Under the Tyrrani of A Policy

Evaluating the impact of subsidized exchange rate on the evolution of prices and its welfare consequences

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Abstract

Due to the economic shock following the United States withdrawal from the JCPOA, Iranian officials, to maintain the welfare situation of households, implemented a policy in which basic and essential commodities were subsidized by the public dollar, which was cheaper than the market dollar. Investigating the impact of this policy on the evolution of prices using the instrumented differences-in-differences approach, we see a 105% increase in price indexes in 12 months and a 52% increase in 6 months. Examining this policy's welfare consequences via a static representative agent model, we find a welfare loss amounting to 4 Kg drop in consumption.

1 Introduction

After President Donald J. Trump got out of the JCPOA, Iran experienced various types of uncertainty and shocks that affected her economy. The shock that affected the most was the exchange rate shock. With this shock, the rial lost its value against the US dollar, and Iranian officials couldn't maintain its value since they could not receive the income from selling their oil. More strikingly, they could not sell oil in the market after a while. This led to high inflation due to an increase in the price of imported goods and services since Iran's economy also depends on the revenue from exporting oil.

The officials, meanwhile, handling the pressure of such a shock on the welfare of households, decided to implement a policy in which primary and essential commodities were subsidized by the public dollar, which was cheaper than the market dollar. This policy was implemented in Farvardin 7th 1397 and lasted for many commodities almost for one year.

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There are many thoughts on the effect of this policy and its efficiency, which we are going to investigate. Using data from the Central Bank of Iran and the Iran Statistic Centre, we used Instrumented Differences-in-Differences to evaluate the effect of this policy on the evolution of prices. We used the difference between the market dollar and subsidized dollar as IV for the interaction term of the DiD. We find a 105% increase in price indexes in 12 months and 52% increase in 6 months. By welfare analysis, we develop a static representative agent model and find a 4 Kg drop in consumption as the social welfare loss.

The report proceeds as follows: section 2 describes the datasets we used for this project, in section 3, we are going to discuss instrumented DiD in this context, section 4 evaluates the welfare consequences of such a policy, and finally section 5 presents concluding remarks.

2 Data

In this project, we use the following datasets:

1. Consumer Price Index, administered by Central Bank of Iran from 1391/01 to 1399/11.
2. Exchange rates (Market, Subsidized, and Nimaee), reported by the Central Bank of Iran from 1391/01 to 1399/11.
3. Essential and basic commodity lists, $1397 - 1399$, Ministry of Industry, Mine and Trade, and the presidential office.
4. Iran Household Income and Expenditure Survey gathered by Statistical Centre of Iran for years 1396 and 1397.

Since the results rely heavily on the sample we use in this project, and some commodities are excluded from the list of subsidized commodities a year after the policy implementation, we use only commodities where we could find the specific date of their exclusion. Therefore, we use only commodities which we could see the particular date of their exclusion. Some of these commodities were subsidized by public exchange rates (treatments), and some were not (controls). These commodities have shown in table B.1. Some of these goods are substitutes, and some are irrelevant. We handle this problem in the next section.

3 Empirical Framework

In the first part of the analysis, we are trying to see the changes in the price of treatment goods relative to that of control goods. Since the treatment of subsidizing goods is quite exogenous, specifically when the rate of subsidization is exogenous, by the motivation of parallel trends of goods CPI, we will implement a differences-in-differences approach. By the way, because the substitution effect exists for commodities in our sample, we use an IV variable to see the policy's impact through the reason for

implementing such a policy, which is exchange rate shock. Thus the substitution effect of this policy has been considered through the policy and not other channels.

3.1 DiD

Seeing the CPI trend of goods before and after the implementation policy, we can see quite a good parallel trend between control and treatment group commodities (figure C.1). Besides the exogeneity of the policy, especially the amount of subsidy, we try the DiD approach. In the figure C.1, you can find parallel trends for both substitute and irrelevant commodities. As you can see, parallel trends are not very precise, and in some cases, they may violate parallel trends, but they are good enough for our purpose.

There are two vertical lines in the graphs; the green vertical line indicates the time of announcing the policy to the public and assigning the public dollar to the commodities, and the gray one shows the time when Central Banks had to fix the public dollar for treated commodities. The history behind the gray line comes from the fact that the president of the Central Bank of Iran, after announcing the policy, did not fix the subsidized exchange rate and tried to increase it smoothly, but in the Khordad 1397, due to president Rouhani's order he had to fix it on 42000 rials/US dollar.

