor. The simulation exercise is based on an input-output model á la Coady and Newhouse (2005). This approach, besides being relatively easy to implement, efficiently combines micro- and macro-data which are commonly available for most countries.

The paper is organized as follows. Section 2 provides background information on the present pricing regime in Madagascar, the petroleum sector market structure, and the pattern of price increases. Sector 3 outlines the method used to asses the welfare effect of higher oil prices, and presents the estimates. Section 4 contains final remarks.

2. GENERAL BACKGROUND

Madagascar is a net oil importer. Madagascar stopped importing crude oil in 2005, after the refinery in Tamatave was closed. It imported, however, 540,106 metric tons of final products in 2006. Besides transport, the lighting and electricity generation sectors are the second largest users of petroleum. More than half of the electricity produced in Madagascar is derived from fuel. More than 85 percent of the rural population use kerosene for lighting.

The market is dominated by four companies: Total, Shell, Galana and Jovenna. Prices were set by the Malagasy Petroleum Office (OMH), the regulatory agency till June 2004, based on a formula with monthly adjustments. In early 2004, when oil prices started moving upwards, the Government froze prices for a couple of months. Prices were expected to be fully liberalized by October 2004, but this date was moved forward to July 2005, after which prices at the pump have been set by the operators, with no oversight whatsoever by the government.

Oil prices have increased dramatically since the beginning of 2004. Figure 1 shows that between January 2003 and December 2006 international prices rose significantly (+1.7 percent per month), if not steadily. From 31.3 USD a barrel in Jan, the price of crude oil peaked in July 2006 (72.45 USD), and closed at 60 USD in December 2006.

Figure 1 - International *versus* Domestic Crude Oil Prices – Madagascar 2003-2006

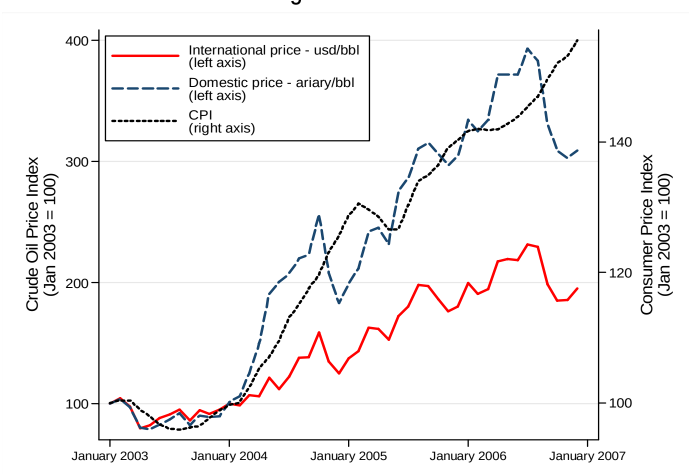
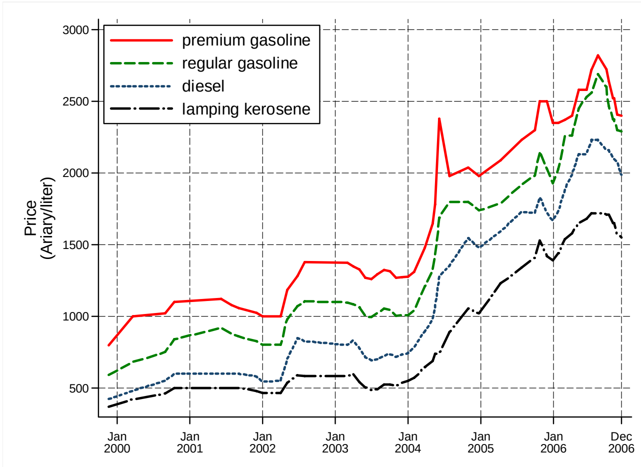


Figure 2 shows the dynamic of prices for a selection of petroleum products.

Figure 2 - Domestic Prices of Selected Petroleum Products



Source: OMH – Malagasy Petroleum Office.

In order to calculate the effect of the exchange rate on the increase of domenstic prices of energy products we define as follows. Let $p_{oil}^{\$}(i)$ be the international price of a given energy product at the beginning of year *i*, and $\lambda(i)$ be the exchange rate (ariary/dollar) at the beginning of year *i.* The change in international price in ariary during the year *i* is given by:

$$\Delta p_{oil}^{Ary} = \lambda(i+1)\, p_{oil}^{\$}(i+1) - \lambda(i)\, p_{oil}^{\$}(i)$$

The (simulated) change of international price in Ariary, *assuming a constant exchange rate* during the year *i* is:

$$\Delta p_{oil}^{Ary}(sim) = \lambda(i)\, p_{oil}^{\$}(i+1) - \lambda(i)\, p_{oil}^{\$}(i)$$

The effect of the exchange rate on the change in domestic prices is therefore given by:

$$\text{Exchange Rate Effect} = \frac{\Delta p_{oil}^{Ary} - \Delta p_{oil}^{Ary}(sim)}{\Delta p_{oil}^{Ary}}$$

Table 1 shows the proportion of the domestic price change due to the variation of the exchange rate for selected oil products

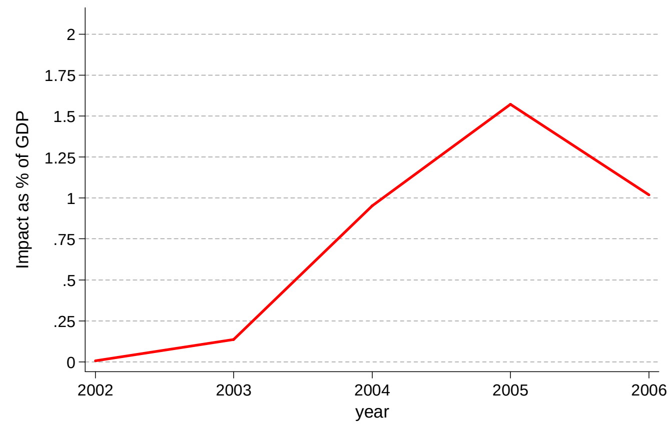
Table 1 – Exchange rate effect on domestic price (percent)

