# Online Appendix: small steps for workers, a giant leap for productivity

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Work Hours and Wage Premium    Total monthly work hours (regular work hours plus overtime) are presented in the following figure. We have data on monthly work hours only for a part of the entire sample period.

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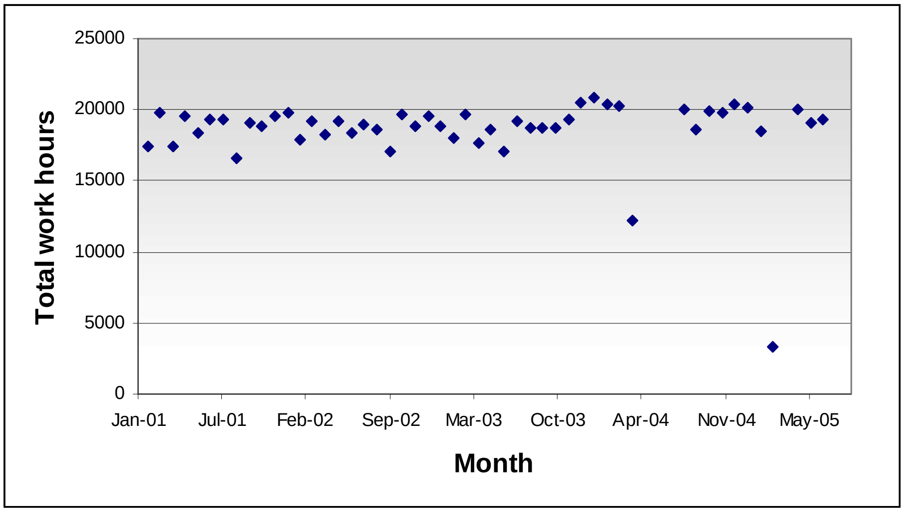


Figure A1: Total work hours, January 2001 - July 2005

The figure shows clearly that monthly work hours remained pretty much constant. It is interesting to note that during the period covered by the figure, the output of billets has increased from an average level of $13,957$ tons per month in 2001 to an average level of $16,464$ tons per month in 2005, which reflects an increase of 18 percent in output.

The following figure shows the total wage premium that was paid to workers above their base salary:

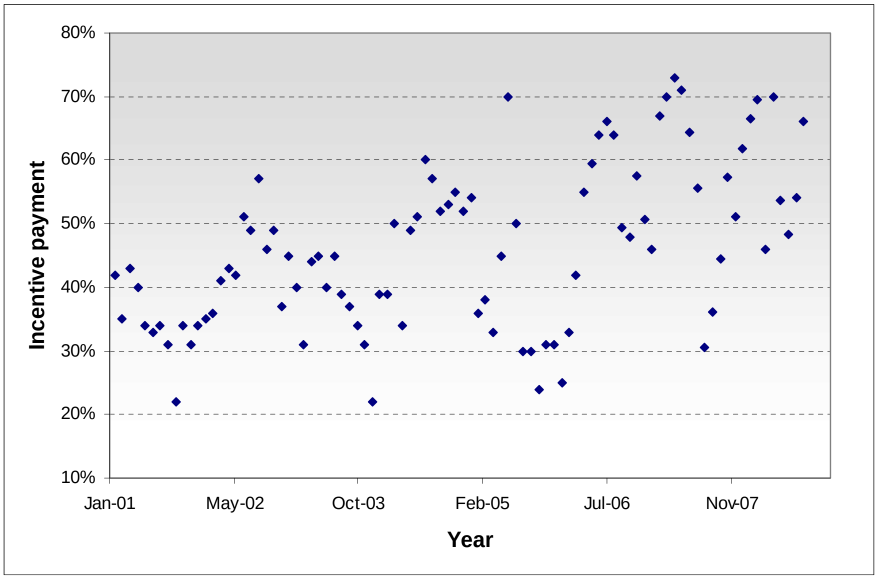


Figure A2: Wage premium paid to employees, 2001-2008

The figure shows an upward trend in incentive payments from around 35 percent of base salary in 2001, when the incentive scheme was just introduced to around 60 percent towards the end of the sample period in 2008, though there is considerable variability of incentive payments around the upward trend line. In fact, the standard deviation of incentive payments around their mean is 64 percent higher in $2005-2008$ than in $2001-2004$.

