RESULTS

I begin by fitting a hedonic regression model to all three datasets. Next, I replicate Beggs & Graddy's (2009) original anchoring findings for their two Impressionist and Contemporary datasets. Then, I apply their same model to my new third dataset of assorted art sales. Finally, I run my anchoring cross-effects regression on all three datasets. I also run my cross-effects regressions on three pairs of "similar" artists, under the suggestion of Hadley Newton.

Commented [J1]: Who is this again?

HEDONIC REGRESSION

We begin by fitting a hedonic regression model to our three datasets in order to construct a measure of artistic value for each piece. For Impressionist art, (as in Beggs & Graddy (2009)), though, predictions are fit separately for observations in London and in New York due to currency differences, then recombined and normalized for the anchoring regressions. Tables 4-7 below show the results of the hedonic predictions.

Overall, hedonic characteristics such as the painting dimensions, the presence of a signature, medium, and artist and time effects (both omitted for brevity; both significant) have a significant impact on the sale price of the painting. It is surprising that a painting's date of creation is generally not significant, which may be explained by the importance of artist variables. For Impressionist Art and Contemporary Art, much of the variation in price is explained by our regression model, indicated by generally

high R^2 values. For our new dataset, however, the R^2 value is extremely low although variables are significant. This is to be expected: our dataset covers a very large variety of paintings, and so we should see very high variance across prices in our regression model (though far lower bias, as indicated by our highly significant hedonic variables). The F-statistic is extremely significant in all cases, which shows that our regression variables are relevant as a whole. In general, the most impactful variables are those for the art medium and the dimensions. This may be attributed to large pieces and pieces from specialized mediums selling for more, as indicated by large, significant coefficients for certain mediums and not for others. Despite a high R^2 value for Impressionist art, the intercept is highly significant. This suggests that non-hedonic factors likely play a large role in determining value for Impressionist pieces, which is understandable given the relatively more pronounced age and renown of those works. Additionally, the presence of a signature specifically, rather than other signs of authenticity such as a monogram, generally seems to be more important to determining hedonic value. We do observe that signature is more significant for Impressionist art auctioned in NYC, while medium is probably a more significant factor for that auctioned in London. As a further note, regressing on only artist and time dummies corresponds to a reduction in R^2 in the Impressionist and Contemporary datasets, as noted in Beggs & Graddy (regressions not included). Generally, it is clear that hedonic factors such as size and medium do play a large role in determininge value for the works we examine.

Commented [J2]: Are you gonna cite "See Table ___" at any point? Better earlier than later in order to be clear. This stuff is much more difficult to understand in paragraph format than in table format.

Commented [J3]: Have you talked about the difference between a signature and a monogram before?

Commented [J4]: How do you observe this?? Maybe I just don't understand regressions. Could be helpful if you described some coefficients and the differences in coefficients?

REPLICATION: BEGGS & GRADDY (2009)

Here, we attempt to replicate some of the work of Beggs & Graddy (2009), who analyze the same Impressionist and Contemporary datasets to test whether the first sale of a painting produces an anchoring effect on its later sales. In this research we only consider sale price, but Beggs &Graddy did~~they~~ also run regressions for presale estimate and the probability of sale. As mentioned earlier, they identified resale observations by cross-checking against presale catalogs, so it is not possible for us to entirely replicate their work. We therefore make the assumption that duplicate hedonic observations refer to multiple sales of the same item, and run our regressions for the full datasets each.

Tables 8 and 9 show our results, alongside the original tables of Beggs & Graddy. We were able to reproduce the discovery of highly significant anchoring effects in Impressionist art, and the more weakly significant effects in Contemporary art. However, our coefficients are not nearly as large, although significant. For Impressionist art, a 10% increase in the difference between past price and current hedonic prediction (anchoring) only corresponds to a 1.7% increase in the current sale price (original: 6.2-8.5%), while for Contemporary art, ~~thi~~the difference between past price and current hedonic predictions~~s~~ is only a 1.3% predicted increase (original: 5%). On the other hand, our regressions show that the residuals from past price (unobserved

Commented [J5]: As what was found in Beggs & Graddy?

Commented [J6]: Is this original citing Beggs & Graddy?

inputs into past price, such as the thrill of bidding) are much stronger than anchoring in the case of Impressionist art (5% increase for Impressionist), which differs from the results of Beggs & Graddy. One explanation could be that the reputation of Impressionist pieces grows over time as these pieces trade ownership across collectors and museums, so that reputation effects tend to drive up buyer demand beyond hedonic value or even past price anchors. This would be captured in the past residuals. We do find a weaker impact of the past residuals on current price in the case of Contemporary art, a result which is shared by Beggs & Graddy. They attribute this to the heavy time-dependent variation in prices in this Contemporary art dataset (not shown here), which suggests past prices would not serve as meaningful anchors. We also replicated their discovery of relatively small time coefficients, particularly for Contemporary art. This indicates that the specific number of months between sales seems to not be a major influence in determining the current price of a work (at least in the context of resale). Finally, our anchoring regressions also share the very high R^2 and adjusted R^2 values of Beggs & Graddy, indicating that much of the variation in hammer prices is explained by this model.

