EMI and productivity

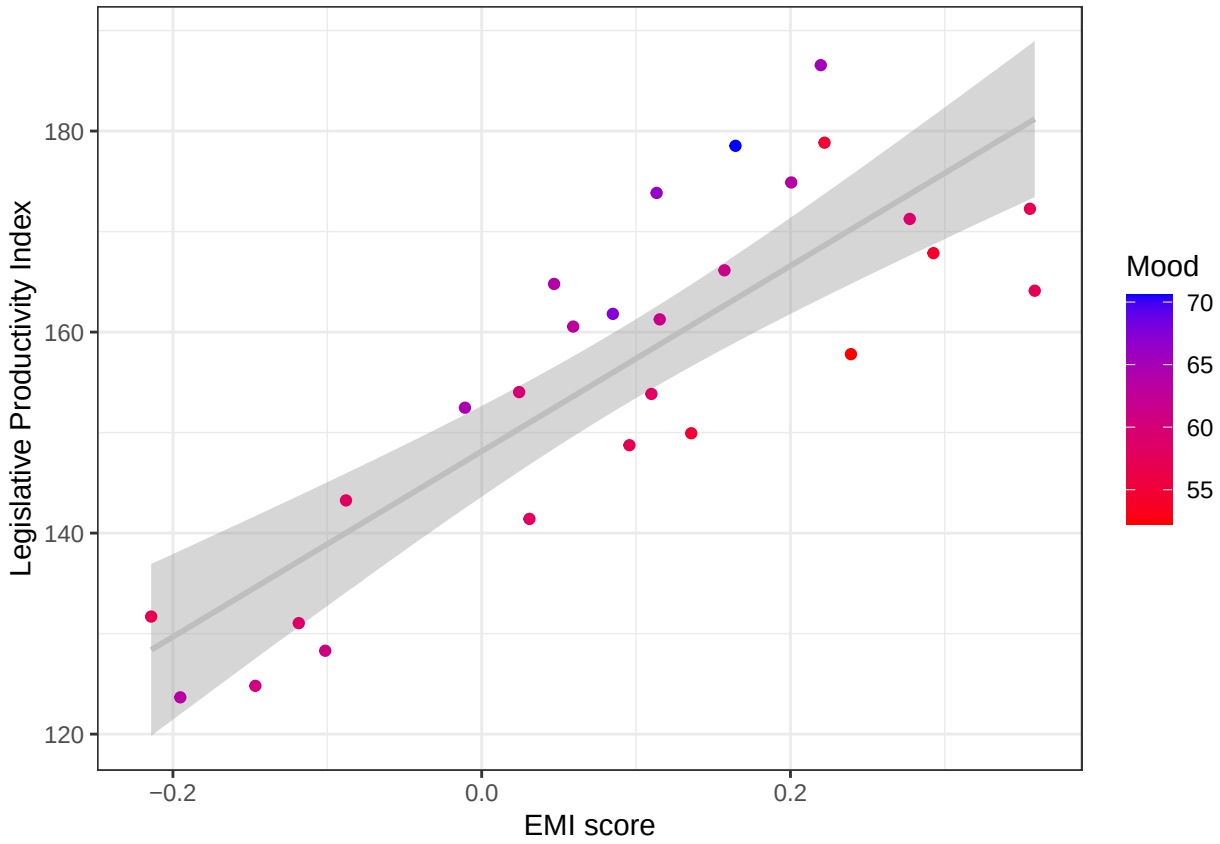
David Garcia and Segun Aroyehun

1: Scatter plots

```
library(dplyr)
library(lmtest)
library(sandwich)
library(tseries)
library(ggplot2)
library(ggrepel)
library(stargazer)
library(car)
library(interactions)
library(lsr)
output_path <- "output"

df <- read.csv("data/emi_congressw2v_prod_variables_public_laws.csv")
df_avg <- df %>% rowwise() %>% mutate(Avg_pol=mean(c(House_party.mean.diff.d1, Senate_party.mean.diff.d
df_avg$EMI <- df_avg$evidence_minus_intuition_score

mood_df <- read.csv('data/mood_biannual.csv')
names(mood_df)[names(mood_df) == "FirstYear"] <- "starting_year"
df_avg %>% left_join(mood_df, by = "starting_year") -> df_plot

df_plot %>% filter(!is.na(Mood)) -> df_plot

ggplot(df_plot, aes(x=EMI, y=LPI, color=Mood)) + geom_smooth(method = "lm", color="gray") + geom_point()
```

```
## Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
```

```
## Warning: Removed 9 rows containing missing values (`geom_point()`).
```

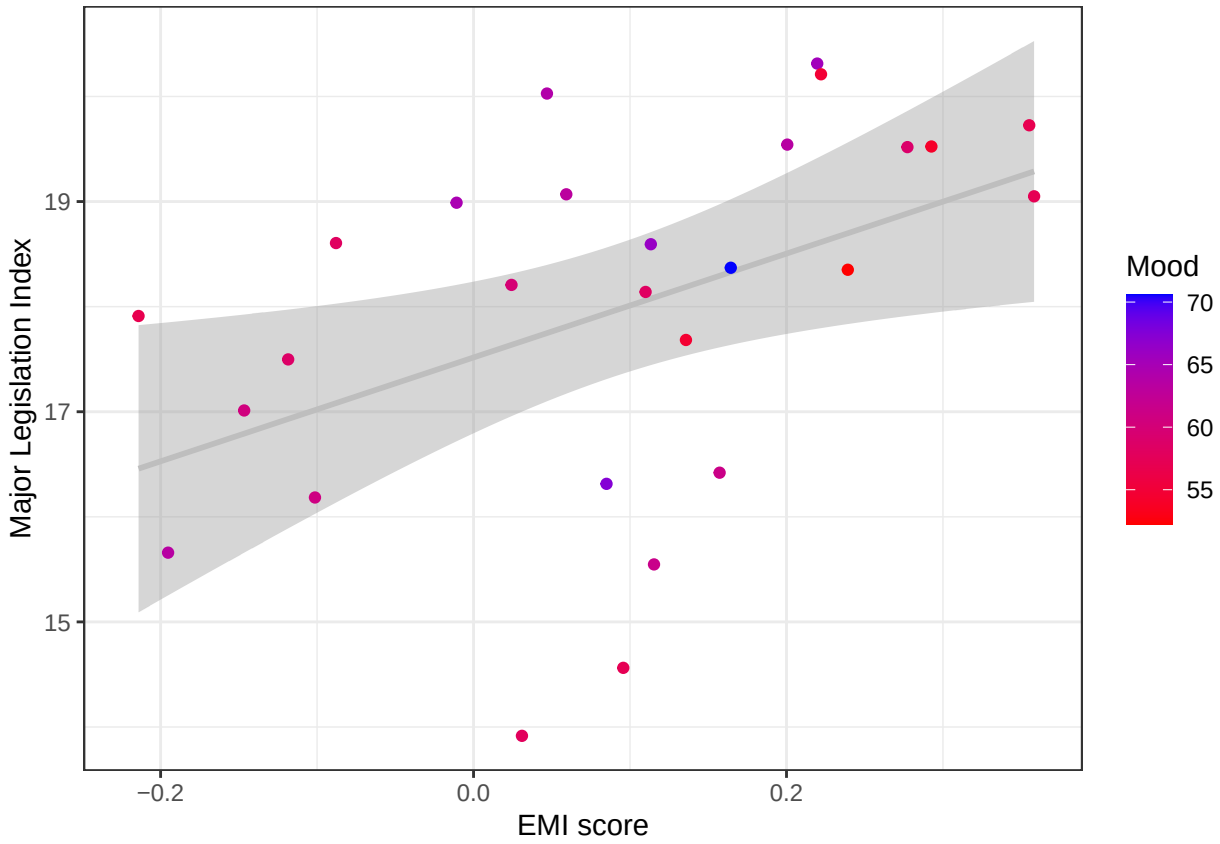



```
ggsave(filename = file.path(output_path, "LPI_scatter.pdf"), width = 4, height = 3, dpi = 300, device =
```

