V. Empirical Results

The regression models for each distribution level for each drug produce thousands of coefficient estimates. In the following tables, we present only the group average effect of amount (AMT) and, in the case of the price model, expected pure grams as well as their corresponding covariance estimates. When the covariance estimates are statistically significant, it means that there is significant variation across cities in the relationship between the dependent variable (price or purity) and the specific variable of interest.

Purity Equation Results

Table 4 presents coefficient estimates and covariance estimates from the purity equations. The first column identifies the specific drug and distribution level being evaluated. The second column indicates the number of observations used to generate the estimate. The third column shows the group average effect of amount (i.e., weight in grams) on purity and thus indicates the relationship between purchase weight and purity within the given distribution level. The fourth column shows the covariance of the random effect of amount on purity across cities and thus indicates the extent to which the relationship between amount and purity varies across locations. Note that this final column does not pertain to variation in the average purity across cities, which is often considerable, nor does it pertain to variation across cities in the extent to which purity differs across market levels. Rather, it shows variation across cities in the extent to which purity varies with purchase weight within the given market level.

Column three of Table 4 shows that higher amounts of powder cocaine and heroin are associated with greater purity at the two highest quantity levels. This would be consistent with dilution/adulteration taking place within these levels. There is no significant relationship between amount and potency at the lower quantity levels for these two drugs. For crack cocaine and d-methamphetamine, there is generally a negative and statistically significant relationship between amount and potency. This is consistent with the observed overall relationship between purchase weight and purity across quantity levels for these drugs, particularly in recent years.

For most substances, the coefficient estimates are smaller for higher quantity levels. At the same time, the range in amounts is greater at these higher levels. For example, amounts of powder cocaine vary by only 8 grams within quantity level 2 (specifically, between 2 and 10 grams), whereas they vary by 40 grams within quantity level 3 (between 10 and 50 grams). The product of the coefficient estimate on amount and the range on amount within the quantity level is indicative of the model's predicted purity variation within that quantity level. In nearly all cases, it is less than 10 percentage points. Thus, the relationship between transaction weight and purity is often statistically significant primarily because there are so many data points, not because the magnitude of the relationship is so extremely large. There do not appear to be "cliffs" marking abrupt changes in purity within any of the quantity levels defined for these substances.

Furthermore, the covariance estimates provided in column four of Table 4 indicate that many of the purity models have insufficient variation in amount across cities to estimate random effects, particularly at the highest quantity levels. In all but two cases (crack cocaine, quantity level 2, and heroin, quantity level 2), the covariance estimates are statistically insignificant. Even in

those cases where the covariance estimate is statistically significant, the covariance estimates are fairly small. This suggests that the relationship between amount and purity across cities is fairly stable.

Price Equation Results

Table 5 shows selected results from the price equations, the second stage of the price/purity model. For each drug and each quantity level, the average mean effect of the log of expected pure grams on price is positive and statistically significant. Furthermore, the average mean effect of expected pure grams on price is relatively stable, falling between 0.7 and 0.8 for all but a few drugs' quantity levels. In the case of powder cocaine and heroin, the same percentage change in expected pure grams generates an even larger increase in price at larger amounts, as shown by the larger average mean effects at higher quantity levels. The results are less consistent for crack cocaine and d-methamphetamine.

Because there are price markups with distance down the distribution chain, repackaging a certain quantity into smaller bundles and selling those smaller bundles increases the market value of the original quantity. For example, if one could buy a gram of a particular drug for $100, divide it into eight packages that each contain 1/8 gram, and sell those eight packages for $20 each, that repackaging and resale would increase the market value by 60 percent, from $100 to $8 \times \$20 = \$160$. The regression coefficients in Table 4 quantify the increase in market value that results from repackaging and resale and allow comparisons to be made across market levels and drugs. For simplicity, these quantifications assume that there is no change in any of the other independent variables (e.g., the smaller packages are sold in the same city and time period as the original quantity would have been) and that the change in quantity and value occurs within a given market level.

Table 4. Selected Results from the First Stage Purity Regressions

Drug and Quantity Level	Number of Observations	Coefficient Estimate on AMOUNT	Covariance Estimate on AMOUNT
Powder Cocaine			
1	6,056	-0.0092	0.0002
		(0.0067)	(0.0003)
2	7,765	0.0022	1.2E-5
		(0.0014)	(1.3E-5)
3	18,894	0.0011***	0
		(0.0002)	(--)
4	12,198	5.5E-5***	0
		(0.9E-5)	(--)
Crack Cocaine			
1	12,609	-0.0290***	0
		(0.0064)	(--)
2	16,376	-0.0080***	3.2E-6**
		(0.0005)	(1.8E-6)
3	15,147	-2.3E-4***	0
		(0.4E-4)	(--)
Heroin			
1	12,865	-0.0223	0.0079***
		(0.0177)	(0.0027)
2	7,482	0.0154***	1.7E-4***
		(0.0026)	(0.5E-4)
3	6,915	2.3E-4***	0
		(0.4E-4)	(--)
D-Methamphetamine			
1	3,429	-0.0108***	5.7E-5
		(0.0029)	(5.7E-5)
2	5,446	-0.0007**	0 (--)
		(0.0003)	
3	3,101	-8.1E-6	0 (--)
		(9.1E-6)	

Note: Standard errors are in parentheses.
*** indicates statistical significance at the 1 percent level
** indicates statistical significance at the 5 percent level
* indicates statistical significance at the 10 percent level

