## DISCUSSION PAPERS IN ECONOMICS

Working Paper No. 11-03

## Exports, Imports, FDI and Economic Growth

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April 2011

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# 71 BA CED\$;? BA CED\$86; 3 @6 75 A @A?;5 9 CAHE:

CYf O+I mq]f

 $I[V:R_V:K] \setminus S7 \setminus X_NQ \setminus Na6 \setminus bXQR_V$ 

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- Q<Mj]ka\mYdk]jaYd[gjj]dMagf GH 1]kl8
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 $\label{thm:limit} \begin{tabular}{ll} $$Xkme $hlagf ak nagdM] \) $J DMo $attl[`Yf_] o al` $j]gj\] $jf g_]f gmk $nYjaYZd_k+O`] [`ga(] \] $YhhjgY[`]k lg \] $Ylo al` $l`] $gj\] $jf g_]f gmk $nYjaYZd_k+O`] [`ga(] \]h]f \k gf $l`] $[gf kakl]f[q $Z]lo]]f $l`] $]kke $Y] \] $Ylo al` $l`] $|gkakl]f[q $Z]lo]]f $|gkakl]f[q $Z]lo]]f[gmk $nYjaYZd_k+O`] [`ga(] \] $|gkakl]f[q $Z]lo]]f $|gkakl]f[q $Z]lo]]f[gmk $nYjaYZd_k+O`] [`ga(] \] $|gkakl]f[q $Z]lo]]f[gmk $nYjaYZd_k+O`] $|gkakl]f[gmk $$ 

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- O`] k][gf\ YhhjgY[` ak lg mk] J DM o al` l`] gj\]jaf\_ g^l`] nYjaYZd]k af l`] Q<Me g\]d o adlZ] Yk ^gdgo k &@f\]jk)/--0) h+/43'7
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  - O`] gj\]jaf\_g^l`] j]e Yafaf\_nYjaYZd]k oadd ^gddgo af gj\]j g^af[j] Ykaf\_[gjj]dMagf Ye gf\_l`]e 8
  - O`]  $dMd hdM[] af 1`] dakl <math>g^g[] jaf_o addZ[j]k[jn] \cdot gj 1`] 1Mj_1nMjaMZd[+$

O'] nYjaYf[] \][ge hgkalagf k Yj] Ydkg k]f kalan] lg

 $OYZd] . Yf \setminus OYZd] / hjgna', ] f'] ]na', ]f[] f'Y f'] 'gnj læ] k]ja]k &j YdB? KXG) j] YdlphgjlkXG) j] Ydæ hgjlkXG Yf \ j] YdA? DXG' Yj] fgfklYlægf Yjq o al` Yf gj\]j g^ gf] 'gj H YdYqkaY+ OYZd] 0 Yf \ OYZd] 1 hjgna', ] ]na', ]f[] f'Y f']k] 'gnj læ] k]ja]k &j YdB? KXG) j] YdlphgjlkXG) j] Ydæ hgjlkXG Yf \ j] YdA? DXG' Yj] fgfklYlægf Yjq o al` Yf gj\]j g^ gf] 'gj F gj] Y+ O`] 'ajkl [gdnæ f g^]Y(` lYZd] ]p`aZalk l`] fYe] g^ l` j k]ja]k+O`] f]pl [gdnæ f k j]hgjl l`] l* klYakla' n Ydn]k) l`] f mæ Z]jk g^ dY_) l`] f mæ Z]jk g^ e Ypæ mæ dY_) Yf \ l`] f mæ Z]j g^ gZk]jnYlægf k) af l`Ylgj\]j) d[Ylg ja_`l+$ 

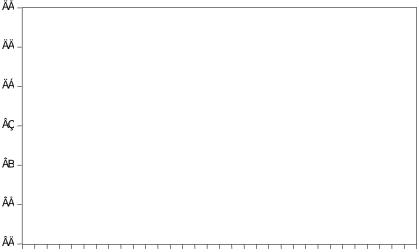
ELMP) 2FXI'CYY'EP] 'TX>P PY Q\ ? LYLC] TL

DP\TP| 'MDYL' | >LR \PXR'S | ? Lb \VLR | AM

## ELMP

## $8T_{P} \ge 6PNTP8Y \le TPPPTTY YQ? LYLC]TL$

#### $8TR_P^*26PNTMP8Y_ETWPDPTPYPYPY$



#### +&? LVLc]TL

 $ELMP-2EP]^Q\setminus >LR>PXR'S 5 \setminus TP\setminus TLQ\setminus ? LVLc]TL$ 

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			-	*4-65. 5-2		*4+166/5/
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0	/ <b>-</b> 5 <del>-5</del> 34 <b>-</b>	00-31/46	26]*-6	*6-013/24		

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	521205	45-8. / 26	/ 6-464- 4	-+
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Oj Y[] l]kl af\a[Y]k0 [gafl]\_j Ylaf\_]i f & Yl l`] -+2 d]n]d (\]f gl]kj]b[[lagf g^l`]`qhgl`]kak Yl l`] -+2 d]n]d

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 $Pfj[klja[l] \setminus gafl]_j Ylagf MYrcO[kla & Ypae me @a_]fn Ydn]'$ 

