Non-Junk Junk Money: Technical Efficiency and Productivity across Junk and Scrap Dealerships

Working Paper No. 7 Version 1 Draft 3 [December 2004]

Voxi Heinrich S. Amavilah[1]
REEPS
PO Box 38061, Phoenix, AZ 85069-8061
amavilah@msn.com

Abstract *- Some forms of environmentalism has generated many positive responses from concerned communities. Sophisticated theories addressing various aspects of environmental policy abound. At the practical level private economic agents following their self-interests confront the challenge of cleaning up the environment through recycling and other waste management programs. Among these agents are what I call here junk and scrap dealerships. But cleaning up will continue only if the marginal costs and benefits are at least equal. How do these firms fare? This simple question is rarely addressed.*

This paper examines the technical efficiency and productivity utilizing data for 26 junk and scrap wholesale dealerships in Arizona, USA. It finds that junk and scrap dealerships are technically efficient and productive on average. However, both efficiency and productivity vary widely among dealerships. A reasonable conclusion is that junk and scrap dealership contribute to a clean environment, and that may alone be a sufficient basis for continued investment in these labor-owned/manage- firms. This recommendation proceeds cautiously because available data did not support clear understanding of the economic efficiency and cost structures of firms.

Keywords: *junk and scrap: production, sales, technical efficiency and productivity*

JEL Code: *L2, C21, R3, Q53*

---

[1] I am grateful to the librarians at the Phoenix Burton Barr Public Library and the Thunderbird Graduate School of International Management Library for helping me locate sources of the data used here, and to Tamara Bishop-Amavilah for editorial assistance. All errors are mine alone.

PEOPLE everywhere in the world desire a high standard of living for themselves and their offspring. Simultaneously they do not like junk and scrap dealerships in their neighborhoods, although a high standard of living is almost always associated with increased production and consumption of goods and services (Luton, 1996, Baumol and Oates, 1988). Production and consumption activities generate junk and scrap which have the effect of reducing the standard of living either by imposing high external costs on, or constraining current and future, economic growth.[2]

In a recent survey of existing literature on the economics of solid waste management, Chakrabarti and Sarkhel (2003) conclude that waste management has become a hot topic for at least three reasons. First, the scarcity of landfills is driving rent (land price) up high, and the implications for this are obvious. Second, waste disposal is imposing higher and higher external costs on the environment. Adjusted for external costs, the cost of living is higher than suggested now; alternatively the standard of living is overestimated if external costs are not subtracted. Third, there is a growing acceptance that waste management provides external benefits. Among the obvious is that the average capital cost of reprocessing secondary metal, for example, is only 20-30% that of processing virgin (primary) metal (Anderson, 1987, Yohe, 1979, Grace, Turner and Walter, 1981). The final benefits are lower prices for the consumer as well as reduced pressure on known reserves of scarce resources (Haque, 1994).

To quantify social benefits some experts like Slade (1980), and many others utilize various rationalizations of Koyck, such as Nerlove's stock adjustment mechanism, to represent the quantity of desired stock of junk and scrap as

$$Q_i^* = \frac{Q_i + (1-\delta)Q_{-i}}{\delta},\ 0<\delta<1, \qquad (1)$$

where $Q^*{}_i$ is the desired level of junk and scrap, Q_i is the new addition to junk and scrap, δ is the rate of decay (depreciation) of junk and scrap, and Q_{-i} is old (undepreciated) junk and scrap. Then (1) is determined according to

$$Q_i^* = f[Y_i, N_i, P_{Q^*}(P_Q)], \qquad (2)$$

where Y_i is some measure of the industrial activity, N_i is population (which can be the human population or population of junk and scrap sources as the two are correlated), and P_{Q^*} is the average price of junk and scrap, which is a function of the price (P_Q) of virgin Q_i .

From (1) and (2) economists such as Hoel (1978, Dasgupta and Heal, 1979) suggest an optimization program for the recovery of junk and scrap. The current value Hamiltonian of the maximization problem allows assessment of social and technical constraints and welfare (Arrow, *et. al.*, 2004, Fisher, 1981, Baumol and Oates, 1988, Conrad, 1999, Neher, 1990). But if highbrow theory is not to be too hoity-toity, then one must be able to show that junk and scrap dealers are technically (productively) efficient, and by implication profitable. The modest objective of this paper is to assess the cross-sectional efficiency and

[2] A *JEP* paper by Dr. Kenneth Arrow and his very distinguished coauthors (2004) provides an authoritative statement on whether human beings are putting Earth at excessive risk by over-consuming.

productivity of 26 wholesale junk and scrap dealers (merchants) in Arizona. In the next section below, I build an empirically-relevant model for that purpose. The third section outlines the data, while the fourth reports estimated results. The paper closes with tentative conclusions.

1. Theoretical and Empirical Models

Theoretical Models

The objective of any firm is profit maximization. But without knowledge of the firm's cost structures and other relevant data, it is not possible for outside observers to calculate the firm's profit. However, profitability can be inferred from the firm's technical efficiency and productivity, both of which can be inferred from the firm's gross revenue. Gross revenue for the ith firm (R_i) is the average price of junk and scrap (P_i) TIMES the desired quantity of junk and scrap (Q^*), i.e., $R_i = P_i Q_i^*, P_i = P_{Q^*}$. Further

$$Q_i^* = \lambda Q_i, \ for \ 0<\lambda<1, \qquad (3)$$

where λ is the recovery rate of junk and scrap such that no junk and scrap is recovered if λ = 0 and all virgin Q_i is recovered as junk and scrap if λ = 1 (Anderson, 1987, Chalier and Parker, 1999). Now assume that the stochastic production function of the producer of virgin Q_i can be expressed as:

$$Q_i = AL_i^{\alpha} K_i^{\beta} \exp(\mu_i), \qquad (4)$$

where A, α and β are coefficients, $\alpha + \beta \leq 1$, L_i is labor input, K_i is physical capital input, exp(.) is the natural logarithmic base, and $\mu_i \sim N(0, \sigma^2)$ is a stochastic disturbance term. The implication of (4) is that (3) can be restated as

$$Q_i^* = \lambda[AL_i^{\alpha} K_i^{\beta} \exp(\mu_i)]. \qquad (5)$$

By definition gross revenue for the ith junk and scrap dealership is

$$R_i \equiv P_i Q_i^* = P_i \cdot \lambda[AL_i^{\alpha} K_i^{\beta} \exp(\mu_i)]. \qquad (6)$$

Since under competition the ith dealer is a price-taker, i.e., P_i is given by the market,we can set P_i = 1 such that the dealer can increase gross revenue only by increasing Q* given input constraints. Taking cue from Hill and Kalirajan (1993) and Turvey and Lowenber-DeBoer (1988), since for a constant P_i $\partial R_i / \partial P_i = 0$,

$$R_i \equiv \Phi L_i^{\alpha} K_i^{\beta} Z_i^{\gamma_i} \exp(\mu_i + v_i), \ \Phi = \lambda \times A, \qquad (7)$$

where Z_i is a vector of industry financial ratios included to capture industry-specific dimension such market structure, and v_i is firm-specific technical efficiency related to all variables. Next define $\exp(v_i) = R_i / R_i^*$, such that

$$\begin{aligned} &\exp(v_i) = 0 \ \Rightarrow \ efficiency \ since \ R_i = R_i^* \\ &\exp(v_i) \neq 0 \ \Rightarrow \ inefficiency \ since \ R_i \neq R_i^*, \end{aligned} \qquad (8)$$

where R_i is *actual* sales and $R_i^* = R_i + \mu_i$ is *potential* sales, respectively. QED

Empirical Models

Taking the natural logarithms of both sides of (7) leads to

$$\ln R_i = \phi + \alpha \ln L_i + \beta \ln K_i + \gamma_i \ln Z_i + v_i + \mu_i \quad (9)$$

The stochastic level of technology associated with (9) will be

$$\Theta_i = \exp(\phi + v_i + \mu_i) = \exp(\ln R_i - \alpha \ln L_i - \beta \ln K_i - \gamma_i \ln Z_i), \quad (10)$$

where $\phi = \ln \Phi, \mu_i = \hat{\mu}_i, v_i = \phi - \hat{\mu}_i$.

Equation (7) can also be expressed in intensive form as

$$r_i = \phi + \beta k_i + \gamma_i z_i + \mu_i + v_i, \quad (11)$$

where $r_i = \ln(R_i/L_i)$, $k_i = \ln(K_i/L_i)$, and $z_i = \ln(Z_i/L_i)$. Eq. (11) is a “labor productivity” measure, and for a given level of ϕ its technical efficiency is

$$\Theta_p = \exp(\phi + v_i + \mu_i) = \exp(r_i - \beta k_i - \gamma_i z_i). \quad (12)$$

QED.