In addition to Impressionist and Contemporary art, we also ran ~~their~~ Beggs & Graddy's original anchoring regression on our new dataset of recent assorted painting sales (Table 10). Because our dataset does not seem to have identifiable multiple sales of the same item, we used the average substitute of an item (constructed as described in

Commented [J7]: You're covering a lot of information in this paragraph so I think you could actually break it up into smaller paragraphs rather than keep it as one big one. Your smaller paragraphs might only be 1-2 sentences long, but it would better maintain clarity for the reader about what's going on.

our methodology) instead of a past sale as a point of comparison for the anchoring effect. This reduces to running our regression for anchoring cross-effects without the measure of substitution, i.e. the control term Q. Despite this naïve approach that does not control for substitution, we can still discover some insight.

We discovered strong and highly significant anchoring effects in this context (5.9% increase), although, just as in our findings for Contemporary art, the residual from past price seemed to be relatively unimportant and less significant. This preliminary evidence suggests that, although we have not controlled for substitution yet, anchoring is at work in this dataset. The R^2 value is much lower due to the very high variation in our data, but the F-statistic is extremely high indicating that our regression variables do seem to be relevant. As in both the original results of Beggs & Graddy and our replication of their work, we found that time effects seemed to be relatively weak, though they are highly significant. Hence, our next Q_1 and Q_2 regressions, designed to control for substitution, should yield more precise and accurate insight into anchoring effects.

Commented [J8]: What is the object of "reduces" here?

Commented [J9]: You probably don't want to call your approach naïve. Simplistic, maybe?

Commented [J10]: Than what?

ANCHORING CROSS-EFFECTS

In this section, we describe our regression results that control for substitution. We employ our measures Q_1, Q_2 which describe how similar a current good is to its "average substitute," a representative good constructed from all other identified

substitutes. As discussed earlier, the measure Q_1 represents the (log) second moment of hedonic prices of substitutes about that of the current good. This allows Q_1 to capture both the spread of hedonic differences as well as the magnitude of those differences. Conversely, the variable Q_2 measures similarity across art pieces according to insight from our interviews, and represents the importance of size, price, and time effects.

Q1: SECOND MOMENT OF HEDONIC PRICE DIFFERENCES

$$\omega_c = b_1\pi_c + b_2(P_s - \pi_c) + b_3(P_s - \pi_s) + b_4\left[Q_1 = -\log\frac{1}{n}\sum_{i=1}^{d}(\pi_c - \pi_{si})^2\right]$$

Tables 11 through 13 show the results of running the above regression for our Impressionist, Contemporary, and assorted art datasets. There are several results particularly worth noting here.

First, after controlling for substitution, anchoring effects lose significance for Contemporary art, and only retain significance for Impressionist and recent assorted art. It is possible that anchoring is no longer significant for Contemporary art because it tends to be especially diverse. For instance, based on our interviews, we learned that over time, the boundaries between art mediums have become finer as mediums are combined in "mixed media" formats. These unusual Contemporary artworks do seem to fetch competitive sums at auction.[1] [2] As a result, a Contemporary artwork to be auctioned may lack obvious precedents for the determination of its value, ~~which means that~~Thus, the current price will be determined by the piece's own characteristics as well as unobserved inputs into price, such as general demand for Contemporary art. These seem to be confirmed by the highly significant hedonic price prediction, as well as the highly significant, non-negative substitute residual. The lack of anchoring effects for

Commented [J11]: Combine footnote

Commented [J12]: Does this refer to unobserved inputs? Contemporary art?

[1] http://www.christies.com/lotfinder/paintings/invader-alias-hk-59-5875653-details.aspx

[2] For instance, Matt Lamb's "Figures" fetched $24K at Christie's, London on June 22, 2010. http://www.christies.com/lotfinder/paintings/matt-lamb-figures-5332422-details.aspx

Contemporary art goes hand-in-hand with the insignificance of the substitution measure, which indicates that price does not seem to be determined by substitution phenomena.