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 $(\] [fgl]kj]b[[lagf g^l^] \] qhgl^]kak Yll^] -+2d[n]d$ 

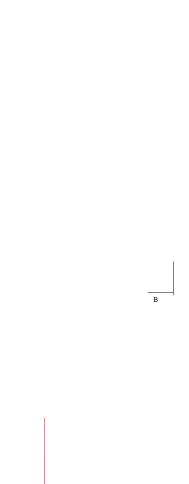
 $((HY)Faffgf*CYm_*Ha[`]dk & 666' h*nYdn]k$ 

 $Og \ [gf ka \ ]j \ l^{\ } \ qhgl^{\ } \ kak \ l^{\ } \ l^{\ } \ ] \ fgl \ [gaf l_j Yl] \ \&g-' \ Y_{kf kl} \ l^{\ } ] \ Ydl] f Ylan \ g^{\ }gf \ gj \ e gj] \ [gaf l]_j Ylaf_n] [lgjk \&g-') o ] \ Yn] \ lg \ dggc \ Yl \ l^{\ } \ n Ydn] \ g^{\ }u_{OMk>@}+>ghe f \ 0 g^{\ }l^{\ } ] \ Ajk \ h^{\ }l \ g^{\ }OYZd \ 6 \ af \ af \ Yl \ h^{\ }l \ n Ydn] \ g^{\ }u_{OMk>@} \ k^{\ }l \ g^{\ }l \$ 

 $\label{eq:continuous_series} $$ YdJjf ManJj91 [Yffgl Z] jJbJ[l] \ Yll'] -+2 dJnJdJZJ[Ynk] l'] nYkhJ g^u_{H<S}&'akdJkkl'Yfl'] 2 hJj[Jfl [jala[YdnYkhJ g^0-51+O'akkm_]klkl'Yll'] f ne ZJj g^[gafl]_j Ylagf n][lgjkakl'j]]+ $$ YdJjf ManJkl g^u_{H<S}&'akdJkkl'Yfl'] -+2 dJnJdJZJ[YnkJ l'] nYkhJ g^u_{H<S}&'akdJkkl'Yfl'] --2 dJnJdZ[YnkJ l'] nYkhJ g^u_{H<S}&'akdJkkl'Yfl'] nYkhJ g^u_{H<S}&'akdJkkl'Yfl'] --2 dJnJdZ[YnkJ l'] nYkhJ g^u_{H<S}&'akdJkkl'Yfl'] nYkhJ g^u_{H<S}&'a$ 

ELMP)(

 $8 \, \mathbb{R} \setminus P + \& 0$ 



 $8\mathbb{R} \setminus P + \mathcal{K} +$ 

8 **TR\_\P+&**,

 $8\mathbb{R} \ P+\&-$ 

 $8\mathbb{R} \ P+\&$ 

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		&0-26/6'	<b>&amp;</b> 0+64'	&0+65/'	&+'
/	-+34064	3. 4. 21-	1-5/21	0-465606	/ <del>4</del> 61616
		&. <del>-6</del> 312'	<b>&amp;</b> +603-5'	&. +4/0'	&-B0644'
0	-+-5-5/	31 + 5 - 5 -	. / + 261/	. 245665	4-53646-
		&0-4/62'	&+ 2/4. '	<b>&amp;</b> -50242'	& <del>0</del> -223/2'
1	$- \pm 233/1$	33-06202	+ 46-4	. 1-4/66/	5-462331
		&2-634-'	& <del>6</del> 31-'	& <del>1</del> -64. 5- '	&t + - 55/ '
2	- <del>/</del> - / 212	40-4233/	3 + 460/5	. / 44-33	4+60060
		& 1-0-46'	<b>&amp;</b> -506-6'	<b>&amp;</b> 5-3611/'	<i>8</i> 9-40. 5. '
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		• "

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	&+3244'	&+00'	&+4630'	& <del>-4</del> 4-51'
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? PHHT	*-+44-//	*- \( \psi \) 053-6	*-+0/0332	*-+0215-
	&+4/6-'	&+/.'	&+55/3'	&-5211/'
	V*/ +1/51/W	<b>⅓</b> / + 122. W	<b>V</b> 0-₿3363W	V*- + 2523W
M⁵ki m∭]∖	654041	- +643/52	- +65//31	5122
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None $ki + j ] ka k$	-+30-55	-+1351/	-+6/161	5-334/36
N+@+]i mMagf	-+243/0	-+546./	-+3644/	8421-2
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< c Yac ] < D	*/ -260/ . 5	*. 415054	*/	/ +0/ 6234
N(`o Yjr N>	*/ +46113	*. <i>+</i> 013. 2	*. +3635/2	/ <b>-</b> 510006
$H]Yf \setminus ]h]f \setminus ]f1$	//0.2/.	/ . ≠ 1-	/.+6204	. 3-2/315
N <del>f?</del> + 006				

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6 PZPXOPX^` L\ TLMP2 C7 3 > 9 6 BK>

ak Yk ^gdtgo k7 ]phgjlk) ae hgjlk) A? DYf\ B? K+O`] ]klae Yl]\ j]kmtlk ^jge J DM &Xk e ]f lagf]\ Z]dgo' Yj] [gf kakl]f loal` l`gk] ^jge l`] B>=@R l]kloal` l`ak gj\]jaf\_ g^ nYjaYZd]k) [gf ^aje af\_l`] jgZmklf]kk g^l`ak gj\]jaf\_+