2. Variables and Data

Basic Variables

For the dependent variable (R_i) I use annual sales of junk and scrap valued in 2003 US$ million. Labor (L_i) is represented by the total number of people employed. The data for both R_i and L_i comes from the *2003/04 D&B Regional Business Directory* (2003).

I could not find data on capital (K_i) for any of the dealerships in this study (that is not surprising because capital data is hard to find even for large and well-established companies). Thus I proxy capital with an industry operating ratio as

$$K_i = \frac{net\ sales}{net\ fixed\ assets}. \quad (13.1)$$

This is a reasonable proxy because it measures the productive use of a firm’s fixed capital. A high ratio suggests that a few net fixed assets generate many net sales.

Other Variables

Vector Z_i contains four other variables: Z_1, Z_2, Z_3, and Z_4. Three of the four variables (Z_1, Z_2, Z_3) are industry financial ratios, and the fourth, Z_4, is a dummy variable. Table 1 lists, by the level of R_i, all four Z_i, along with K_i. Table 2 contains all basic data. The data shows that total sales for these dealerships is about \$134 million, or an average of \$5.2 million per dealership. The 26 dealerships employ 38 workers on average, a total of 966 workers overall. Average fixed capital stock appears to range from \$30,400 to just under \$3.0 million.

Here is what each Z_i means and measures. First,

$$Z_1 = \frac{cost\ of\ sales}{inventory} \approx \lambda, \quad (13.2)$$

is a liquidity ratio. It measures the rate at which inventory turns over into cash. Experts suggest that a low Z_i implies high turnover and thus excellent conversion of junk and scrap into cash or near-cash. A low Z_1 means a high cost of running inventory (RMA, 2003/04, Hall, 1983). Second,

$$Z_2 = \frac{net\ fixed\ assets}{tangible\ net\ worth}, \qquad (13.3)$$

is a leverage ratio that measures the productivity of owner's capital. A low Z_2 means that low investment generates high net worth. Third,

$$Z_3 = [\frac{profit\ before\ taxes}{tangible\ net\ worth}] \times 100, \qquad (13.4)$$

indicates management performance, or a return on investment. A high Z_3 implies effective management and that the firm is undercapitalized; a low Z_3 means ineffective as well as risk-averse, management.

To control for the difference in the industrial activity and population of the area in which the junk and scrap dealership is locate, let

$$\begin{aligned} Z_4 &= 0 \ \ if\ Phoenix \\ &= 1 \ \ if\ otherwise. \end{aligned} \qquad (13.5)$$

Variable Interactions

This section states key interactions between variables. Some will be considered, while others will not be. When high

$$L_i Z_1 = L_i \times \frac{cost\ of\ sales}{inventory}, \qquad (13.6)$$

indicates that high turnover is due to labor efforts. On the other hand,

$$\begin{aligned} \lambda K_i &= (\frac{cost\ of\ sales}{inventory}) \times (\frac{net\ sales}{net\ fixed\ assets}) \\ &= (\frac{cost\ of\ sales}{net\ fixed\ assets}) \times (\frac{net\ sales}{inventory}). \end{aligned} \qquad (13.7)$$

Expectations are for the first quotient to be low and the second high so that K_iZ_i is consistent with either K_i or Z_1 whichever the case might be. Note that K_i and λK_i pose the danger of multicolinearity.

Next consider the interaction between L_i and Z_2 as

$$L_i Z_2 = L_i \times \frac{net\ fixed\ assets}{tangible\ net\ worth}, \qquad (13.8)$$

which means that net fixed assets and labor have *separate* as well as *joint* effects on the creation of tangible net worth. This is unlike in K_iZ_2 below where it is net sales that matters because

$$\begin{aligned} K_i Z_2 &= (\frac{net\ sales}{net\ fixed\ assets}) \times (\frac{net\ fixed\ assets}{tangible\ net\ worth}) \\ &= \frac{net\ sales}{tangible\ net\ worth}. \end{aligned} \qquad (13.9)$$

If we assume a labor-owned (or labor-managed) junk and scrap dealership,

$$L_i Z_3 = L_i \times (\frac{profit\ before\ taxes}{tangible\ net\ worth}), \qquad (13.10)$$

would indicate that labor is motivated by profit expectations.

For a capital-abetted operation

$$K_iZ_3=(\frac{net\ sales}{net\ fixed\ assets})\times(\frac{profit\ before\ taxes}{tangible\ net\ worth})$$
$$=(\frac{net\ sales}{tangible\ net\ worth})\times(\frac{profit\ before\ taxes}{net\ fixed\ assets}) \quad (13.11)$$

while

$$Z_1Z_2=(\frac{cost\ of\ sales}{inventory})\times(\frac{net\ fixed\ assets}{tangible\ net\ worth})$$
$$=(\frac{cost\ of\ sales}{tangible\ net\ worth})\times(\frac{net\ fixed\ assets}{inventory}) \quad (13.12)$$

would measure conversions of inventory into sales, and profit into net worth. Next to last

$$Z_1Z_3=\lambda\times[\frac{profit\ before\ taxes}{Tangible\ net\ worth}]\times 100 \quad (13.13)$$

Finally

$$Z_2Z_3=(\frac{net\ fixed\ assets}{tangible\ net\ worth})\times(\frac{profit\ before\ taxes}{tangible\ net\ worth}) \quad (13.14)$$

which implies that the owners are also the managers of the dealership.

Again Table 1 lists Z_i data according to the R_i size of dealership and Table 2 gives basic data. The first six observations in Table 2 are specific to SIC 5015 for used motor vehicle parts. Observations 9 and 15 refer to SIC 4953 concerning material recovery facilities, while the remaining observations fall under SIC 5093 for scrap and waste materials. The source of Z_i data is: RMA (2003).

3. Results

This section presents and interprets estimated results. Table 3 shows five different specifications of (9). In Specifications 1-4 gross sales respond positively to changes in labor and capital inputs. The marginal impacts of labor and capital are both positive and significantly different from zero. In fact, $\alpha + \beta > 1$, implying that doubling inputs would likely double sales, with the largest marginal effect coming from labor.

Specifications 1 and 3 in the same table indicate that sales are an increasing function of the turnover of junk and scrap inventory (Z_1). Similarly, the marginal contribution of Z_3 to sales is a robust 0.12, suggesting junk and scrap management (at least in Arizona) is effective and that these dealerships may be undercapitalized. An inverse relationship is observed between sales and the Z_4 variable, which measures (dis)advantages resulting from location in high population and/or industrial areas. Although negative, the association is not statistically significant. Even so, there is a strong indication that locating in low population density and industrial areas is a disadvantage.

Considering variable interactions, as the table shows, only one such interaction is significant; L_iZ_3 has a strong effect on sales. According to this result junk and scrap dealerships appear to be labor-managed operations.

Summary statistics in Table 3 point to reasonable goodness-of-fits; 83-87% of variations in R_i are explained by the included variables. Figure 1.1, for instance, shows actual and predicted sales. In the figure about half of the observations fall below and half above a gradually rising linear trendline. The predictive power of the models as measured by the ratio of the standard error of the estimate to the mean of the estimated R_i

Table 1- Financial Ratios for the Junk and Scrap Industry, 2002/2003

R_i (Million US$)	K_i	Z_1	Z_2	Z_3
SIC 5015				
0-1	15.93	3.37	0.30	-
1-4	15.73	4.34	0.93	-
3-5	20.47	6.27	0.57	12.60
0-25 +	18.87	4.37	0.90	12.87
Average	**17.75**	**4.59**	**0.68**	**6.40-13.20**
SIC 5093				
0-1	15.33	21.00	-5.50	11.03
1-4	8.60	56.93	15.83	6.33
3-5	13.45	31.40	1.23	6.93
0-25 +	11.87	18.70	1.40	5.87
Average	**12.31**	**32.01**	**3.24**	**7.54**
SIC 4953				
0-1	-	-	-	-
1-4	-	-	-	-
3-5	-	-	-	-
0-25 +	-	-	-	-
Average	**3.80**	**-**	**12.77**	**41.43**

Table 2 - Basic Data for Arizona Junk and Scrap Wholesale Merchants (Dealers), 2003

Name & Location	SIC	R_i, Million US$)	Labor (L_i)	Capital (K_i)	Z_1	Z_2	Z_3	Z_4
Buessing Enterprises, Chandler	5015	1.30	30	15.73	4.34	0.93	-	1
Tri-City, Inc., Mesa	5015	3.20	17	20.47	4.34	0.57	12.60	1
Arizona Auto & Truck Parts, Inc., Phoenix	5015	1.70	30	15.73	4.34	0.93	-	0
Riteway Auto Sales & parts, Inc., Tucson	5015	2.40	14	15.73	4.34	0.93	-	1
Street Beat Customs, Inc., Phoenix	5015	1.00	20	15.93	3.37	0.30	-	0
New Way Auto Sales & Parts, Inc., Tucson	5015	0.61	14	15.93	3.37	0.30	-	1
Valley Recycling Works, Inc., Chandler	5093	18.10	100	12.31	32.01	3.24	7.54	1
Consolidated Resources, Inc., Glendale	5093	2.40	19	8.60	56.93	15.83	6.33	1
Glendale Iron & Metal, Co., Glendale	4953	7.01	90	3.80	32.01	3.24	7.54	1
American Metal Co., Inc., Mesa	5093	5.00	30	13.45	31.40	3.24	6.93	1