```
## Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
## Removed 9 rows containing missing values (`geom_point()`).
```

```
ggplot(df_plot, aes(x=EMI, y=MLI, color=Mood)) + geom_smooth(method = "lm", color="gray") + geom_point(
```

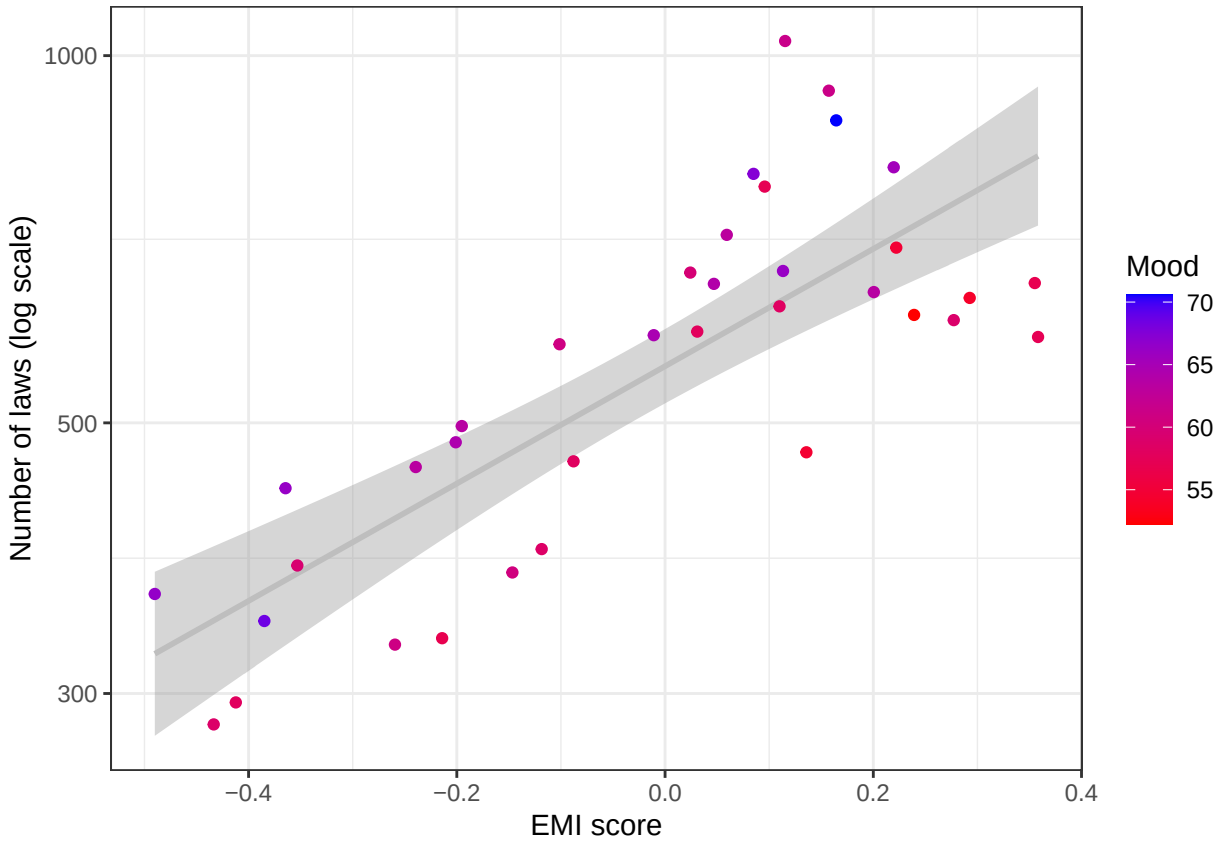
```
## Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
## Removed 9 rows containing missing values (`geom_point()`).
```




```
ggsave(filename = file.path(output_path, "MLI_scatter.pdf"), width = 4, height = 3, dpi = 300, device =
```