 $Aa\_nj] \ 1 \ ]p`aZalk \ 1`] >`gd]kcq \ Ykqe \ hlgla[ \ ae \ hmik] \ j]khgfk] \ ^nf[lagf+D \ af[dn_k]k \ . \ 3 \ ke \ Ydd ^a\_nj]k \ o`a[` \ Yj] \ |fgl] \ Aa\_nj] \ 1+) \ Aa\_nj] \ 1$ 

 $8\mathbb{R}\setminus P$ , &

8 TR\_\P, &

 $Aa\_nj] 1+6 k`gokl`Ylaehgjlk`g[c`YkYk`gjl*jnfhgkalan]]^M][lgfB?KYll`]\\ Z]\_affaf\_+O`jj]YN]j)l`akaehY[lk]]eklgZ]afka\_fa'a[Yflafl`]k][gf\q]Yj)Yf\lmjfkgmllgZ]\\ f]\_Ylan]afl`]l`aj\Yf\'gmjl`q]Yjk+AafYttq)l`akaehY[lZ][ge]kafka\_fa'a[Yflafl`]'a'N`q]Yj+O`jj]akfgaehY[lg^aehgjlk`g[cgf]phgjlkafAa\_nj]1+-+Aa\_nj]1+.$ 

 $8 \, \mathbb{R} \setminus P, \&)$ 

8 **TR\_\P**, &\*

 $Gggcaf\_Yl\ Aa\_nj]k\ 1+0\ v\ 1+2)\ A?\ Dk`\ g[c\ ak\ kl\ Ylakla[\ Ykth\ af\ ka\_f\ a'a[\ Yfl\ af\ alk\ ]^n][l\ gf\ B?\ K)\ ]phgjlk\ Yf\ ae\ hgjlk+=ml)\ al\ `Yk\ Yk`\ gjl*jnf\ hgkalan]\ ]^n][l\ gf\ A?\ D'gj\ l`\ ]\ ^ajkl\ lo\ g\ q]\ Yjk+O`\ ]j]\ Yl]j)l`]\ ae\ hYl\ g^A?\ Dk`\ g[c\ gf\ A?\ Dak\ fgl\ kl\ Ylakla[\ Ykth\ ka\_f\ a'a[\ Yfl\ \&Aa\_nj]\ 1+3'+$ 

8 **TR\_\P, &**+

8 **T**R\_\P, &,

8 TR\_\P, &-

8 TR\_\P, &.

A? D-O`] æ hY[l 'jge ]phgjlk gf A? DYf\ æ hgjlk ak hgkalan]+@phgjlk Yj] fgl Y'\][l]\ Zq B? K) æ hgjlk Yf\ A? D\o`a[` Ykkg\a'\]jk 'jge l`] H YkYqkaYf j]kmdk+

 $Ggcaf\_\ Yl\ OYZd]\ .5)\ l^\ ]\ ^dn[lnMagfk\ g^B?\ K\ Yj]\ ]\ phoYaf]\ e\ Yaf\ dj\ Zq\ B?\ K\ Yf\ ]\ phgjl\ k^\ g[ck+B?\ K\ k^\ g[c\ Y[[gnflk\ ^cj]\ 25-6\#\ Yl\ l^\ ]\ ^ajkl\ q]\ Yj+Dk\ hjghgjlagf\ af\ l^\ ]\ nYjaYf[]\ g^B?\ K\ ^\ ][j]\ Yk]\ k\ gn]j\ lae\ ]\ Yf\ j]\ Yj+Qphgjl\ k^\ g[c\ Y[[gnflk\ ^cj]\ .1-04\#\ af\ l^\ ]\ ^ajkl\ q]\ Yj+Qphgjl\ k^\ g[c\ Y[[gnflk\ ^cj]\ .1-04\#\ af\ l^\ ]\ ^ajkl\ q]\ Yj+Qphgjl\ k^\ g[c)\ o^\ af\ Yk]\ k\ ynj\ lae\ ]\ Yl\ ynj\ [gflaf\ nynkdl\ ^cj]\ af\ Yj)\ [gflaf\ nynkdl\ ^cj]\ af\ l^\ ]\ ^ajkl\ q]\ Yj+Qphgjl\ k^\ g[c\ ak\ l^\ ]\ e\ gkl\ ae\ hgjl\ Yl\ kgnjj\ lae\ ]\ Znl\ kladl\ Y[[gnflk\ ^cj]\ sdl\ hdYq]\ Zq\ ]\ phgjl\ k^\ g[c\ af\ [j]\ Yk]\ k\ gn]j\ lae\ ]\ Yf\ Y[[gnflk\ ^cj]\ 55-63\#\ af\ l^\ ]\ kapl^\ q]\ Yj+Db\ Y\ alagf)\ l^\ af\ l^\ ]\ ^ajkl\ q]\ Yj)\ ^Ydk\ lg\ .2+\#\ af\ l^\ ]\ l^\ af\ l^\ ]\ Yf\ ak\ fgl\ ka_f\ a'a[Yl\ l^\ ]j]\ Yl]\ +\ A?\ D$ 

