فصل‌نامه‌ی مطالعات اقتصاد انرژی/ سال هفتم / شماره‌ی ۲۶/ پاییز ۱۳۸۹/ صفحات ۱۳۰- ۱۰۵

تجزیه‌ی شدت انرژی و بررسی عوامل مؤثر بر آن در اقتصاد ایران

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چکیده

با توجه به ضرورت صرفه جویی در مصرف انرژی در ایران، شناسایی عوامل موثر بـر شـدت انرژی در اقتصاد ایران ضروری به نظر می رسد. هدف اصلی این مطالعه شناسایی عوامل کلیدی مؤثر بر تغییرات شدت انرژی در ایران و در بـازه زمـانی ۱۳۸۵-۱۳۴۷ مـی‌باشـد. بـه‌کـارگیری متدلوژی تجزیه، امکان تحلیل دقیق‌تر روند شدت انرژی در گذشته و پیش‌بینی آن در آینده را برای کاربردهای سیاستی فراهم می‌نماید. بهره‌وری انرژی یکی از عوامل تعیین‌کننـده‌ی شـدت انرژی می‌باشد اما علاوه بر بهره‌وری انرژی، ترکیب فعالیت‌های اقتصادی نیـز در تعیـین شـدت استفاده از انرژی نقش به‌سزایی دارد. با افزایش فعالیت‌های اقتصادی انرژی‌بر، شدت انرژی کـل نیز افزایش می‌یابد. هدف این مطالعه تجزیه شدت انرژی در ایران به دو عامل کلیدی مـؤثر بـر تغییر در شدت انرژی یعنی افزایش بهره‌وری و تغییر در فعالیت‌های اقتصادی می باشـد. نتـایج این تجزیه به روش شاخص ایده‌آل فیشر نشان می‌دهد که افزایش شدت انرژی در کشور در اثر تغییر ساختار فعالیت‌های اقتصادی و نیز کاهش بهره‌وری در بهره‌گیـری از انـرژی بـوده اسـت. هم‌چنین براساس نتایج به‌دست آمده، یکی از عوامل بسیار تأثیرگذار بـر شـدت انـرژی، قیمـت انرژی می‌باشد. بطوری که حساسیت شدت انرژی نسبت به قیمت انرژی بسیار بالا می باشد.

طبقه بندی JEL : C43; C50; C65;

کلیدواژه: شدت انرژی، بهره‌وری انرژی، ساختار فعالیت‌های اقتصادی، متدولوژی تجزیه

۱- مقدمه

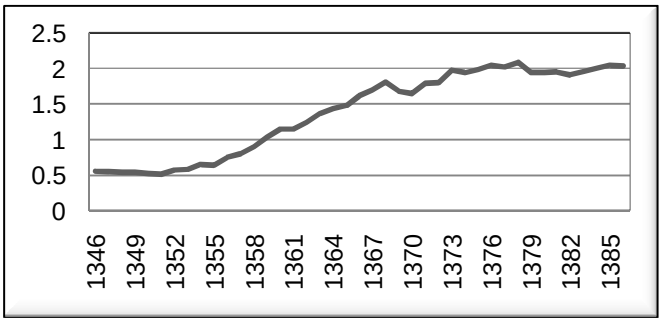
s , 8 ?a4/e O M 3 3 G 3 X * + 7 . Q y +3 j
3 ' F + s \:+ K __Q" " ?GDP s u \" 1
' L T s , 8 3 u \" H"G" $v . , 7 O cl
G " $ s , 8 &T ` P:B" O3 T Ol G-
@#@" DO ' W" s ,8 &T 2 K K,##@N
& * ? s u\" 3K . ‡ _ s ,8 \:+ :M 2
,8 H" , P@ G" $ 3 ?s ,8 &T ? p 1$ D O
, #@" , p ,W \:+ OU N' 3 3K . % &' 7#Ns
7 2 #8 `P:B" K3 7 s ,8 % &' %O @ D." G" $:
U N' , 3 O K,8 u \" s %O @ T#" s3K . % &' @
0 @ ? U N' ?"8 7" =N#- gl!"; K~ 3 ^%B Y \:+
O U N' * 2 s \:+ OU N' ; \:+ OU N'
{ " 3 K . G " $:' F S ‡W$ s u \" 3, \:+
2
:" FDC[% &' p a * ; C@ s ,8 , 3 7O p
? :" % & ' , 3 :#@ L F U3 2 72 K M OD
s , 8 7 " 2 7C &' , 3 3,8 7" H"G" $ 7 2 #8
?K s 3K . %O @ 78 % &' ,#@@ T n2
3, s OU N' s \:+ O U N' 7# &F K,#O C
7 C &' ,3 T#" \:+ OU N' :M 2 p 1$ 3 2 K
H " , P@ O3 7 2 #8 NU R" 7P-2u,K8 s ,8
,8 7" a6</ba6>) 7 " K 3 s ,8
7 T NU R" 3 s , 8 &T ` P:B" O3 , : S#"
OK K X: 2 ?% B jk 2 ? 87" 3 " 63(O%B "
, 8 3 K, 8 :M y h " 7 T G PQ \:+ `P:B" O%B