	2004	2005	2006
Aircraft gasoline	92	100	23
Lamping kerosene	61	24	30
Premium gasoline	66	26	26
Regular gasoline	71	24	30
Diesel	66	23	29
Fuel Oil	99	12	93
Total	*60*	*22*	*32*

Source: OMH and authors' calculation.
Note: domestic prices are assumed to be a linear transformation of international prices.

The increase in international oil prices caused a net deterioration of the terms of trade by 5.1% in 2004 and 6.2% in 2005. In addition, the net impact of these international price movements is estimated at 1.57% of GDP in 2005 (Figure 3): this is a measure of the aggregate burden to the economy caused by the increase of the international oil product.

Figure 3 - Impact of the increase of international oil price on imports (as % of GDP)



Source: OMH and authors' calculation.

3. THE WELFARE IMPACT OF HIGHER ENERGY PRICES

The effects of increasing petroleum prices on household welfare are twofold. First, the *direct* effect: households are affected through increases in the price of petroleum products they consume directly, *e.g.* kerosene for lighting and/or cooking, gasoline for private transport, etc.. Second, the *indirect* effect: households are affected through increases in the prices of other goods and services, as higher energy costs are passed through onto the consumer.

One way of assessing the scale of the two effects is by decomposing the total welfare effect (TWE) into its two components, namely the direct welfare effect (DWE) and the Indirect Welfare Effect (IWE), and estimate them separately:

$$\text{(1)} \qquad \text{TWE} = \text{DWE} + \text{IWE}$$

Let w_j^{oil} (j=1,..n) denote the budget share for the j-th petroleum product, and Δp_j^{oil} its price variation (expressed in percent). The DWE of price changes in petroleum products can be calculated by multiplying the price variation by the corresponding household budget share and aggregating across goods:

$$\text{(2)} \qquad \text{DWE} = \sum_{j=1}^{J} \Delta p_j^{oil} w_j^{oil}$$

where J is the number of petroleum products consumed by the households. Equation (2) expresses DWE as a percentage of total household expenditure.

The procedure is more involved for the IWE. Below, we provide a broad outline of the strategy for estimating IWE, while section 3.2 provides a full account.

Let p^{oil} denote an aggregate (scalar) measure of the price of petroleum products:

(3) $$p^{oil} = \sum_{j=1}^{J} \delta_j p_j^{oil} \text{ with } \sum_{j=1}^{J} \delta_j = 1$$

where the last term is quantity-share based. The change in this aggregate price is:

(4) $$\Delta p^{oil} = \sum_{j=1}^{J} \delta_j \Delta p_j^{oil}$$

Now let us define $\Delta\mathbf{q}$ as a (row) vector of changes in consumer prices:

(5) $$\Delta\mathbf{q} = f\left(\Delta p^{oil}\right)$$

Equation (5) makes clear that consumer prices for non-petroleum goods and services depend on prices of petroleum goods, as the latter enter the production of the former as intermediate goods.

Once estimates for equation (5) are available, calculating IWE is a simple matter:

(6) $$\text{IWE} = \sum_{j=1}^{S} f_j\left(\Delta p^{oil}\right) w_j$$

where $f_j\left(\Delta p^{oil}\right)$ denotes the change in price for the *j*-th good (or service) consumed by the household. The difficulty, as we shall see in section 3.2, is in calculating $\Delta\mathbf{q}$, since the function $f_j(\cdot)$ in equation (6) is a mapping between producer and consumer prices that must account for the production structure of various sectors of the economy, in particular, for the different intensity in the use of petroleum products as inputs by various sectors.

In sections 3.1 and 3.2 we discuss equations (2) and (6) in detail, and obtain estimates for both the direct and indirect effects.

3.1. The Direct Welfare Effect

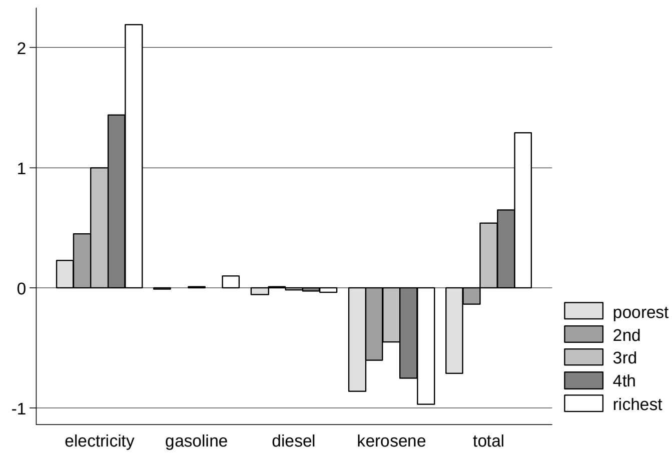
Measuring the direct effect of a change in petroleum product prices on households' welfare is a relatively straightforward matter. Schematically, it requires three steps. *(i)* Identifying the petroleum products directly consumed by households. According to the EPM 2005, information is available for electricity (*électricité*), gasoline (*essence*), diesel (*gas-oil*), kerosene (*pétrole*). *(ii)* Identifying the price increases for each petroleum product. Data on prices are available from the OMH. *(iii)* Estimating the direct impact of price increases on households by multiplying the budget share of each petroleum product by its percentage price increase.