## GL\ TLXNP 6 PNYWZY] T'NX YQ\ PLYDZKV

BP\ TYO	D <b>&amp;</b> &	C73>7I BK>	C73>;? BK>	C73>86;K>	C73>96BK>
	-+546./	+	-+	-+	-+
		&+'	&+'	&+'	&+'
/	-+2164/	64-42422	. +533513	- <b>≠</b> - 040-	- ± 4. 544
		<b>&amp;</b> -54/01'	<b>&amp;</b> 9-0-360'	& <del>-2</del> 6./4'	&±./41'
0	- <b>≠</b> . 153-	62-202. 1	0-31060/	$- \pm 2/5$	- +3355//
		&B1. 3'	&+04.5'	<b>&amp;</b> -3/665'	&±/6'
1	<i>- ¥</i> 3546 <i>-</i>	61-00/55	1-25/065	- + 2531-	- +6/ 3- 54
		&2-2660'	&4+16325'	&4-B/ 261'	<i>&amp;</i> 4-2600/'
2	- <del>-</del> 0. 5144	60-63440	1-412541	- <del>≠</del> 36- 40	. + . 40. 6
		&5+16/'	& <del>-3</del> 6-5-'	<b>&amp;</b> +4/53-'	<b>&amp;</b> -34 6'
3	- +033-41	$61 \pm 0 / 13$	1+1234.1	- 4 540	. +-6616
		&-+321'	<b>&amp;</b> 6-51/'	<b>&amp;</b> -02/3.'	&. ≠3-6'

#### GL\ TXNP6 PNYWZY| T'NX YQ\ PLVWZKV

BP\ TVO	D& &	~.	C73>;? BK>	C73>86;K>	C73>96BK>
	-+3644/	04-06. 13	3/-8-521	-+	-+
		&1-2465'	&1-2465'	&+'	&+'
/	-+. 2531	36-03612	$0 - \pm 6. / 1$	- <b>≠</b> / 15. /	- <b>≠</b> . 116-
		&0+.55'	&/ 400-'	<b>&amp;</b> 0+521. '	& <sub>+</sub> 1. 234'
0	- + 305 - 0	51-0 22	. 2+ - 206	05. 2. /	- <b>≠</b> . / 212
		&6433'	<b>&amp;</b> +15. 46'	<b>&amp;</b> 0+632-4'	<b>&amp;</b> 9-36 2'
1	- <b>≠</b> . 1/ 01	55-3410.	41/ . 20	- 416.00-	- +1. / 5/6
		&/+0/.	&4-0/431'	<b>&amp;</b> +14535'	&± 440/ '
2	- <i>¥</i> 3110/	56+.443	6-31221/	0/0514	- +5. / 52/
		&1-2154'	<b>&amp;</b> ≠11. 3'	&4+641/'	<b>&amp;</b> -50-4. '
3	- <del>-</del> 0. 044.	55-3346/	6-3/0.46	0 1. 1	. +065151
		&4+6/2'	<b>&amp;</b> +435/2'	<b>&amp;</b> -0. 443'	<b>&amp;</b> ±15400'

## GL\ TLXNP6 PNWZY] TNX YQ\ PLW6; K>

BP\TYO	D& &	C73>7I BK>	C73>;? BK>	C73>86;K>	C73>96BK>
	- 43421-2	. 3-055	1-600222	45 <del>-8</del> 4510	-+
		&0+2/3'	&+ 5-0-'	&0 <del>-0</del> 150'	&+'
/	5. 4602	/2+0131	. 1-5/60/	24 ≠ 3 - 1.	/ +54230/
		& 1-0. 24'	&. <i>4</i> 445'	&0 <del>-2</del> 201'	<b>&amp;</b> -24055'
0	- +614/62	/ 5 <b>≠</b> 0- / 6	/ 0-64342	11-2026.	0+24-21
		& 1-64. 4'	&/ D. 0/'	&/ ≠ 16. '	<b>&amp;</b> -2-335'
1	. + 6. 545	/ 5-350/ 6	/ 5-52332	$01 \pm 60.6$	5 <i>¥</i> 3354.
		& 3+20. '	&0 <del>-0</del> 05-'	&B/11'	&5-B-3/-'
2	. + 52364	/ 6-5/ 021	0 - + / 261	/ 6± 3030	+65356
		&4+-53'	&1+-10'	&. B. 50'	&. + 2. 6'
3	. #01 6	0. +45005	$/6 \pm 0.66$	/ 4 <del>-0</del> 4622	4-2-6
		&4 <del>-</del> 362. '	&1+.66'	&. +36-'	&/-B1'

 $O`] klae Y] \ j] kmdk ^jge \ l`] \ BjYf_]j \ [YmkYddq,=dg[c] pg_]f] alq \ l]kl) \ l`] \ ae \ hmdk] j] khgf k] \ l]kl Yf \ nYjaYf[] \][ge hgkalagf \]e gf kljYl] \li`] phgjl*d] \ _jgo l` `qhgl`] kak+O`]j] ak [YmkYddq g^ae hgjlk gf B? K) Zml l`ak ae hY[l ak o] Yc+R] [Yff gl _an] Yf q [gf[dnkagf YZgml l`] ae hY[l g^ljY,] ddZ]jYdr Ylagf gf ][gf ge a[ _jgo l` af l`] [Yk] g^F gj] Y+$ 