Table 5. Selected Results from the Second Stage Price Regressions

Quantity Level	Number of Observations	Coefficient Estimate on Log(Expected Pure Grams)	Covariance Estimate on Log(Expected Pure Grams)
Powder Cocaine			
1	6,122	0.716***	0.0033**
		(0.014)	(0.0018)
2	7,543	0.751***	0.0012*
		(0.010)	(0.0007)
3	18,399	0.787***	0.0012***
		(0.007)	(0.0004)
4	11,889	0.813***	0.0005***
		(0.005)	(0.0002)
Crack Cocaine			
1	13,165	0.731***	0.0052**
		(0.017)	(0.0024)
2	16,393	0.661***	0.0041***
		(0.012)	(0.0012)
3	15,038	0.833***	0.0007***
		(0.006)	(0.0002)
Heroin			
1	12,711	0.531***	0.0281***
		(0.029)	(0.0074)
2	7,219	0.718***	0.0228***
		(0.027)	(0.0060)
3	6,664	0.764***	0.0026***
		(0.012)	(0.0010)
D-methamphetamine			
1	3,426	0.707***	0.0050**
		(0.018)	(0.0029)
2	5,196	0.796***	0.0074***
		(0.021)	(0.0029)
3	3,060	0.663***	0.0115***
		(0.026)	(0.0040)
Marijuana			
1	2,112	0.573***	0.1162***
		(0.066)	(0.0401)
2	815	0.802***	N/A
		(0.025)	
3	1,432	0.783***	0.0012**
		(0.013)	(0.0006)

Note: Standard errors are in parentheses.
*** indicates statistical significance at the 1 percent level
** indicates statistical significance at the 5 percent level
* indicates statistical significance at the 10 percent level

The model suggests that repackaging and reselling a quantity of powder cocaine into K = 8 equal-size smaller packages increases the market value by 44 to 51 percent when done at quantity level 4, 51 to 60 percent at quantity level 3, 61 to 75 percent at quantity level 2, and 70to 91 percent at quantity level 1.[18] Thus, for a given size step down the distribution chain, the markup is greater further down the distribution chain. Conversely, the size (in percent) of the quantity discount for buying K times as much is greatest at the lower market levels. This same basic pattern holds for the other substances, with certain exceptions, specifically, larger than expected quantity discounts at crack cocaine, quantity level 2, and d-methamphetamine, quantity level 3. Markups are also much larger for heroin and marijuana at quantity level 1 than at quantity level 2 (the expected direction but greater difference than for other substances). Apart from these specific exceptions, the price markups are all roughly similar at comparable quantity levels, with point estimates ranging from 42 to 63 percent at the highest quantity level and 75 to 84 percent at the lowest quantity level. Again, these specific figures are for K = 8; for different values of K, the percentages will be different but will still display the same relationship across drugs and quantity levels.

The covariance estimates of the group average effect of expected pure grams on price are all positive and statistically significant except in the case of marijuana, quantity level 2, for which there was either insufficient sample size or insufficient variation in the small sample to calculate random effects. The clear conclusion from these estimates, however, is that cities vary substantially in the quantity discounts offered at every quantity level. This suggests that it is important to estimate quantity discounts by city, rather than arbitrarily assuming the rates are the same around the country either directly by not allowing the relevant regression coefficients to vary by location or indirectly by pooling data from many cities in a single regression. Further, the differences across cities appear to be larger for some drugs (e.g., heroin) than for others (e.g., powder cocaine or crack cocaine).

Estimates from these models are used to generate city-specific predicted price and purity estimates for each drug and quantity level in every quarter possible from 1981 through the second quarter of 2003. To generate each prediction, the model requires that potency and amount be specified at a certain value. In all instances, potency was set to 100 percent. Amounts varied depending on the quantity level being estimated. In all cases, a round number close to the median value within a specific quantity level was used (see Table 6). Estimated annual price and purity values for specific cities shown in the main report (Tables B.1 through B.8) are reported in Appendix D. We estimate these city-specific price and purity series for the lowest quantity level for all drugs except d-methamphetamine, for which we use the middle quantity level, due to low geographic distribution at the lowest quantity level.

One important step taken *ex post* the regressions is the deletion of the predicted annual price for d-methamphetamine in the third quantity level for 1987. In 1987, there were only five observations on which to base this estimate, all of which were in the first quarter and four of which were from Baltimore on February 2. The observations from Baltimore all share the same extremely large nominal price ($17,200) and have ranges of amounts and purities that are amazingly close (amount ranged between 102 and 105 grams, and purity ranged between 5.4 and 8.2 percent). It was concluded that these four records were likely to be duplicates that were not

[18] Ranges based on the point estimates +/– 2 standard errors.

caught previously because they were not exact duplicates. If they are treated as duplicates, then there are only two observations for 1987, an insufficient amount to estimate the model. Thus, we deleted all five observations for that quarter from the sample. While these nearly duplicate records were easy to identify because of the huge price spike they generated in the model, there are likely to be many other probable duplicates in the data that remain unidentified. Future work should attempt to identify and delete likely duplicates.

Table 6. Evaluation "Amount" in Grams for Each Quantity Level

Drug	Quantity Level 1	Quantity Level 2	Quantity Level 3	Quantity Level 4
Powder cocaine	0.75	5	27	108
Crack cocaine	0.3	5	38	
Heroin	0.4	2.5	27.5	
d-Methamphetamine	2.5	27.5	225	
Marijuana	2.5	26	443	