```
## Warning: Removed 9 rows containing non-finite values (`stat_smooth()`).
## Removed 9 rows containing missing values (`geom_point()`).
```

```
ggplot(df_plot, aes(x=EMI, y=nlaw, color=Mood)) + geom_smooth(method = "lm", color="gray")  + geom_poin
```




```
ggsave(filename = file.path(output_path, "nlaw_scatter.pdf"), width = 4, height = 3, dpi = 300, device =
```

2: Models including mood

```
df <- read.csv("data/emi_congressw2v_prod_variables_public_laws.csv")

df_avg <- df %>% rowwise() %>% mutate(Avg_pol=mean(c(House_party.mean.diff.d1, Senate_party.mean.diff.d

df_avg$MLI <- scale(df_avg$MLI)
df_avg$MLIpre <- lag(df_avg$MLI)
df_avg$LPI <- scale(df_avg$LPI)
df_avg$LPIpre <- lag(df_avg$LPI)
df_avg$lognlaw <- scale(log(df_avg$count))
df_avg$lognlawpre <- lag(df_avg$lognlaw)

df_avg$controlDif <- df_avg$party_control!=lag(df_avg$party_control)
df_avg$controlDif <- df_avg$party_control!=lag(df_avg$party_control)
df_avg$EMI <- scale(df_avg$evidence_minus_intuition_score)
df_avg$Pol <- scale(df_avg$Avg_pol)
df_avg$logpatents <- scale(log(df_avg$number_of_patents))


mood_df <- read.csv('data/mood_biannual.csv')
names(mood_df)[names(mood_df) == "FirstYear"] <- "starting_year"

df_avg %>% left_join(mood_df, by = "starting_year") -> df_avg_mood
```

```
df_avg_mood$MLIpre <- lag(df_avg_mood$MLI)
df_avg_mood$LPIpre <- lag(df_avg_mood$LPI)
df_avg_mood$lognlawpre <- lag(df_avg_mood$lognlaw)
df_avg_mood$controlDif <- df_avg_mood$party_control!=lag(df_avg_mood$party_control)
df_avg_mood$controlDif <- df_avg_mood$party_control!=lag(df_avg_mood$party_control)


df_avg_mood %>% filter(LastYear>=1949) -> df_avg_mood #one session before mood data starts

df_avg_mood$MLI <- scale(df_avg_mood$MLI)
df_avg_mood$LPI <- scale(df_avg_mood$LPI)
df_avg_mood$lognlaw <- scale(log(df_avg_mood$count))

df_avg_mood$MLIpre <- scale(df_avg_mood$MLIpre)
df_avg_mood$LPIpre <- scale(df_avg_mood$LPIpre)
df_avg_mood$lognlawpre <- scale(df_avg_mood$lognlawpre)

df_avg_mood$EMI <- scale(df_avg_mood$evidence_minus_intuition_score)
df_avg_mood$Pol <- scale(df_avg_mood$Avg_pol)
df_avg_mood$logpatents <- scale(log(df_avg_mood$number_of_patents))
df_avg_mood$Mood <- scale(df_avg_mood$Mood)

attach(df_avg_mood)

model_mli0 <- lm(MLI~MLIpre+Pol+party_control+controlDif+Mood)
etaSquared(model_mli0)
```

```
##                    eta.sq eta.sq.part
## MLIpre        0.808378529  0.81637089
## Pol           0.032738306  0.15257658
## party_control 0.005064057  0.02709567
## controlDif    0.007241234  0.03829870
## Mood          0.028794833  0.13671060
```

```
model_mli0_coefs <- coeftest(model_mli0, vcov=vcovHAC(model_mli0))
model_mli <- lm(MLI~MLIpre+EMI*Pol+party_control+controlDif+Mood)
vif(model_mli)
```

```
##        MLIpre           EMI           Pol party_control    controlDif
##      2.078284      6.334590      4.680607      1.194112      1.170732
##          Mood       EMI:Pol
##      1.206852      2.322269
```

```
model_mli_coefs <- coeftest(model_mli, vcov=vcovHAC(model_mli))
model_mli_coefs
```

```
##
## t test of coefficients:
##
##                   Estimate Std. Error t value  Pr(>|t|)
## (Intercept)      -0.135679   0.159269 -0.8519  0.404889
## MLIpre            0.768745   0.072478 10.6066 2.021e-09 ***
## EMI               0.669028   0.253970  2.6343  0.016343 *
## Pol               0.211636   0.237671  0.8905  0.384357
## party_controlUNI -0.084345   0.187283 -0.4504  0.657548
```

```
## controlDifTRUE    0.266026   0.194546  1.3674  0.187454
## Mood              0.236889   0.082201  2.8818  0.009552 **
## EMI:Pol           0.232486   0.297494  0.7815  0.444149
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
adf.test(residuals(model_mli))
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  residuals(model_mli)
## Dickey-Fuller = -2.8176, Lag order = 2, p-value = 0.2603
## alternative hypothesis: stationary
```

```
kpss.test(residuals(model_mli))
```

```
## Warning in kpss.test(residuals(model_mli)): p-value greater than printed p-value
```

```
##
##  KPSS Test for Level Stationarity
##
## data:  residuals(model_mli)
## KPSS Level = 0.062135, Truncation lag parameter = 2, p-value = 0.1
```

```
jarque.bera.test(residuals(model_mli))
```

```
##
##  Jarque Bera Test
##
## data:  residuals(model_mli)
## X-squared = 0.94254, df = 2, p-value = 0.6242
```

```
model_lpi0 <- lm(LPI~LPIpre+Pol+party_control+controlDif+Mood)
etaSquared(model_lpi0)
```

```
##                    eta.sq eta.sq.part
## LPIpre        0.271513405  0.65881342
## Pol           0.040244786  0.22252359
## party_control 0.004309374  0.02973605
## controlDif    0.010229684  0.06781759
## Mood          0.028231226  0.16720429
```

```
model_lpi0_coefs <- coeftest(model_lpi0, vcov=vcovHAC(model_lpi0))
model_lpi <- lm(LPI~LPIpre+EMI*Pol+party_control+controlDif+Mood)
vif(model_lpi)
```

```
##        LPIpre           EMI           Pol party_control    controlDif
##      3.281626      5.969536      2.624503      1.188459      1.168623
##          Mood       EMI:Pol
##      1.327453      2.328786
```

```
model_lpi_coefs <- coeftest(model_lpi, vcov=vcovHAC(model_lpi))
model_lpi_coefs
```

```
##
## t test of coefficients:
##
##                   Estimate Std. Error t value  Pr(>|t|)
```

