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Consumer responses to gasoline price and non-price policies

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ABSTRACT

Gasoline consumption in emerging economies have been rising rapidly due to economic growth and increasing urbanization rate in recent years. However, the development has brought about new socio-economic and environmental challenges leading governments to adopt various policies to control the trend. Although the impacts of price changes on gasoline consumption are well-researched in the literature, studies on different policies in a specific country is limited. In this paper, we investigate the impact of three distinct policies (price reform, rationing, and fuel-efficiency) on consumer responses in Iran. We estimate price, income, and efficiency elasticities across household characteristics, income groups, and provinces using the AIDS model and the household expenditures data for the period 2005–2016. The results show that the average price elasticity is -76, however, it varies across household characteristics, time, and space. The price responses are greater in provinces neighbouring the countries with high price differentials and welfare losses of price reform are more sever for lower income families. The estimated elasticities under different policy regimes show that energy price reform has led to significantly higher elasticities, while rationing has led to decreased elasticities. The more stringent efficiency regulation and increasing imports of fuel-efficient cars have also increased elasticities.

1. Introduction

Passenger car transportation and gasoline consumption in emerging and developing economies have been rising rapidly due to economic growth and increasing urbanization rate in recent years. For instance, the use of refinery products in China and India has been increasing by more than 6 percent annually for the period 2006–2016 (BP Statistical Review, 2017). Moreover, the heavily subsidized prices in some oil-rich countries have led gasoline consumption to increase even more dramatically with, for example, gasoline consumption per capita in the oil-rich countries such as Saudi Arabia and Iran being way higher than that in emerging economies.[2] This recent rapid rise in the level of gasoline consumption has created new socio-economic and environmental challenges, such as traffic congestion and increasing level of air pollution locally and globally. The large investments in infrastructure to support the private transportation demand as well as the increasing direct and indirect subsidies have also caused a significant burden on government budgets. To address the challenges, various price and non-price measures have been adopted to curb the gasoline consumption growth. The policies include increasing gasoline prices, energy price reform by means of removing subsidies, restrictions on the use of private vehicles in large cities, rationing, fuel efficiency regulations, and easing restriction on imports of high efficiency cars. While there are myriad studies on the effects of price changes on gasoline consumption in developed countries, the number of studies in developing countries is limited. Most studies also focus on a particular policy effect, specially price changes, as the cases where various price and non-price policies being embarked on in a country are rare.

In this study, we investigate the impact of different gasoline policies on consumer elasticities in Iran using household budget data over time. Iran is an interesting case study, as the country has experienced a rapid growth in gasoline consumption and adopted various price and non-price policies to curb the trend in recent years. The high demand for personal cars due to a rise in income, population growth, increasing

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[2] In 2012, the gasoline consumption per capita in Saudi Arabia and Iran was 6.35 and 1.94 barrels per year but in China, India, and Turkey was 0.65, 0.12, and 0.87 bb/y, respectively (https://www.indexmundi.com/energy).

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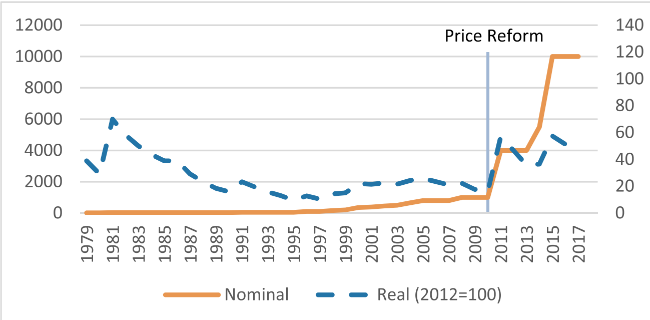

Fig. 1. Nominal and Real Gasoline Prices (1979–2017).
Current prices are rials per liter. Real prices are the current prices deflated by CPI. Source: Economic Data (Central Bank of Iran).

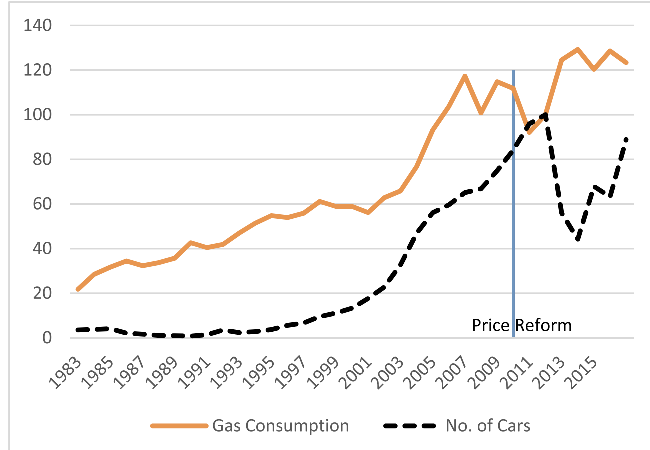

Fig. 2. Number of cars and gas consumption indexes (1983–2016). 2012 = 100.
Source: Central Bank of Iran data Bank.

urbanization, and lack of sufficient infrastructure for public transportation have led gasoline consumption to increase dramatically.[3] Moreover, subsidized gasoline prices along with low efficiency standards of the domestically produced cars have also contributed to the increasing gasoline consumption.

The gasoline prices in Iran have been historically one of the cheapest in the world, thanks to the generous direct and indirect subsidies. Given the exchange rates, the prices have been in the range of US $0.10 to $0.30 per liter for the past 40 years. Fig. 1 depicts the current and real prices of gasoline since 1979. The nominal prices were constant in the 1980s, steadily rising in the 1990s, and quadrupled in 2010 with the initiation of the energy subsidy reform program. The real price of gasoline, however, has been declining by 0.6 percent per year on average for the period 1982–2017 with a sharper decline in recent years. Fig. 2 shows increasing trends for the gasoline consumption and the number of cars, noticeably since 2000. Gasoline consumption has been rising by more than 5 percent per year on average and the number of cars by about 10 percent per year for the period 1982–2017. Gasoline consumption declined temporarily after the price reform in 2010 and the number of new cars fell in 2012 due to the tightening sanctions of the Iranian oil and banking sectors by the U.S. and the E.U., which led to a reduction in car production and imports.

The sharp increase in gasoline consumption in the early 2000s led to imports of gasoline and, given the subsidized prices, to greater fiscal imbalances. The social and environmental impacts of the rising gasoline consumption, particularly in large cities, also became more pronounced in this period. Moreover, tightening sanctions by the US and the EU restricted the imports of gasoline causing a shortage in the domestic market.[4] To curb the increasing growth in gasoline consumption, government adopted a range of policies, such as rationing in 2008–2014, removing subsidies through the energy subsidy reform program in 2010, imposing more stringent fuel efficiency standards on domestically produced cars, easing restrictions on imports of foreign cars, and providing incentives for replacing the old cars with new and more efficient cars. Furthermore, other restrictions on driving in large cities, such as the odd/even driving days based on the plate numbers and zoning system, were also enforced.

Gasoline rationing policy was officially announced and implemented in 2008 and ended in 2014. In the first year of the policy, each private passenger car was assigned a ration of 60 L per month with a fixed price of $0.10 per liter, which rose in subsequent years. The over-ration quantities were also available at a price of $0.40 per liter. The consumption was monitored by fuel cards and a centralized electronic system installed in the gas stations. The rationing system seemed to be effective in the short run as the total gasoline consumption fell by 14 percent from 422 thousand barrels per day in 2007 to 362.7 thousand barrels per day in 2008. The sharp decline in gasoline consumption in such a short period, however, could also be ascribed partly to the decline in gasoline smuggling across the international borders (Ghoddusi et al., 2018). The extensive price differentials across the borders, particularly the Iran-Turkey border, where the price ratio was 1–20, incentivized the large-scale cross-border gasoline smuggling. Although there is no reliable data, it is not unreasonable to assume that a great deal of the consumption declines during the early period of the rationing regime had been due to the cut in smuggling.