1 Gross Domestic Production

!"#

(") & ! "# $%

1+ , $ - ./0 %$!*%

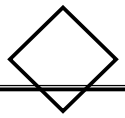


7 " 3) "6 " 5 $ 23"/0 2+) !/4- $%
8 ; $% 2 8" 3"< : 9 1) % 6 8
%1 2 $ 20$" 2> % = $%

! "#

%$% 2 3%$ % % 0 2?>)5 $; %"?)* 8
" B % 2/) $" C3 2 "4D C 7 " " "6 ; @*A " 7 " '
" 5 $!/ 4- $% 1 % " 5 $ ($' F +E 7 "
I $ JD"K 1$% $ 23"/0 8$ = 3) $% $ G H$")
m $% H L ./0 ="D '$ F $% 2+ L !* M +
D " 2+ L : 9 1 " P11 8" ' ;$ "F '! = " ON>)
%"?) * %$ " %/ 2 , ; '23 6 D " ")*
Q 2 2+ ; 8$ =
t E"* $% $ F $% H L Q1t

1- Arithmetic Mean Divisia.
2- Fisher Ideal Index.



t i $E_{i,t}$

t Y_t

t i $Y_{i,t}$

$Y_{i,t}/Y_t$! t i $S_{i,t}$

E_t/Y_t ! t " I_t

$E_{i,t}/Y_{i,t}$! t i " $I_{i,t}$

3 2 (1 ,- ./ (0 +,) * $S_{i,t}$ '(#$%&

#8)9) 8* t 8 i 567 4$I_{i,t}$ '(

#848 8 " 2 $ 7 :0) +7

#8(/ D 8E4 #8B 48 m@, " 2 ;<= > ? " >

-

I_t $S_{i,t}I_{i,t}$ @A

i

8 " 8 8 (1 8,- ./ 2F (0 # #(G " 4H$ +

8 ' T) I_T #4J> I " #I) +I 3 2 ,

) * $ K #) 2 ' H$4+

D_{tot} I_T/I ML

I_{tot} I_T I MN

C #8B #8 #8= 8 4#8 2 #(0 + 2 O #$%& +7 4L K

-) 2

D_{tot} I_T/I $D_{str}D_{int}$ @P

8 " 8 8 ' (0 " ' R # 4 D_{int} D_{str} # Q #

S 8 ' H8$ 28 8 28.<= #8$%&N K 3, 2) * , $

8 68* A 8 " 8 ' (0 " ' @T / U%= % 2FO J

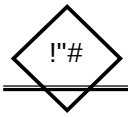
, V ;<= > ? " > # U%= H$ K H$ # " HJ$ 4-

I_{tot} I_T I I_{str} I_{int} @V

! " $Y_{i,t}/E_{i,t}$

2- Multiplicative Decomposition.

3- Additive Decomposition.



" 8 ' 48 " " ' R # 4 I_{int} I_{str} 4 I_{tot} # Q #
) 828 T / ,K 3+, 2) * , " ' (0
" 8> H8$ 3 8 8 #8 %8 -.+8> 8 " ' #$%&
#8$%&8 8Q #8 84 28 XD= @4 # . E_t $Y_i S_{i,t} I_{i,t}$
68 H$ 8 28.<= K D_{tot} E_T/E 8 D2 0 # $ / 42 O
" 8Y7 8 4+ 8+28< 8 ' 28F J X4 E_{tot} E_T E 2 $ Y
S^_B8> #8 8 28 WP]8 Y_t 8 8 Z # [% \$
3 #(0 + Z) +7 # 4#$%&