Name & Location	SIC	R_i, Million US$)	Labor (L_i)	Capital (K_i)	Z_1	Z_2	Z_3	Z_4
ABS, Inc., Phoenix	5093	10.9	75	12.31	32.01	3.24	7.54	0
Cars 4Parts, Inc., Phoenix	5093	1.80	15	8.60	56.93	15.83	6.33	0
Crown Imports, Corp., Phoenix	5093	1.30	15	8.60	56.93	15.83	6.33	0
Davis Salvage, Co. LLC, Phoenix	5093	5.60	30	13.45	32.01	3.24	7.54	0
Earth Protection Services, Inc., Phoenix	4953	6.15	50	3.80	-	12.77	7.54	0
Global Electric Recyling, LLC, Phoenix	5093	3.50	15	13.45	31.40	1.23	6.93	0
Metal Management of Arizona, Phoenix	5093	17.00	80	12.31	32.01	3.24	7.54	0
Phoenix Metal Trading, Inc., Phoenix	5093	10.51	32	12.31	32.01	3.24	7.54	0
State Iron & Metal, Phoenix	5093	5.30	35	12.31	32.01	3.24	7.54	0
Thermo Fluids, Inc., Phoenix	5093	16.51	150	12.31	32.01	3.24	7.54	0
Kuhles Services, Inc., Prescott	5093	1.50	14	8.60	56.93	15.83	6.33	1

Name & Location	SIC	R_i, Million US$)	Labor (L_i)	Capital (K_i)	Z_1	Z_2	Z_3	Z_4
Busby Metal, Inc., Tempe	5093	1.14	12	8.60	56.93	15.83	6.33	1
Gila-Recycling, Inc., Tempe	5093	4.60	32	13.45	31.40	1.23	6.33	1
AM CEP, Inc., Tucson	5093	1.20	12	8.60	56.93	15.83	6.33	1
Allied Precious Metals & Recycling Co., Tucson	5093	2.60	20	8.60	56.93	15.83	6.33	1
National Aircraft, Inc., Tucson	5093	1.60	14	8.60	56.93	15.83	6.33	1
Total (26)	**--**	**133.93**	**965**	**303.78**	**--**	**--**	**--**	**--**
Average	**--**	**5.15**	**37.11**	**11.68**	**31.91**	**6.73**	**5.82**	**--**

(0.008 < σ/Mean R_i < 0.023) is also reasonable. After using White's scheme for correcting autocorrelation and unknown forms of heteroskedasticity, the Durban-Watson, DW(ρ), is generally in the no-trouble range. However, Normal t and χ^2 tests of the normality of distribution of the error term seem negative.

The stochastic levels of technology ($\phi + v_i + \mu_i$), identified as Frontier 1 to 4, appear in Figure 1.2. The two components of (10) are in Figure 1.3 for v_i and Figure 1.4 for μ_i. In Figure 1.3a $v_i = \phi - \mu$ and in Figure 1.3 $v_i = R_i / R_i^* = \mu_i$. In that case $R_i = \Phi(\cdot)\exp(2\mu_i), \mu_i = v_i$. In all four cases $\phi > 0$ (Figure 1.2). By Figure 1.3 five dealerships are efficient ($R_i^* = R_i$), 13 are sub-optimal ($R_i^* > R_i$), and 8 are supra-optimal ($R_i^* < R_i$)).

Table 4 presents results from the estimation of (11). These results are econometrically more troubled than those discussed above. For example, the most striking finding here is that considering all potential variables even the capital-labor ratio $k_i = \ln[(K_i \cdot 100)/L_i]$ is negatively and insignificantly related to sales per worker. As Specification 3 shows, the explanatory power is very low, in fact the (adjusted) $\overline{R}_i^2 < 0$.

The second column of Table 4 includes k_i, the interaction $k_i z_3 = \ln[(K_i Z_3)/L_i]$, as well as inventory per worker, $z_1 = Z_1 / L_i$. In this case k_i has a positive but still statistically insignificant effect on sales per worker. The coefficient of the interaction between K_i and Z_1, i.e., $k_i z_3 = \ln[(K_i Z_1)/L_i]$ is also positive and insignificant, while that of $z_1 = Z_1 / L_i$ is significantly negative. Not surprisingly adjusted R^2 is even lower. However, in Specification 1 up to 58.6% of variations in sales per worker are strongly explained by the two variable interactions: $k_i z_3$ and $z_1 z_2$. The former has a direct , whereas the latter a negative effect, on average sales.

Figure 2.1 shows actual and predicted sales per worker for the 26 junk and scrap dealerships in Arizona. The stochastic levels of "productivity" ($\phi + v_i + \mu_i$) appear in Figure 2.2, whereas in Figure 2.3a $v_i = \phi - \mu$ and in Figure 2.3b $v_i = r_i / r_i^* = \mu_i$ as depicted in Figure 2.4. Essentially $r_i = \Phi(\cdot)\exp(2\mu_i), \mu_i = v_i$. Generally $\phi > 0$ (Figure 2.2). By Figure 2.3 some operations are efficient ($r_i^* = r_i$), some are sub-optimal ($r_i^* > r_i$), and the remainder are supra- optimal ($r_i^* < r_i$)).

4. Tentative Conclusions

Evidence that economic activities are a double-edged sword that produces the good and the bad simultaneously are incontrovertible. Many, perhaps too many, conclusions are drawn from such evidence including the fact that recycling of junk and scrap makes good economic sense. Sophisticated theories back up these conclusions. What is missing from the literature is an empirical justification of recycling operations. This paper utilizes a familiar model to assess the cross-sectional technical efficiency and productivity of 26 wholesale junk and scrap merchants (dealerships) in Arizona, USA.

The results lead to the conclusion that junk and scrap dealership are, on average, technically efficient. However, efficiency

Table 3 - Regressions of Sales of Junk and Scrap Dealerships in Arizona, 2003
(Mean R_i = 15.009, Observations = 26, Parentheses t-ratios at 5% significance level)

Variable	**Specification 1**	**Specification 2**	**Specification 3**	**Specification 4**
Constant	8.614 (7.709)	8.823 (6.572)	8.394 (6.910)	7.567 (7.930)
$\ln L_i$	0.989 (10.553)	0.977 (14.734)	1.014 (9.871)	0.818 (15.622)
$\ln K_i$	0.351 (2.573)	0.329 (1.831)	0.361 (2.339)	0.543 (4.653)
Z_1	0.0013 (0.268)	--	0.001 (0.205)	--
Z_3	0.119 (7.357)	0.122 (9.733)	0.119 (5.254)	--
Z_4	-0.129 (-0.781)	-0.127 (-0.797)	--	--
$\ln(L_i Z_3)$	--		--	0.215 (6.146)
$\overline{R}^2$	0.8378	0.8450	0.8405	0.8710
σ/[Mean R_i]	0.0077	0.0226	0.0229	0.0229
DW[ρ]	1.9389 [0.0091]	1.9400 [0.0078]	1.6883 [0.1264]	1.6291 [0.1707]
LLF	-8.7895	-8.83325	-9.2046	-7.0499
Normal t	-0.2842	-0.7746	0.4338	-0.9781
χ^2 [df]	8.4772 [2]	9.0618 [3]	6.6556 [3]	9.3625 [4]

Figure 1.1 - Actual and Predicted Sales of Junk and Scrap Dealership in Arizona, 2003