The energy price reform officially began in February 2010, mostly in response to the sanctions, which restricted energy trade, particularly the imports of gasoline. According to the reform law enacted by the parliament (Targeted Subsidies Law), energy prices were to increase up to 90 percent of the border prices in five years, generating up to $20 billion revenues for government. To make the plan publicly acceptable, a compensation package according to which everyone would receive $45/month was also established (Moshiri, 2015; Moshiri and Lechtenböhmer, 2015). Government also adopted fuel efficiency policies on domestically produced cars and, more importantly, easing the imports restrictions in 2013. As a result, the imports of foreign and more fuel-efficient cars rose from 1.6 percent of the car fleet in 2012 to about 6 percent in 2016. However, savings from those efficiency measures are not clear. In 2012–2014, the gas consumption rose by 29 percent while the number of cars fell by 55 percent per year on average and the imports of foreign cars increased. The declining real prices of gasoline by about 8 percent per year seems to have contributed more significantly to the rising gasoline consumption in this period.

We use the Almost Ideal Demand System (AIDS) model to estimate the price, income, and efficiency elasticities of gasoline consumption under the rationing, subsidy removal, and the efficiency policies in Iran for the period 2005–2016. Our large micro data set from household budget surveys over time allows us to control for myriad intervening factors and household characteristics. To the best of our knowledge, this is the first study analyzing the impacts of various gasoline policies in the context of a specific oil-rich country using a micro data. Conducting different policies in a country provides a natural experiment to study consumer responses as institutional factors and political system remain the same contrary to the cross country studies with a great deal of

[3] For the past 30 years, GDP has been growing on average by more than 5 percent per year, population has increased by about 60 percent from 52 million to more than 80 million, and urbanization rate from 55 percent to 74 percent (Economic Time Series Data, Central Bank of Iran, www.cbi.ir).

[4] Although the rationing system was terminated after the removal of sanctions under the Comprehensive Joint Plan of Action signed by the 5 + 1 group, it might be brought back because of the resumption of the sanctions by the US following its unilateral exit of the agreement in June 2018.

heterogeneities in the data. In what follows, we first review the previous studies in Section 2 and then discuss theoretical background in Section 3. Data analysis, methodology, and results are presented in Sections 4, 5, and 6, respectively, followed by discussion and conclusion in Sections 7.

2. Review of the previous studies

Although there is a rich literature on the consumer responses to gasoline policies (see Huntington et al., 2017, for a survey), a few studies have focused on both price and non-price policies in developing countries. Specifically, studies on the rationing effect on gasoline consumption is rare, as the policy is not widely used in recent decades. Wang and Chern (1992) study the rationing effect on Chinese urban household behaviour using the average income group data for the period 1981–1987. They consider the rationing on housing, food grain, and fuel, but focus on the impacts of rationing on the consumption of non-ration items such as non-staple food. The study reports that the sums of income and price elasticities are significantly smaller or close to zero in most goods under rationing system. Ghoddusi et al. (2018) estimate the price elasticity of gasoline smuggling in Iran using a semi-structural estimation approach and show that the elasticities are very small during the rationing period.

The studies on the fuel efficiency effect and its associated rebound effect (efficiency induced consumption) on gasoline consumption have mostly used data from developed countries. A 2014 survey by Economic Consulting Associates finds that only 34 estimates out of 241 estimates by 163 published papers are on developing countries. The survey reports that the fuel efficiency effects are in the range of 70–90 percent for the high-income countries and 50–70 percent for the middle and low-income countries, implying the rebound effects of 10–30 percent and 30–50 percent, respectively. The studies also show that the rebound effects are higher in transportation than other energy services such as heating, lighting, and cooling (Greening et al., 2000). In another survey, Gillingham et al. (2014) show that rebound effects are greater in developing countries than developed countries. Specifically, the direct rebound effect for gasoline and electricity consumption in developed countries are in the order of 5–40 percent, but in developing countries between 10 and 60 percent, with the upper limit in countries such as China (Lin and Zeng, 2013), Lebanon (Ben Sita et al., 2012), and Mexico (Crotte et al., 2010).

Table 1 shows a summary of the papers on the rationing and the fuel efficiency or rebound effect in the transportation sector in developed and developing countries. The studies in developed countries have estimated elasticity of gasoline demand and direct rebound effect using the aggregate time series data, household expenditures and the vehicle distance traveled surveys data. Overall, price elasticities and implied rebound effects are reported smaller when aggregate data are used.[5] For instance, the rebound effects obtained from national or state/provincial level data by Matos and Silva (2011) for Portugal (1987–2006), Brännlund et al. (2007) for Sweden (1980–1997), Small and Van Dender (2007) for the US (1966–2001), and Barla et al. (2009) for Canada (1990–2004) are in the range of 5–50 percent. However, household level studies by West (2004) for US (1997), Frondel et al. (2008) for Germany (1997–2009), Chitnis et al. (2014) for the UK (1964–2015), and Moshiri and Aliyev (2017) for Canada (1997–2009) report rebound effects in the range of 25–89 percent. Studies in developing countries have mostly used aggregate time series data to estimate the elasticity of gasoline demand. As Table 1 shows, the range of price elasticities in countries such as China, Lebanon, Mexico, and Iran are higher than other developing countries. We contribute to the literature by estimating consumer responses to both price and non-price policies on gasoline using a large micro pooled time series data in an oil-rich country. We report and compare the price, income, and efficiency elasticities across income groups, provinces, and household characteristics under different policies. We also estimate the welfare impacts of price changes on different income groups.

3. Theoretical background

A consumer decides how much to consume of different goods and services, given his/her preference structure, disposable income, and relative prices. Policies such as tax or subsidies may also affect consumer choices directly or indirectly through changes in income or prices. In our context, the consumer basket includes three goods (gasoline, food, and other goods) and policies considered are price reform, rationing, and fuel efficiency. The price reform in the form of removing subsidies can be analyzed using a standard demand-supply model. Removing subsidies has similar effects as levying taxes, which shifts supply curve leftward, increasing prices and lowering quantity demanded. The magnitude of the changes will depend on the current level of prices and the size of subsidy removal. When gasoline prices are low, an excessive change in price is required to generate a meaningful response in the quantity demanded, whereas when prices are high, a small change in prices can generate a comparable outcome.

Under the rationing system, price and the total supply are fixed and thus demand is expected to be inelastic if the ration price is less than the market price. If consumers can purchase gasoline more than their ration at higher prices, demand curve will be nonlinear and price will be endogenous as it will change with consumption level. However, if prices for ration and over-ration quantities are set exogenously by government and consumers can trade their ration, rationing will not be binding and the market will be similar to the non-rationing market. The car owners use up their ration or would transfer it to others at higher prices. In other words, when there is an effective parallel market in which excess demand is zero and the state-planned prices are strictly less than the market prices, then rationing will only have income redistribution effect among consumers (Sincular, 1988). The effective price each consumer pays will then be equal to the weighted average of the ration and the over-ration prices with weights being the ratios of the corresponding quantities. In addition to the price effect, rationing policy may also induce some behavioural responses. Rationing may be considered as a right and, therefore, every effort will be made to exercise that right, implying that the total ration amount in the system will be used up. Rationing may also be perceived as a measure of equality or fairness and the ration as a reference level of consumption. Therefore, willingness to consume above the ration, if available, may decrease. Overall, whether price or behavioural effects, the elasticities are expected to be lower under the rationing system.