 $O`] \ \ a^{\}j]f[]k\ af\ ]klae\ Y]\ \ j]kmdk\ Z]lo]]f\ Fgj]Y\ Yf\ \ H\ YdYqkaY\ Ykc\ ^gj\ ]phdYf\ Ylagf\ +\ N][lagf\ 0+l\ o\ adde\ Yh\ l`]\ ][gf\ ge\ a[\ hgdb[a]k\ g^Fgj]Y\ Yf\ \ H\ YdYqkaY\ gf\ lg\ l`]\ j]kmdk\ g^l`]\ Bj\ Yf\ ][Ymk\ Ydlq,=dg[c\ ]pg_]f]alq\ l]kl)l`]\ ae\ hmdk]\ j]khgf\ k]\ ^mf[lagf\ Yf\ n\ YjaYf[]\ ][ge\ hgkalagf\ +\ N]$ 

# +& 3 XLV:] TJ\$5 YWZL\ TJYX LXO7 bZYLXL/TJX YQ/SP6 TQP\ PXNP] TX 'SP7 ] ^TWL/POCP]\_V] QYW? LYLC] TL LXO= Y\ PL

 $O`ak k][lagf [gf kaklk g^lo g h Yjlk+O`]^ajkl h Yjl ]phdYaf k l`]]klae Yl] \ j]kmdk l`jgm_` Yf Ydqkak g^H YdYqkaYf ][gf ge a[ hgda[q+O`] k][gf \ h Yjl ]phdYaf k l`]]klae Yl] \ j]kmd l`jgm_` Yf Ydqkak g^F gj]Yf ][gf ge a[ hgda[q Yf \ hgaf lk gml l`] \ a^]j]f[]k Z]lo]]f l`] lo g [gmf lja]k+$ 

#### +&&? LVLc]TL

H YMqkaYk`a'l]\ 'jge Yf æ hgjl\*knZklalnlægf hgdl[q lg Yf ]phgjl\*gja]fl]\ hgdl[q af . 635  $jaf_al) Yf (gl) je l'g k \& ge g /--0 h+16'+Ajge l' ].64-k gf (l') _gn jf e ]f l [gf ka ]j | l' ]$ ]phgjl\*gja]fl]\ hgda[q lg Z] l`] e gkl æ hgjlYfl dgf\_\*l]je hgda[q ^gj \]n]dghaf\_ H YdYqkaYkk  $\label{eq:local_problem} $ [gfgeq+D] \] \] \] km[[]kkg^1 akhgdq kmhhgjlkeq^af af_l M] phgjlk M] \] Yhgkalan] $$ ]^][1 gf H YdYqkaYf ][gf ge a[ \_jgo l` + OYZd] . 6 k` go k l` Yl H YdYqkaY46 ]phgjl k` Yl] g^ B? K  $af[j]Y_k$ \ ^jge 1. +1# af . 64- lg . . - \text{# af } / \cdot - 4+O`] Y\_n]jY\_] ]phgjl \_jgol` jYl] Yf\ l`] . 6'+Dî l`]][gfge a[Yf\^afYf[aYd[jakak)Y`]Ynq\][j]Yk] af]phgjl\_jgol`jYl]d[\ lg Y\][j]Yk] af 1`] B? K\_jgo 1` jY]+OYZd] . 6 Ydkg j]hgjlk 1`] B? K]phgjl k`Yj]) 1`] ]phgjl \_jgo 1` jY]) Yf\ 1`] B? K\_jgo1` jYl] g^H YdYqkaY^jge . 64- lg /--4+Agj ]pYe hd]) af 1`] . 641v42 gad[jak]k)1`] ]phgjl\_jgo1`jYl]^]dd^jge .2-6# &641'lg \*0# &642')o`a[`hYjldqd]\ lg Y\][j]Yk] af 1`] B?  $K_jgol^jM$ ] ^jge 5-0# &641' lg - 5# &642'+O'] . 665 < kaYf ^af Yf [aYd[jakak [Ymk]\ l']  $] phgjl \_jgol`jM] \; lg \; ^Ydd ^jge \; 6 + \# \; \&663' \; lg \; - 2 \# \; \&665') \; o \; a[ \; d] \setminus \; lg \; Y \setminus ][j] \; Yk] \; af \; B? \; K$ \_jgo l` jYj] ^jge .-# &663' lg \*4+1# &665'+O`]k] ^Y[lk Yj] [gf kakl]fl o al` gf] \*o Yq [Ymk Ydalq g^]phgjlk gf ][gf ge a[ \_jgo l` +