The top panel of Table 1 shows household budget shares for electricity, gasoline, diesel and kerosene. Overall, petroleum products absorb, on average, 2.6 percent of the household budget. However, Table 1 shows that the consumption of energy products differs significantly across households according to their expenditure levels. For example, kerosene – the single most important product with a 1.9 percent budget share – accounts for as much as 3.2 percent of expenditures among the poorest households, but only 1 percent among households in the upper quintile. Consumption of gasoline, by contrast, is negligible for most households, but for the 0.3 percent of expenditures among the richest 20 percent.

Similarly, the budget share for electricity increases dramatically with the household's living standard, from 0.06-0.10 percent in the bottom two quintiles of total expenditure to 1.17 percent for the richest 20 percent of households.

Figure 4 investigates the differences in consumption patterns among urban and rural households. Three features stand out. First, the budget share allocated to electricity is always higher for urban households than rural, with a clear pattern across income quintiles. Second, rural households allocate a higher percentage of total consumption to kerosene. Third, the overall pattern in budget shares for energy products differs according to living standards: poor rural households allocate a higher percentage of their total expenditure to energy than poor urban households, while the reverse is true for the richest 40 percent.

Figure 4 - Difference between urban and rural energy consumption patterns



Note: the graph charts the average *difference* between urban and rural budget shares for energy products, by national per capita expenditure quintiles. A positive bar implies a higher consumption in urban than in rural areas.

Table 1 - Direct Welfare Effect of Price Changes

Per capita expenditure quintiles	Q1 (poorest)	Q2	Q3	Q4	Q5 (richest)	All
Household Budget Shares (%)						
Electricity	0.06	0.10	0.21	0.45	1.17	0.48
Gasoline	0.02	0.00	0.00	0.02	0.27	0.08
Diesel	0.19	0.10	0.08	0.07	0.08	0.10
Kerosene	3.18	2.31	1.96	1.64	1.04	1.89
All	3.46	2.51	2.25	2.19	2.56	2.55
Direct Welfare Effect (% of total household expenditure)	1.19	0.86	0.73	0.64	0.50	0.74
Mean consumption of petroleum products (*ratio to bottom quintile*)	1.00	1.08	1.16	1.34	3.10	1.69

Notes: *Budget shares are based on the EPM 2005. Quintiles are based on the national distribution of per capita annual expenditures. The estimation of the direct welfare effect is based on price increases observed during 2005 (11 percent for gasoline, 13 percent for diesel, and 36 percent for kerosene). The change in the price of electricity is assumed to be one-third of the average change in petroleum prices.*

Table 1 shows estimates of the direct welfare effect, as defined in equation (2). The average direct impact of the increase in the price of energy products on total household expenditure is 0.74 percent. The table shows that the loss of purchasing power is higher for the poor (1.2 percent) than for the rich (0.5 percent). Part of this difference is attributable to differences in the total budget share of all fuels, while the rest is due to the budget share structure.

It is worth mentioning that the estimates in Table 1 are effectively a Laspeyres index that hold budget shares fixed, overstating the loss in welfare. This issue will be taken up again in the final section.

Figure 5 - Components of Direct Effect by Quintile of Per Capita Expenditure

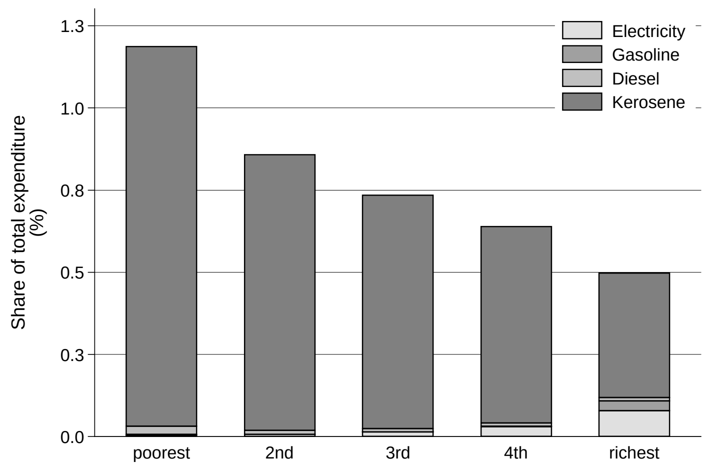


Figure 5 clearly shows the regressive nature of the welfare effect of energy price increases. The poor are affected most severely (1.2 percent of their total expenditure), mostly by the increase in price of kerosene, with other fuels and electricity playing a marginal role only. The negative impact on welfare decreases monotonically with per capita expenditure. Rich households are affected the least (0.5 percent of total expenditure), as a consequence of the increase in prices of both kerosene and electricity.

3.2. Indirect Welfare Effect

Measuring the indirect effect of a change in petroleum product prices on households' welfare is *not* a straightforward matter. In this section we use the price-shifting model introduced in Coady and Newhouse (2005). The building blocks of this model are *(i)* an input-output matrix, and *(ii)* household expenditure patterns, available from the recent EPM 2005.

The Price-Shifting Model

We start by assuming that the technology of the economy is fully described by the input-output matrix (IO matrix, henceforth). The IO matrix describes the use of sectoral inputs in the production of sectoral outputs, and, in particular, it provides information on the use of petroleum products as inputs in each sector of the economy. In the case of Madagascar, the IO table contains 30 economic sectors, and was last estimated for the year 1995.[2] A stylized representation of the IO matrix is as follows:

[2] See the Appendix.