```
## (Intercept)      -0.425279   0.129835 -3.2755 0.0039786 **
## LPIpre            0.444191   0.075341  5.8957 1.121e-05 ***
## EMI               0.827706   0.205655  4.0247 0.0007241 ***
## Pol              -0.137315   0.160821 -0.8538 0.4038303
## party_controlUNI -0.065400   0.138079 -0.4736 0.6411494
## controlDifTRUE    0.294248   0.140824  2.0895 0.0503518 .
## Mood              0.298359   0.068927  4.3286 0.0003620 ***
## EMI:Pol           0.129086   0.246394  0.5239 0.6064038
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
adf.test(residuals(model_lpi))
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  residuals(model_lpi)
## Dickey-Fuller = -3.4675, Lag order = 2, p-value = 0.06793
## alternative hypothesis: stationary
```

```
kpss.test(residuals(model_lpi))
```

```
## Warning in kpss.test(residuals(model_lpi)): p-value greater than printed p-value
```

```
##
##  KPSS Test for Level Stationarity
##
## data:  residuals(model_lpi)
## KPSS Level = 0.054263, Truncation lag parameter = 2, p-value = 0.1
```

```
jarque.bera.test(residuals(model_lpi))
```

```
##
##  Jarque Bera Test
##
## data:  residuals(model_lpi)
## X-squared = 0.22468, df = 2, p-value = 0.8937
```

```
model_nlaws0 <- lm(lognlaw~lognlawpre+Pol+party_control+controlDif+Mood)
etaSquared(model_nlaws0)
```

```
##                     eta.sq  eta.sq.part
## lognlawpre    0.0096487085 0.0569943969
## Pol           0.2002032412 0.5563569345
## party_control 0.0019253622 0.0119166649
## controlDif    0.0000307087 0.0001923209
## Mood          0.0913819077 0.3640344660
```

```
model_nlaws0_coefs <- coeftest(model_nlaws0, vcov=vcovHAC(model_nlaws0))
model_nlaws <- lm(lognlaw~lognlawpre+EMI+Pol+party_control+controlDif+Mood)
vif(model_nlaws)
```

```
##    lognlawpre           EMI           Pol party_control    controlDif
##      6.255830      6.159443     12.986386      1.160240      1.144889
##          Mood
##      1.563108
```

```
model_nlaws <- lm(lognlaw~lognlawpre+EMI*Pol+party_control+controlDif+Mood)
model_nlaws_coefs <- coeftest(model_nlaws, vcov=vcovHAC(model_nlaws))
```

```
model_nlaws_coefs
```

```
##
## t test of coefficients:
##
##                     Estimate Std. Error t value  Pr(>|t|)
## (Intercept)        0.0057518  0.1247802  0.0461  0.963561
## lognlawpre        -0.2061457  0.1571212 -1.3120  0.200170
## EMI                0.2698952  0.1580621  1.7075  0.098791 .
## Pol               -0.8918055  0.2642280 -3.3751  0.002178 **
## party_controlUNI -0.0618383  0.2021352 -0.3059  0.761924
## controlDifTRUE     0.0518599  0.1524204  0.3402  0.736213
## Mood               0.3937340  0.0791867  4.9722 2.992e-05 ***
## EMI:Pol            0.0024512  0.0976903  0.0251  0.980160
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
adf.test(residuals(model_nlaws))
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  residuals(model_nlaws)
## Dickey-Fuller = -3.8164, Lag order = 3, p-value = 0.03057
## alternative hypothesis: stationary
```

```
kpss.test(residuals(model_nlaws))
```

```
## Warning in kpss.test(residuals(model_nlaws)): p-value greater than printed
## p-value
```

```
##
##  KPSS Test for Level Stationarity
##
## data:  residuals(model_nlaws)
## KPSS Level = 0.05562, Truncation lag parameter = 3, p-value = 0.1
```

```
jarque.bera.test(residuals(model_nlaws))
```

```
##
##  Jarque Bera Test
##
## data:  residuals(model_nlaws)
## X-squared = 1.1435, df = 2, p-value = 0.5645
```

```
stargazer(model_mli,model_lpi, model_nlaws,type = "latex", digits = 2, df = F,
          se=list(model_mli_coefs[,2], model_lpi_coefs[,2], model_nlaws_coefs[,2]),
          p=list(model_mli_coefs[,4], model_lpi_coefs[,4],  model_nlaws_coefs[,4]),
          out="output/EMI-Prod-Mood-LM.tex")
```

```
##
## % Table created by stargazer v.5.2.3 by Marek Hlavac, Social Policy Institute. E-mail: marek.hlavac a
## % Date and time: Wed, Mar 27, 2024 - 12:20:55
## \begin{table}[!htbp] \centering
##   \caption{}
##   \label{}
## \begin{tabular}{@{\extracolsep{5pt}}lccc}
```

```
## \\[-1.8ex]\hline
## \hline \\[-1.8ex]
##  & \multicolumn{3}{c}{\textit{Dependent variable:}} \\
## \cline{2-4}
## \\[-1.8ex] & MLI & LPI & lognlaw \\
## \\[-1.8ex] & (1) & (2) & (3)\\
## \hline \\[-1.8ex]
##  MLIpre & 0.77$^{***}$ &  &  \\
##   & (0.07) &  &  \\
##   & & & \\
##  LPIpre &  & 0.44$^{***}$ &  \\
##   &  & (0.08) &  \\
##   & & & \\
##  lognlawpre &  &  & $-$0.21 \\
##   &  &  & (0.16) \\
##   & & & \\
##  EMI & 0.67$^{**}$ & 0.83$^{***}$ & 0.27$^{*}$ \\
##   & (0.25) & (0.21) & (0.16) \\
##   & & & \\
##  Pol & 0.21 & $-$0.14 & $-$0.89$^{***}$ \\
##   & (0.24) & (0.16) & (0.26) \\
##   & & & \\
##  party\_controlUNI & $-$0.08 & $-$0.07 & $-$0.06 \\
##   & (0.19) & (0.14) & (0.20) \\
##   & & & \\
##  controlDif & 0.27 & 0.29$^{*}$ & 0.05 \\
##   & (0.19) & (0.14) & (0.15) \\
##   & & & \\
##  Mood & 0.24$^{***}$ & 0.30$^{***}$ & 0.39$^{***}$ \\
##   & (0.08) & (0.07) & (0.08) \\
##   & & & \\
##  EMI:Pol & 0.23 & 0.13 & 0.002 \\
##   & (0.30) & (0.25) & (0.10) \\
##   & & & \\
##  Constant & $-$0.14 & $-$0.43$^{***}$ & 0.01 \\
##   & (0.16) & (0.13) & (0.12) \\
##   & & & \\
## \hline \\[-1.8ex]
## Observations & 27 & 27 & 36 \\
## R$^{2}$ & 0.85 & 0.92 & 0.85 \\
## Adjusted R$^{2}$ & 0.80 & 0.89 & 0.82 \\
## Residual Std. Error & 0.45 & 0.33 & 0.43 \\
## F Statistic & 15.45$^{***}$ & 30.91$^{***}$ & 23.06$^{***}$ \\
## \hline
## \hline \\[-1.8ex]
## \textit{Note:}  & \multicolumn{3}{r}{$^{*}$p$<$0.1; $^{**}$p$<$0.05; $^{***}$p$<$0.01} \\
## \end{tabular}
## \end{table}
```