The specification we use is as follows:

$$\log(\text{Index}_{it}) = \alpha_i + \gamma_t + \beta D_{it} + \varepsilon_{it}, \tag{1}$$

where Index_{it} is the price index of commodity i in time t. α_i is the commodity fixed effect, γ_t is the time fixed effect, and D_{it} equals 1 for subsidized commodity i in time t and zero otherwise. The coefficient of interest is β.

We run this regression in 2 symmetric periods, 12 months, and 6 months. Therefore we evaluate the effect of the policy in the period of 1396/01 - 1397/12.

3.2 Instrumented DiD

There are some reasons we might not have confidence in our DiD results. First, we do not have an equivalent dataset from the demand side; second, there is a substitution effect in the impact we are estimating, and this effect is not totally due to the policy and other channels, but the policy channel may contribute to this effect. Since there is no grown literature on instrumented DiD, we got help from Hudson et al. (2017) and de Chaisemartin (2010)[1].

We use the difference between the market and subsidized dollar as IV for the interaction term. The most important reason we use this IV is for its exclusion restriction. We argue that the reason for the

[1] You can find these notes from here.

policy is the gap between the market dollar, and the dollar held the welfare better than the market dollar. So, this policy must affect demands through this gap, and any differences in demands from the substitution effect should result from this policy. The other substitution effects of other channels are excluded from this instrumented DiD estimator. We cannot control substitute commodities since that would be a bad control. Monotonicity, exogeneity, and relevance are quite straightforward assumptions for our IV.

You can see trends of Market Dollar (MD), Nimaee Dollar (ND) and, subsidized dollar (ND42) in figure C.2. As you can see the trend of subsidized is fixed on 42000 rials.

The result of Instrumented DiD is in tables B.2 and B.3. As you can see, the IV estimator is greater than the OLS estimator of the interaction term. This may occur because the substitution effect through the policy has more effect, and policymakers should have considered this. You can see such increases in the parallel trends, in which, in some of them, the price index of treatments eventually goes above the price index of control commodities.

4 Welfare Analysis

In order to assess the efficiency cost of the discretionary exchange rate policy, drawing on Chetty (2008), we develop a static representative agent model and derive a formula that relates the subsidy rate to the social welfare.

The firm's problem. A representative price-taker firm produces $N-1$ consumption goods, $x_1, \ldots, x_{N-1}$, receiving a subsidy on x_1. It solves

$$\max_{\{x_n\}_{n=1}^{N-1}} \quad \{p_1 x_1 + \cdots + p_{N-1} x_{N-1} - c(x_1, \ldots, x_{N-1}) + S(x_1)\},$$

where $p_1, \ldots, p_{N-1}$ are competitive prices, $c(\bullet)$ is the cost function and $S(x_1)$ denotes the subsidy received.

The household's problem. A representative household receives utility from consumption and leisure, which serves as the numeraire in the model. It solves

$$\begin{aligned} &\max_{\{x_n\}_{n=1}^{N}} \{u(x_1, \ldots, x_{N-1}) + x_N\} \\ &\text{s.t.} \quad p_1 x_1 + \cdots + p_{N-1} x_{N-1} + x_N + T(s) = \omega, \end{aligned} \tag{BC}$$

where $u(\bullet)$ is the utility function, x_N the numeraire, $T(s)$ a tax levied on the household to fund the firm's subsidy of rate s, and ω the household endowment.

In the equilibrium the good markets clear and the government budget balances, which closes the model.

We define the social welfare as sum of private benefits and the subsidy program's cost:

$$
\begin{aligned}
&W(x_1, \ldots, x_N; S, T) = \\
&\left[\max_{\{x_n\}_{n=1}^{N-1}} \{p_1 x_1 + \cdots + p_{N-1} x_{N-1} - c(x_1, \ldots, x_{N-1}) + S(x_1)\} \right] \\
&+ \left[\max_{\{x_n\}_{n=1}^{N}} \{u(x_1, \ldots, x_N) + x_N + \lambda[\omega - T(s) - p_1 x_1 - \cdots - x_N]\} \right] \\
&+ [-S(x_1)]
\end{aligned}
$$