(7) $$\mathbf{A} = \begin{bmatrix} a_{11} & a_{21} & \cdots & a_{1S} \\ a_{21} & a_{22} & & \\ \vdots & & \ddots & \\ a_{S1} & & & a_{SS} \end{bmatrix}$$

In our application, the matrix A is a 30 ×30 square matrix. The generic element of A, a_{ij} (i,j=1, 2, ..., S) represents the cost of the i-th input per 1 unit of value of the j-th output. Units of output are defined so that they have a user price of unity. Appendix A shows that the a_{ij} coefficient represents the change in the cost of producing one unit of j due to a unit change in the price of input i. [3]

The next step is modeling each sector of the economy as a producer of an "aggregate" or composite commodity. There are as many composite commodities as the number of economic sectors in the IO matrix. For instance, sector "CN01 Agriculture" produces the "agricultural commodity", sector "CN02 Animal Production" produces the "animal production commodity" and so on.

Each sector is assumed to face a certain market structure, which determines the mechanism through which changes in *input* prices are passed onto *output* prices. Precisely, we assume that three market structures are enough to describe the sectors of the economy (notation is as follows: $\boldsymbol{p}$ denotes the 1 × S vector of *producer* prices net of sales taxes and/or tariffs, while $\boldsymbol{q}$ denotes the 1 × S vector of *consumer* prices):

A) Cost-push sectors. These are sectors where higher input costs are pushed fully on to output prices. This is likely to occur for most government services, construction, public utilities, trade and transportation, and retail and wholesale trade. In general, one would expect this pricing scheme to apply to non-traded commodities. The formula:

(8) $$\mathbf{q}^{cp} = \mathbf{p}^{cp} + \mathbf{t}^{cp}$$

According to equation (8), the final price paid by consumers ($\mathbf{q}^{cp}$) is equal to the price set by producers ($\mathbf{p}^{cp}$) plus sales or excise taxes ($\mathbf{t}^{cp}$) imposed by the government

B) Traded sectors. These are sectors that compete with internationally traded goods. Foreign goods compete with domestic goods, therefore higher input costs cannot be passed onto output prices.

(9) $$\mathbf{q}^{ts} = \mathbf{p}^{world} + \mathbf{t}^{ts}$$

In equation (9) consumer prices ($\mathbf{q}^{ts}$) are determined by world prices ($\mathbf{p}^{world}$), and by trade taxes ($\mathbf{t}^{ts}$, inclusive of tariffs and sales taxes).

C) Controlled sectors. These are sectors where output prices are controlled by the government:

(10) $$\mathbf{q}^{cs} = \mathbf{p}^{*}$$

In equation (10) consumer prices ($\mathbf{q}^{cs}$) are determined by pricing controls ($\mathbf{p}^{*}$). For the sake of simplicity, domestic taxes are set to zero.

Having defined the price-setting equations, we now turn to modeling the mechanisms through which factor price *changes* are passed onto output prices. Changes in prices for traded sectors are given by:

[3] A sketch of the proof is contained in the Appendix.

(11) $$\Delta\mathbf{q}^{ts} = \Delta\mathbf{p}^{world} + \Delta\mathbf{t}^{ts}$$

where both Δp^{world} and Δt^{ts} on the right-hand side are assumed to be exogenous.

For controlled sectors the formula for the changes in prices is most simple, and is obtained from equation (10):

(12) $$\Delta\mathbf{q}^{cs} = \Delta\mathbf{p}^{*}$$

where the right-hand side variable is exogenously determined by the government pricing controls.

Finally, the change in consumer prices in the cost-push sector is given by:

(13) $$\Delta\mathbf{q}^{cp} = \Delta\mathbf{p}^{cp} + \Delta\mathbf{t}^{cp}$$

A problem arises in calculating the term Δp^{cp}. Producer prices depend on all factor prices of intermediate goods. Let w denote the vector containing the prices of production factors *not* included in the IO table (wages, for instance) and let q be the vector of intermediate goods included in the IO table; equation (13) can then be re-written as follows:

(14) $$\Delta\mathbf{q}^{cp} = \Delta\mathbf{p}^{cp}(\mathbf{w},\mathbf{q}) + \Delta\mathbf{t}^{cp}$$

Equation (14) shows that the difficulty in calculating Δq^{cp} arises because output prices q are in fact input prices for certain industries: this is what the term $\Delta p^{cp}(q)$ represents. How do changes in q pass on to final prices? For simplicity we will ignore changes in w and will focus on q, so that $\Delta p^{cp}(w,q)$ is reduced to $\Delta p^{cp}(q)$.

The solution suggested by Coady and Newhouse (2005) is based on the assumption that each of the composite commodities described above is made up of a certain proportion of cost-push, traded and controlled commodities. Let α, β and γ denote these proportions, respectively. To illustrate, let us assume that the producers of the "agricultural commodity" buy α_s percent of inputs from producers in the cost-push sectors, β_s percent of inputs from the traded sector and γ_s percent from the controlled sector. The suffix *s* refers to the sector, and ranges from 1 to 30. These proportions should, obviously, sum to unity and never be negative:

(15) $0 \le (\alpha s,\beta s,\gamma s) \le 1$ and $\alpha s+\beta s+ \gamma s=1$ (s = 1, ... 30)

The change in the price of the *j*-th commodity (the "agricultural commodity") can be expressed as a linear combination of the three market structures identified above:

(16) $$\Delta p_j^{cp}(\mathbf{q}) = \sum_{i=1}^{S}\alpha_i a_{ij}\Delta q_j^{cp} + \sum_{i=1}^{S}\beta_i a_{ij}\Delta q_j^{ts} + \sum_{i=1}^{S}\gamma_i a_{ij}\Delta q_j^{cs} \quad (j=1,...,S)$$