Og hjge gl] ]phgjlk) l`] H XtNqkaY\_gn]jfe ]fl]p]e hl]\ Yf æ hgjl lYp gf afl]je]\aM] af hmlw [YhalYd\_gg\ kw l`Yl o]j] mk]\ ^gj ]phgjl hjg\ m[lægf gj æ hgjl\*kmZklalmlægf af\ mklja] k+O`]j]^gj]) af H XtNqkaY) æ hgjlk g^ afl]je]\aM] \_gg\ k Yf\ [YhalYd\_gg\ k hjge gl]\ ]phgjl e Yf mfY[lmj] Yf\ \ge ]kla[ hjg\ m[lægf + Df gl`]j o gj\ k) æ hgjlk `Y\ Y [YhkYd]j\dMæf k` ah o al`]phgjlk Yf\ B? K+O`] ]phgjl nYdn] g^ H YdNqkaYaf[j]Yk]\ ^jge . +4 Zadbgf P N? af . 64- lg . . 1 Zadbgf P N? af /--1 &OYZd] . 6') Yf\ hjgna\]\ Y ^gj]a\_f ]p[`Yf\_] kgmj[] ^gj j]æ hgjlaf\_afl]je]\aM] af hml) [YhalYd\_gg\ k) Yf\ [gf kme hlæf \_gg\ k+J f] [Yf k]] l`Yl'] H YdNqkaYf æ hgjl

 $nYth] Ytkg af[j]Yk] \ \ \, \'ige . - B Zattlef PN? af . 64- lg ... 6 Zattlef PN? af /--1 & gjd, ZYfc ? YYk]1*R? D+Df /--1)1`] af1]je ]\ aYl] _gg\ k Yf\ ]i mahe ]f1 ^gj ]phgjl e Yf mYy[mjaf_`Y\ fgl q]1 Z]]f hjg\ m[]\ Zq \ ge ]kla( af\ mklja]k) Yf\ 1` mk1`] [gmfljq klatdl`Y\ lg ae hgjl+O`]j]^gj]) Yf af[j]Yk] af B? K Ykck ^gj af[j]Yk] af ae hgjlk g^ af1]je ]\ aYl] _gg\ k Yf\ [YhalYd_gg\ k+O`]k] ^Y[lk Yj] [gf kakl]f1 o al` 1`] ]klae Yj]\ j]kmdlk ^jge Bj Yf_]j > YmkYthla]k) 1`Yl]phgjlk Yf\ ae hgjlk Yk o ]tdYk ae hgjlk Yf\ B? K af H YtYqkaY`Yh] lo g*o Yq [YmkYthla]k+$ 

ELMP) 127 bZY\ ^DSL\ P YX 9 6 B LXO7 bZY\ ^9 \ Ya ^S CL/P YQ? LYLc] TL\$) 1/( %((/ '! #

J PL\	7 bZY\ ^	7 bZY\ ^	96B	J PL\	7 bZY\ ^	7 bZY\ ^	96B
	DSL\ P YX	9 \ Ya 'S	9 \ Ya 'S		DSL\ PYX	9 \ Ya 'S	9 \ Ya 'S
	96B	CL/P	CL/P		96B	CL/P	CL/P
TM 64-	. 0-₿	. 6-₿	5-0	TM 656	05	*1	3-4
TM 64.	. 2	/ . <del>-4</del>	5≠	TM 66-	/ 5	1-2	<b>6</b> ⊬
TM 64/	. 6+1	04⊬	1-2	TM 66.	/ 3-0	+	6-1
TM 640	/ 5 <del>-4</del>	23	./+	TM 66/	/ 3-3	./₩	2-6
TM 641	/ 3-4	*. +6	4+⁄	TM 660	/ 3-2	./₩	3+
TM 642	/ 3-16	. 5-4	2-16	TM 661	/ 3-3	. 3-0	5-2
TM 643	0-	06-2	B	TM 662	/ 5-5	/ 1-1	6+

TM 644 0-4

ELMP\*(2ESP5 YWZYXPX^YQ? LYLc]TLX7 bZY\^] YX? LX\_QN\_\TXR\$) 1/(%11-'! #

				17 . ( 7.		
;XO_]^ <b>T</b> ]	) 1. 0	) 1/ +	) 10(	) 10-	)11(	) 11-
$Agg\setminus$	. 4-2	. 6-₿	2-4	3≠	0-5	. 45
$= ]n]jY_]kYf \setminus lgZY[g$	-+6	/ <b>-16</b>	-+0	<b>-</b> ₩	<b>-</b> ₩	-+0
O]plad])[dgl`af_Yf\^gglo]Yj	. +1	3÷	2	<del>1</del> 6	5-5	1-3
R gg\	0+1	6 <del>-4</del>	2-4	0+	0+1	1+1
>`]e a[Ydk	0+	1-1				