Assuming $S(x_1) = sx_1$ and $T(s) = sx_1$, the Envelop Theorem implies

$$
\begin{aligned}
\frac{\mathrm{d}}{\mathrm{d}s} W(\mathbf{x}; T, S) &= \sum_{n=1}^{N} \frac{\partial W}{\partial x_n} \frac{\mathrm{d}x_n}{\mathrm{d}s} + \frac{\partial W}{\partial T} \frac{\mathrm{d}T}{\mathrm{d}s} + \frac{\partial W}{\partial S} \frac{\mathrm{d}S}{\mathrm{d}s} \\
&= -2\lambda x_1(s) - (1 + \lambda)\, s\, \frac{\mathrm{d}}{\mathrm{d}s} x_1(s).
\end{aligned}
$$

Using the first-order condition of the household problem with respect to x_1 or x_N, one can show that $\lambda = 1$. Then the derivative of social welfare W with respect to the subsidy rate s is

$$
\frac{\mathrm{d}}{\mathrm{d}s} W(\mathbf{x}; T, S) = -2 \left[x_1(s) + s x_1'(s) \right] \tag{2}
$$

The differentiating steps of W and calculation of λ appear in Appendix A.

In order to quantify welfare cost of the policy, we integrate out both sides of (2) over $[s_1, s_2]$, the observed support of subsidy rate, which leads to

$$
W(s_2) - W(s_1) = -2 \left[s_2 x_1(s_2) - s_1 x_1(s_1) \right]. \tag{3}
$$

The relative calculations are included in the appendix A. A major flaw in our integration exercise is that we substitute $\frac{\partial}{\partial s} x_1(s)$ for $\frac{\mathrm{d}}{\mathrm{d}s} x_1(s)$, which means the cross-price elasticities of the subsidized good are ignored:

$$
\frac{\partial x_1}{\partial s} \neq \frac{\mathrm{d}x_1}{\mathrm{d}s} = \frac{\partial x_1}{\partial p_1} \frac{\mathrm{d}p_1}{\mathrm{d}s} + \cdots + \frac{\partial x_1}{\partial p_{N-1}} \frac{\mathrm{d}p_{N-1}}{\mathrm{d}s}
$$

We let s_1 be 1, which makes sense because it represents the baseline subsidy rate. We set s_2 relative to the proportion of the discretionary exchange rate and the prevailing one in the year of implementing the policy; the smaller proportion, the greater s_2. In 1397 the average Dollar exchange rate was 102000

rials and the discretionary exchange rate was 42000 rials, so based on the aforementioned logic

$$1 - r = \frac{\text{discretionary exchange rate}}{\text{prevailing exchange rate}} = \frac{4.2}{10.2} \Rightarrow r = 0.6$$

$$s_2 = s_1 + r = 1 + 0.6 = 1.6.$$

We substitute the average households' demands of good x_1 in 1396 for $x_1(s_1)$ and that in 1397 for $x_1(s_2)$ in equation (3), using Iran Household Income and Expenditure Survey (HIES) data. Then we calculate the welfare cost of the policy independently for 8 consumption goods. The results are reported in Table B.4. We observe that the policy caused an average of 4 Kg welfare loss.

We also conduct welfare analysis for counterfactual subsidy rates. Figure C.3 depicts the average welfare cost of the 8 consumption goods as a function of the the proportion of the discretionary exchange rate and the prevailing one. Our model implies that welfare loss monotonically approaches zero as the discretionary exchange rate approaches the market one.

5 Conclusion

In this study, first, we examined the impact of a subsidized exchange rate policy on the evolution of prices in Iran 1397. Using an instrumented DiD design, we found that this policy increased treated commodities' prices by 105% and 52% relative to control ones, 12 and 6 months following its introduction, respectively. Second, we address the welfare effects of this policy. Our static model with representative agents implied that the policy decreased the social welfare, on average, an amount equal to 4 Kg consumption good. This negative effect increased when we fed the model with counterfactual, more discretionary exchange rate polices.

There are some caveats that apply to our results. First, we neglect dynamic heterogeneous treatment effects of the subsidized exchange rate policy in the empirical framework. We leave taking account of these effects for the future works. Second, in our model, we assume price-taker firms, which is a strong assumption, because discretionary policies potentially drive the market from a perfectly competitive one and give rise to market power. Third, we derive the welfare change formula ignoring cross-price elastisities of the treated goods. Obtaining formulas that relies on just own-price elasticity or designing identification strategies for measuring cross-price elasticities are a worthwhile line of future research.