Equation (16) can be compacted by using matrix notation:

(17) $\Delta pcp = \Delta qcp\ \alpha A + \Delta qts\ \beta A + \Delta qcs\ \gamma A$

where Δp^{cp} is a 1 × S row vector, **α**, **β** and **γ** are diagonal S × S matrices, Δq^{cp} is 1 × S, Δq^{ts} is 1 × S, and Δq^{cs} is 1 × S. Equation (17) gives the changes in the *producer* prices for the controlled sectors. Now substitute (11), (12) and (13) in equation (17):

(18) $\Delta pcp = \Delta pcp\ \alpha A + \Delta tcp\ \alpha A + \Delta pworld\ \beta A + \Delta tts\ \beta A + \Delta p^{*}\ \gamma A$

The reduced form of equation (18) is given by:

$$\Delta \mathbf{p}^{cp} = \Delta \mathbf{t}^{cp} \boldsymbol{\alpha} \mathbf{A} \mathbf{V} + \Delta \mathbf{p}^{world} \boldsymbol{\beta} \mathbf{A} \mathbf{V} + \Delta \mathbf{t}^{ts} \boldsymbol{\beta} \mathbf{A} \mathbf{V} + \Delta \mathbf{p}^{*} \boldsymbol{\gamma} \mathbf{A} \mathbf{V} \tag{19}$$

where to simplify the notation we let $V = (I - \boldsymbol{\alpha} A)^{-1}$. Equation (19) gives the vector of *producer* price changes in the cost-push sectors. The matrix V captures both the direct and indirect effects of input price changes on output price changes.

The equation we are interested in is *consumer* price changes:

$$\Delta \mathbf{q} = \Delta \mathbf{q}^{cp} \boldsymbol{\alpha} + \Delta \mathbf{q}^{ts} \boldsymbol{\beta} + \Delta \mathbf{q}^{cs} \boldsymbol{\gamma} \tag{20}$$

In our application to Madagascar we further simplify the model by assuming that *(i)* the only exogenous price changes are changes in the controlled sector (in other words, we assume no changes in producer prices abroad $\Delta p^{world} = 0$, no changes in either taxes or tariffs $\Delta t^{ts} = 0$ and $\Delta t^{cp} = 0$); *(ii)* all petroleum products are within the controlled sector (this poses restrictions on the matrices **α**, **β** and **γ**), and *(iii)* all other products are cost-push sectors. As a consequence, equation (11) is reduced to $\Delta q^{ts} = 0$, and equation (13) becomes $\Delta q^{cp} = \Delta p^{cp}$. Under hypotheses *(i)*-*(iii),* equation (20) can be re-written as:

$$\Delta \mathbf{q} = \Delta \mathbf{p}^{cp} \boldsymbol{\alpha} + \Delta \mathbf{p}^{*} \boldsymbol{\gamma} \tag{21}$$

Finally, we substitute (19) in (21):

$$\Delta \mathbf{q} = \Delta \mathbf{p}^{*} \boldsymbol{\gamma} \mathbf{A} \mathbf{V} \alpha + \Delta \mathbf{p}^{*} \boldsymbol{\gamma} = \Delta \mathbf{p}^{*} \left[\boldsymbol{\gamma} \mathbf{A} \mathbf{V} \alpha + \boldsymbol{\gamma} \right] \tag{22}$$

Equation (22) is key for the evaluation of the impact of a change in energy prices on consumer prices for the range of sectors available in the I/O table.

The Estimates

Table 2 shows the impact of higher petroleum prices on the prices in other sectors. Multiplying these induced price increases (column 2) by the corresponding household budget shares (column 1) and aggregating across goods and services gives the percentage increase in costs due to the indirect price increases.

According to the estimates inTable 2, the generalized increase in prices in goods and services caused by a 17 percent increase in petroleum prices implies a drop in household real income of 1 percent (row total of column 3). This is the estimate of what was referred to as the "indirect welfare effect" in previous paragraphs. also shows that the single most important contribution comes from products in the food industry, which accounts for almost two-thirds of the indirect effect. The aggregate of all food-related sectors, accounts for almost 80 percent of the overall indirect effect. The second highest source is the textile sector, which accounts for some 7 percent of the indirect effect.

Table 2 - Indirect Price and Real Income Effects by Sector

Sector	Budget Shares (%) (1)	Price Effect (%) (2)	Impact on Expenditure (%) (1)×(2) /100	Percent of Total Impact (%)
Agriculture	10.17	0.29	0.03	2.94
Farming	0.20	1.13	0.00	0.23
Agro-industry	1.53	2.75	0.04	4.19
Food industry	39.53	1.61	0.64	63.38
Beverage	0.70	1.29	0.01	0.90
Tabac	2.15	0.95	0.02	2.03
Fats	2.00	3.48	0.07	6.93
Chemical	2.30	2.21	0.05	5.06
Textile	2.97	2.44	0.07	7.22
Metal	0.00	1.69	0.00	0.00
Electrical products	0.00	1.08	0.00	0.00
Paper	0.01	2.81	0.00	0.03
Leather	0.66	1.49	0.01	0.98
Transport (people)	0.94	3.14	0.03	2.94
Transport (other)	0.02	1.26	0.00	0.03
Telecommunication	0.06	0.87	0.00	0.05
Trade	0.30	1.04	0.00	0.31
Services (coll.)	3.15	0.87	0.03	2.73
Services (indiv.)	0.18	0.36	0.00	0.06
Total	66.87	—	1.00	100.00