Fuel efficiency policy is expected to reduce gas consumption proportional to the efficiency measure, assuming that the distance traveled remains unchanged. However, the rebound effect literature suggests that the lower traveling cost associated with the fuel-efficient cars may encourage consumers to drive longer distances, offsetting total or partial saving of fuel efficiency. The direct rebound effect can be estimated by the elasticity of distance traveled with respect to fuel efficiency. Since data on traveled distances is not readily available in many developing countries, one can also use the price elasticity of gasoline as a measure of the rebound effect. If fuel efficiency (ε) is assumed to be exogenous, the fuel cost (P_G) would be proportional to efficiency implying that the relative prices of gasoline (P_G)and distance traveled (P_T)are proportional $\left(P_T = \frac{P_G}{\varepsilon}\right)$. In other words, the price elasticities of distance traveled and gasoline consumption are equal and, therefore, the latter can be used to estimate the rebound effect (Khazzoom, 1989). This approach also allows one to make use of the rich household spending data on gasoline and other goods over time and to control for the

[5] In a meta-analysis, Labanderia et al. (2017) report that energy and gasoline price elasticities of demand are higher in developing countries and residential consumers as well as in models using system of equations and cross-section and micro data.

Table 1
A summary of the fuel efficiency rebound effect in developed and developing countries.

Author	Country	Dependent Variable	Period	Data	Price Elasticity
Developed Countries					
Greene (1992)	US	VMT*	1957–1989	National (time series)	(-0.05, −0.15)
Jones (1993)	US	VMT	1957–1990	National (time series)	(-0.11, −0.3)
Orasch and Wirl (1997)	UK, France, Italy	Fuel Consumption	1971–1993	National (time series)	(-0.15, −0.3)
Matos and Silva (2011)	Portugal	VMT	1987–2006	National (time series)	−0.24
Haughton and Sarkar (1996)	US	VMT	1970–1991	State panel	(-0.16, −0.22)
Small and Van Dender (2007)	US	VMT	1966–2001	State panel	(-0.05, −0.22)
Hymel et al. (2010)	US	VMT	1966–2004	State panel	−0.09
Su (2011)	US	VMT	2001–2008	State panel	(-0.03, −0.11)
Barla et al. (2009)	Canada	VMT	1990–2004	Provincial panel	(-0.08, −0.2)
Greene et al. (1999)	US	VMT	1979–1994	Residential Transportation Survey (pool)	(-0.17, −0.28)
West (2004)	US	VMT	1997	Consumer Expenditure Survey (cross section)	−0.87
Brännlund et al. (2007)	Sweden	Expenditure shares	1980–1997	Household Consumption Data (pool)	(-0.15, −0.42)**
Frondel et al. (2008)	Germany	VMT/fuel Consumption	1997–2009	Household Survey (pool)	(-0.57, −0.62)
Chitnis et al. (2014)	UK	Expenditure Shares	1964–2013	Household Budget (pool)	(-0.25, −0.87)
Moshiri and Aliyev (2017)	Canada	Expenditure Shares	1997–2009	Household Spending Survey (pool)	(-0.82, −0.88)
Developing Countries					
Wang and Chern (1992)	China	Expenditure shares	1981–1987	Household Budget	−0.019**
Lin and Zeng. (2013)	China	Expenditure shares	1997–2008	Household Budget	(-0.2, −0.5)
Alves and da Silveira Bueno, 2003	Brazil	Gasoline consumption per capita	1974–1999	Aggregate Time Series	−0.09
Iwayemi et al. (2010)	Nigeria		1976–2006		−0.25
Ben Sita et al. (2012)	Lebanon	Gasoline Consumption	2000–2010	Aggregate Time Series	−0.62
Crotte et al. (2010)	Mexico	Gasoline Consumption	1980–2006	National and Local Time Series	−0.15
Ismaielnia and Ekhtiari (2012)	Iran	Fuel Consumption	1997–2009	Provincial Time Series	−0.09
Khoskalam (2014)	Iran	Household Budget	2011	CGE	−0.27

*VMT: Vehicle Mile Traveled. **the total own price elasticity for private and public transports. The range for other energy services are 5–79. Developing countries figures are implied rebound effects based on the reported short-run and medium-run gasoline demand elasticities.
**Sum of price and expenditures elasticities.

household characteristics, which may be relevant to gasoline consumption (Moshiri and Aliyev, 2017). Fig. A1 in appendix shows demand for gasoline under rationing system and the rebound effects.

The elasticities of demand are often estimated by the widely applied Almost Ideal Demand System (AIDS) model developed by Deaton (1980). The model links the consumer behaviour theory of cost minimizing to the data by estimating a set of expenditure share equations as follows [6]:

$$s_i = \alpha_i + \sum_j^n \gamma_{ij} \ln p_j + \beta_i \ln\left\{\frac{y}{a(p)}\right\}. \tag{1}$$

where s_i is the expenditure share for good *i*, p_j is the price of good *j* (*j*=1, …, *n*), and *y* represents income. $a(p)$ is a linearly homogeneous function which corresponds to the cost of subsistence level. It has a flexible functional form so can reproduce any arbitrary set of first and second order derivatives of the cost function at any single point.

$$\ln a(p) = a_0 + \sum_{i=1}^n \alpha_i \ln p_i + \frac{1}{2}\sum_{i=1}^n \sum_{j=1}^n \Upsilon_{ij} \ln p_i \log p_j \tag{2}$$

The following restrictions apply to ensure the consistency with the consumer theory: Slutsky symmetry ($\Upsilon_{ij} = \Upsilon_{ji}$, *for all* i, j), homogeneity of the Marshallian demand functions of degree zero in prices and income ($\sum_{j=1}^n \Upsilon_{ij} = 0$, *for all* i), and adding up condition ($\sum_{i=1}^n \alpha_i = 1$, $\sum_{i=1}^n \Upsilon_{ij} = 0$, $\sum_{i=1}^n \beta_i = 0$). Using equation (5), the Marshalian uncompensated price elasticity and income elasticity are obtained as follows:

$$e_{ij}^u = \frac{\mu_{ij}}{s_i} - \delta_{ij} \tag{3}$$

$$e_i = \frac{\mu_i}{s_i} + 1. \tag{4}$$

where $\mu_i = \frac{\partial s_i}{\partial \ln y} = \beta_i$, $\mu_{ij} = \frac{\partial s_i}{\partial \ln p_j} = \gamma_{ij} - \beta_i\left(\alpha_j + \sum_k \Upsilon_{ij} \ln P_k\right)$, and δ is the Kronecker delta $\left(\delta_{ij} = \begin{cases} 0 \text{ if } i \neq j \\ 1 \text{ if } i = j \end{cases}\right)$. The uncompensated price elasticities include both substitution and income effects of price changes. The compensated price elasticity measures the effect of price changes on demand when a consumer is compensated for the income effect of price changes. The difference between the uncompensated and compensated price elasticities represents the pure income effect as shown below:

$$e_{ij}^u - e_{ij}^c = -e_i s_j. \tag{5}$$

where "*u*" and "*c*" stand for uncompensated and compensated. The price elasticities above offer different measures of rebound effect. e_{ii}^c represents the own substitution (price) effect and $-e_i s_i$ the pure income effect on gasoline demand. We can also measure the effect of the fuel efficiency on demand for other goods by obtaining the cross-price elasticities. Specifically, e_{ij}^c measures the substitution effect of changes in gasoline prices on the demand for other goods, and $-e_i s_j$ measures the income effect of changes in gasoline prices on other goods.

The welfare effects of the price changes can also be estimated using the compensation variation (CV). CV shows how much a household should be compensated if its utility is to remain at the same level as the pre price change period. It can be calculated as $CV = e(p,{}^1u^0) - e(p^0,u^0)$, where $e(p,u)$ is the expenditure function, *p* and *u* are the price and utility, respectively. The subscripts 0 and 1 show the pre and post policy periods. Applying Shephard's lemma and a second-order Tylor approximation, CV relative to income can be written as a function of observable variables as follows:

$$\frac{CV}{y} = \sum_{i=1}^n s_i \pi_i + \frac{1}{2}\sum_{i=1}^n \sum_{j=1}^n s_i e_{ij} \pi_i \pi_j, \tag{6}$$

where *y* is the income, *s* expenditure share, *e* elasticity and π the relative price changes.