`8$ Z # - (1 a -< 1 b c :0 + <, 4 b c :0
2 ? 4 , 2 '( )9 # ' = # 4 +2 : * R H$ # '(
@8 #8 e 8=3 2 #\ - Z 4#$ d a , '($ a #
- , 0 4 R

D_{str} $S_{i,t} I_{i,} \Big/ S_{i,} I_{i,}$ @a

D_{int} $S_{i,} I_{i,T} \Big/ S_{i,} I_{i,}$ @a

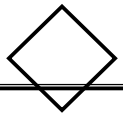
D_{rsd} $D_{tot} / D_{str} D_{int}$ @

i O # , 2) * D_{tot} " ' 2* 4 A D_{rsd} @ < 1 U%= " Y7
$ @Q H(/ D E 2.<= K 3 *

I_{str} $S_{i,T} I_{i,}$ $S_{i,} I_{i,}$ @

I_{int} $S_{i,} I_{i,T}$ $S_{i,} I_{i,}$ @

I_{rsd} I_{tot} I_{str} I_{int}



ACmmd 86<, c 8/ 8+@ 8aal 280 428.<#$%&E+ #
8Ga # +2+ #Y I > " > # " ' AAmmdb 6 D
2 > ? $] I A c .

$$I_{str}/I = \sum_i S_{i,T} I_{i,} - \sum_i S_{i,} I_{i,} - D_{str}$$ Arm@

$$I_{int}/I = \sum_i S_{i,} I_{i,T} - \sum_i S_{i,} I_{i,} - D_{int}$$ AC@

$$I_{rsd}/I = I_{tot}/I - I_{str}/I - I_{int}/I$$ AR@

) 828 4t T 09 (t=0) #$d , ' T /] H +I ,
8$ " > # # d :0 ga f a] o 3 9 - # # d :0
+, 0

$$P_{str} = \sum_i S_{i,T} I_{i,T} / \sum_i S_{i,} I_{i,T}$$ Af b@

$$P_{int} = \sum_i S_{i,T} I_{i,T} / \sum_i S_{i,T} I_{i,}$$ (gb@

p 2<($ \ 2 G? H \ :0 K MR@
28/ . ACmmd$p$ $] # - 2 \(7 :0 ` $0 H$
$ A@ # . #El q D # 33

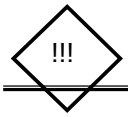
$$d\ln I_t/dt = \sum_i w_i \, d\ln S_{i,t}/dt \quad d\ln I_{i,t}/dt$$ CA@

-8 8 8 8 8, 4 $w_i \quad E_{i,t}/E_t$)9 # Q #
#& (4 J>) \(3 2 #(/ DE i)) +7 # e <&
, 2 - # $

$$\ln I_T/I = \sum_i^T w_i \, d\ln S_{i,t}/dt \quad \sum_i^T w_i \, d\ln I_{i,t}/dt$$

1- Farla et al.
2- Golove and Schipper.

(Diewert, 1980 Hulten, 1973)



3 8 $ 8Y 2 8O 8/ #8) 8@ #8B 4) 8) 8 #8 8

Q # 4 $D_{tot} \quad D_{str}D_{int}$

$$D_{str} \quad \exp \sum_i w_i \, d\ln S_{i,t} \, / dt$$

$$D_{int} \quad \exp \sum_i w_i \, d\ln I_{i,t} \, / dt$$

#8 RFr) ; 4 +(G, #(GGD " > # 42 & " . B # =9

2 H < 4Γ J> , ,) 2 G? H \ " >

$$D_{str} \quad \exp \sum_i w_{i,T} \quad w_{i,} \Big/ \ln S_{i,T}/S_{i,}$$

$$D_{int} \quad \exp \sum_i w_{i,T} \quad w_{i,} \Big/ \ln I_{i,T}/I_{i,}$$

8$ -G D_{tot} @ @ N O > ? # - #= $

-

#8 R H <, #)2 % p $ 2.<= :0 $D_{tot} \quad D_{str}D_{int}D_{rsd}$

9 -

$$I_{str} \quad \sum_i E_{i,T}/Y_T \quad E_{i,}/Y \Big/ \ln S_{i,T}/S_{i,}$$

$$I_{int} \quad \sum_i E_{i,T}/Y_T \quad E_{i,}/Y \Big/ \ln I_{i,T}/I_{i,}$$

$$I_{tot} \quad I_{str} \quad I_{int} \quad I_{rsd}$$

8p $ 2<($ 8H \0 8 8 #8 8\$ @ 8 t8

38 0 2$c 8 #8$%'&81 $ d # 2/ . (LMDI)

28 ; 8 H$%\$ 8=28 #Y I $ #B # 2<($ \ H \ K H$

-

1- Ang and Liu .