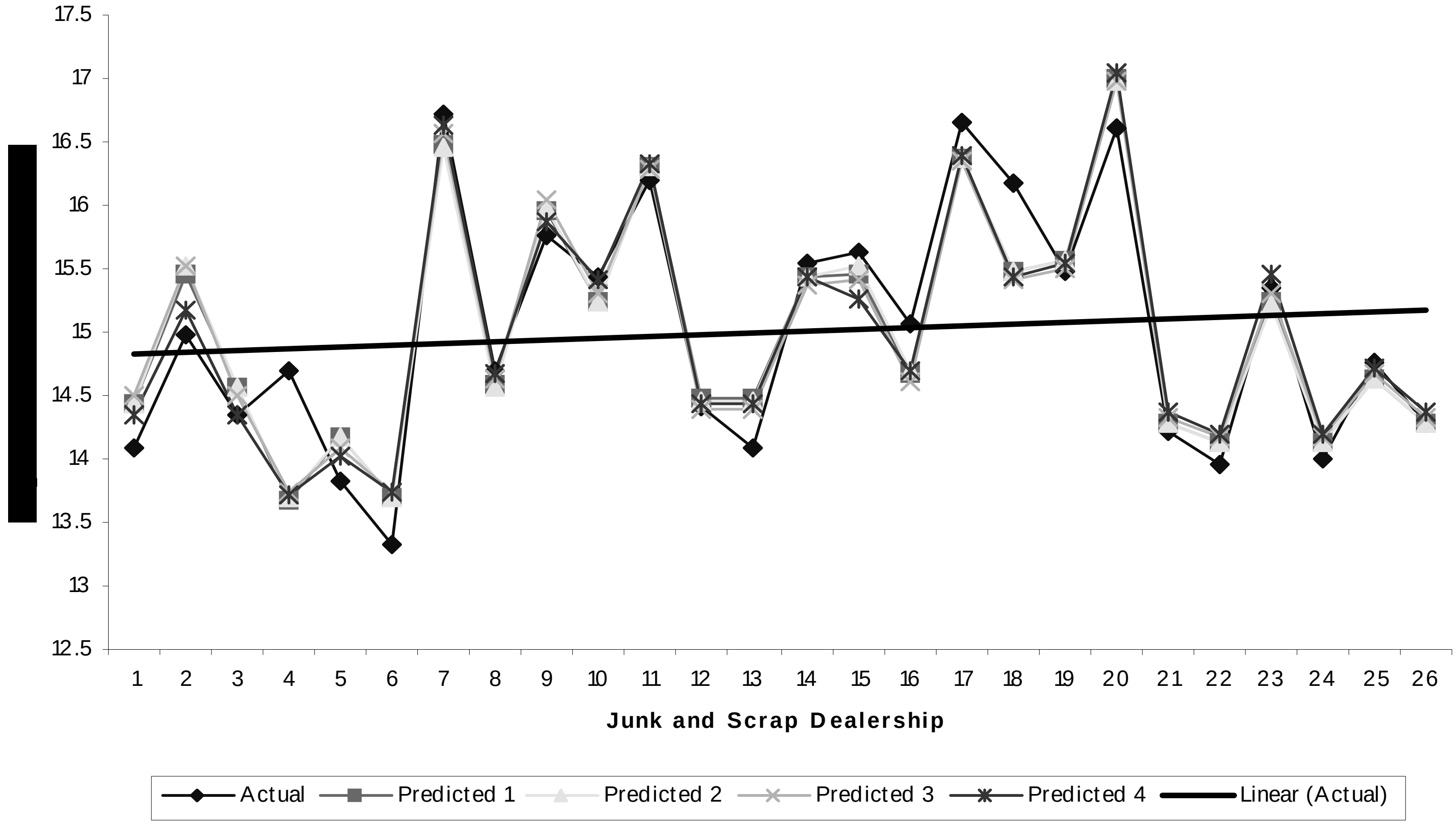


Figure 1.2 - Sales Frontiers of Junk and Scrap Dealerships in Arizona, 2003

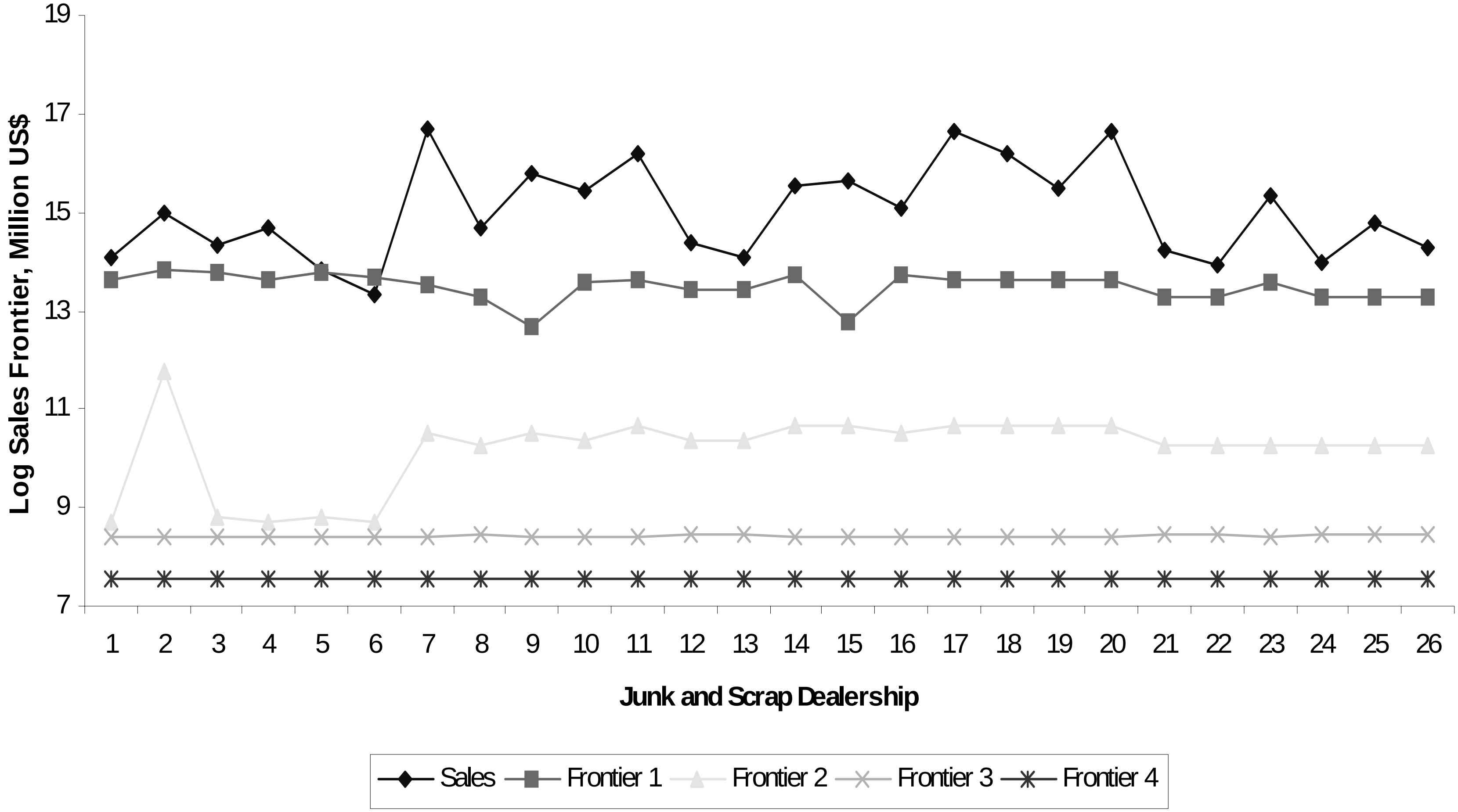


Figure 1.3 -Specific Technical Efficiency of Junk and Scrap Dealerships in Arizona, 2003