[6] See Deaton (1980) for detailed description of the model and Moshiri and Aliyev (2017) for a recent application.

4. Data

Our main data source is the annual household expenditures surveys available by the Statistical Center of Iran. The data on prices are obtained from the Central Bank of Iran. We focus on urban areas as passenger car transportation is not an important part of the household expenditures in rural areas and the data from rural areas is not as reliable. We use total expenditures as a proxy for the total income since the income level is often underreported and biased in the household budget surveys. The total expenditures include non-durable and durable goods, which are adjusted for depreciation rates. To address the heterogeneity in demand, households are divided in three income groups: high-income (the top three income deciles), mid-income (the middle four deciles), and the low-income (the bottom three deciles). We remove outlier observations including households with gasoline expenditure shares over 20 percent and food expenditure shares over 60 percent. We also remove observations by households that own cars but report zero gasoline consumption. We limit the gasoline consumption up to 300 L per month to exclude commercial use.[7] The period of study is 2005–2016 and the total number of observations is 104,441, which is reduced to 62,519 after the adjustments made.

The expenditures share variables are the ratios of the expenditures on goods of interest to the total expenditures. Figs. 3 and 4 show the average gasoline expenditures and their shares by income groups. The expenditure trends are positive for all income groups, while the higher income groups spend 2.5 times as much as the low-income groups. The expenditure shares are, however, higher for the low-income households. The gasoline expenditures and their shares have shifted upward for all income groups after the energy price reform in 2010. Fig. 5 depicts the gasoline expenditure shares under different policy regimes. After the price reform in 2010, the gasoline expenditure share has risen by a factor of 0.67 on average and 1.27 for higher income groups. This might reflect the fact that the universal cash rebate, included in the reform program, has increased the income of low-income households more proportionally than the high-income households. The gasoline shares have declined under the rationing policy but increased during the efficiency policy period.

Table 2 shows the summary statistics for the sample data used in the estimation. The gasoline prices are fixed annually across the income groups, but the weighted average prices increase with income, because of the greater over-ration consumption by higher income groups during the rationing system. The average food price index is the highest among the mid-income groups, because their food expenditure shares are greater than the other two groups. The prices of other goods also increase with income as their expenditure shares rise. The total expenditures for the high-income households are on average greater than those for the mid-income and the low-income households by a factor of 2.1 and 3.5, respectively.

5. Methodology

We estimate the model and the elasticities in four cases to tease out the impacts of price reform, rationing, and efficiency policies on consumer responses. We first estimate the model using the total sample period (2005–2016) and then the sub-sample periods based on the relevant policies. Specifically, the impact of the price reform is analyzed by comparing the elasticities in the pre- (2010) and post-reform periods and likewise for the rationing (2008–2014) and the efficiency (2014–2016) periods. We also adjust for the periods with overlapping policies.

The system of expenditure share equation (1) is used to estimate the elasticities. The regression equations based on equation (1) will be as follows:

$$s_{it} = \alpha_i + \sum_j^n \gamma_{ij} \ln p_{jt} + \beta_i \ln\left\{\frac{y}{a(p)}\right\}_{it} + \delta_i Z_{it} + \theta_i T + \varepsilon_{it} \tag{7}$$

where i and t represent goods and time, respectively, Z represents a vector of household characteristics, T trend, and ε the random error term with zero mean and constant standard deviation. The rest of the variables are explained in equation (1). The model includes three expenditure share equations for gasoline, food, and other goods and is estimated using the nonlinear seemingly unrelated regression equations (NLSURE) model and the feasible generalized nonlinear least square method (FGNLS). The last equation for other goods is dropped because of the adding-up restriction and the corresponding coefficients are retrieved from the estimated equations. To avoid the heteroscedasticity problem in cross-section data, the residuals are adjusted using the robust standard errors, which are calculated using the nonlinear Delta method. A series of household characteristics is also incorporated in the estimation model. The education levels are measured based on two categories: literacy and the level of education (high school, university undergraduate and graduate degrees). Dummy variables are used for households with married couples and those whose head are employed. To control for the wealth effect on consumption, we construct an index, which varies between zero and one, representing the housing and car ownership with a 75 percent weight on housing and 25 percent on car. We have also included a trend variable to account for the changes in household preferences over time. During the rationing periods, there were two distinct prices for the ration and the over-ration quantities, both set by the government in its annual budget approved by the parliament. Since the ration quantity is rather low, it is reasonable to assume that all car owners use up their ration and the difference between the total gasoline consumption and the total ration consumption is purchased using the over-ration prices. We use the over-ration prices to estimate the consumer responses, but we also use ration prices as well as virtual prices by calculating the weighted average of the ration and the over-ration prices with weights being the expenditure shares on the ration and the over-ration quantities. The price index for other goods is calculated using the equation below:

$$P_o = \left[P - \left(s_g P_g + s_f P_f\right)\right] / s_o \tag{8}$$

where P_i is the price of good i ($i =$ *g:gasoline, f:food, and o:other goods*), P is the total consumer price index (CPI), and s_i is the expenditure share of good *i.* The real expenditures are obtained by dividing the current values by the 2005 prices. The population weights are applied to all estimations.

There are a few concerns regarding the empirical set up of our model, which need to be addressed. The first issue is the endogeneity problem of price, total expenditures, and the policies. Prices can be affected by quantities demanded under the two-tier pricing regime and total expenditures variable is used to construct the expenditure shares as dependent variables (Dhar et al., 2003). In our context, prices are set by government in its annual budget and are mostly determined by political rather than economic factors as the authorities are often concerned with the public dissatisfaction over the price changes and their perceived effects on inflation. Furthermore, the nonlinearity associated with the two-tier pricing system, such as electricity pricing, is not applicable here as consumers can trade their rations. Therefore, it is not unreasonable to assume that prices are exogenous in our model. However, total expenditure is prone to endogeneity problem because it enters the model as part of the dependent variable (expenditure shares) as well as the independent variable (a proxy for income). We will first test for the endogeneity of total expenditures and will use an IV, if needed, to fix the estimation process. Finally, one can argue that policies might also be driven in response to consumption and therefor are endogenous. However, this is unlikely applicable to our case since the reform and

[7] Using personal car as a taxi is a common practice in large cities, particularly among low-income households.

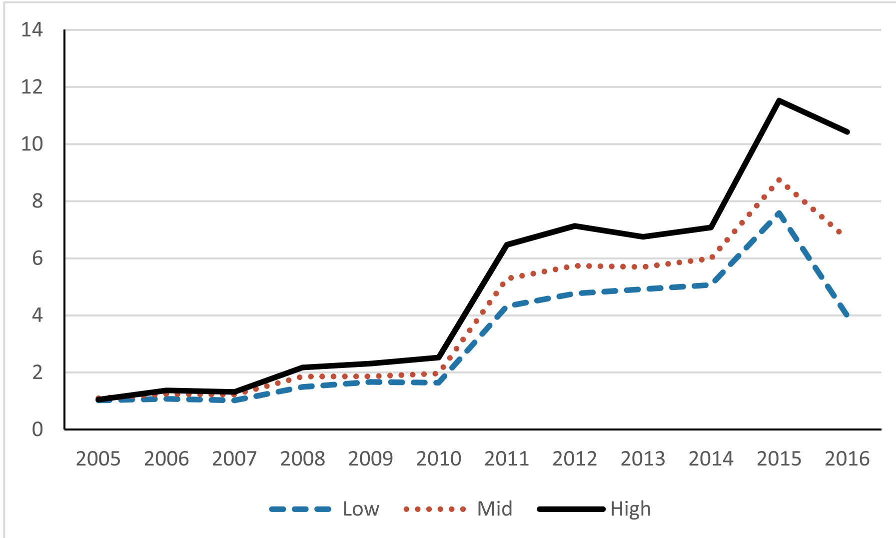

Fig. 3. The Average Gasoline Expenditure by Income Groups (2005–2014)- Million rials.