2- Log Mean Divisia.

$$L(x,y) \equiv (y-x)\Big/\ln\left(\frac{x}{y}\right), \quad x \neq y$$

: , 0 $u 6 # Ck Cja] K H$

$$D_{str} \equiv \exp\left[\sum_i \frac{L(E_{i,} , E_{i,T}) / L(E , E_T)}{\ln(S_{i,T}/S_{i,})}\right]$$

$$D_{int} \equiv \exp\left[\sum_i \frac{L(E_{i,} , E_{i,T}) / L(E , E_T)}{\ln(I_{i,T}/I_{i,})}\right]$$

8* / 38 # d b c , :0 2 +, H \ -a a? :0 H$
:0 8 # v :0 #$%& :0 H$ #) * CmPC
]$ * / 9 $:0 4% #. B H$3 R + N FB 4v -< 1
F_t^{pro} 8 (1 8 ,:0 # " :0 #$%& c
+ 2 , / < 1 U%=) F_t^{str} - ./

$$F_{str} \equiv L_{str} P_{str} \Big/$$

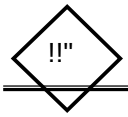
$$F_{int} \equiv L_{int} P_{int} \Big/$$

8 " :0 4#$ d ") +7 # 4 e H(/ D E
2 &$ e_t/e " > #

$$e_t/e \equiv I_t \equiv F_t^{pro} F_t^{str}$$

286$ #8 -8 8 < 1 U%=) :04 H$2 #E?_ # Q) <,
#8 +(8G, < 1 U%= :0 4\$ # I 4 2)9 R = ,2Dp$
3 +2 6* " Z - ./ " Z 2YG - <, H .

"% & " $ " ! " #
`8 6J # " #$%& w 0 2F0 2= 0 " . B -<G1 H$
3 D2 12 <=2



8, 8+$c9*( ) % " " ' D 4#(XD#, +I
38 #(D*I 4 #$%& + K D # " 2
4CmmmCmjm 2Q (1 ? ;= # aCn # Q #
t8 9 #. B A8Pnnn4) @ " #$%&#+ # a -J,
28Q " #+ #(/ D & # aCnn # A4Pnnn@t
fn 8?4PnnC8Pnnn 2Q # 2 ? 4#(0 dCmmmCmjk
8. #(8 d " 8> #8 %8)9 8. x I8# ? H$ \$ # a
3 #(/ $ $ %/ ? H$ = ". B
8 4#8(/ D & 0#, # ". B H$ 20 #+ @4 =
8 7 #+ #(/ $& 2 & ". B 27 O " # # 3
3 , 0 " Zy

+ ,	() & *	' &	##$ %#$
!"			
et &'(		% #$$$	
) * +, - . /0		$ #$$$	
3 1 4 5 '	1+ ;	% %	
7 0		#$$$#$$	! " #
3 1 4 -&",&		8 %	$ %
		%$ #$$	& %
-& 9:	1+ ;	$ #$$	& '" %

1- Bunn.
2- Zhang .

) 86<,) 8 M8* / 3 81 28JF(8, '(Zz-l "
8 (1 2F , # { / " Zy 7 : * A Pnnf@
2 Pg #B " > # |_D M N / #+$%, 1 ?
C P_K, P_L, P_E, P_M, Q $A^1 P_K^K P_L^L P_E^E P_M^M$ (
A Rg@
-< 1 P_L 4#$ -< 1 P_K 4 l iB Q)9 #
X 8 8* $_X$ #8 8 8 -8< 1 P_M 4 8 -< 1 P_E 4
| 3 +6 iB +,) * A H +l , 3 2 (X=K,L,E,M@
#8+$%, ; 8 }(* , O a a$%4,#+ #+ ; 4 J
8 8, 0 A L@ O a a H$ + 42)9 -< 1 # -YG