Another interesting question to ask is how frequently did the workers meet the predetermined thresholds in the incentive scheme? To answer this question, let $b$ denote the average production of billets in tons per effective plant hour in a given day and recall from Table 3 that the incentive scheme specifies three thresholds on $b$: $Q_0$, $Q_1$, $Q_2$. Workers receive a bonus $w_1$ if $Q_0 \leq b \leq Q_1$, a bonus $w_2$ if $Q_1 \leq b \leq Q_2$. The bonus is maxed out at $Q_2$, and no bonus is paid if $b < Q_0$. In the next figure we show the distribution of $b$ for each month from July 2001 to September 2008.[1]

[1] Although the incentive scheme starts on June 2001, we do not have daily data on June 2001..

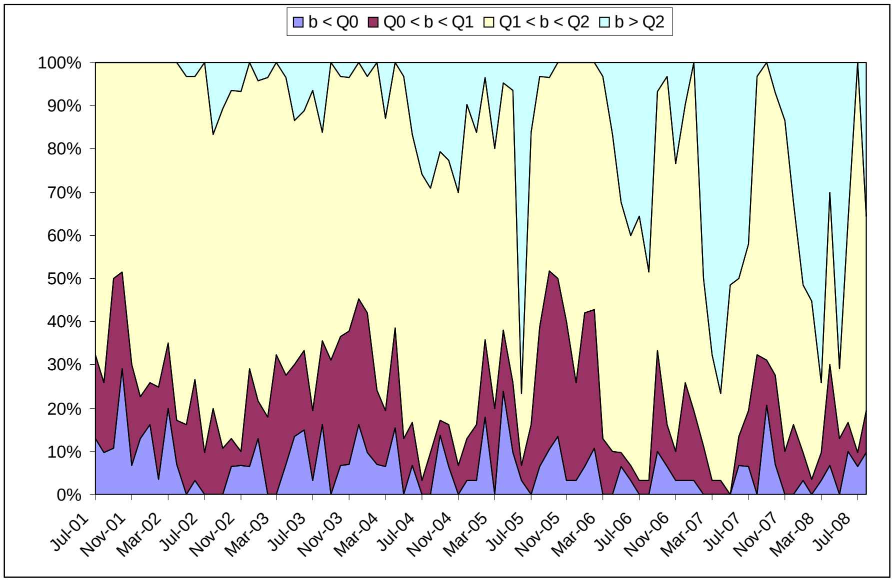


Figure A3: The distribution of the daily average production of tons of billets per effective plant hour, $b$, for each month, July 2001- September 2008

As the figure shows, about 60 percent of the time, $b$ was between $Q_1$ and $Q_2$. It exceeded $Q_2$ about 16 percent of the time (though more frequently in later periods), and fell short of $Q_0$ only 6 percent of the time. In the next Table we summarize the distribution of $b$ for the different time periods (before and after the incentive scheme was revised).

**Table A1 – The distribution of $b$**

| Dates | $b < Q_0$ | $Q_0 \leq b \leq Q_1$ | $Q_1 \leq b \leq Q_2$ | $b > Q_2$ |
|---|---|---|---|---|
| July 1, 2001 - March 1, 2003 | 8.2 percent | 16.3 percent | 72.7 percent | 2.7 percent |
| March 1, 2003 - July 1, 2005 | 7.5 percent | 17.1 percent | 62.5 percent | 12.8 percent |
| July 1, 2005 - September 28, 2008 | 4.5 percent | 14.6 percent | 54.0 percent | 26.8 percent |
| July 1, 2001 - September 28, 2008 | 6.3 percent | 15.8 percent | 61.1 percent | 16.8 percent |

One can see that over time, $b$ was much more likely to exceed $Q_2$, which the upper threshold on the incentive scheme: while in the first period $b$ was above $Q_2$ in only 2.7 percent of the cases, it was above $Q_2$ in close to 27 percent of the cases in the last part of the sample. Moreover, cases where $b$ fell short of $Q_0$, which is the lower threshold above which the workers start getting a bonus, fell from 8.2 percent at the first period to 4.5 percent during the last period of the sample. In general, the distribution in the last period stochastically dominates the distribution in the second period and the first period. This explain why the total incentive payments trended up as we saw earlier.