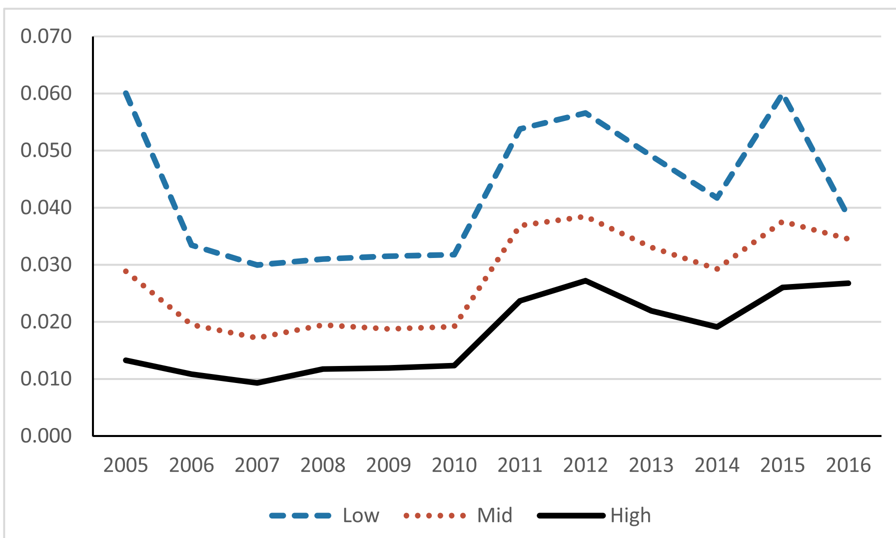

Fig. 4. The gasoline expenditure shares by income groups (2005–2014).

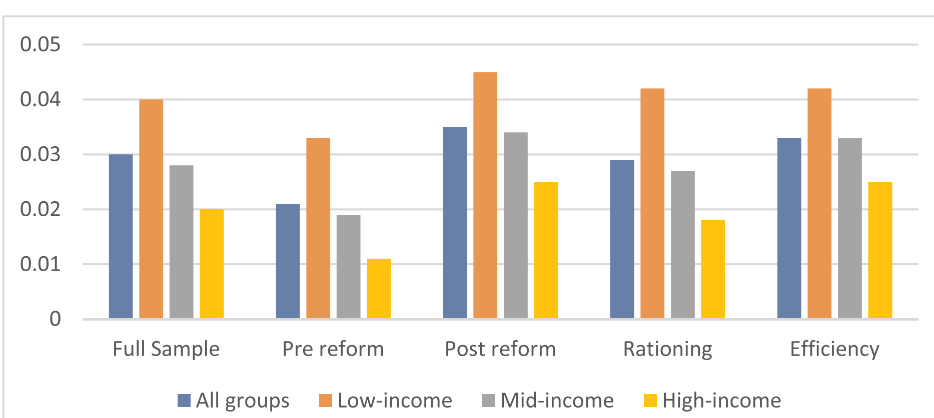

Fig. 5. Gasoline expenditure shares under different policy regimes.

Table 2
Summary statistics of the data (2005–2014).

Variables	Total Sample				Low Income				Mid-income				High-income			
	mean	std. dev	min	Max	mean	std. dev	min	max	mean	std. dev	min	max	mean	std. dev	min	max
Gasoline Price (rial/liter)	691.80	372.22	100	1250	622.14	339.27	100	1250	717.08	379.27	100	1250	716.16	381.51	100	1250
Food Price index	429.18	256.40	100	860.58	385.60	239.39	100	860.57	446.94	261.44	100	860.57	441.81	259.08	100	860.57
Other Goods Price index	309.57	167.27	100	725.53	268.07	145.62	100	715.93	319.93	169.22	100	723.33	330.47	175.37	100	725.53
Gasoline Expenditure Share	0.02	0.02	0.0004	0.20	0.04	0.02	0.00	0.19	0.02	0.02	0.002	0.18	0.01	0.01	0.00	0.13
Food Expenditure Share	0.25	0.10	0.002	0.60	0.30	0.10	0.02	0.59	0.26	0.10	0.003	0.59	0.20	0.09	0.00	0.59
Other Goods Expenditure Share	0.71	0.11	0.252	0.99	0.65	0.10	0.25	0.94	0.70	0.10	0.31	0.98	0.77	0.10	0.36	0.98
Total Expenditures (rial)	5.4E+7	4.2E+7	1.7E+5	1.5E+09	2.3E+7	8.3E+5	4.1E+5	4.8E+7	4.7E+7	1.4E+7	2.0E+7	8.9E+7	9.7E+7	5.1E+7	4.0E+7	1.5E+9
Consumer Price Index	357.32	197.17	100	739.8	323.93	182.46	100	739.86	371.55	202.01	100	739.86	366.15	199.17	100	739.86
No. of Children	2.032	1.30	0	14	1.89	1.29	0	11	2.09	1.30	0	14	2.10	1.29	0	12
Marriage	0.04	0.20	0	1	0.05	0.21	0	1	0.04	0.19	0	1	0.04	0.20	0	1
Literacy	0.07	0.26	0	1	0.111	0.31	0	1	0.07	0.25	0	1	0.05	0.22	0	1
Education Level	1.33	0.56	1	3	1.19	0.45	1	3	1.33	0.54	1	3	1.50	0.63	1	3
Employment	0.23	0.42	0	1	0.23	0.42	0	1	0.23	0.42	0	1	0.24	0.43	0	1
No. of observations		62519				21961				25611				14947		

Gasoline prices are the weighted average prices for the rationed and over-quota consumptions with weights being the expenditure shares on the ration and the over-ration quantities. Food and other goods price indexes are the weighted average prices using the expenditures shares as weights.
Source: Household Budget Survey and the authors' calculations. The dummy variables: Married = 0, unmarried = 1, (the head of household) literate = 0, illiterate = 1, (the head of household) education level: high school = 1, college = 2, university = 3, the head of household) employed = 0, unemployed = 1.

particularly the rationing policies have been in response to the tightening international sanctions, which restricted the oil exports, government revenues, and the gasoline imports. The imports policy has also been driven by the long support of the domestic car industry in the context of industrialization policy. To protect domestic production, the imports of foreign cars have been highly restricted and subject to extensive tariffs. However, due to inability of the domestic producers to meet the increasing demand, some of the restrictions on car imports are eased.

6. Results

Table A1 in appendix presents the estimation results for the entire sample period (2005–2016). Income has negative and significant effect and prices have positive and significant effects on the gasoline and food expenditure shares. The wealth effect is negative for gasoline, but positive for food. As for the household characteristics, higher number of children and marital status increase but education level and employment status decrease the expenditure shares for both gasoline and food. Literacy has negative impact on gasoline expenditure share but positive effect on food expenditure share. The trend coefficients show that gasoline share has risen whereas food share has declined over the sample period, implying that households are allocating more budget to driving relative to food as their income increases.

The price and income elasticities and the implied efficiency elasticities for gasoline are obtained using equations (3), (4) and (7) for different income groups. The results reported in Table 3 shows that the Marshallian uncompensated price elasticities are all negative, significant, and less than one and income elasticities are positive, significant, and less than one, suggesting that gasoline is a necessity and normal good for all households at different income groups.

According to equation (5), the uncompensated price elasticity, which represent the direct rebound effect, is divided into compensated price elasticity (−0.75) and income effect (−0.01), which indicates the income rebound effect. We also report the uncompensated and compensated cross-price elasticities for gasoline, food, and other goods. The uncompensated gasoline price elasticities of demand for food and other goods are positive and negative, respectively. This implies that gasoline and food are substitutes, but gasoline and other goods are complements. Specifically, a one percent decrease in gasoline price leads to lower demand for food by 0.75 percent and higher demand for other goods by 0.36 percent. The positive gasoline-food price elasticity suggests that the lower gasoline prices may encourage the purchase of gasoline and other goods at the expense of food.[8] The cross-price elasticities vary across the income groups. Specifically, the gasoline-food price elasticity is greater (0.90) in low-income households and smaller (0.70) in mid-income households, but the gasoline-other goods elasticity is greater in high-income households. The high-income households can afford to switch to larger and more expensive cars or to increase their recreational activities when gasoline prices are lower, without sacrificing much food.