 $\begin{tabular}{ll} M$?) Yk o ] dtlYk af ljY \af_ le Yjc] laf_ Yf \dg[YdZjYf \] n] dghe ] fl+<fa? Dhjgb] [l o Yk Yo Yj \] hagf]]j klYlnk af al kYlakfa] \lambda [j] [jal]jaY7 0-# gj e gj] nYdn] Y \] \lambda [Y] \lambda [Y] \dg Yd e Yf Y_]jaYd l] [fal Yd) gj kmh]jnakgjq h]jkgff] dy Yf \Y [gfljaZmlagf dln] dlg H YdYqkaYxk af \mkljaYd kljm[lmj] & ge g) /--0 \h+.--'+A? Dak hj]^jj] \af \a_\alpha \] l] [fgdg_q af \mklja]k km[ \Yk [ge hml]jk) G>? k & dhi ma \[ [jqklYd \akhdYqk') e ] \a[Yd] i mahe ]fl) Zag*l][ \fgdg_q af \mklja]k km[ \Yk [ge hml]jk) G>? k & dhi ma \[ [jqklYd \akhdYqk') e ] \a[Yd] i mahe ]fl) Zag*l][ \fgdg_q y Ymlge Ylagf ]i mahe ]fl) Y \n Yf[] \e Yl]jaYd \] d[[ljgfa[k) kg^lo Yj]) Ydl]jf Ylan] [f]j_q Yf \YjjgkhY[]+D kme e Yjq) A? Daf[j]Yk] \hjg \m[lanalq 1 \jgm_ \hjge glaf_ 1][ \fgdg_q Yf \affgnYlagf) o \alpha[ \frac{1}{3} \$ 

#### $+&& = Y_1PL$

 $\label{eq:final_state} Fgj]Yak Yke Yktlj Yj]Y)Znl`Yk YdYj_]j hghmtMagf &15-60 e attlegf)o`a[`ak f]Yjdq lo a[] l`Yl g^ H YdYqkaY Yf\ hggj]j f YmjYd j]kgmj[]k l`Yf H YdYqkaY & YY kgmj[]7 P-N+?]hYjle ]fl'+O`]j]^gj])l`] Fgj]Yf _gn]jfe ]fl[`gk] l`]aj Bjgo l`*D\ mkljq J mlo Yj\*J ja]fl]\ kljYl]_q &B D' & Qf_)/--0)h+.0'+$ 

 $<11^{\circ}] Z]_{aff} af_g^{\circ}] ]phgjl*gja]fl] \land pdd(q) Fgj] Yo Yk \ a^{\circ}]jfl ^{\circ}ge \ H YdYqkaY+R ^{\circ}a] af 1^{\circ}] . 63-k) ]phgjlk g^ hjæ Yjq _gg\k \ ge af Y]\ 1^{\circ}] ]phgjl _gg\k g^ H YdYqkaY) ]phgjlk g^ e Yf mYl[mjaf__gg\k Y[[gmfl]\ ^gj lo g*l^aj\k g^1^] ]glYdFgj] Yf ]phgjl _gg\k +GYZgj*afl]f kan] e Yf mYl[mjaf__gg\k Y[[gmfl]\ ^gj 4-# g^lglYd]phgjl*e Yf mYl[mjaf__gg\k &^ g) . 661) h+ 14'+ R ^al] H YdYqkaY^ Yk [gflafm]\ lg [gfka\]j ]phgjl gja]f lYlagf Yk alk d] Yl af_ hgdb[q) ^jge 1^{\circ}] . 63-k lg 1^{\circ}] hj]k]fl) Fgj]Yj]Ydr]\ 1^{\circ}Y e Ypæ ar af_ ]phgjl k o Yk fgl Ydb Yqk Y_gg\ hgdb[q) Yf\ e Yl] Yf Yl bnkle ]fl af ][gfge a[ kljYl]_q+C]f[]) 1^{\circ}] Fgj]Yf ]phgjl k Yj] g^ B? K af[j]Yk]\ ^jge . 0-\text{-}# af . 64- lg 0/+# af 1^{\o}] . 65- k &OYZd] /.') Yf\ o Yk 1^{\o}] f c]hl Yjgmf\ 0-# v1-# mh lg 1^{\o}] hj]k]fl+Cgo]n]j) 1^{\o}] H YdYqkaYf ]phgjl k Yj] g^ B? K af[j]Yk]\ [gflaf mgmkdp ^jge 1. +l# af . 64- lg . . -\text{-}# af /--4 Yf\ Yl Y a_ Yn]jY_] d|n]dg^41-2# &OYZd] /.'+$ 

 $Naf[\ ] \ '\ ] \ .63-k) \ Fgj]Y \ 'Yk \ j] \ 'Kar] \ '\ 'Yh \ |\ 'Nah \ 'Yh \ |\ 'Yh \ '$ 

	) 1/) %-	) 1/. %%(	) 10) %-	) 10. % (	)11)%+
= <b>Y</b> \ <b>PL</b>	. +6	- +1	2	. +0	- <del>-</del> B
? LVc]TL	. 2⊬	2	5	2	/ 1-3

 $G(b\_PR3IB7H58"NPVRQV>Z\backslash\%)), \%'+\#$ 

 $= ]^gj] l^3 - f Yf [aYd [jakak) l^3] ggd g^A? Do Yk f gl j] [g_f ar] \ Zq l^3 ] F gj] Yf \_gn] f le f le Yn] f g af [] f lan] k lg Yllj Yl A? D \ m] lg ^] Yj l^Y Y ^gj] a_f [ge h Yf q o gmd \ ge af Yl] l^3] e Yjc] l+J f l^3 ] gl^3 ] Yf \ Yk e ] f lagf] \ YZgn] l^3 ] \ ge ] kla( ^aje k \ a\ f gl ^ Yn) Yf q af [] f lan] lg$ 