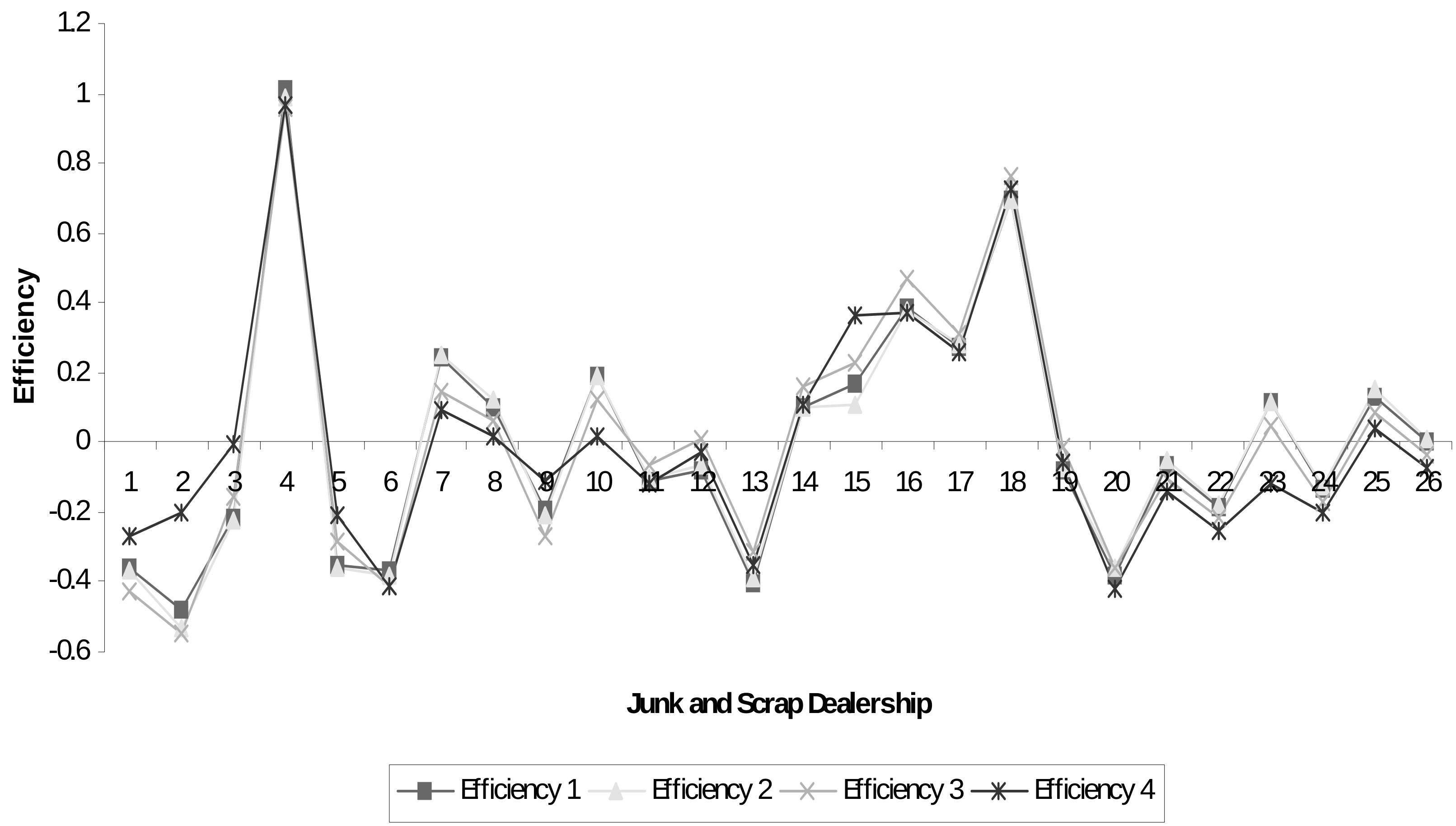


Figure 1.3b - Specific Technical Efficiency of Junk and Scrap Dealerships in Arizona, 2003

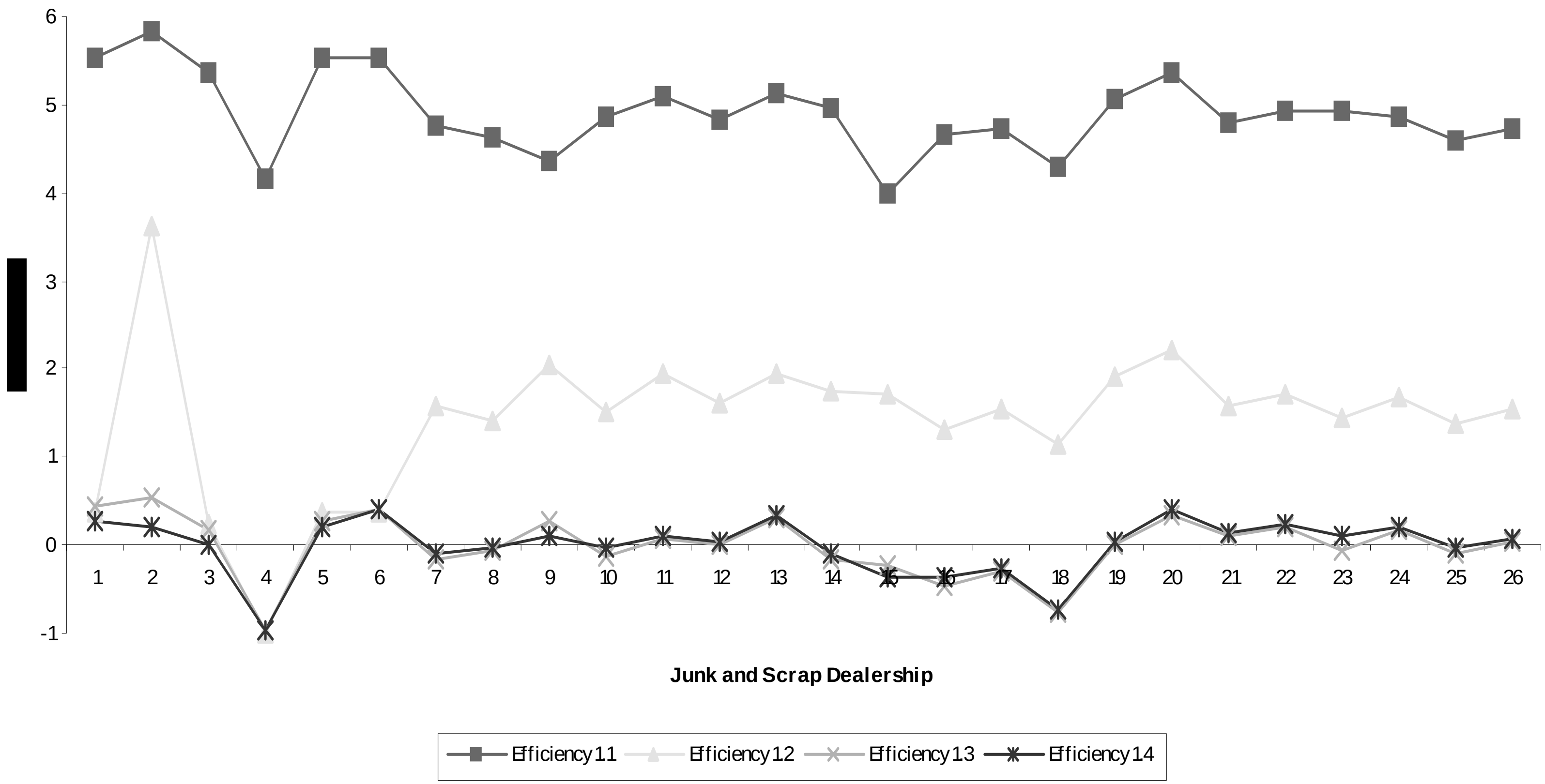


Figure 1.4 - Random Sales Residuals of Junk and Scrap Dealerships in Arizona, 2003