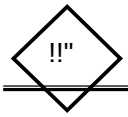
$$E \quad \frac{{}_E A^{1} P_K^{K} P_L^{L} P_E^{E} P_M^{M} Q}{P_E}$$

9 - # 2 . ") 2 Q H / Q Ga

$$\frac{E}{Q} \quad \frac{{}_E A^{1} P_K^{K} P_L^{L} P_E^{E} P_M^{M}}{P_E}$$

A h@
2 7 Zz-l " H$ +
7 $ +6 M
, $ 2YG -< 1 M
4 c $ S +6 iB #l , 4 = E 2 Y |
8 #8F<@ 8 8, 8 #8 8A? `$ ~_o@ H . a
-/ 8* d 4H$ 8+8 8, 0 H $ 8d 8 8' H$ 8+8 A
D # % , / $ 2$9 $ %/) 6 +6
8G 8Y-$% ,- / V D (a <? , \ ,K
4 8*<= @8 8, 0 8Y #8 8*8 " , -
8 c 8 # -YG , $ -< 1 #l , \$ 3 Annk
8 2+$%\$ 8= # $ < 4) 2YG Q# \$ " Y7 #

1- Fisher-Vanden .
2- Shephard's lemma.
3- Jamshidi.



$ %/ 4) D ++ o 3 , 0 , $ = #
8\$ 28 3$ 8+, 0 i = 8 8 8 8$ = " %8 & 8$#
2D 8 `Y8 $ (2 <7 , 2Dp$ 4 " Zy , '(
++2 # & #(/ * d2D (# 2$, * 3 2 (1 `$
J(8 %8 8 8 8 $ 8 ,c 4 +(G, 0 c / iB
4L 8@+8 #(8 % c ") % + 2 E H$ X ++2
2D 8 (8 :0) +7 # # GDP% " . B 20 H$.A CWkj
3 • I " ;
48 #8(0 d 8 " 8 8Zy8 8 7 28 # # 2 & " .B)
-Y8G 28J+ 8Z+,) * # A nnk@ , #. B #) 2
:0 8) 8+7 #8 GDP #8 2= 80 " 8& -YG # #$ =
) 8* #8. B H8$8 €$H 8+,I 3 2 H I * " +6
$ 8 -8< 1 8 8 .) 8+7 #8++ -< 1 :0 -Yo Z +,
28 H 8 8 8, 3 8 28 8 8* H8$ 8 " 8(8 8 8, 8
8 -8< 1 #8) * H I * \$ #. B A nng@G+•F,d
#(8 8* H8$ 8 " -Yo Z GDP , $ -< 1 2J+ Z
8 -8< 1 $ %8/ # -) * I("c $ * A nnk@+$ 3
9 8 8Z #8 2 84#(8 * H$ " , ++ H . a
8Z 8+,) 8* %8 I("c $ A nnk@L 6(#. B 3 % I
A nnk@ 8 3 " # GDP -Yo Z -< 1 2J+
8 " 8 8 8&) 8 8 #8= 8Z 2 # * H #. B `$
%8 8 " 8 42= 80 " 8& $ %8/ # -#& (H$ # #(0 d
-Y8G # 8 GDP -8Yo Z +,) * #. B H +I , 3 $2 $ %/

1- Liu and Han.
2- Shi and Polenske.
3- Wing.
4- Metcalf.
5- Cole.

8* APnnj@8 t8+,38 2 " # #$ =
3 2 * €$ (# % H I

8 7 8 " 8 #8$%& 8? & " . B . # #
28 #8 28*, pd ACWkB) 86<, <7$ d2) $)9 Zy
OECD 8ƒ7 , * " 2F0 : 0 -< 1 " Zz
8 8 " 8) 8a 7) a #B #(0 dCmhgCmmh, 2Q
8+,28) * #. B €$ 3 1 H 2F0 : 0 -< 1
#8 2 8 28(? #4F0 : 0 -< 1 $ %/ Y # + # #
28+.) 8 H8$ - #(/ $, % " 4#(/ $, % , '(
#8 - 2+$ 2(.+> N_a (G (J,#, ,) I # -
3 2F&(#+ $ %/
8 2 # 4CWgMCWjm , 2Q 4ACWkC@& 2/ p 2 Y7
28(< 1 8 8* H 8< 8 (1 LF(,
) 8* 8H < €$ (3 #(0 d 4SLSK a <? -.+>
-8< 1 „ 8 " ' # -)9 $ D H $ d ~ (4ZC< 1 , * # , 2
8a <?)9) % 2 = 1 Zz 2< 2$ + #
8 7 $ -< 1) - Z { / $, $ %/ " > \ 4 #(
-<8 #8 $ -0 `$ a(4-< 1 … .Y ,- <7
3\$ $ -0
2+ a <? " #$%& 4ACWkC@ p 2< 1
8\ 8 " ' \ 3 #(0 d CWjMCWkC,
#8& (H8$ 3# J(p $ `$ (d K " " '
" 8 8 " 8 ' i O 2J .O G 4 (0 Z # -
8 H$8 8 : 0 " Z #(a <?
3 2+ a <? " " ' i O

