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When Did the Breakdown for the Manufacturing Sector Really Begin?

In an earlier piece in our Occasional Macro notes series, *An ULTRA for the Turkish Industrial Production ENIGMA*, we tried to determine when each sector would start to recover and how severely they had been hit on a sector by sector basis. In that study, however, we had to "guesstimate" the start of the setback for each sector. Moreover, the focus of that piece was to gauge the severity of the crisis for the manufacturing sector and for each particular subsector as well with a specific emphasis on the bottom of the trough and exit dates for the prevailing recession. Entry date (which we prefer to call structural break date here in compliance with the methodology of this piece) was by default a byproduct, but not the main point of focus in our earlier piece.

In this short piece, we use a more formal procedure to pinpoint the date of structural break. We apply Zivot and Andrews (1992) testing procedure whereby they treat the breakpoint as endogenous. For details, please refer to Zivot, E. and Andrews, D. W. K. (1992), "Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis", *Journal of Business & Economic Statistics*, Vol. 10, No. 3, pp. 251-270.

The null hypothesis states that each series is integrated without an exogenous structural break:

$$y_t = \mu + y_{t-1} + \varepsilon_t$$

In the alternative hypothesis, it is assumed that each series can be represented by a trend-stationary process with a single break in the trend at an unknown point in time. The main objective therefore is to find the breakpoint that favours the alternative hypothesis the most. As alternative models, we prefer using specifications that allow only trend and both trend and intercept to have a break:

Model 1:

$$\Delta y_t = \mu_1 + \beta^1 * t + \gamma^1 * DT_t(\lambda) + \alpha^1 * y_{t-1} + \sum_{j=1}^{k} \theta^1 * \Delta y_{t-j} + \varepsilon_t^1$$

Model 2:

$$\Delta y_t = \mu_2 + \delta^2 * DU_t(\lambda) + \beta^2 * t + \gamma^2 * DT_t(\lambda) + \alpha^2 * y_{t-1} + \sum_{j=1}^{k} \theta^2 * \Delta y_{t-j} + \varepsilon_t^2$$

Where $1<\lambda<T$ is the breakpoint and t is the time trend. $DU_t(\lambda) = 1$ if $t > \lambda$ and 0 otherwise. $DT_t(\lambda) = t - \lambda$ if $t > \lambda$ and 0 otherwise. Identification of the breakpoint is based on minimizing the t-statistic for testing $\alpha^i = 0$ over all regressions that include various values of λ.

We used Akaike's Information Criterion to determine the number of additional lags and worked backwards from 9.

We applied the procedure to each sector and identified possible breakpoints between January 2002 and March 2009 period. Data set utilized here is identical with that used in our previous study. Results are as follows:

Sectors	Break		t-value		Lag
	Model 1	Model 2	Model 1	Model 2	
Manufacturing	2008-8	2008-6	-4.55	-4.49	4
Food	2007-4	2005-9	-8.85	-10.86	8
Tobacco	2004-10	2004-6	-3.53	-4.80	5
Textile	2007-12	2007-9	-3.68	-3.77	6
Wearing	2008-1	2007-3	-7.70	-7.88	0
Leather	2008-11	2006-8	-3.72	-3.78	9
Wood	2003-12	2003-7	-3.65	-3.79	7
Paper	2008-9	2008-3	-7.72	-8.00	0
Printing	2004-11	2004-5	-4.04	-4.41	4
Petroleum	2008-10	2008-8	-6.34	-6.18	3
Chemical	2008-6	2008-2	-5.01	-4.92	6
Plastics	2008-6	2008-4	-5.02	-4.96	1
Non-metal	2007-5	2007-4	-5.88	-5.86	9
Basic Metal	2008-7	2008-3	-6.29	-6.66	2
Metal	2008-4	2008-3	-3.69	-3.68	7
Machinery	2008-6	2008-5	-6.49	-6.44	0
Electrical Mach.	2008-8	2007-11	-3.53	-3.67	2
Radio-Tv	2004-12	2006-1	-6.28	-6.90	0
Optical	2003-3	2003-2	-4.18	-4.10	9
Motor Vehicles	2008-6	2008-3	-5.40	-5.70	1
Other Transport	2003-10	2003-1	-3.62	-3.72	4
Furniture	2002-12	2005-1	-5.77	-6.54	0