Note*: Budget shares are derived from EPM 2005 based on commodity groupings that match the more aggregated input-output table sectoral breakdown available for the year 1995. Quintiles are based on the national distribution of per capita annual expenditures. The estimation of the indirect welfare effect is based on price increases observed during 2005 (11 percent for gasoline, 13 percent for diesel, and 36 percent for kerosene). The change in the price of electricity is assumed to be one-third of the average change in petroleum prices.*

3.3. Total Welfare Effect

After calculating separately the direct effect by aggregating real income changes across petroleum products, and the indirect effect, by aggregating real income changes across all other commodities, the total effect can be calculated as the sum of the two separate effects.

presents the key estimates for understanding the distributional impact of higher petroleum prices in Madagascar. A number of findings are worthy of a comment. First, the top panel of the table shows that the the total welfare effect (row 3) is significant in magnitude: an average increase of 17 percent in energy prices causes a loss equal to 1.75 percent of total household expenditure. The loss is greater for housholds in the bottom quintile (2.14 percent). It decreases for households in the upper quintile (1.52 percent). The incidence of the increase in oil prices is therefore unambiguosly regressive.

Second, circa 60 percent of the total welfare loss is due to the indirect welfare effect. This implies that the main channel through which households are affected by higher energy prices is the indirect effect on non-oil prices (especially food prices, as noted above). The combination of *(i)* a relatively high sensitivity of food prices to oil prices (Table 2, column 2), and *(ii)* a large budget share devoted to food, column 1) is largely responsible for the prevalence of the indirect welfare effect shown inTable 3.

Third, the share of the indirect effect is lowest for the poorest households, accounting for 44 percent of the total welfare effect, compared to 67 percent for the households in the top quintiles. This result is driven by the pattern observed for the direct effect.

Table 3 - Total Welfare Effect of Energy Price Changes
(% of total household expenditure)

Per capita expenditure quintiles	Q1 (poorest)	Q2	Q3	Q4	Q5 (richest)	All
Direct Welfare Effect	1.19	0.86	0.73	0.64	0.50	0.74
Indirect Welfare Effect	0.95	1.01	1.01	1.03	1.02	1.01
Total Welfare Effect	2.14	1.87	1.74	1.67	1.52	1.75
IWE as % of total	44	54	58	62	67	58
Share of the burden						
Direct Welfare Effect	13.4	16.0	17.8	20.4	32.4	100
Indirect Welfare Effect	6.9	11.7	15.5	21.2	44.7	100
Total Welfare Effect	9.2	13.2	16.3	20.8	40.4	99.9

Note: Budget shares are derived from EPM 2005 based on commodity groupings that match the more aggregated input-output table sectoral breakdown available for the year 1995. Quintiles are based on the national distribution of per capita annual expenditures. The estimation of the total welfare effect is based on price increases observed during 2005 (11 percent for gasoline, 13 percent for diesel, and 36 percent for kerosene). The change in the price of electricity is assumed to be one-third of the average change in petroleum prices.

The bottom panel of translates the percentage effects shown in the top panel into shares of aggregate real expenditure loss borne by each quintile. Although energy products may absorb a higher proportion of the total consumption budget of low-income households, high-income households typically consume larger quantities of these products. Hence, it is important to assess the distribution of the total loss, in absolute terms (that is in local currency units), by quintile. This is precisely what is shown in the bottom panel of.

The top two quintiles, representing only 40 percent of the population, account for circa 60 percent of the total loss, compared to circa 22 percent for the bottom two quintiles. The pattern observed for the total welfare effect mirrors the pattern for both indirect and direct effects.

The main finding here is that although price increases hurt the poor more in percentage terms (third rows of Table 3), subsidizing energy prices would involve a substantial leakage in favor of higher income households (last row of Table 3). This empirical finding raises the issue of identifying more cost-effective policies to protect the poor households against energy price increases.

4. SUMMARY AND FINAL REMARKS

High on most governments' agendas is the issue of how to deal with the adverse consequences of higher energy prices on living standards of the poorest segments of the population. A hotly debated question is whether governments should introduce price controls and/or intervene in other ways to mitigate the social costs of oil price increases. In the absence of compelling, unambiguous theoretical arguments, assessing the advisability of price controls must be based on the empirical evidence.

In this paper we assess the distributional impact of the increase in petroleum prices during 2005, by estimating the impact on household real expenditures. The main findings can be summarized as follows. First, a 17 percent rise in the price of energy products leads to a 1.75 percent average decrease in real expenditure. This percentage is higher for low-income households (2.1 percent) than for for high-income households (1.5 percent). This implies that the benefits of introducing energy price subsidies would be *progressive*, *i.e.* in percentage terms, subsidies would benefit poor households more than rich households. However, subsidizing would involve substantial leakage in favor of high-income households, who account for more than 60 percent of the total burden of price increases. This raises the issue of identifying more cost-effective policies to protect poorest households. The relatively large size of the “leakage to the rich” implied by our estimates, suggests that improvements in the ability to target social transfers and/or expenditure should be a priority. The analysis carried out in the paper suggests that subsidies on kerosene represent one such option worth exploring. Consistent with our results is an overall re-thinking of the system of safety nets.

It is well to bear in mind the limitations of the method used here. A first simplification in our analysis is the assumption that all “composite goods” (with the exception of energy products) are produced in cost-push sectors. As noted by Kopdar (2006), this is likely to over-emphasize the importance of the indirect price effect, though the bias is hard, if at all possible, to quantify. Second, our analysis does not take into account the fact that consumers are likely to change their consumption behaviour in response to the initial price shock. Nor does it account for the fact that producers are also likely to modify their use of factors of production. To deal with substitution effects would require a different approach, based on the estimation of a computable general equilibrium model, a task which goes beyond the scope of this paper – see Banks, Blundell and Lewbel (1996).