1- Hang and Tu.

8 " Zy 7 2 #4 * H #. B `$ ACWk@
" 8 ' -Yo Z +,) * #. B H$ €$3(#(0 d LF(, *
8 ACWk@ 86<, 2J$ 83 2 " , * -? G (0
8* / 9 $:0 J(4CWjMCWkW, 2 , |
€$ 8(38 #8(0 d) 8$#8 D #8 ;$ +> " #$%& 42 O K
2 8 8 (0 8 8Z 4# D # ;$ +> # -)9 2 ? , pd
8 8Z " 8 ' 8 8 8 42$ Z #(" Z " '
" 8 , 8 -8 = 2$ Z 4LF(, 4;$ +> 3 #(
3 #(" , 2J .O (0 Z - ?
" 8. B 8 }8 al28 + K 28 8 # < E O ? #. B
#8 8 " #$%& _7 #. B H$ H +I , #(<7 " J 2F0
H8$H 8+I8, 3 8 2 #(0 d % #$%& = `$, Zy 7 2
H8$ 28 9 28 & " 8. B 84H$,K 2/ . K_ #. B
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1- Fisher Ideal Index for Structure of Economic Activities.

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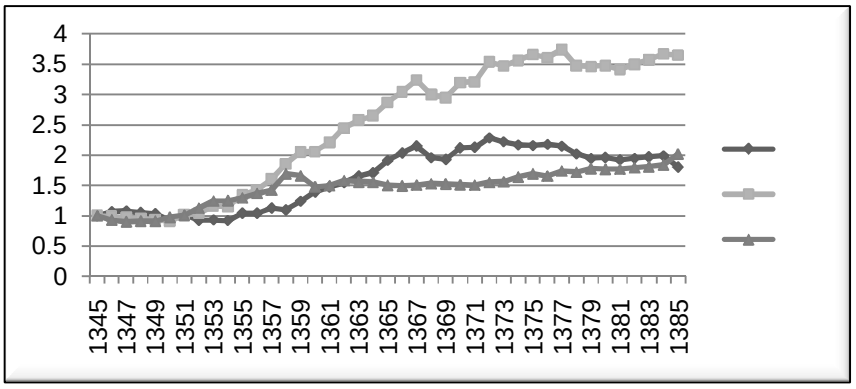

F_{pro} " ! F_{str}
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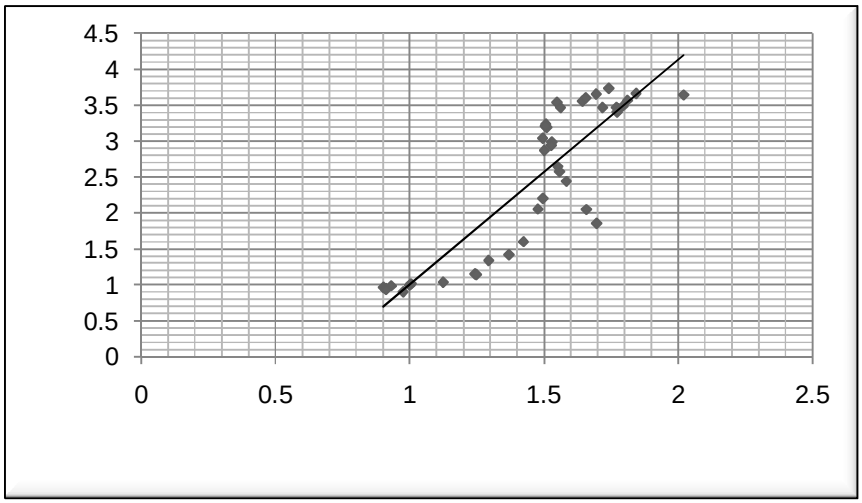
1- Fisher Ideal Index for Total Energy Intensity.