```
stargazer(model_mli,model_lpi, model_nlaws,type = "text", digits = 2, df = F,
          se=list(model_mli_coefs[,2], model_lpi_coefs[,2], model_nlaws_coefs[,2]),
          p=list(model_mli_coefs[,4], model_lpi_coefs[,4],  model_nlaws_coefs[,4]),
          out="output/EMI-Prod-Mood-LM.txt")
```

```
##
```

```
## ================================================
##                          Dependent variable:
##                      ---------------------------
##                         MLI       LPI     lognlaw
##                         (1)       (2)       (3)
## ------------------------------------------------
## MLIpre                0.77***
##                       (0.07)
##
## LPIpre                          0.44***
##                                 (0.08)
##
## lognlawpre                                 -0.21
##                                           (0.16)
##
## EMI                   0.67**    0.83***    0.27*
##                       (0.25)    (0.21)    (0.16)
##
## Pol                    0.21      -0.14   -0.89***
##                       (0.24)    (0.16)    (0.26)
##
## party_controlUNI       -0.08     -0.07     -0.06
##                       (0.19)    (0.14)    (0.20)
##
## controlDif             0.27      0.29*     0.05
##                       (0.19)    (0.14)    (0.15)
##
## Mood                  0.24***   0.30***   0.39***
##                       (0.08)    (0.07)    (0.08)
##
## EMI:Pol                0.23      0.13      0.002
##                       (0.30)    (0.25)    (0.10)
##
## Constant               -0.14   -0.43***    0.01
##                       (0.16)    (0.13)    (0.12)
##
## ------------------------------------------------
## Observations            27        27        36
## R2                     0.85      0.92      0.85
## Adjusted R2            0.80      0.89      0.82
## Residual Std. Error    0.45      0.33      0.43
## F Statistic          15.45***  30.91***  23.06***
## ================================================
## Note:                  *p<0.1; **p<0.05; ***p<0.01
```

```
stargazer(model_mli0, model_mli, model_lpi0, model_lpi, model_nlaws0, model_nlaws,type = "latex", digits
          se=list(model_mli0_coefs[,2], model_mli_coefs[,2], model_lpi0_coefs[,2], model_lpi_coefs[,2],
          p=list(model_mli0_coefs[,4], model_mli_coefs[,4], model_lpi0_coefs[,4], model_lpi_coefs[,4],
          out="output/EMI-Prod-Mood-LM-ext.tex")
```

```
##
## % Table created by stargazer v.5.2.3 by Marek Hlavac, Social Policy Institute. E-mail: marek.hlavac a
## % Date and time: Wed, Mar 27, 2024 - 12:20:55
## \begin{table}[!htbp] \centering
##   \caption{}
```

```
##   \label{}
## \begin{tabular}{@{\extracolsep{5pt}}lccccc}
## \\[-1.8ex]\hline
## \hline \\[-1.8ex]
##  & \multicolumn{6}{c}{\textit{Dependent variable:}} \\
## \cline{2-7}
## \\[-1.8ex] & \multicolumn{2}{c}{MLI} & \multicolumn{2}{c}{LPI} & \multicolumn{2}{c}{lognlaw} \\
## \\[-1.8ex] & (1) & (2) & (3) & (4) & (5) & (6)\\
## \hline \\[-1.8ex]
##  MLIpre & 0.95$^{***}$ & 0.77$^{***}$ &  &  &  &  \\
##   & (0.06) & (0.07) &  &  &  &  \\
##   & & & & & & \\
##  EMI &  & 0.67$^{**}$ &  & 0.83$^{***}$ &  & 0.27$^{*}$ \\
##   &  & (0.25) &  & (0.21) &  & (0.16) \\
##   & & & & & & \\
##  LPIpre &  &  & 0.75$^{***}$ & 0.44$^{***}$ &  &  \\
##   &  &  & (0.09) & (0.08) &  &  \\
##   & & & & & & \\
##  lognlawpre &  &  &  &  & $-$0.24 & $-$0.21 \\
##   &  &  &  &  & (0.15) & (0.16) \\
##   & & & & & & \\
##  Pol & $-$0.31$^{***}$ & 0.21 & $-$0.45$^{**}$ & $-$0.14 & $-$1.16$^{***}$ & $-$0.89$^{***}$ \\
##   & (0.08) & (0.24) & (0.16) & (0.16) & (0.14) & (0.26) \\
##   & & & & & & \\
##  party\_controlUNI & $-$0.16 & $-$0.08 & $-$0.14 & $-$0.07 & $-$0.10 & $-$0.06 \\
##   & (0.17) & (0.19) & (0.14) & (0.14) & (0.20) & (0.20) \\
##   & & & & & & \\
##  controlDif & 0.19 & 0.27 & 0.23 & 0.29$^{*}$ & 0.01 & 0.05 \\
##   & (0.20) & (0.19) & (0.18) & (0.14) & (0.16) & (0.15) \\
##   & & & & & & \\
##  Mood & 0.17$^{**}$ & 0.24$^{***}$ & 0.17$^{**}$ & 0.30$^{***}$ & 0.37$^{***}$ & 0.39$^{***}$ \\
##   & (0.08) & (0.08) & (0.06) & (0.07) & (0.09) & (0.08) \\
##   & & & & & & \\
##  EMI:Pol &  & 0.23 &  & 0.13 &  & 0.002 \\
##   &  & (0.30) &  & (0.25) &  & (0.10) \\
##   & & & & & & \\
##  Constant & $-$0.16 & $-$0.14 & $-$0.25$^{**}$ & $-$0.43$^{***}$ & 0.03 & 0.01 \\
##   & (0.12) & (0.16) & (0.11) & (0.13) & (0.09) & (0.12) \\
##   & & & & & & \\
## \hline \\[-1.8ex]
## Observations & 27 & 27 & 27 & 27 & 36 & 36 \\
## R$^{2}$ & 0.82 & 0.85 & 0.86 & 0.92 & 0.84 & 0.85 \\
## Adjusted R$^{2}$ & 0.77 & 0.80 & 0.83 & 0.89 & 0.81 & 0.82 \\
## Residual Std. Error & 0.47 & 0.45 & 0.42 & 0.33 & 0.43 & 0.43 \\
## F Statistic & 18.90$^{***}$ & 15.45$^{***}$ & 25.67$^{***}$ & 30.91$^{***}$ & 31.58$^{***}$ & 23.06$
## \hline
## \hline \\[-1.8ex]
## \textit{Note:}  & \multicolumn{6}{r}{$^{*}$p$<$0.1; $^{**}$p$<$0.05; $^{***}$p$<$0.01} \\
## \end{tabular}
## \end{table}
```

```
stargazer(model_mli0, model_mli, model_lpi0, model_lpi, model_nlaws0, model_nlaws,type = "text", digits
          se=list(model_mli0_coefs[,2], model_mli_coefs[,2], model_lpi0_coefs[,2], model_lpi_coefs[,2],
          p=list(model_mli0_coefs[,4], model_mli_coefs[,4], model_lpi0_coefs[,4], model_lpi_coefs[,4],
```

```
          out="output/EMI-Prod-Mood-LM-ext.txt")
```

```