On the other hand, anchoring effects and substitution are significant for Impressionist art. In general, Impressionist works tend to have better-defined mediums such as oil and watercolor, which likely makes it easier to identify similar sale precedents. Hence, anchoring is significant (though not particularly strong): a 10% gap between the substitute's sale price and the current piece's hedonic value corresponds to 0.3% change in the current price. More impactful is the substitute sale residual, which exhibits a highly significant and stronger coefficient. We believe this may be due to reputation effects. Impressionist pieces, which tend to be much older, scarcer, and well-known, seem to be purchased more as an investment ~~rather~~ than as a decoration.[3] [4] Hence, we would expect their non-hedonic value to rise as their provenance and auction history becomes more and more illustrious over time. As a result, the sale prices of these pieces begin to reflect their historical reputation more than their hedonic value. Historical reputation may be tied to general attributes such as the artist and provenance, which may of course be shared by multiple works. Thus, we should expect

[3] http://pierrebittar.com/why-invest.html

[4] Impressionist price index in Beggs & Graddy (2009)

buyers of a piece to draw upon price signals from sales of similarly reputable works, which are captured in the significant substitute residual here.

Finally, our assorted art dataset exhibits strong and highly significant anchoring effects. We believe this is partially due to the far smaller time gaps between sales, which as discussed in our literature review, seem to be more conducive to anchoring. However, in addition to containing both Impressionist and Contemporary works, the assorted art dataset is much larger and diverse. This means that for a given art piece, it may be possible to find more appropriate substitutes, which is suggested here by the highly significant coefficient for the substitution measure. < need to work hard on this section. Maybe go into data, .Rdata, or regression here >

Time effects (months since last sale) have small coefficients across the board, and are insignificant for Impressionist art. From our interviews, we learned that buyers of art tend to be myopic, in that they do not tend to internalize the full range of historical prices (only recent prices, e.g. anchoring). This seems to be confirmed by the price indices and small time coefficients in Beggs & Graddy (2009), which suggest that prices can climb up dramatically over long stretches of time. Here, for assorted art, a 100 month (8.3 year) time interval between sales only corresponds to an 8% decrease in the current price. For Contemporary art, the same gap corresponds to a 5% decrease, while for Impressionist art the association is almost nonexistent. Nevertheless, the fact that

Contemporary and assorted art have somewhat larger coefficients suggests that smaller time intervals between sales can counteract buyer nearsightedness.

The R^2 values are generally in line with our results for the original anchoring regression: there is much less variation in the Impressionist and Contemporary datasets than in our assorted art one. High F-statistics confirm the relevance of our variables, as before.

Commented [J13]: I'm so sorry Evan. I probably will not be able to read for contradictions because I don't understand what any of this means…..

Q2: DOMAIN KNOWLEDGE

$$\omega_c = b_1\pi_c + b_2(P_s - \pi_c) + b_3(P_s - \pi_s) + b_4\left[Q_2 = -\log\frac{1}{n}\sum_{i=1}^{n}\left(\frac{(S_c - S_s)^2}{1 + (\pi_c + \pi_s)} + \Delta days(t_c, t_s)\right)\right]$$

Tables 14 through 16 show the results of using Q_2 as a control for substitution. Even though the design and focus of Q_2 is considerably different from those of Q_1, we reach similar results, which further confirms our overall discovery of anchoring effects.

First, as in the Q_1 case, anchoring is significant for Impressionist and assorted art, but insignificant for Contemporary art. This is what we found in the Q_1 case, which is surprising ~~given~~ since Q_2 only focuses on a couple of key variables (size, time) that were carefully suggested by our experts. Nevertheless, anchoring coefficients are weaker across the board, which suggests that Q_1 might be a more stringent control.

Although Q_2 becomes a significant predictor of price across all three datasets, the impact of Q_2 on price is mixed, compared to the Q_1 case. For Impressionist art, Q_2 has a larger coefficient (in absolute value) than Q_1 did; on the other hand, for Contemporary art Q_2 is weaker. This suggests that when buyers of a given art piece research sales of comparable pieces, they base their hedonic value judgments primarily on size, and do not delve into sales too far in the past. For Contemporary art, we see that Q_2 ~~becomes~~ is significant, ~~(~~as opposed to ~~difference from~~ the Q_1 case), indicating that domain knowledge of artistic similarity does seem to be legitimately helpful in predicting price.

Commented [J14]: Wow! A sentence I understand!!

This is consistent with our discussion of Contemporary art pieces in the Q_1 case, and the lower R^2 for Impressionist art in our hedonic regression model (Table 5 and 6). Compared to Impressionist pieces, Contemporary art pieces do seem to generally have a more limited provenance and history, and so derive much of their value from hedonic factors. That said, here the quality of substitution Q_2 is still comparatively stronger for Impressionist art than for Contemporary art. This is because time effects are stronger for Contemporary art than for Impressionist art: some of the predictive ability of Q_2 is sapped by the significant time coefficient also included in the regression (-0.05039). Prices for Impressionist pieces generally seem to be somewhat resistant to long intervals between sales, as indicated by the lower and non-significant time coefficient (0.8457).

Commented [J15]: This makes sense to me!