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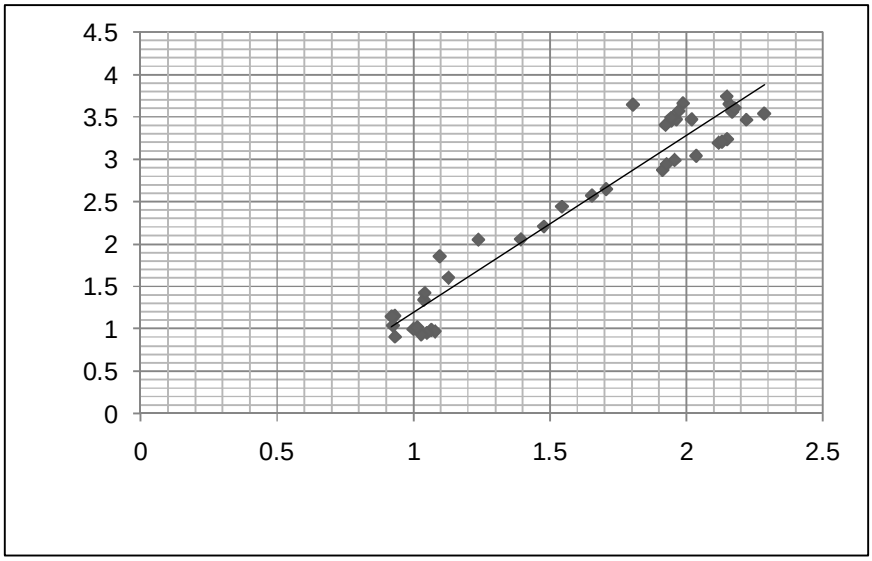

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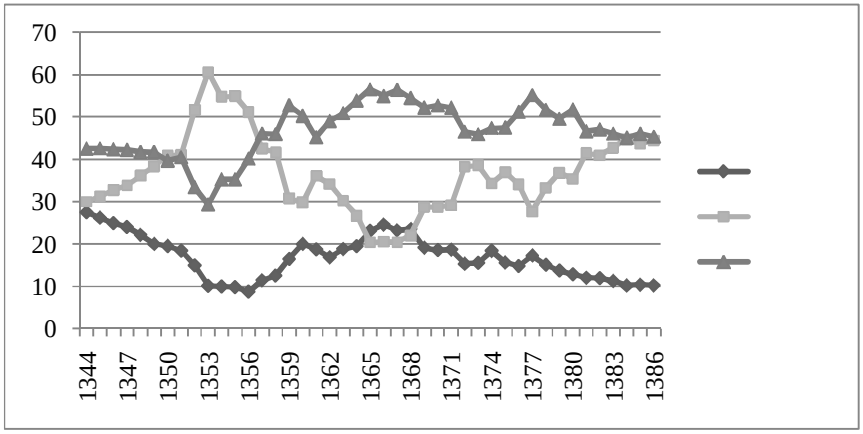

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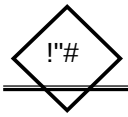

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Decomposition and Determinants of Energy Intensity in Iran

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Abstract

Due to the necessity of energy saving in Iran there is a need to identify factors affecting the intensity of energy use in the economy. The main purpose of this study is to identify key factors affecting energy intensity over the period of 1968-2006. Applying decomposition methodology allows for more accurate energy-intensity trend analysis in the past and forecasting future trends. Energy productivity is an important determinant of energy intensity. An additional factor that affects energy intensity is the structure of economic activity. An increase in energy-intensive economic activities increases total energy consumption. This study decomposes the energy intensity index of Iran into two key factors: productivity index and changes in index of economic activities structure. The results of applying Fisher ideal index method indicate that increased energy intensity is due to reduction of productivity and changes in the structure of economic activities. Based on the results, one of the most important factors that influences energy intensity and productivity index is the energy price index, with energy intensity highly sensitive to energy prices.

JEL classification: C43. C50. C65. O4.

Key words: Energy Intensity, Energy Productivity, Structure of Economic Activities, Decomposition Methods.