Table 4 reports the elasticities across household characteristics. Overall, elasticities decrease with education level and are greater, by 6 percentage points, for households with married couples and those having children. Table 5 shows the elasticities vary across space and population size. Specifically, the elasticities decrease with population density as people in provinces with more disperse population have higher demand for traveling by passenger cars due to long distances and limited public transportation. Moreover, the large variation in provincial elasticities might also stem from the large gasoline price differentials across the border. As Ghoddusi et al. (2018) illustrate, provinces closer to the borders with large cross-border price differentials are

[8] The fuel-food relationship would be different if their prices were highly correlated. This is not the case in our data as the main food prices are heavily subsidized and fixed by government.

Table 3
Income, price, and efficiency elasticities for gasoline (2005–2016).

Income Group	Elasticities						
	Uncompensated Own Price	Income	Compensated Own Price	Uncompensated Cross Price (Gas-Food)	Uncompensated Cross Price (Gas-Others)	Compensated Cross Price (Gas-Food)	Compensated Cross Price (Gas-Others
Total	−0.76	0.38	−0.75	0.75	−0.36	0.94	−0.61
High-income	−0.80	0.42	−0.81	0.81	−0.65	1.01	−1.11
Mid-income	−0.78	0.40	−0.76	0.70	−0.38	0.87	−0.65
Low-income	−0.74	0.37	−0.70	0.90	−0.35	1.12	−0.60

All estimated coefficients are statistically significant at 1% level.

Table 4
Gasoline demand elasticities across household characteristics (2005–2016).

Characteristics	Elasticities	
	Price	Income
Illiterate	−0.79	0.57
Literate	−0.68	0.62
Education – some high school	−0.72	0.60
Education –University (Undergraduate)	−0.66	0.60
Education –University (Graduate)	−0.58	0.62
Married	−0.66	0.62
Single	−0.60	0.62
Children	−0.68	0.63
No Children	−0.62	0.61

All estimated coefficients are statistically significant at 1% level.

Table 5
Provincial gasoline demand elasticities (2005–2016).

	Elasticities	
	Price	Income
Geographical Size (m^2)		
Large[a]	0.65-	0.67
Medium	0.67-	0.58
Small	0.78-	0.55
Population Size[b]		
Large	−0.69	0.61
Medium	−0.72	0.60
Small	−0.69	0.62
Population Density (population/m^2)[c]		
Large	−0.61	0.59
Medium	−0.72	0.60
Small	−0.74	0.62
Cross-border Provinces[d]		
High Price Differentials	-0.80	0.59
Low Price Differentials	-0.65	0.64
Non-border Provinces	-0.63	0.61

All estimated coefficients are statistically significant at 1% level.
[a] Large = 64,000–181000, medium = 21,000–46,000 $m^{2,}$ small = 11,000–20,000 m^2.
[b] Large = >3 million, medium = 2–3 million, small= <2 million.
[c] Large=>78, Medium = 46–77, small=<45.
[d] Price differentials with Afghanistan, Pakistan, and Turkey are in the range of $0.50-$1.80 and with Turkmenistan, Azerbaijan, and Iraq in the range of $0.10-$20.

expected to have higher price elasticities because of smuggling. Cheap gasoline in provinces near the borders with significant price differentials across the borders provides an income opportunity through smuggling and, therefore, any changes in domestic gasoline prices would lead to stronger responses by locals than they would otherwise.[9] Our results show that the average price elasticity in three provinces in the neighbourhood of countries with large price differentials is higher than the elasticities in other provinces by about 40 percent (−0.80 vs −0.65). It is also interesting to note that average elasticity in the other near-the-border provinces with no significant cross-border price differentials is not different than the average elasticities in non-border provinces (−0.63 vs −0.65).

To examine the policy impacts on consumer responses, we estimate the elasticities for the periods associated with different policies. We first estimate the elasticities in two periods prior to the energy price reform program (2005–2010) and afterward (2011–2016). The program aimed at curbing the high growth of energy consumption and decreasing the fiscal pressure through removing energy subsidies. According to the reform plan, the energy prices increased dramatically[10] and all individuals received a $45 cash hand out per month as a compensation for the higher energy prices (Moshiri, 2015). Table 6 shows that the elasticities are small and not statistically significant in the pre-reform period but increased significantly after the reform. The response of the lower income households to the price reform is much stronger than that of the higher income households. Part of the pre-reform period (2008–2010) also coincides with the rationing period, which may corrupt our identification. As a remedy, we also estimate the model for the pre reform period prior to rationing policy, i.e., 2005–2007. The results reported in the second row under the pre reform section of Table 6 indicate some differences in the magnitudes of the elasticities, but like the first row they are all statistically not different from zero (except for the income elasticity for low-income group).[11]

Table 6 also shows that the elasticities are significantly lower across all income groups during the rationing period (2008–2014). Since part of rationing period (2010–2014) overlaps with the price reform policy period, we also estimate the elasticities excluding the overlapped period. The results indicate that the elasticities are still low but, in some cases, higher than those for the sample including the overlapped period. This implies that rationing has had stronger effects on elasticities than the price reform policy, particularly for the mid- and low-income households. The theory suggests that ratioing is not be binding if consumers can over ration, which means that the elasticities should be the same as if there is no rationing. The smaller elasticities under the rationing, however, imply that rationing may have an impact even if agents can go over ration. This might be explained by the behavioural factor through which consumers see the ration as a reference point and, therefore, are reluctant to go well beyond that.

The efficiency policy effect is analyzed by estimating the elasticities for the period 2013–2016, when imports restrictions on foreign cars are relaxed. The results reported in the last row of Table 6 show that

[9] For a literature on cross-border shopping and smuggling due to price differentials see Leal et al. (2010), and Antweiler and Gulati (2016).

[10] Gasoline prices rose by a factor of 4 for monthly ration of 60 L per passenger car and by 7 for the over-the-ration consumption (OSCP, 2012).

[11] As a caveat, we should note that although the estimation results with the excluded overlapped periods would better reflect the specific policy impacts, the time variation in prices might not be enough to capture the full effects.

Table 6
Elasticities under different policy regimes.

Policy	All		High-Income		Mid-Income		Low-Income	
Price Reform	Price	Income	Price	Income	Price	Income	Price	Income
Pre-reform								
(2005–2010)	−0.01	0.47	−0.23	0.70	−0.25	0.31	0.13	0.47
(2005–2007)	−0.07	0.06	−0.37	0.04	−0.06	0.02	−0.04	0.12[a]
Post-reform								
(2011–2016)	−0.56[a]	0.28[a]	−0.42[a]	0.26[a]	−0.53[a]	0.60[a]	−0.53[a]	0.70[a]
Rationing								
(2008–2014)	−0.10[a]	0.84[a]	−0.28[a]	0.92[a]	−0.16[a]	0.67[a]	−0.10[a]	0.64[a]
(2008–2010)	−0.37[a]	1.17[a]	−0.24[a]	1.11[a]	−0.24[a]	1.15[a]	−0.33[a]	1.13[a]
Efficiency								
(2013–2016)	−0.62[a]	0.33[a]	−0.65[a]	0.68[a]	−0.60[a]	0.65[a]	−0.62[a]	0.47[a]
(2014–2016)	−0.78[a]	0.80[a]	−0.74[a]	0.85[a]	−0.64[a]	0.70[a]	−0.78[a]	0.70[a]

[a] Represents statistical significance at 1 percent level.

elasticities increase in response to the policy across income groups. This may also reflect the rebound effect of high efficiency cars by 38 percent. The effect is higher in high-income households than the other income groups. Since part of the efficiency period, i.e. 2013, overlaps with the rationing policy period, we estimate the model excluding the overlapped period. The results show that the elasticities are even higher when rationing period is removed, particularly among the high- and low-income households.