Appendix

A calculations

Social Welfare Derivative.

$$\begin{aligned}\frac{\mathrm{d}}{\mathrm{d}s}W(\mathbf{x};T,S) &= \underbrace{\sum_{n=1}^{N}\frac{\partial W}{\partial x_n}\frac{\mathrm{d}x_n}{\mathrm{d}s}}_{A} + \underbrace{\frac{\partial W}{\partial T}\frac{\mathrm{d}T}{\mathrm{d}s}}_{B} + \underbrace{\frac{\partial W}{\partial S}\frac{\mathrm{d}S}{\mathrm{d}s}}_{C} \\ &= -2\lambda x_1(s) - (1+\lambda)\, s\, x_1'(s)\end{aligned}$$

Assuming $S(x_1) = sx_1$ and $T(s) = sx_1$,

- $A = -s\frac{\mathrm{d}x_1}{\mathrm{d}s}$ (Envelope Theorem)
- $B = -\lambda \times (x_1 + s\frac{\mathrm{d}x_1}{\mathrm{d}s})$
- $C = +x_1 + \frac{\mathrm{d}x_1}{\mathrm{d}s} - \lambda x_1 - x_1 - \frac{\mathrm{d}x_1}{\mathrm{d}s}$

Calculation of λ. Using FOC of household problem with respect to x_N,

$$\begin{aligned}&\frac{\partial L}{\partial x_N} = \frac{\partial u}{\partial x_N} + \lambda\frac{\partial \mathrm{BC}}{\partial x_N} = 0 \\ &\Rightarrow 1 + \lambda \times -1 = 0 && \text{(Quasi-linearity in the numeraire)} \\ &\Rightarrow \lambda = 1\end{aligned}$$

or with respect to x_1,

$$\begin{aligned}&\frac{\partial L}{\partial x_1} = \frac{\partial u}{\partial x_1} + \lambda\frac{\partial \mathrm{BC}}{\partial x_1} = 0 \\ &\Rightarrow (p_1 + s) + \lambda \times (-p_1 - s) = 0 \\ &\Rightarrow \lambda = 1\end{aligned}$$

Integrating out equation (2)

$$\frac{\mathrm{d}}{\mathrm{d}s}W(\mathbf{x};T,S) = -2\left[x_1(s) + sx_1'(s)\right]$$

$$\int_{s_1}^{s_2}\mathrm{d}W(s) = -2\left[\int_{s_1}^{s_2}x_1(s)\mathrm{d}s + \underbrace{\int_{s_1}^{s_2}sx_1'(s)\mathrm{d}s}_{I}\right] \tag{4}$$

$$I = sx_1(s) - \int_{s_1}^{s_2} x_1(s)\mathrm{d}s \quad \text{(Integration by part)} \tag{5}$$

Substituting (5) into (4) yields:

$$W(s_2) - W(s_1) = -2\left[s_2x_1(s_2) - s_1x_1(s_1)\right]$$

B Tables

Table B.1: Treatment and Control groups.

Treatment	Control
Substitutes	
Oil	Home made Oil
Red Beans	Pinto Beans
Chicken	Tunna
Foreign Rice	Domestic Rice
Meat	Processed Meat(Kalbas)
Butter	Cheese
Irrelevant	
Sugar	Salt
Newspapers	Books & Notebooks
Imported Tea	Soda
Wheel Pad	Break Pad
Medicine	Medicare Tools

Table B.2: First stage and OLS/2SLS results for all commodities.

	(1) 12 Months First stage	(2) 12 Months OLS	(3) 12 Months 2SLS	(4) 6 Months First stage	(5) 6 Months OLS	(6) 6 Months 2SLS
MN42	0.00000476***			0.00000619***		
	(0.00000116)			(0.00000151)		
D		0.307***	1.053***		0.121***	0.522***
		(0.0429)	(0.249)		(0.0239)	(0.132)
_cons	0.0695***	4.830***	4.661***	0.0958***	4.800***	4.713***
	(0.0169)	(0.0261)	(0.0164)	(0.0233)	(0.0224)	(0.0191)
N	575	575	575	276	276	276
chi2	16.89	51.27	17.88	16.86	25.37	15.65

Standard-errors are robust.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B.3: First stage and OLS/2SLS results for substitute commodities.