##
## ===============================================================================
##                                      Dependent variable:
##                     ------------------------------------------------------------
##                             MLI                LPI              lognlaw
##                       (1)      (2)      (3)      (4)      (5)      (6)
## -------------------------------------------------------------------------------
## MLIpre               0.95***  0.77***
##                       (0.06)   (0.07)
##
## EMI                            0.67**            0.83***            0.27*
##                                (0.25)            (0.21)            (0.16)
##
## LPIpre                                   0.75***  0.44***
##                                           (0.09)   (0.08)
##
## lognlawpre                                                  -0.24    -0.21
##                                                             (0.15)   (0.16)
##
## Pol                  -0.31***   0.21   -0.45**   -0.14   -1.16*** -0.89***
##                       (0.08)   (0.24)   (0.16)   (0.16)   (0.14)   (0.26)
##
## party_controlUNI      -0.16    -0.08    -0.14    -0.07    -0.10    -0.06
##                       (0.17)   (0.19)   (0.14)   (0.14)   (0.20)   (0.20)
##
## controlDif             0.19     0.27     0.23    0.29*     0.01     0.05
##                       (0.20)   (0.19)   (0.18)   (0.14)   (0.16)   (0.15)
##
## Mood                  0.17**  0.24***   0.17**  0.30***  0.37***  0.39***
##                       (0.08)   (0.08)   (0.06)   (0.07)   (0.09)   (0.08)
##
## EMI:Pol                        0.23              0.13              0.002
##                                (0.30)            (0.25)            (0.10)
##
## Constant              -0.16    -0.14   -0.25**  -0.43***   0.03     0.01
##                       (0.12)   (0.16)   (0.11)   (0.13)   (0.09)   (0.12)
##
## -------------------------------------------------------------------------------
## Observations            27       27       27       27       36       36
## R2                     0.82     0.85     0.86     0.92     0.84     0.85
## Adjusted R2            0.77     0.80     0.83     0.89     0.81     0.82
## Residual Std. Error    0.47     0.45     0.42     0.33     0.43     0.43
## F Statistic         18.90*** 15.45*** 25.67*** 30.91*** 31.58*** 23.06***
## ===============================================================================
## Note:                                          *p<0.1; **p<0.05; ***p<0.01
```

3: MLI models with patents

```
df <- read.csv("data/emi_congressw2v_prod_variables_public_laws.csv")
attach(df_avg)
```

```r
model_mli0 <- lm(MLI~MLIpre+Pol+logpatents+party_control+controlDif)
model_mli0_coefs <- coeftest(model_mli0, vcov=vcovHAC(model_mli0))
model_mli0_coefs
```

```
##
## t test of coefficients:
##
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -0.018147   0.050406 -0.3600 0.720197
## MLIpre            0.672853   0.094005  7.1576  1.9e-09 ***
## Pol              -0.194202   0.068747 -2.8249 0.006542 **
## logpatents        0.276589   0.114696  2.4115 0.019192 *
## party_controlUNI  0.071211   0.071376  0.9977 0.322722
## controlDifTRUE    0.095482   0.076728  1.2444 0.218528
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
model_mli <- lm(MLI~MLIpre+EMI+Pol+logpatents+party_control+controlDif)
vif(model_mli)
```

```
##        MLIpre           EMI           Pol    logpatents party_control
##      9.426628      1.596349      3.181818      5.379051      1.204671
##    controlDif
##      1.094396
```

```r
model_mli <- lm(MLI~MLIpre+EMI*Pol+logpatents+party_control+controlDif)
model_mli_coefs <- coeftest(model_mli, vcov=vcovHAC(model_mli))
model_mli_coefs
```

```
##
## t test of coefficients:
##
##                   Estimate Std. Error t value  Pr(>|t|)
## (Intercept)      -0.058277   0.056239 -1.0362  0.304715
## MLIpre            0.588313   0.083092  7.0802 3.052e-09 ***
## EMI               0.109546   0.048499  2.2587  0.027962 *
## Pol              -0.197662   0.071641 -2.7591  0.007897 **
## logpatents        0.367314   0.104140  3.5271  0.000866 ***
## party_controlUNI  0.101495   0.068182  1.4886  0.142414
## controlDifTRUE    0.108690   0.076561  1.4197  0.161456
## EMI:Pol          -0.020009   0.086607 -0.2310  0.818160
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```r
adf.test(residuals(model_mli))
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  residuals(model_mli)
## Dickey-Fuller = -4.0324, Lag order = 3, p-value = 0.01411
## alternative hypothesis: stationary
```

```r
kpss.test(residuals(model_mli))
```

```
## Warning in kpss.test(residuals(model_mli)): p-value greater than printed p-value
```

```
##
##  KPSS Test for Level Stationarity
##
## data:  residuals(model_mli)
## KPSS Level = 0.054298, Truncation lag parameter = 3, p-value = 0.1
```

```
jarque.bera.test(residuals(model_mli)) #slight skewness in residuals - solved by HAC standard errors
```

```
##
##  Jarque Bera Test
##
## data:  residuals(model_mli)
## X-squared = 10.974, df = 2, p-value = 0.00414
```

```
set.seed(1985)
library(boot)
bootf <- function(df, indices)
{
  model_mli <- lm(MLI~MLIpre+EMI+Pol+logpatents+party_control+controlDif, data=df, subset=indices)
  return(model_mli$coefficients[3])
}
boots <- boot(df_avg, bootf, R=10000)
quantile(boots$t, p=c(0.025, 0.5, 0.975))  # to verify, we perform a bootstrapping test, low part of CI
```

```
##       2.5%        50%      97.5%
## 0.02585457 0.11960447 0.21402484
```

4: LPI and nlaws models with patents

```
model_lpi0 <- lm(LPI~LPIpre+Pol+logpatents+party_control+controlDif)
model_lpi0_coefs <- coeftest(model_lpi0, vcov=vcovHAC(model_lpi0))
model_lpi0_coefs
```