#### , 5A@5>FD;A@D

O`ak [`Yhl]j Yhhdı]k l`] ^gmj\*nYjaYZd] Q<Meg\]d) o`a(`ak [gfkljm[l]\ ^jge ^gmj]f\g\_]fgmknYjaYZd]kw l`] dg\_Yjal`e g^j]YdB? K) l`] dg\_Yjal`e g^j]Ydlphgjlk) l`] dg\_Yjal`e g^j]Ydlæhgjlk Yf\ l`] dg\_Yjal`e g^A? Dv af gj\]j lg gZk]jn] l`] afl]\_jYl]\ j]dMagfk`ah Z]lo]]f ljY\]) A? DYf\][gfge af \_jgo l` ^gj H YdYqkaY Yf\ Fgj]Y\mjaf\_ l`] læ] h]jag\ ^jge . 64- lg /--1 &H YdYqkaY Yf\ ^jge . 643 lg /--4 &Fgj]Y+

, ,

#### C787C7@57D

- | f lagm) K+Yf\ <+Njjd| lak+/---+J mlhml Bjgo l`Yf\ QYjaYZaddq g^@phgjl Yf\ To hgjl Bjgo l`7
  To ljif Ylagf Yd @na\ ]f[] ^jge BjYf\_]j > YmkYddq O] klk+HUR8RCRX / VT9P [\ ZVR LLLJ ==XT . 1. VT30+
- <d\_mM(ad) H +O+Yf\ Q+J jlk+/--0+Dfo Yj\ Agj]a\_f ? aj][1 Dfn]kle ]f1 Yf\ De hgjlk af NhYaf+  $\neq$  aR\_J NaW | NY9 P\_i\ Z VP > b\_NY. 47. 6v05+
- $< kYm^* < bYq]) E+Yf \ ? +> `Ycj YZgjlq+. 666+@phgjl*G] \ Bjgo l` Yf \ De hgjl > ge hj]kkagf 7 Anjl` ]j Oae ] Njja]k @na\ ]f[] 'jge <math>G? > k+5b`a\_NW9P \ [\ ZVP' DN]R\_` 057. 31v. 42+$
- = Y Yjme k' Y) < +U+Yf\ N+MYk' a\ +. 666+@phgjlk) De hgjlk Yf\ @[gfge a[ Bjgo l' af H YdYqkaY7 @e haja[Yd@na\]f[] = Yk]\ gf H mdan YjaYl] Oae | N|ja|k+5`W|  $9P_1/ZVP > b_1/NY$ . 07056v1-3+
- $= Y e Yfa^*J kcgg]]) H + Yf \ C + E+M]] + .664 + <j] De hgjlk Yf \ @phgjlk g^F gj] Y > gafl]_jY] \ ;$  $= dR \int NdV [NY9P_i \ Z + D JN. .7. 6v. .. +$
- O+) R +AYf\_) R +Gam) Yf\ O+C]fjq+/---+@phgjlk De hgjlk Yf\ De [ge ] af OYao Yf7<f @pYe af Ylagf g^1`] @phgjl\*G]\ Bjgo 1` Cqhg1`] kak+= $\frac{1}{2} \frac{1}{2} \frac{1}{2$
- >`g) N+.  $661+HUR8f[NZVP` \ S? \ RV[9P\ [\ ZVP8RcRX]\ ]ZR[a+R Yk`af_lgf? > 7Diklalml] ^gj$  Dil] jf Ylagf Yd @f ge a[k+
- $@f \setminus jk$  R +/--0+5]]  $XRQ9P \setminus [XRa_VPHZRGR_VR+CgZgc]f$  I E/R adjq+
- @k^Y Yf a) C+N+. 66. +@phgjlk) De hgjlk Yf\ @[gf ge a[ Bjgo l` af N]e a\*D\ mkljadar]\ > gmf lja] k+  $\Rightarrow b \int M \setminus S8 RcRY [ZR] a9P [\setminus ZVP] 02760v...3+$
- $Anf_) C \not= B \not= +NYo `f] q) R \not= +Gg) Yf \ K+S aYf_+. 661+@phgjlk) De hgjlk Yf \ Df \ mkljaYd Kjg \ mf lagf 7 @na\ ]f[] ^jge < \nYf[] \ Yf \ I ]o dq Df \ mkljaYdar af_ > gmf lja] k+<math>\neq aR \int NdV [NY + QR \int NdV] Nf \ P = NYS + P = NYS +$
- CkaYg) A+N+O+Yf\ H  $\not$ >+R +CkaYg+/--3+A? D @phgjlk) Yf\ B? K af @Ykl Yf\ Ngml`] Ykl < kaYw KYf]d? YlYn]jknk Oae ] N]ja]k > YnkYddq < f Ydqk]k+ $\Rightarrow$ b $\int MY S5$ `W $\int P \{ |X|^2 \cdot 47.-5/v..-3+ MY S5$
- Cmkl]\) N+. 66/+0`] @e ]j\_af\_P+N+>mjj]f1 < [[gmf1?]^a[al af 1`] .  $65-k7Y>gaf1]_j$  Magf < f Ythkak+HUR FRc VRd \  $S9P_i$  \ Z VP' N/Q GaNdV dP' 417. 26v. 33+

IDH A + & - - 6' +

		<b>"</b> ~