	(1) 12 Months First stage	(2) 12 Months OLS	(3) 12 Months 2SLS	(4) 6 Months First stage	(5) 6 Months OLS	(6) 6 Months 2SLS
MN42	0.00000456**			0.00000593**		
	(0.00000163)			(0.00000212)		
D		0.196***	0.937**		0.0700***	0.427*
		(0.0276)	(0.353)		(0.0111)	(0.176)
_cons	0.0666**	4.844***	4.684***	0.0918**	4.808***	4.734***
	(0.0238)	(0.0327)	(0.0186)	(0.0329)	(0.0253)	(0.0203)
N	300	300	300	144	144	144
chi2	7.831	50.21	7.028	7.802	39.85	5.897

Standard-errors are robust.

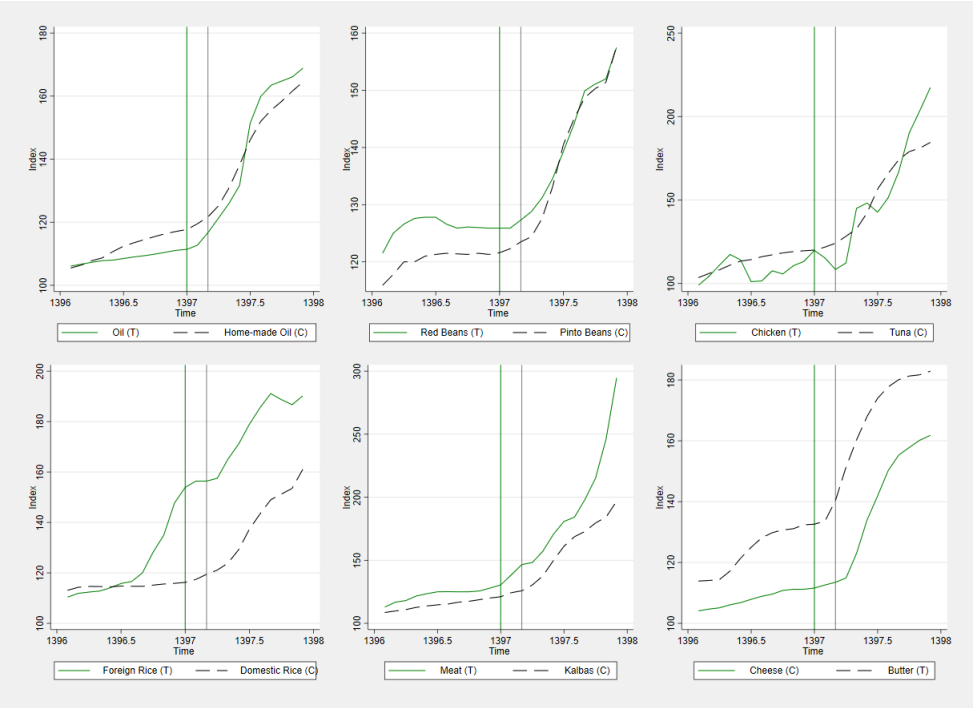
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B.4: Consumption and welfare change due to the policy

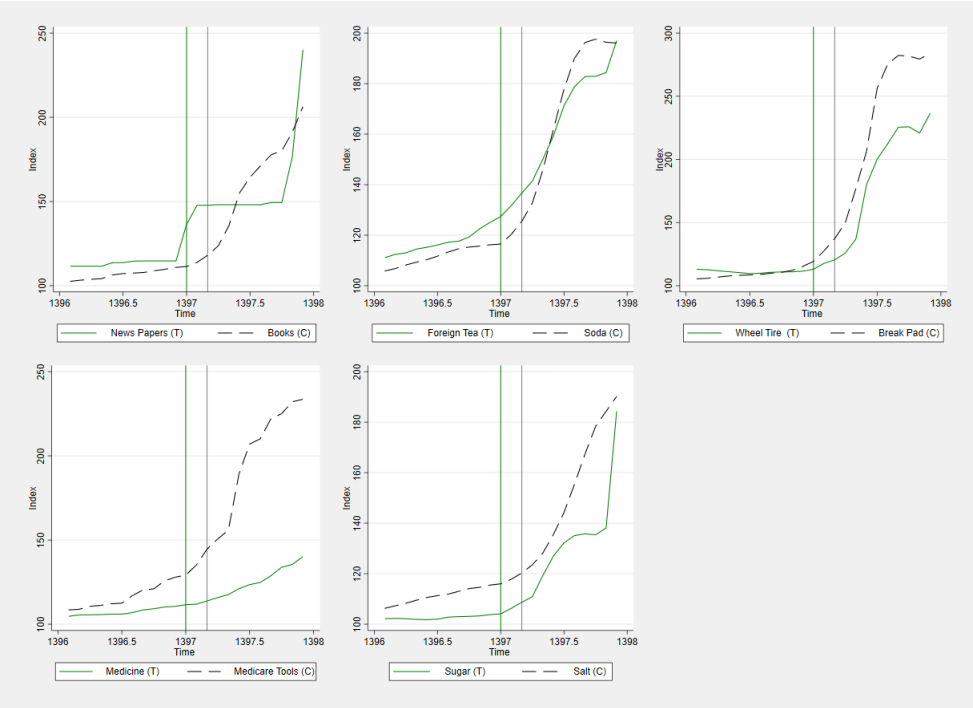
good_name	c_96	c_97	c_change	welfare_cost
Butter	491	497	6	-608.4
Chicken	5850	5685	-165	-6492
Imported rice	11513	11274	-239	-13050.8
Imported tea	590	572	-18	-650.4
Meat	2015	1965	-50	-2258
Red bean	1228	1239	11	-1508.8
Sugar	2440	2358	-82	-2665.6
vegetble oil	5147	4940	-207	-5514