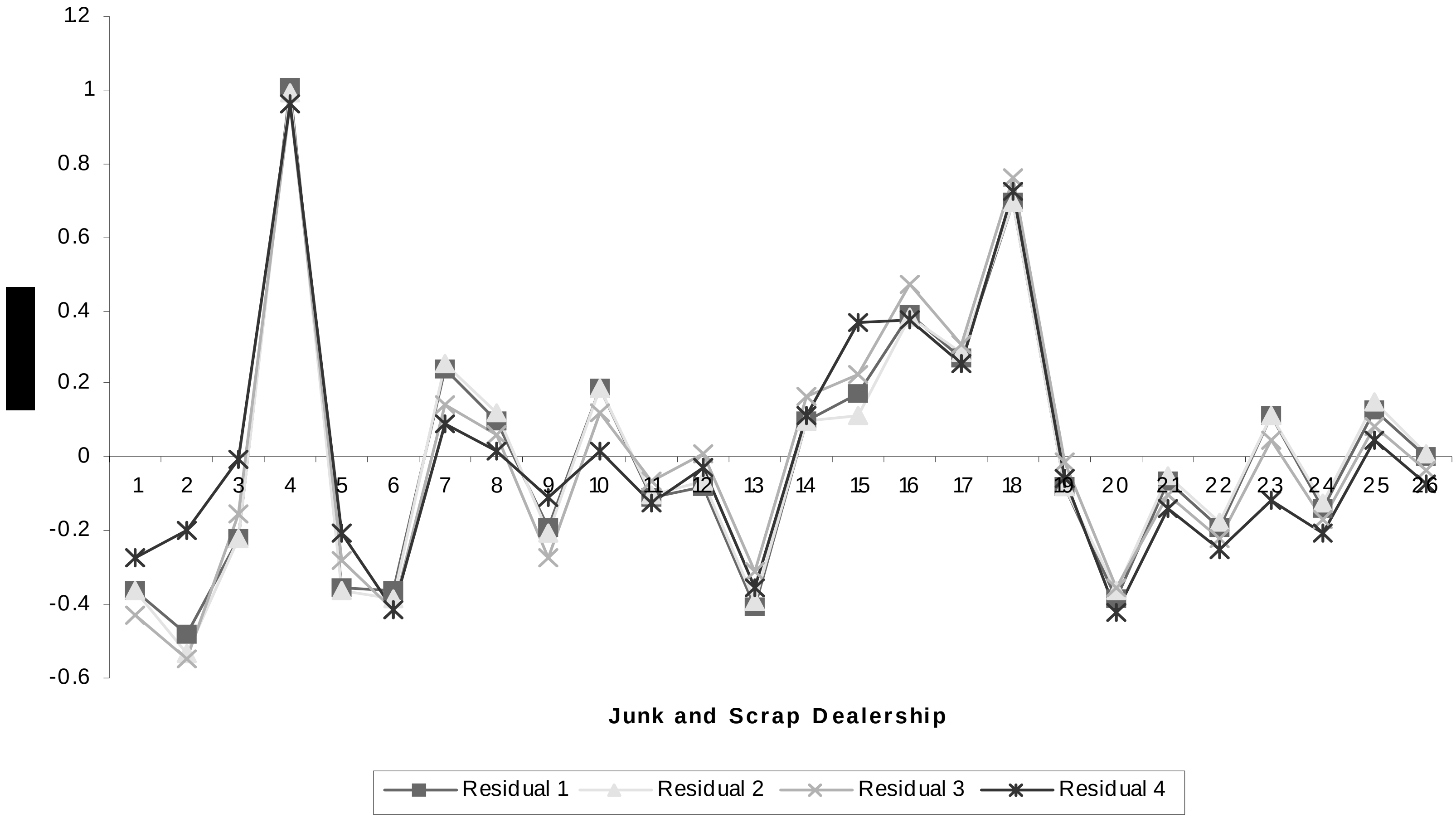


Table 4 - Regressions of Average Sales of Junk and Scrap Dealerships in Arizona, 2003
(Mean r_i = 11.609, Observations = 26, Parentheses t-ratios at 5% significance level)

Variable	**Specification 1**	**Specification 2**	**Specification 3**
Constant	11.389 (91.648)	10.845 (13.114)	11.931 (28.607)
$k_i z_3$	0.128 (5.465)	0.148 (0.819)	--
$z_1 z_2$	-0.0006 (-5.236)	--	--
k_i	--	0.156 (0.521)	-0.065 (-0.571)
z_1	--	-0.187 (-1.842)	--
$\overline{R}^2$	0.5856	-6.1052	-0.0285
σ/[Mean r_i]	0.0266	0.1078	0.0428
DW[ρ]	1.959 [0.0045]	0.777 [0.5006]	1.9994 [-0.0745]
LLF	-6.363	-42.7268	-322.722
Normal t	-0.554	-2.2156	1.2394
χ^2 [df]	9.772 [1]	38.2657 [4]	1.2402 [2]

Figure 2.1 - Average Sales of Junk and Scrap Dealerships in Arizona, 2003

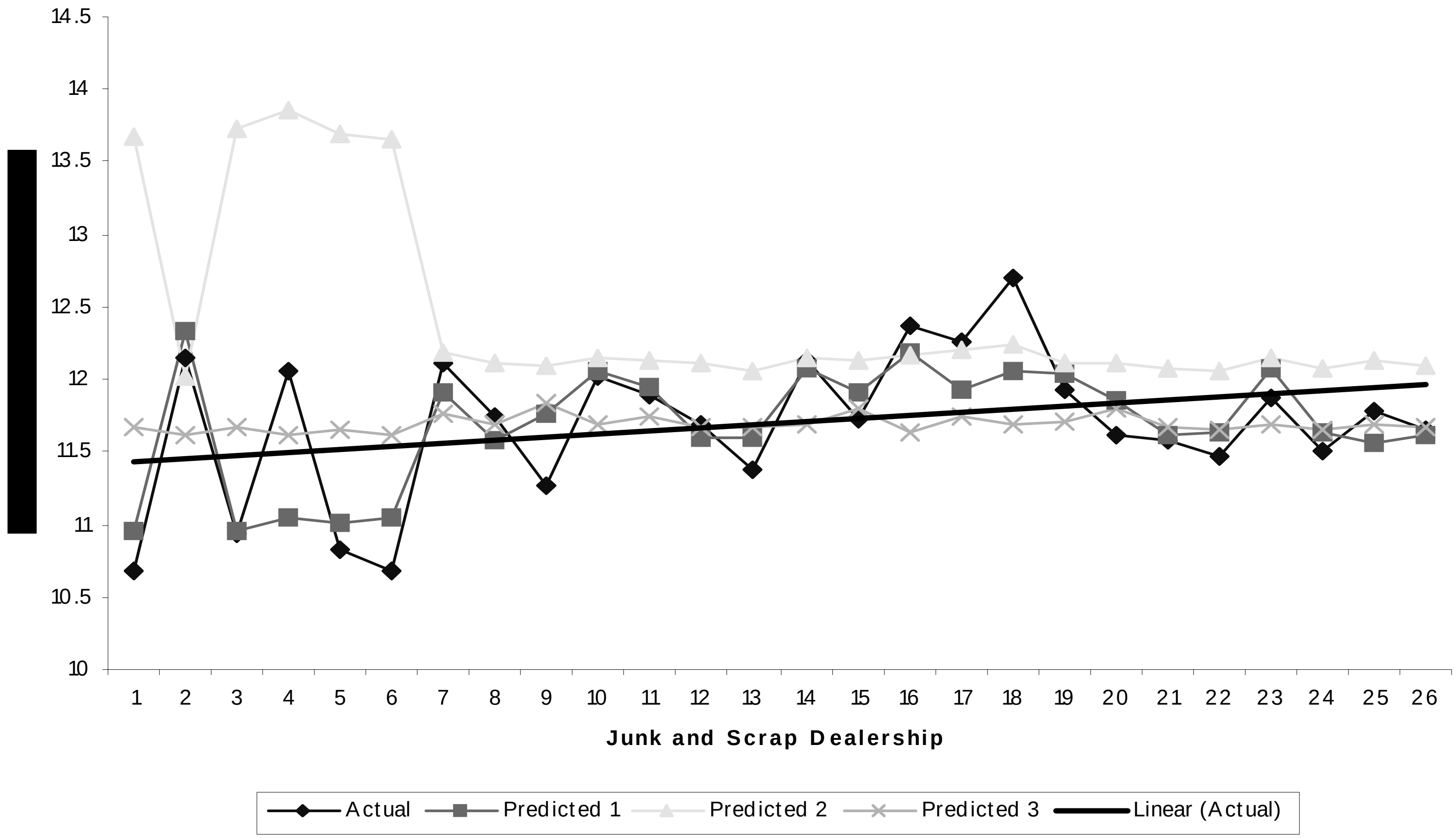


Figure 2.2 - Average Sales Frontiers of Junk and Scrap Dealerships in Arizona, 2003