That said, it is probably a fair claim, that given the relatively low substitutability of petroleum products for both consumers and producers in the context of Madagascar, the results obtained in the paper may be deemed reasonable, and possibly realistic, at least, for the short term.

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6. APPENDICES

Appendix A - On the interpretation of the coefficients of the Input-Output matrix

This Appendix shows that the a_{ij} coefficient of the IO table represents the change in the cost of producing one unit of *j* due to a unit change in the price of input *i*.

According to equation (7) in the text, a_{ij} denotes the cost of input *i* to produce one unit of output *j*. Now re-scale the unit of measurement of each output so that total value of each output is equal to one:

$$(23) \qquad v_j = \sum_{i=1}^{S} a_{ij} + AV_j = 1 \quad \forall j$$

where v_j is the total value of the *j*-th output, and AV_j is the added value for output *j*. Let b_{ij} denote the quantity of input *i* required to produce one unit of output *j*, as defined above. By definition we have:

$$(24) \qquad a_{ij} = b_{ij}\, p_i$$

The elasticity of the monetary *cost* of producing *j* with respect to the price of the input *i* is:

$$(25) \qquad \frac{\partial v_j}{\partial p_i} \times \frac{p_i}{v_j} = b_{ij} \times \frac{p_i}{v_j} = b_{ij}\, p_i = a_{ij} \qquad \text{QED}$$

Appendix B – The IO table for Madagascar 1995

This Appendix shows the IO table for 1995, based on a compilation of data from the Household Survey, the Ministry of Economy and Finance, the Ministry of Trade, the Ministry of Agriculture, and the Central Bank of Madagascar. External trade data are from the National Institute for Statistics and other survey to enterprises, NGOs, the banking sector and insurance companies.

	agric.	farming	hunting	fishing	agro	mining	energy	food	bever.	tabac	fats	chem.	textile	wood	nonmetal	metal
agriculture	0.0137	0.0879	0.0000	0.0141	0.3896	0.0000	0.0000	0.3250	0.1476	0.2160	0.0700	0.0049	0.0514	0.0000	0.0000	0.0000
farming	0.0194	0.0019	0.0000	0.0000	0.0000	0.0000	0.0000	0.2464	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000
hunting	0.0076	0.0328	0.0000	0.0386	0.0018	0.0002	0.0000	0.0004	0.0003	0.0092	0.0025	0.0035	0.0001	0.1023	0.0042	0.0110
fishing	0.0000	0.0516	0.0000	0.0000	0.0000	0.0000	0.0000	0.0261	0.0000	0.0000	0.0197	0.0000	0.0000	0.0000	0.0000	0.0000
agro	0.0014	0.0000	0.0000	0.0000	0.0042	0.0016	0.0000	0.0271	0.0166	0.0000	0.0131	0.0013	0.0000	0.0000	0.0000	0.0000
mining	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.3247	0.0194	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
energy	0.0035	0.0214	0.0497	0.0635	0.1253	0.0756	0.0180	0.0479	0.0433	0.0189	0.0918	0.0251	0.0549	0.0282	0.0704	0.0241
food	0.0000	0.2091	0.0000	0.0003	0.0000	0.0000	0.0000	0.1132	0.0000	0.0000	0.0000	0.0002	0.0012	0.0000	0.0000	0.0000
beverage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0008	0.0000	0.0000	0.0002	0.0000	0.0000	0.0000	0.0000
tabac	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0535	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
fats	0.0000	0.0257	0.0000	0.0000	0.0000	0.0000	0.0000	0.0041	0.0000	0.0000	0.3818	0.0253	0.0000	0.0000	0.0000	0.0000
chemical	0.0628	0.0393	0.0093	0.0045	0.1134	0.0594	0.0335	0.0094	0.0419	0.0108	0.1810	0.5608	0.0072	0.0295	0.0076	0.0620
textile	0.0006	0.0024	0.0023	0.0091	0.0007	0.0003	0.0006	0.0001	0.0006	0.0008	0.0035	0.0016	0.5602	0.0008	0.0000	0.0000
wood	0.0047	0.0000	0.0000	0.0000	0.0000	0.0297	0.0027	0.0003	0.0012	0.0016	0.0000	0.0000	0.0006	0.1657	0.0000	0.0107
nonmetal	0.0058	0.0000	0.0000	0.0000	0.0000	0.0000	0.0010	0.0000	0.0000	0.0000	0.0022	0.0000	0.0004	0.0014	0.0311	0.0015
metal	0.0110	0.0112	0.0346	0.0241	0.0579	0.0221	0.0791	0.0041	0.0612	0.0445	0.0060	0.0247	0.0144	0.0583	0.0579	0.5472
electrical pr.	0.0000	0.0005	0.0000	0.0003	0.0034	0.0000	0.0164	0.0001	0.0012	0.0000	0.0000	0.0000	0.0000	0.0018	0.0267	0.0118
paper	0.0003	0.0025	0.0026	0.0040	0.0077	0.0020	0.0086	0.0088	0.0069	0.0896	0.0084	0.0153	0.0061	0.0017	0.0397	0.0033
leather	0.0001	0.0007	0.0008	0.0021	0.0197	0.0095	0.0173	0.0006	0.0497	0.0101	0.0089	0.1025	0.0090	0.0041	0.0269	0.0107
construction	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
transstuff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
transpeople	0.0008	0.0148	0.0056	0.0064	0.0022	0.0068	0.0085	0.0107	0.0164	0.0051	0.0050	0.0404	0.0102	0.0003	0.0411	0.0199
transother	0.0021	0.0026	0.0073	0.0129	0.0142	0.0404	0.0070	0.0005	0.0315	0.0253	0.0070	0.0308	0.0050	0.0123	0.0204	0.0488
telecom	0.0001	0.0014	0.0011	0.0041	0.0011	0.0008	0.0008	0.0007	0.0052	0.0052	0.0033	0.0073	0.0047	0.0009	0.0112	0.0023
trade	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
banks	0.0006	0.0042	0.0078	0.0095	0.0028	0.0016	0.0011	0.0007	0.0099	0.0103	0.0095	0.0043	0.0072	0.0016	0.0069	0.0013
servicefirm	0.0027	0.0274	0.0265	0.0375	0.0878	0.1506	0.0064	0.0050	0.0666	0.0722	0.0096	0.0101	0.0104	0.0937	0.0553	0.0195
servicecoll	0.0032	0.0121	0.0430	0.0597	0.0472	0.1295	0.0227	0.0092	0.0525	0.0480	0.0176	0.0347	0.0152	0.0705	0.0651	0.0244
serviceind	0.0095	0.0340	0.0234	0.0331	0.0480	0.0355	0.0074	0.0003	0.0287	0.0171	0.0449	0.0192	0.0049	0.0276	0.0248	0.0111
serviceap	0.0040	0.0047	0.0115	0.0044	0.0000	0.0075	0.0000	0.0000	0.0000	0.0080	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002