We use equation (6) to estimate the welfare impacts of price changes and report the results in Fig. 6. The relative price changes of other goods due to the gasoline price changes are obtained from the macro econometrics (Noferesti and Jololi, 2013) and the input-output (Abbasinejad, 2007) models. As the figure shows, the welfare impacts of increasing gasoline prices are greater under the price reform policy. The welfare loss of increasing prices under the fuel-efficiency policy is lower by a factor of two, as the decreasing traveling costs partially offsets the impacts of the higher prices. Furthermore, the welfare impact of gasoline price changes is more sever in low-income households compared to the high-income households, mostly due to the high expenditure shares of gasoline and other goods, particularly food, in low-income households.[12]

6.1. Robustness checks

The reported estimation results are based on the virtual of weighted average gasoline prices. However, since the ration may not be sufficient for many consumers, their consumption decision might be based on the over ration prices. As a robustness check, we re-estimate the model using both ration and over-ration prices for the entire sample and the different income groups. The results reported in Table A2 in Appendix show that the elasticities are significantly smaller when ration prices are used and slightly greater in the case of the over-ration prices. However, the result that elasticities are larger for higher income groups remains the same.

We test for the endogeneity of the total expenditures using the Durban-Wu-Hausman (DWH) method. The test compares the estimated coefficients under the exogeneity and the endogeneity assumptions and has a χ^2 distribution under the null of exogenous variable. We obtain the DWH test statistics by comparing the results of the NLSURE and the 2SLS estimation models using the lags as instrumental variables. Alternatively, we apply a two-stage method by first estimating the total expenditures as a function of prices, wealth, and size of households and then using their predicted values in the AIDS model. The test results are mixed depending on the type of instrumental variables. Specifically, the null cannot be rejected when lags are applied as IVs ($\chi^2 = 3.84$) but rejected when other variables are used to estimate the total expenditures ($\chi^2 =$ -680.89). To check the robustness of our results reported in Section 4, we re-estimate the model using the 2SLS method and obtain the elasticities. The price elasticity is −0.87 and income elasticity 0.58, which are similar to those obtained in the original model.

7. Conclusion and policy implications

Thanks to high economic growth and urbanization in emerging and some developing countries, demand for urban transportation and therefore gasoline consumption has been increasing markedly in recent years. The generous energy subsidies in some oil-rich developing countries have also helped expand the passenger car transportation at rates faster than infrastructural development creasing new environmental, social, and fiscal challenges. To address the issues, some governments in developing world have adopted various price and non-price policies. In this study, we analyze the impacts of different policies on gasoline consumption using the household budget data in Iran. The country has faced a dramatic rise in demand for passenger cars and gasoline in recent years and adopted a variety of policies to stabilize the trend. The policies include subsidy removal, rationing, and easing imports restrictions on fuel-efficient cars. The rationing policy seems to have been more effective in slowing down the consumption growth in the short-run, mostly due to a reduction in smuggling to neighbouring countries. The policy, which was costly and prone to corruption, discontinued as the international sanctions on Iran was removed through the 5 + 1 agreement allowing for gasoline imports. The price reform policy has not had a meaningful effect on gasoline consumption, because the policy targeted the nominal price while real prices decreased over time. The efficiency policies have also helped control the growth of gasoline consumption, but changes in consumers behaviour in the form of driving longer distances (intensive margin) or purchasing larger cars with more recreational and luxury options (extensive margin) may have eroded some of the initial effects of the policies.

We aim to quantify the consumer responses to different policies using a system of expenditure share equations and the urban household budget data over the period 2005–2016. We also incorporate a variety of household characteristics in the model and estimate the heterogeneous elasticities and the rebound effects across income groups and provinces. The results for the entire sample show that on average price elasticity is −0.76, however, the effect varies across household characteristics. Specifically, elasticities increase with income and decrease with the education level. Moreover, the elasticities are higher among the households with married members and those who have children. The spatial analysis also indicate that the elasticities are greater in provinces with smaller population densities and those neighbouring the countries with large price differentials.

[12] Noferesti and Jololi (2013) estimate that a removal of subsidies will increase the overall price level by 7.4 percent and Abbasinejad (2007) shows that a 100 percent rise in gasoline price will increase the price level by 5.4 percent. We use both ratios but report the results based on the former study here. The relative changes among income groups are the same when using the ratios from the second study.

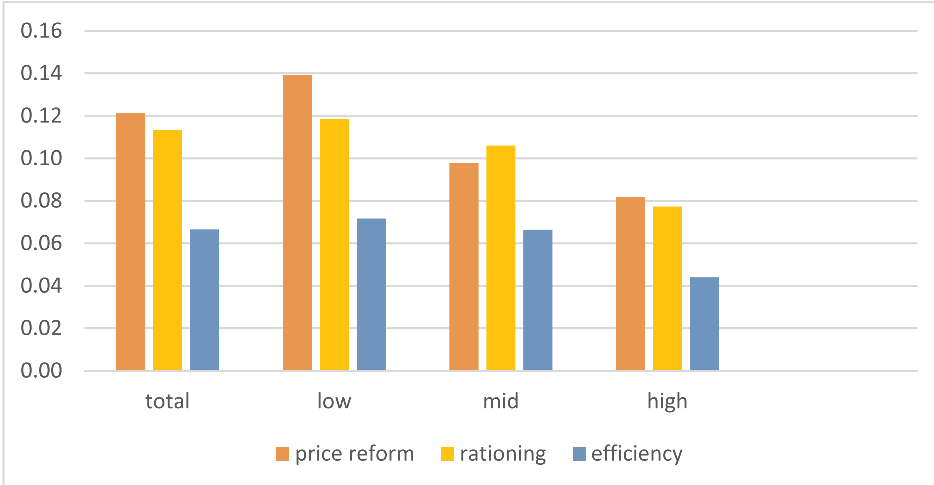

Fig. 6. The welfare effects of gasoline price changes.

Our estimated gasoline price elasticities are higher than those previously reported for Iran (Moshiri, 2015).[13] The differences can be explained by the fact that most studies have used the pre-reform data, particularly the early 2000s, when the gasoline prices were heavily subsidized making them the cheapest in the world. Under the low-price regime, any rise in gasoline prices is not expected to generate a significant change in consumption. However, after the 2010 energy price reform policy, according to which gasoline prices quadrupled, consumers responses to changes in prices have become meaningful. The estimated elasticities for sub-sample periods reflecting different policies also show that the price elasticities increased significantly after the energy price reform, decreased during the rationing period, and increased under the fuel-efficiency policy, implying the rebound effects.

Our results have important policy implications. The results show that higher gasoline prices will decrease demand and fuel efficiency leads to smaller than expected energy saving. Oil-rich developing countries, such as Iran, have kept their gasoline prices significantly lower than the border prices by allocating direct and indirect subsidies. Under the low-price regime, higher efficiency will not cause significant changes in intensive margin but may lead to changes in extensive margin in the form of increasing fuel consumption through adopting larger cars and additional luxury features associated with higher efficient cars. However, under the high-price regime, fuel efficiency becomes more important as increases the saving per distance traveled, encouraging rebound effect. This might have a misleading policy implication in that low gasoline prices are favorable because of smaller rebound effect. In other words, the fuel efficiency policy would be more effective under the low-price regime than the high-price regime. Nevertheless, if the objective is to decrease gasoline consumption for private passenger cars and reduce its adverse environmental and socio-economic effects, the low-gasoline prices will lead to an opposite outcome. In fact, given the low-efficiency car fleet in Iran, the authorities should not be much concerned about the high rebound effects when gasoline prices increase.