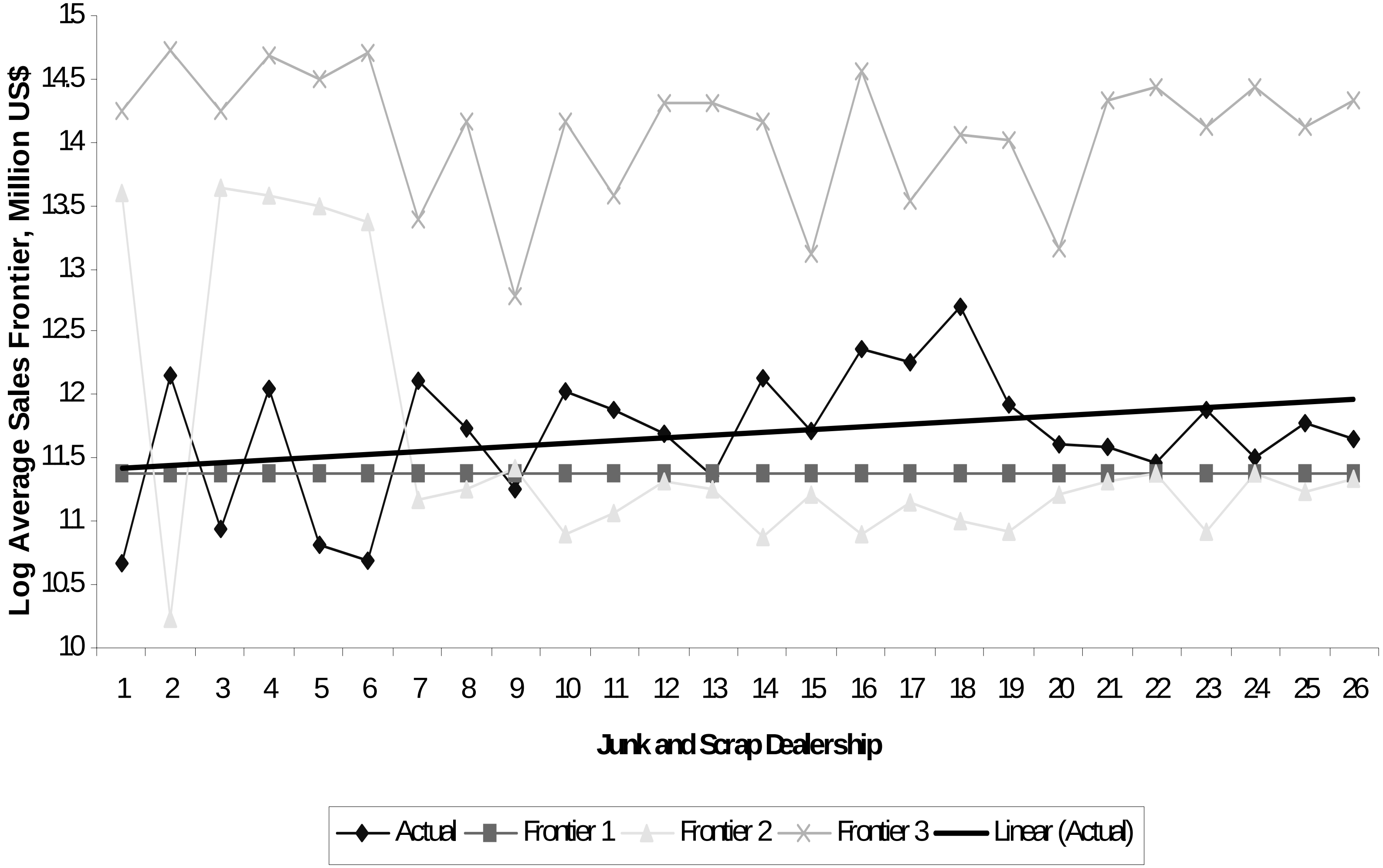


Figure 2.3a - Specific Technical Efficiency of Junk and Scrap Dealerships in Arizona, 2003

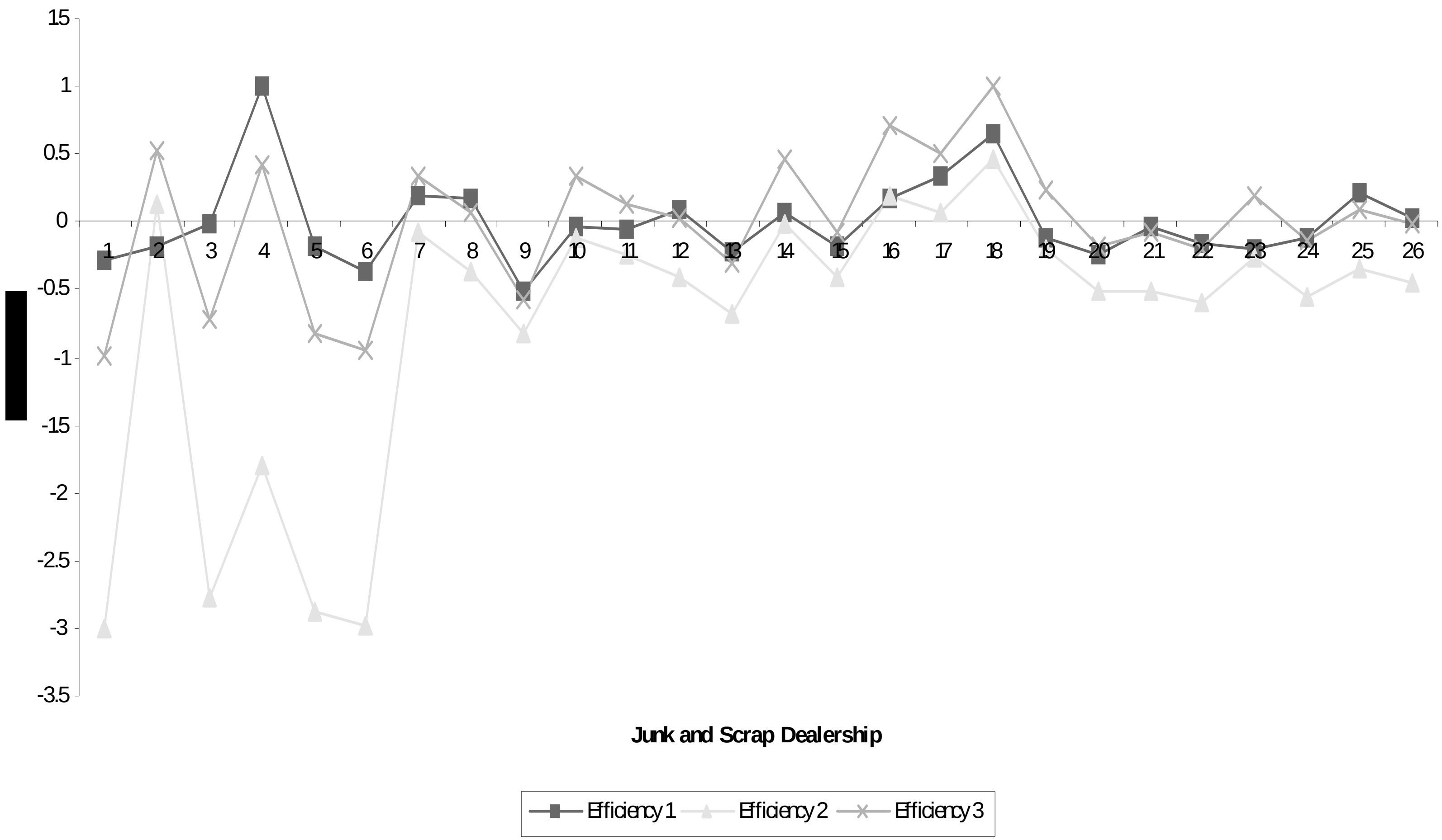


Figure 2.3b - Specific Technical Efficiency of Junk and Scrap Dealerships in arizona, 2003