(continued on next page)

The IO table for Madagascar 1995 *(continued)*

	electric. pr.	paper	leather	constr.	transstuff	transpeople	transother	telecom	trade	banks	servicefirm	servicecoll	serviceind	serviceap
agriculture	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0906	0.0000	0.0006
farming	0.0000	0.0000	0.0009	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0196	0.0000	0.0003
hunting	0.0000	0.0068	0.0002	0.0040	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0112	0.0004	0.0000
fishing	0.0000	0.0000	0.0403	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0586	0.0000	0.0002
agro	0.0000	0.0001	0.0140	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0187	0.0000	0.0006
mining	0.0000	0.0000	0.0234	0.0214	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0066	0.0000	0.0000
energy	0.0056	0.0468	0.0421	0.0203	0.1780	0.1483	0.0398	0.0297	0.0533	0.0089	0.0123	0.0120	0.0198	0.0324
food	0.0000	0.0000	0.0331	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.1787	0.0000	0.0018
beverage	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0305	0.0005	0.0000
tabac	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
fats	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0122	0.0000	0.0000
chemical	0.0003	0.2271	0.0935	0.0735	0.0204	0.0241	0.0062	0.0014	0.0018	0.0000	0.0003	0.0043	0.0009	0.0090
textile	0.0000	0.0003	0.0001	0.0002	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0041	0.0005	0.0002
wood	0.0021	0.0000	0.0173	0.0877	0.0050	0.0039	0.0000	0.0000	0.0021	0.0000	0.0000	0.0014	0.0006	0.0025
nonmetal	0.0258	0.0006	0.0036	0.1776	0.0000	0.0000	0.0000	0.0034	0.0000	0.0000	0.0000	0.0000	0.0005	0.0003
metal	0.0128	0.0111	0.0181	0.3708	0.1068	0.2425	0.0470	0.0073	0.0009	0.0022	0.0287	0.0105	0.0028	0.0182
electrical pr.	0.7410	0.0242	0.0291	0.0222	0.0030	0.0029	0.0059	0.0000	0.0004	0.0000	0.0005	0.0005	0.0004	0.0004
paper	0.0135	0.4596	0.0167	0.0065	0.0004	0.0004	0.0764	0.0642	0.0065	0.0285	0.0056	0.0011	0.0002	0.0392
leather	0.0146	0.0283	0.0951	0.0259	0.0001	0.0002	0.0069	0.0397	0.0006	0.0062	0.0005	0.0006	0.0003	0.0176
construction	0.0000	0.0000	0.0000	0.0009	0.0000	0.0000	0.0013	0.0047	0.0000	0.0000	0.0000	0.0002	0.0003	0.0032
transstuff	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
transpeople	0.0070	0.0056	0.0137	0.0126	0.0074	0.0123	0.0114	0.0042	0.0102	0.0149	0.0209	0.0044	0.0010	0.0257
transother	0.0099	0.0380	0.0004	0.0131	0.0234	0.0172	0.0029	0.0000	0.0172	0.0000	0.0040	0.0062	0.0000	0.0009
telecom	0.0081	0.0044	0.0067	0.0050	0.0067	0.0069	0.1124	0.0000	0.0123	0.0140	0.0096	0.0014	0.0007	0.0082
trade	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
banks	0.0021	0.0060	0.0041	0.0045	0.0587	0.0985	0.0406	0.0004	0.0094	0.0112	0.0075	0.0011	0.0015	0.0552
servicefirm	0.0098	0.0460	0.0239	0.0155	0.0249	0.0980	0.1059	0.0236	0.0612	0.0255	0.0113	0.0629	0.0034	0.0559
servicecoll	0.0079	0.0492	0.0492	0.0100	0.0244	0.0321	0.0735	0.0855	0.0247	0.0064	0.0212	0.0096	0.0077	0.1094
serviceind	0.0058	0.0028	0.0298	0.0198	0.0315	0.0402	0.0423	0.0134	0.0251	0.0275	0.0249	0.0010	0.0008	0.0352
serviceap	0.0000	0.0000	0.0000	0.0022	0.0024	0.0017	0.0011	0.0000	0.0000	0.0000	0.0000	0.0022	0.0000	0.0000

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