As our results indicate, the price elasticities are higher under the high-price regime and fuel efficiency policy will further reduce gasoline consumption, although not fully, contributing to better environmental quality and social welfare. Therefore, a policy mix of higher gasoline prices matching those in neighbouring countries and higher efficiency standards for domestically produced and imported cars will help achieve the objectives of the low carbon targets and less fiscal pressure. The current policy of uniform subsidies and gasoline prices across all provinces with various income levels, population densities, and geographical locations encourages consumption and is also regressive. A better policy would require gasoline prices to reflect the private and social costs and disincentivize smuggling by removing the cross-border price differentials. The proceeds from the removed subsidies on gasoline can be used to fund the public transport infrastructures and development projects or to compensate low-income households through the existing cash-payment or a new social security program.

[13] In a recent survey, Huntington et al. (2017) report a long-term gasoline price elasticity of −0.73 for Iran, which is higher than many countries in the region but consistent with our findings for the full sample.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.enpol.2019.111078.

References

Abbasinejad, H., 2007. The impacts of petroleum price changes on economic sectors using input-output tables. Econ. Res. (Pajouhesh-haie Eghtesadi) 38, 1–15.
Alves, Denisard, da Silveira Bueno, Rodrigo De Losso, 2003. Short-run, long-run and cross elasticities of gasoline demand in Brazil. Energy Econ. 25 (2), 191–199.
Antweiler, W., Gulati, S., 2016. Frugal Cars or Frugal Drivers? How Carbon and Fuel Taxes Influence the Choice and Use of Cars. "SSRN Working Paper 2778868.
Barla, P., Lamonde, B., Miranda-Moreno, L., Boucher, N., 2009. Traveled distance, stock and fuel efficiency of private vehicles in Canada: price elasticities and rebound effect. Transportation 36 (4), 389–402.
Sita, Ben, Bernard, Walid Marrouch, Abosedra, Salah, 2012. Short-run price and income elasticity of gasoline demand: evidence from Lebanon. Energy Policy 46, 109–115.
BP Statistical Review. BP Statistical Review of World Energy, 2017.
Brännlund, R., Ghalwash, T., Nordström, J., 2007. Increased energy efficiency and the rebound effect: effects on consumption and emissions. Energy Econ. 29 (1), 1–17.
Central Bank of Iran, Economic Time Series Database, https://tsd.cbi.ir/.
Chitnis, M., Sorrell, S., Druckman, A., Firth, S.K., Jackson, T., 2014. Who rebounds most? Estimating direct and indirect rebound effects for different UK socioeconomic groups. Ecol. Econ. 106 (0), 12–32.
Crotte, Amado, Noland, Robert, Graham, Daniel, 2010. An analysis of gasoline demand elasticities at the national and local levels in Mexico. Energy Policy 38 (8), 4445–4456.
Deaton, A., 1980. An Almost ideal demand system. Am. Econ. Rev. 70 (3), 312–326.
Dhar, T., Chavas, J.-P., Gould, B.W., 2003. An empirical asessment of endogneity issues in demand analysis for differentiated products. Am. J. Agric. Econ. 85 (3), 605–617.
Frondel, M., Peters, J., Vance, C., 2008. Identifying the rebound: further evidence for German household panel. Energy J. 29 (4), 145–163.
Ghoddusi, H., Rafizadeh, N., Rahmati, M.H., 2018. Price elasticity of gasoline smuggling: a semi-structural estimation approach. Energy Econ. 71, 171–185.
Gillingham, K., Rapson, D., Wagner, G., 2014. The Rebound Effect and Energy Efficiency Policy. Resources for Future (RFF) Discussion Paper 14-39. November.
Greene, D.L., 1992. Vehicle use and fuel economy: how big is the "rebound" effect? Energy J. 13, 117+.
Greene, D.L., Kahn, J.R., Gibson, R.C., 1999. Fuel economy rebound effect for U.S. Household vehicles. Energy J. 20 (3), 1–31.
Greening, L.A., Greene, D.L., Difiglio, C., 2000. Energy efficiency and consumption- the rebound effect- a survey. Energy Policy 28, 389–401.

Haughton, J., Sarkar, S., 1996. Gasoline tax as a corrective tax: estimates for the United States, 1970-1991. Energy J. 17 (2), 103–126.
Huntington, H.G., Barrios, J.J., Vipin, A., 2017. Review of Key International Demand Ealsticities for Mjaor Industrializing Economies, Working Paper Series. U.S. Energy Information Administration, Washington, DC, 20585.
Hymel, K.M., Small, K.A., Dender, K.V., 2010. Induced demand and rebound effects in road transport. Transp. Res. Part B Methodol. 44 (10), 1220–1241.
Ismaielnia, A., Ekhtiari, S., 2012. Rebound effect in car efficiency improvement on fuel consumption. Q. Energy Econ. Stud (Farsi) 9 (34), 185–213.
Iwayemi, Akin, Adenikinju, Adeola, Babatunde, Adetunji, 2010. Estimating petroleum products demand elasticities in Nigeria: a multivariate cointegration approach. Energy Econ. 32 (1), 73–85.
Jones, C.T., 1993. Another Look at U.S. Passenger Vehicle use and the Rebound Effect from Improved Fuel Efficiency. Energy Journal 14 (4), 99–110.
Khazzoom, J.D., 1989. Energy savings from more efrficient appliances: a rejonder. Energy J. 10 (2), 157–166.
Khoshkalam, M., 2014. Rebound effect in gasoline and gasoil consumption in transportation sector in Iran, a CGE approach. Iran. Res. Energy Econ. 3 (11), 131–158.
Lbanderia, X., Labeaga, J.M., Lopez-Otero, X., 2017. A meta-analysis on the price elasticity of energy demand. Energy Policy 102, 549–568.
Leal, A., Lopez-Laborda, J., Rodrigo, F., 2010. Cross-border shopping: a survey. Int. Adv. Econ. Res. 16 (2), 135–148.
Lin, C.Y., Zeng, J., 2013. The elasticity of demand for gasoline in China. Energy Policy 59 (C), 189–197.
Matos, F.J.F., Silva, F.J.F., 2011. The rebound effect on road freight transport: empirical evidence from Portugal. Energy Policy 39 (5), 2833–2841.
Moshiri, S., 2015. The effects of energy price reform on households consumption in Iran. Energy Policy 79, 177–188.
Moshiri, S., Aliyev, K., 2017. Rebound effect of efficiency improvement in passenger cars on gasoline consumption in Canada. Ecol. Econ. 131, 330–341.
Moshiri, S., Lechtenböhmer, S., 2015. Sustainable Energy Strategy for Iran. Wuppertal Institute for Climate, Environment, and Energy, Germany.
Noferesti, M., Jololi, M., 2013. The impacts of energy subsidiy removal on economic sectors using a macroeconometrics model. Econ. J. 1 (89), 81–105. Shahid Beheshti University.
Orasch, W., Wirl, F., 1997. Technological efficiency and the demand for energy (road transport). Energy Policy 25 (14–15), 1129–1136.
Organization for Support of Consumers and Producers (OSCP), 2012. Ministry of Industry, Mining, and Trade.
Sincular, T., 1988. Plan and market in China's agriculature commerce. J. Policital Econ. 96 (2), 283–307.
Small, K.A., Dender, K.V., 2007. Fuel efficiency and motor vehicle travel: the declining rebound effect. Energy J. 28 (1), 25–51.
Su, Q., 2011. Induced motor vehicle travel from improved fuel efficiency and road expansion. Energy Policy 39 (1), 7257–7264.
Wang, Z., Chern, W.S., 1992. Effects of rationing on the consumption behaviour of Chinese urban households during 1981-1987. J. Comp. Econ. 16, 1–26.
West, S.E., 2004. Distributional effects of alternative vehicle pollution control policies. J. Public Econ. 88 (3–4), 735–757.