Sample Period: January 2002 – March 2009

Model 1 critical t-values: -4.42 for 5% and -4.93 for 1%
Model 2 critical t-values:-5.08 for 5% and -5.57 for 1%

In the table above, highlighted cells indicate the statistically significant results. In line with our expectations, it seems that some sectors had experienced a shift in trend long before they actually felt the effects of the global crisis.

The analysis above deals with the whole sample while we are more interested in the impact of the latest developments from 2008 onward. To serve the purpose, we searched for other (second best) breakpoints that fall in the January 2008 – January 2009 period:

Sectors	Break		t-value		Lag
	Model 1	Model 2	Model 1	Model 2	
Manufacturing	2008-8	2008-6	-4.55	-4.49	4
Food	2008-1	2008-1	-8.34	-8.60	8
Tobacco	2008-1	2008-7	-2.54	-2.60	5
Textile	2008-1	2008-2	-3.64	-3.58	6
Wearing	2008-1	2008-4	-7.70	-7.67	0
Leather	2008-11	2008-12	-3.72	-3.70	9
Wood	2008-12	2008-4	-3.11	-3.22	7
Paper	2008-9	2008-3	-7.72	-8.00	0
Printing	2008-1	2008-1	-3.21	-3.36	4
Petroleum	2008-10	2008-8	-6.34	-6.18	3
Chemical	2008-6	2008-2	-5.01	-4.92	6
Plastics	2008-6	2008-4	-5.02	-4.96	1
Non-metal	2008-1	2008-1	-4.59	-4.58	9
Basic Metal	2008-7	2008-3	-6.29	-6.66	2
Metal	2008-4	2008-3	-3.69	-3.68	7
Machinery	2008-6	2008-5	-6.49	-6.44	0
Electrical Mach.	2008-8	2008-5	-3.53	-3.49	2
Radio-Tv	2008-1	2008-1	-5.20	-5.44	0
Optical	2008-8	2008-11	-3.60	-3.25	9
Motor Vehicles	2008-6	2008-3	-5.40	-5.70	1
Other Transport	2008-12	2008-12	-2.00	-2.14	4
Furniture	2008-7	2008-3	-5.36	-5.78	0

Sample Period: January 2008 – January 2009

Model 1 critical t-values: -4.42 for 5% and -4.93 for 1%
Model 2 critical t-values:-5.08 for 5% and -5.57 for 1%

Although it is difficult to make a clear cut distinction between the models due to lack of data in the post-era of possible structural breaks in 2008, the second model seems to fit Turkish industrial production data better than the first model. For instance, second model asserts that both level and trend for manufacturing sector production shifted as of June 2008. First model, on the other hand, detects a shift in trend as of August 2008.

We would like to draw attention to the finding that for the entire manufacturing industry, it does not matter whether one takes the full sample period or the one constrained by the post-2008 slice of the full period. In both cases, the break period comes out as 2008-08 and 2008-06 for model 1 and model 2, respectively. One would also have to keep in mind that as data for the post-2008 period keeps piling up, current statistically insignificant break inferences could have to be reversed and the dates stated above for series not highlighted in the table would become the most likely date candidates for shift realizations (technically speaking, the likelihood that the t-values would be approaching the threshold test values would be increasing provided that another break does not occur).

The procedure implemented here is data-driven and therefore results may change if we repeat the analysis with more observations in the ex-post period. Yet, the approach is efficient enough to show us the relative positions of sectors vis-à-vis each other in the current economic setting and provides a plausible starting point for further research.

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