```
##
## t test of coefficients:
##
##                   Estimate Std. Error t value  Pr(>|t|)
## (Intercept)      -0.079888   0.046180 -1.7299  0.089153 .
## LPIpre            0.625272   0.109246  5.7235 4.263e-07 ***
## Pol              -0.294853   0.108469 -2.7183  0.008718 **
## logpatents        0.179419   0.086898  2.0647  0.043592 *
## party_controlUNI  0.141299   0.067478  2.0940  0.040797 *
## controlDifTRUE    0.035849   0.069488  0.5159  0.607952
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
model_lpi <- lm(LPI~LPIpre+EMI+Pol+logpatents+party_control+controlDif)
vif(model_lpi)
```

```
##        LPIpre           EMI           Pol    logpatents party_control
##     12.734637      1.481295      7.673421      3.551798      1.218801
##    controlDif
##      1.144974
```

```
model_lpi <- lm(LPI~LPIpre+EMI*Pol+logpatents+party_control+controlDif)
model_lpi_coefs <- coeftest(model_lpi, vcov=vcovHAC(model_lpi))
```

```
model_lpi_coefs
```

```
##
## t test of coefficients:
##
##                    Estimate Std. Error t value  Pr(>|t|)
## (Intercept)      -0.1111911  0.0468135 -2.3752  0.021120 *
## LPIpre            0.5822219  0.1068017  5.4514 1.271e-06 ***
## EMI               0.0728561  0.0510916  1.4260  0.159627
## Pol              -0.3055842  0.1112943 -2.7457  0.008184 **
## logpatents        0.2174967  0.0843501  2.5785  0.012682 *
## party_controlUNI  0.1691191  0.0669214  2.5271  0.014461 *
## controlDifTRUE    0.0433164  0.0705149  0.6143  0.541605
## EMI:Pol           0.0032665  0.0811126  0.0403  0.968025
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
adf.test(residuals(model_lpi))
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  residuals(model_lpi)
## Dickey-Fuller = -3.2196, Lag order = 3, p-value = 0.09268
## alternative hypothesis: stationary
```

```
kpss.test(residuals(model_lpi))
```

```
## Warning in kpss.test(residuals(model_lpi)): p-value greater than printed p-value
```

```
##
##  KPSS Test for Level Stationarity
##
## data:  residuals(model_lpi)
## KPSS Level = 0.071217, Truncation lag parameter = 3, p-value = 0.1
```

```
jarque.bera.test(residuals(model_lpi))
```

```
##
##  Jarque Bera Test
##
## data:  residuals(model_lpi)
## X-squared = 2.2169, df = 2, p-value = 0.3301
```

```
model_nlaws0 <- lm(lognlaw~lognlawpre+Pol+logpatents+party_control+controlDif)
model_nlaws0_coefs <- coeftest(model_nlaws0, vcov=vcovHAC(model_nlaws0))
model_nlaws0_coefs
```

```
##
## t test of coefficients:
##
##                    Estimate Std. Error t value  Pr(>|t|)
## (Intercept)      -0.021181   0.109402 -0.1936 0.8470972
## lognlawpre        0.327938   0.119670  2.7403 0.0079448 **
## Pol              -0.433469   0.112297 -3.8600 0.0002665 ***
## logpatents       -0.102152   0.077354 -1.3206 0.1913439
## party_controlUNI  0.233465   0.150917  1.5470 0.1267989
```

```
## controlDifTRUE   -0.254417   0.165221 -1.5399 0.1285243
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
model_nlaws <- lm(lognlaw~lognlawpre+EMI+Pol+logpatents+party_control+controlDif)
vif(model_nlaws)
```

```
##    lognlawpre           EMI           Pol    logpatents party_control
##      2.213807      2.271791      2.649096      1.606919      1.196803
##    controlDif
##      1.105261
```

```
model_nlaws <- lm(lognlaw~lognlawpre+EMI*Pol+logpatents+party_control+controlDif)
model_nlaws_coefs <- coeftest(model_nlaws, vcov=vcovHAC(model_nlaws))
model_nlaws_coefs
```

```
##
## t test of coefficients:
##
##                   Estimate Std. Error t value Pr(>|t|)
## (Intercept)      -0.063844   0.133514 -0.4782 0.634203
## lognlawpre        0.323999   0.123855  2.6160 0.011161 *
## EMI               0.049058   0.102349  0.4793 0.633393
## Pol              -0.410465   0.133755 -3.0688 0.003186 **
## logpatents       -0.114012   0.116266 -0.9806 0.330594
## party_controlUNI  0.254166   0.161605  1.5728 0.120863
## controlDifTRUE   -0.250502   0.163899 -1.5284 0.131500
## EMI:Pol          -0.052713   0.102184 -0.5159 0.607788
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
adf.test(residuals(model_nlaws))
```

```
## Warning in adf.test(residuals(model_nlaws)): p-value smaller than printed
## p-value
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  residuals(model_nlaws)
## Dickey-Fuller = -4.3042, Lag order = 4, p-value = 0.01
## alternative hypothesis: stationary
```

```
kpss.test(residuals(model_nlaws))
```

```
## Warning in kpss.test(residuals(model_nlaws)): p-value greater than printed
## p-value
```

```
##
##  KPSS Test for Level Stationarity
##
## data:  residuals(model_nlaws)
## KPSS Level = 0.039311, Truncation lag parameter = 3, p-value = 0.1
```

```
jarque.bera.test(residuals(model_nlaws))
```

```
##
##  Jarque Bera Test
##
```

```
## data:  residuals(model_nlaws)
## X-squared = 1.2794, df = 2, p-value = 0.5275
```

```
stargazer(model_mli0, model_mli, model_lpi0, model_lpi, model_nlaws0, model_nlaws,type = "latex", digits
          se=list(model_mli0_coefs[,2], model_mli_coefs[,2], model_lpi0_coefs[,2], model_lpi_coefs[,2],
          p=list(model_mli0_coefs[,4], model_mli_coefs[,4], model_lpi0_coefs[,4], model_lpi_coefs[,4],
          out="output/EMI-Prod-LM.tex")
```

```