1. Profitability

One may argue that a possible reason why we see increase in productivity is that the price of billets and rebars increased dramatically just before the global financial crisis in September 2008 and hence, the melt shop found it profitable to expand output while beforehand it did not work at full capacity not because it was unable to do that but rather because it did not find it profitable to do so. Interviews with the steelmaker's management reveal that was not the case: the melt shop was trying to operate at full capacity from the day the current owner acquired the melt shop at least until September 2008, and the only impediment to production expansion was the effective capacity of the melt shop, which was limited, but kept increasing over time in the way we document in this paper.

Still, one may wonder if production was profitable or not. To examine this issue, we compute the direct profitability of billet production, defined as the international price of billets as quoted in *Metal Bulletin*, times the monthly production of billets, net of the variable cost of billets, including the price of scrap, electricity, Carbon, Lime, Ferro alloys, etc. (directly profitability is in fact similar to the concept of value added except that it is expressed in terms of current rather than constant prices). The computation shows that the direct profitability of billets production was positive until the eruption of the global financial crisis at the end of 2008. This finding is consistent with the management's claim that it was had an incentive to expand output as much as possible. The implication then is that the constraint on production was technical, rather than a deliberate restraint on output by management. The puzzle is how did the steelmaker manage to expand output, and given that this was profitable all along, why wasn't it done earlier?

## 2. Delays

One of the important determinants of productivity are various delays and problems in the production process. In the following figure we present some of the delays and problems over the period August 2001- September 2001. The delays and problem that we report are in loading the scrap into the EAF (scrap leveling and scrap waiting delays), problems with electricity and electrodes, problems with the ladle furnace, delays when pouring the molten steel from the EAF to the ladle furnace (tapping delays), delays due to the need to repair damages to the refractories which line the EAF's shell and protect it from melting, and total delays.