Note: This table reports the welfare cost of discretionary exchange rate policy independently for 8 consumption goods. The second and third columns show the average households' demands for the good in 1396 and 1397, respectably. The forth column the change in average consumption of these goods. The rightmost column present the welfare cost calculated based on equation (3). All quantities are reported in gram.

C Figures



(a) Substitute Commodities.



(b) Irrelevant Commodities.

Figure C.1: Parallel trends for treatment and control commodities.

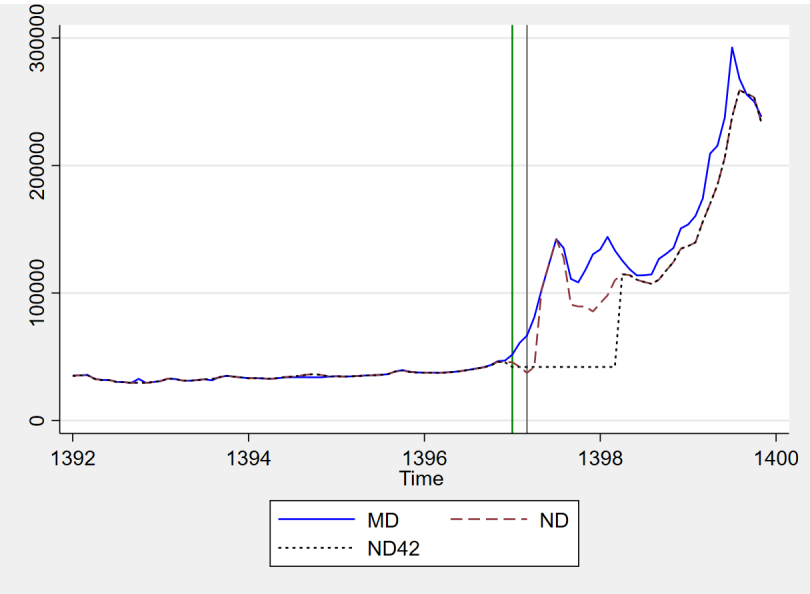


Figure C.2: Dollars price in time.

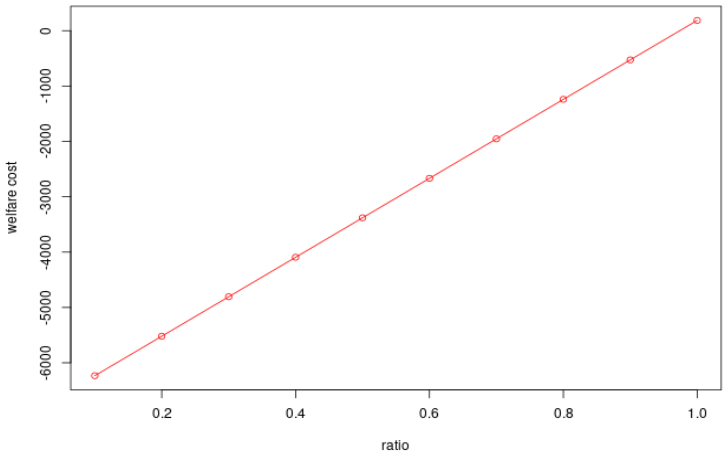


Figure C.3: Average welfare cost by $\frac{\text{discretionary}}{\text{market}}$ ratio

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