##
## % Table created by stargazer v.5.2.3 by Marek Hlavac, Social Policy Institute. E-mail: marek.hlavac a
## % Date and time: Wed, Mar 27, 2024 - 12:21:07
## \begin{table}[!htbp] \centering
##   \caption{}
##   \label{}
## \begin{tabular}{@{\extracolsep{5pt}}lccccc}
## \\[-1.8ex]\hline
## \hline \\[-1.8ex]
##  & \multicolumn{6}{c}{\textit{Dependent variable:}} \\
## \cline{2-7}
## \\[-1.8ex] & \multicolumn{2}{c}{MLI} & \multicolumn{2}{c}{LPI} & \multicolumn{2}{c}{lognlaw} \\
## \\[-1.8ex] & (1) & (2) & (3) & (4) & (5) & (6)\\
## \hline \\[-1.8ex]
##  MLIpre & 0.67$^{***}$ & 0.59$^{***}$ &  &  &  &  \\
##   & (0.09) & (0.08) &  &  &  &  \\
##   & & & & & & \\
##  EMI &  & 0.11$^{**}$ &  & 0.07 &  & 0.05 \\
##   &  & (0.05) &  & (0.05) &  & (0.10) \\
##   & & & & & & \\
##  LPIpre &  &  & 0.63$^{***}$ & 0.58$^{***}$ &  &  \\
##   &  &  & (0.11) & (0.11) &  &  \\
##   & & & & & & \\
##  lognlawpre &  &  &  &  & 0.33$^{***}$ & 0.32$^{**}$ \\
##   &  &  &  &  & (0.12) & (0.12) \\
##   & & & & & & \\
##  Pol & $-$0.19$^{***}$ & $-$0.20$^{***}$ & $-$0.29$^{***}$ & $-$0.31$^{***}$ & $-$0.43$^{***}$ & $-$0
##   & (0.07) & (0.07) & (0.11) & (0.11) & (0.11) & (0.13) \\
##   & & & & & & \\
##  logpatents & 0.28$^{**}$ & 0.37$^{***}$ & 0.18$^{**}$ & 0.22$^{**}$ & $-$0.10 & $-$0.11 \\
##   & (0.11) & (0.10) & (0.09) & (0.08) & (0.08) & (0.12) \\
##   & & & & & & \\
##  party\_controlUNI & 0.07 & 0.10 & 0.14$^{**}$ & 0.17$^{**}$ & 0.23 & 0.25 \\
##   & (0.07) & (0.07) & (0.07) & (0.07) & (0.15) & (0.16) \\
##   & & & & & & \\
##  controlDif & 0.10 & 0.11 & 0.04 & 0.04 & $-$0.25 & $-$0.25 \\
##   & (0.08) & (0.08) & (0.07) & (0.07) & (0.17) & (0.16) \\
##   & & & & & & \\
##  EMI:Pol &  & $-$0.02 &  & 0.003 &  & $-$0.05 \\
##   &  & (0.09) &  & (0.08) &  & (0.10) \\
##   & & & & & & \\
##  Constant & $-$0.02 & $-$0.06 & $-$0.08$^{*}$ & $-$0.11$^{**}$ & $-$0.02 & $-$0.06 \\
##   & (0.05) & (0.06) & (0.05) & (0.05) & (0.11) & (0.13) \\
##   & & & & & & \\
## \hline \\[-1.8ex]
## Observations & 62 & 62 & 62 & 62 & 70 & 70 \\
## R$^{2}$ & 0.94 & 0.94 & 0.94 & 0.95 & 0.63 & 0.63 \\
```

```
## Adjusted R$^{2}$ & 0.93 & 0.93 & 0.94 & 0.94 & 0.60 & 0.59 \\
## Residual Std. Error & 0.26 & 0.25 & 0.24 & 0.24 & 0.63 & 0.64 \\
## F Statistic & 167.22$^{***}$ & 125.51$^{***}$ & 186.41$^{***}$ & 133.02$^{***}$ & 21.39$^{***}$ & 14
## \hline
## \hline \\[-1.8ex]
## \textit{Note:}  & \multicolumn{6}{r}{$^{*}$p$<$0.1; $^{**}$p$<$0.05; $^{***}$p$<$0.01} \\
## \end{tabular}
## \end{table}
```

```
stargazer(model_mli0, model_mli, model_lpi0, model_lpi, model_nlaws0, model_nlaws,type = "text", digits
          se=list(model_mli0_coefs[,2], model_mli_coefs[,2], model_lpi0_coefs[,2], model_lpi_coefs[,2],
          p=list(model_mli0_coefs[,4], model_mli_coefs[,4], model_lpi0_coefs[,4], model_lpi_coefs[,4],
          out="output/EMI-Prod-LM.txt")
```

```
##
## ===============================================================================
##                                        Dependent variable:
##                      ---------------------------------------------------------
##                              MLI                 LPI              lognlaw
##                        (1)       (2)       (3)       (4)      (5)      (6)
## -------------------------------------------------------------------------------
## MLIpre                0.67***   0.59***
##                       (0.09)    (0.08)
##
## EMI                             0.11**               0.07               0.05
##                                 (0.05)              (0.05)             (0.10)
##
## LPIpre                                    0.63***   0.58***
##                                           (0.11)    (0.11)
##
## lognlawpre                                                     0.33***   0.32**
##                                                                (0.12)    (0.12)
##
## Pol                  -0.19***  -0.20***  -0.29***  -0.31***  -0.43*** -0.41***
##                       (0.07)    (0.07)    (0.11)    (0.11)    (0.11)   (0.13)
##
## logpatents            0.28**    0.37***   0.18**    0.22**    -0.10    -0.11
##                       (0.11)    (0.10)    (0.09)    (0.08)    (0.08)   (0.12)
##
## party_controlUNI       0.07      0.10      0.14**    0.17**    0.23     0.25
##                       (0.07)    (0.07)    (0.07)    (0.07)    (0.15)   (0.16)
##
## controlDif             0.10      0.11      0.04      0.04     -0.25    -0.25
##                       (0.08)    (0.08)    (0.07)    (0.07)    (0.17)   (0.16)
##
## EMI:Pol                         -0.02               0.003              -0.05
##                                 (0.09)              (0.08)             (0.10)
##
## Constant               -0.02     -0.06     -0.08*    -0.11**   -0.02    -0.06
##                       (0.05)    (0.06)    (0.05)    (0.05)    (0.11)   (0.13)
##
## -------------------------------------------------------------------------------
## Observations            62        62        62        62        70       70
## R2                     0.94      0.94      0.94      0.95      0.63     0.63
## Adjusted R2            0.93      0.93      0.94      0.94      0.60     0.59
```

```
## Residual Std. Error   0.26      0.25      0.24      0.24      0.63     0.64
## F Statistic         167.22*** 125.51*** 186.41*** 133.02*** 21.39*** 14.98***
## ============================================================================
## Note:                                          *p<0.1; **p<0.05; ***p<0.01
```