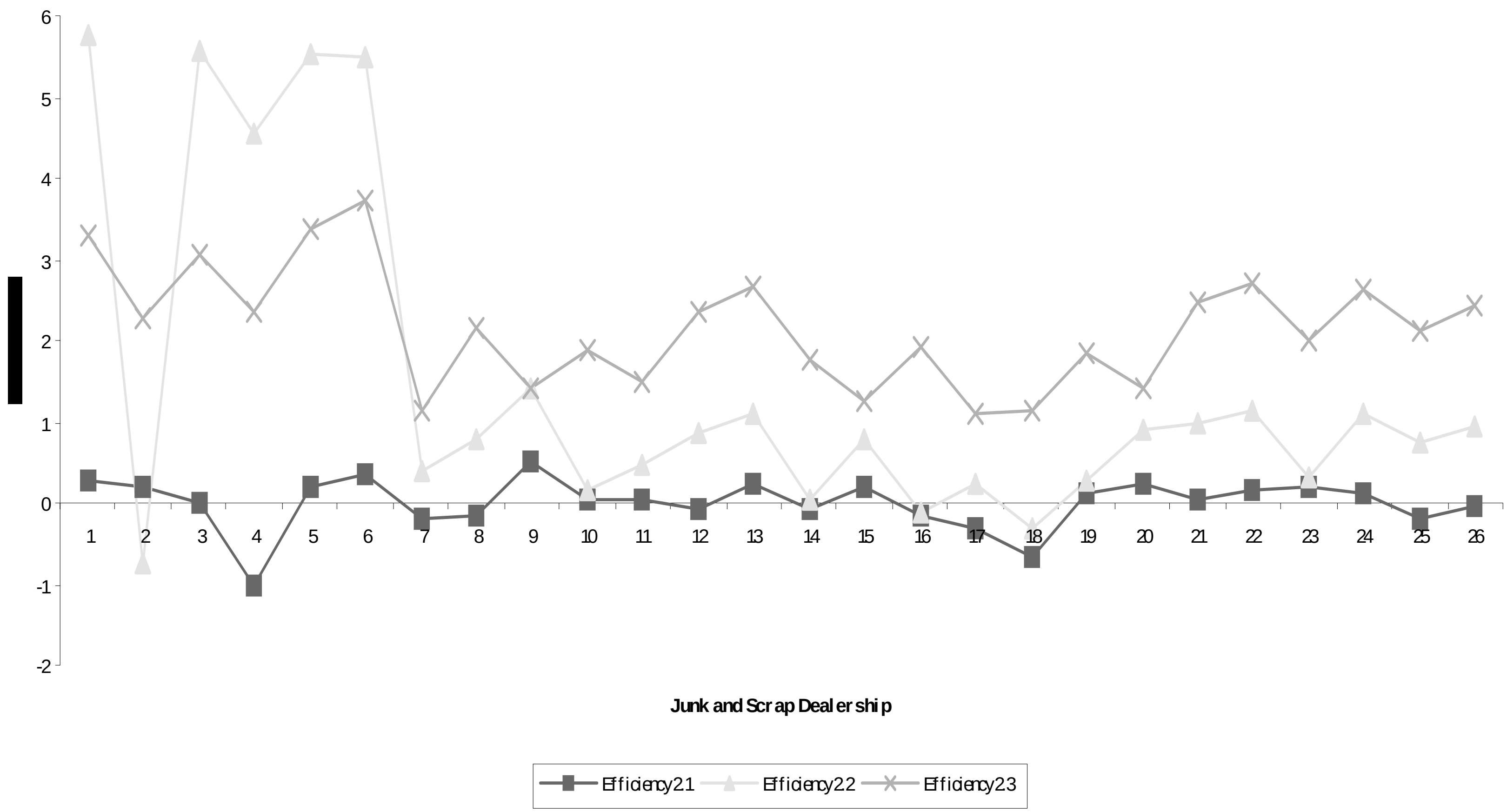
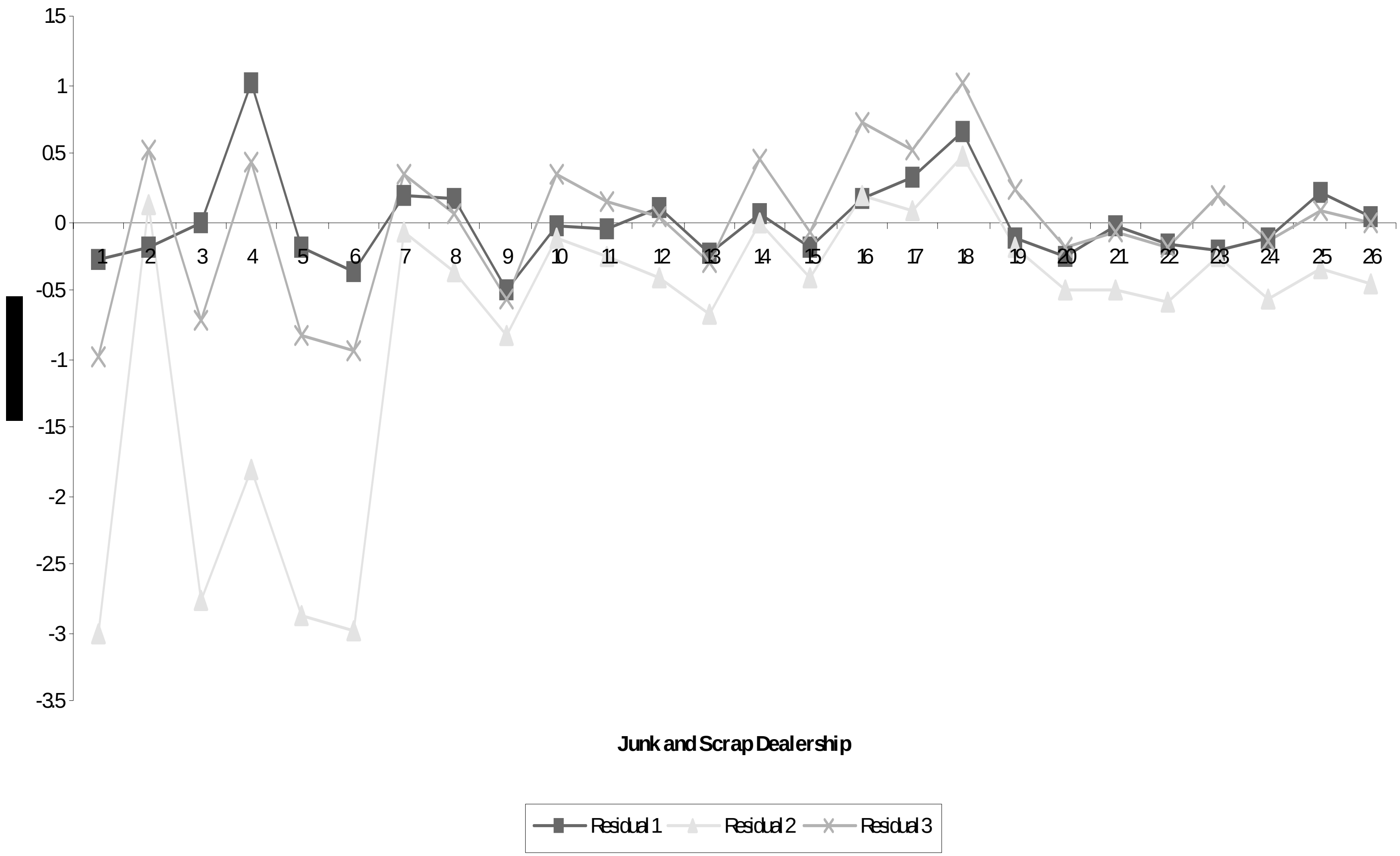


Figure 2.4 - Random Sales Residuals of Junk and Scrap Dealerships in Arizona, 2003



varies widely among dealerships.

The findings also suggest that the productivity of junk and scrap dealerships depends on the interactions of owners, workers, and managers of those entities. For example, $\ln[L_iZ_3]$ and $\ln[K_iZ_3/Li]$ are strongly related to gross sales and average sales, respectively. Thus, it seems reasonable to conclude that the same people invest in, work for, and manage the average junk and scrap dealership in Arizona - a general characteristic of family-owned businesses.

A number of dealerships have been in business since the 1980s or earlier, which suggests that there profits (positive returns) in this industry. However, this investigation focuses on only 26 entities and only for one year (2003). While it is sufficiently clear from the data that capital and labor influence sales, it is not as clear whether investments in this sample of dealerships are necessarily justified. To make that recommendation requires careful evaluation of the industry's growth potential.

An obvious policy implication of the conclusions above is support for junk and scrap businesses, many of them family-owned and labor-intensive operations. However, before making a mountain out of a small anthill, I must hastily add that the results also indicate a need for extensions to this study. One possible area of extension would be to increase the sample size to cover more operations over a wider geographical space and a longer time period than one year. Another implication for research recommends use of alternative estimators and model specifications to deal with the econometric problems apparent from the estimates. Yet another useful research direction would require focusing on economic efficiency and profitability. To do that requires understanding the market and cost structures of these operations.

References

Arrow, Kenneth, et. al. (2004) Are we consuming too much? *Journal of economic Perspectives*, 18(3):147-172.

Anderson, CL (1987) The production process: Inputs and wastes. *Journal of Environmental Economics and Management* 14: 1-12.

Baumol, WJ and WE Oates (1988) *The Theory of Environmental Policy*, Second Eidtion. Cambridge: Cambridge University Press.

Chakrabarti, S. And P. Sarkhel (2003) Economics of Solid Waste management: A Survey of Exising Literature. Kolkata: Economic Research Unit, Indian Statistical Institute.

Chalier, A. And J. Parker (1999) The Economics of Technological Innovation in Recycling. Department of Economics, Reed College, OR, USA [October Version].

Conrad, JM (1999) *Resource Economics*. Cambridge: Cambridge University Press.

Dasgupta and GM Heal (1979) *Economic Theory and Exhaustible Resources*. Cambridge: James Nisbet & Co. Ltd./Cambridge University Press.

Dunn & Bradstreet (2004) *2003/04 D & B Regional Business Directory*. Bethlehem (PA). Volumes 1, 2, and 3.

Fisher, AC (1981) *Resource and Environmental Economics*. Cambridge: Cambridge University Press.

Gonzales, EM (2003) From Waste to Waste: The Scavengers of Payatas. Interantional Conference on Natural Assets No.7. Political Economy Research Institute and Centre for Science and the Environment [December

Revision].

Grace, R., K. Turner and I. Walter (1978) Secondary materials and international trade. *Journal of Environmental Economics and Management* 5: 172-186.

Hall, RW (1983) *Zero Inventories*. Homewood (IL): Dow Jones-Irwin.

Haque, M (1994) Measuring the trends of natural resource commodity prices: An empirical Analysis. *Hitotsubashi Journal of Economics* 35: 59-71.

Hill, H. and KP Kalirajan (1993) Small enterprise and firm-level technical efficiency in the Indonesian garment industry. *Applied Economics*, 25: 1137-1144.

Hoel, M (1978) Resource extraction and recycling with environmental costs. *Journal of Environmental Economics and Management* 5:22-235.

Luton, LS (1996) *The Politics of Garbage: A Community Perspective on Solid Waste Policy Making*. Pittsburgh: University of Pittsburgh Press.

Neher, PA (1990) *Natural Resource Economics, Conservation and Exploitation*. Cambridge: Cambridge University Press.

RMA (2003) *Annual Statement Studies: 2003/2004*. The Risk Management Association.

Slade, ME (1980) An econometric model of the US secondary copper industry: recycling versus disposal. *Journal of Environmental Economics and Management* 6: 123-41.

Turvey, CG and J. Lowenberg-DeBoer (1988) Farm-to-farm productivity differences and whole-farm production functions. *Canadian Journal of Agricultural Economics* 36: 295-312.

Yohe, GW (1979) Secondary materials and international trade: A comment on the domestic market. *Journal of Environmental Economics and Management*, 6:199-203.

2004 Working Papers by this author: http://econpapers.hhs.se/RAS/pam8.htm