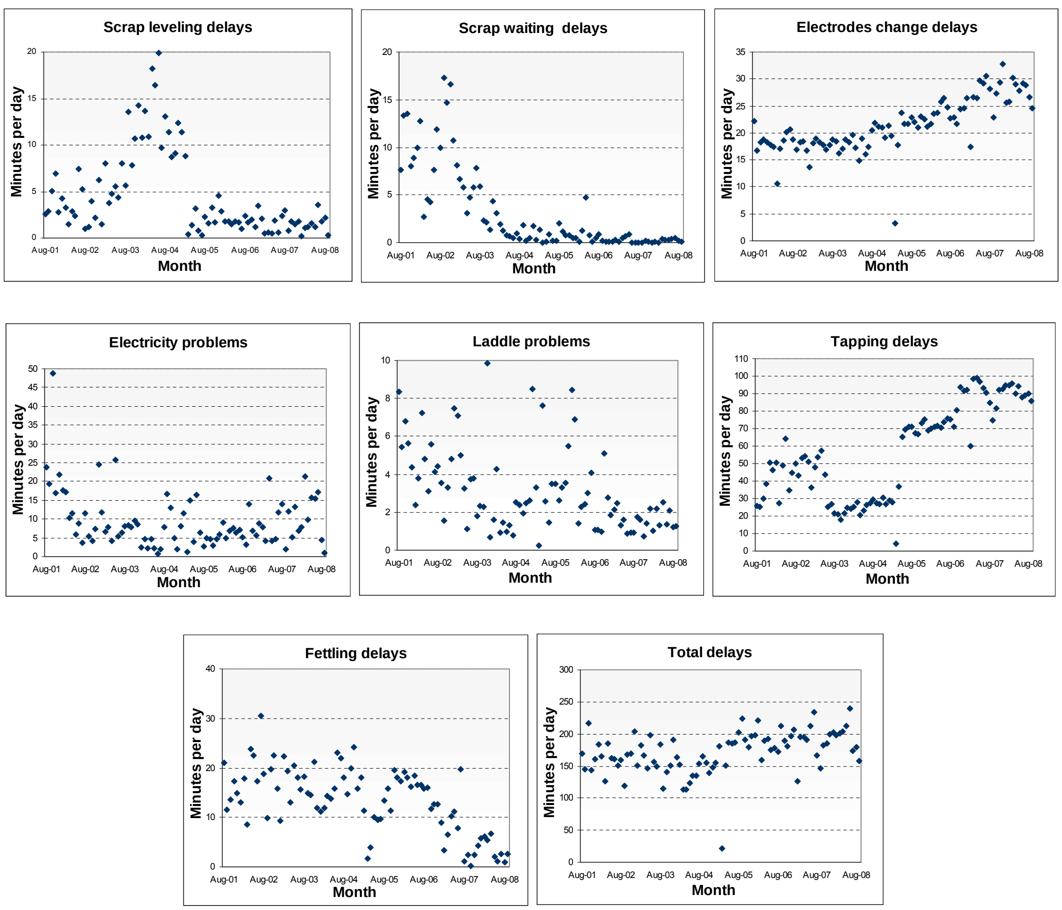


Figure A4: Average delays and problems in minutes per day, August 2001-September 2008

The figure shows that delays due to feeding the scrap into the EAF were cut significantly in 2004. Electricity problems, Ladle problems, and fetling delays also show a decreasing trend although these trends seem to be less dramatic than the decrease in scarp related delays. On the other hand, the need to change electrodes led to increasing delays as production grew over time, and tapping delays also show an increasing trend with a temporary decrease in $2003 - 2004$. The final figure shows that total delays grew somewhat over time as production increased.

3. Value added

Value added in constant prices is computed for each period by multiplying the quantity of billets and the quantity of inputs by their respective average prices over the entire sample period. The price of billets is the international price published in Metal Bulletin (the steelmaker consumes all billets in its rolling mill and does not sell them on the market). We than regressed value added on the same dummies that were used in Tables 5 and 6. Due to missing observations in January 1997 and since March 1997 is an "event" month with an unusually low output level, the regression starts from April 1997.

**Table A2 – Value Added regression, April 1997 – September 2008**

**Monthly data**

| Dependent Variable | Value added | |
|---|---|---|
| | Coeff | t-stat |
| Sep 1997 | $-416$ | $-1.38$ |
| Mar 1998 | 158 | 0.68 |
| Oct 1998 | $658^{***}$ | 2.76 |
| Aug 1999 | $-553^{***}$ | $-2.57$ |
| Feb 2000 | $412^{***}$ | 2.73 |
| Sep 2000 | $-104$ | $-0.46$ |
| Mar 2002 | $316^{**}$ | 1.84 |
| Jan 2003 | $-800^{***}$ | $-7.30$ |
| Mar 2005 | $-239$ | $-0.93$ |
| Feb 2007 | $574^{*}$ | 1.70 |
| Incentive | 144 | 0.68 |
| Incentive 1 | $611^{***}$ | 3.75 |
| Incentive 2 | $-367$ | $-1.29$ |
| 4th shift | $-32$ | $-0.13$ |
| Trend | 20 | 1.41 |
| Constant | $5,093^{***}$ | 18.25 |
| $R^2$ | 0.76 | |
| Joint significance of dates | $F = 18.1^{***}$ | |
| Joint significance of incentives | $F = 6.53^{***}$ | |
| $N$ | 126 | |

t-statistics computed using the Newey-West standard errors with 4 lags

The total increase in value added from 1997 to 2008 was $3,181$, from an average of $4,992$ in 1997 (April till December) to an average of $8,173$ in 2008 (January till September). Since the sum of the significant date dummies is 606, while the sum of the incentive dummies is 611, combined, physical investments and incentives explain 38.2 percent of the increase in value added over the sample period. The remaining 61.7 percent or $1,964$, remain unexplained and amount to an annual growth rate of 3.06 percent $((1 + 1,964/4,992)^{1/11} - 1)$.