While both Q_1 and Q_2 are significant for assorted art, Q_2 is a hugely more impactful measure of substitution: a 10% improvement in substitution quality corresponds to a 3.0% increase in sales price. Focusing on size and time duration seems to be far more effective as a control, since for this assorted art dataset, it is possible that Q_1 (as a more general hedonic measure of similarity) may capture too much noise to be helpful for measuring substitution. Nevertheless, regardless of which measure we use, we are still accounting for a lot of variation in the data, as evidenced by moderate-low R^2 values.

THREE EXPERIMENTS

Hadley Newton helped us ~~to~~ sift through our assorted art dataset for pairs of "similar" artists to compare. This includes Joan Miro & Salvador Dali, Pablo Picasso & Marc Chagall, and Edvard Munch & Henri de Toulouse-Lautrec. While the first two pairs produced artistically similar work, the last pair ~~are~~ is ~~regarded as~~considered similar for historical reasons, as ~~we briefly mention~~discussed in ~~their section~~ below. In this section, we run our Q_1 and Q_2 regressions on those three pairs of artists for comparison. Specifically, we test whether one artist serves as an anchor for the other, and vice-versa: an artist may not be their own anchor. This allows us to directly test our anchoring regressions on known substitutes, and evaluate our results more thoroughly. Only Contemporary artist pairs were suggested to us.

Commented [J16]: Who is this again? Could be helpful just to say "Sotheby's analyst Hadley Newton" or whatever his job is.

Commented [J17]: Any particular reason why? Was that his area of specialty?

SUBSTITUTION EXPERIMENT #1:

JOAN MIRO (1893-1983) AND SALVADOR DALI (1904-1989)

Miro and Dali were two of the most iconic Spanish Surrealists, and created pieces that are at once abstract, imaginative, and occasionally absurd. The work of Miro draws heavily on well-defined geometric shapes and lines, filled with bright colors and political overtones[5]. Dali's work, which ranges from bizarre scenes to nightmarish landscapes, is dreamlike yet shows an appreciation for the realistic nature of classical

Commented [J18]: I know this is hard here because you should talk about art in the present tense and history in the past tense, but it would read much better to consistently stick with one verb tense. I would recommend past.

[5] http://joanmiro.com/style-of-joan-miro/

and Renaissance art.[6] Works by both Surrealists have sold at auction for 6- and 7-figure sums, and the two Surrealists are occasionally paired together at museum and gallery exhibitions.[7] We were told that works by these two artists tend to also attract the same kinds of clients.

Tables 18 and 19 show the anchoring regression results for Miro and Dali (in our assorted art dataset) with our respective controls Q_1 and Q_2. First, it is notable that anchoring is entirely insignificant with Q_1, but gains a highly significant p-value and becomes much stronger when Q_2 is used. However, Q_1 is highly significant and impactful, but Q_2 is not. This relationship between the anchoring effect and the measure of substitution in this dataset suggests that Q_2 is not an appropriate control, which would indicate that the anchoring effects in the Q_2 case may be illusory. Either way, there is a large amount of variation that our model cannot explain, as evidenced by our low R^2 values. It is also surprising that the hedonic price predictions are relatively weak and insignificant, and that unobserved inputs into the substitute's price (the substitute's residual) are impactful and highly significant. Even further, the intercept term is very large and significant. Together, all these observations suggest that there are other influential inputs at work (in the error term) beyond our identified variables. Thus, a substitution control better tailored to Dali and Miro might be required in this scenario,

Commented [J19]: Maybe I'm misunderstanding but how can Q2 have a highly significant p-value while Q1 is the one that is highly significant?

[6] http://www.theartstory.org/artist-dali-salvador.htm

[7] http://www.galeriemichael.com/current-exhibitions/miro-dali-poetic-visions-two-catalan-surrealists/

as anchoring effects between Dali and Miro pieces are inconclusive here. However, this experiment does highlight the importance of controlling for substitution to prevent anchoring effects from being falsely detected.

As confirmed by our earlier regressions, time effects are significant and influential for both Dali and Miro who (as Surrealists) may be classified as Contemporary artists. Despite the variation in our data, a high F-statistic ensures the relevance of our model. Nevertheless, due to our mixed results, we cannot say from our Q_1 and Q_2 regressions that there is anchoring between Dali and Miro.

Commented [J20]: You should add a sentence here explaining why mixed results don't necessarily negate the relevance of your model either.

SUBSTITUTION EXPERIMENT #2:

PABLO PICASSO (1881-1973) AND MARC CHAGALL (1887-1985)

Picasso and Chagall, former friends turned opponents[8] and two of the best-known Contemporary artists, spanned multiple artistic traditions. The works of Picasso range from Cubist nude portraits to Neoclassical and Surrealist paintings, and frequently depict real life in abstract forms. Chagall drew upon a variety of movements including Surrealism, Cubism, and Expressionism for his works, many of which focus on scenes from Eastern Europe.[9] [10] The two painters are frequently featured together at

Commented [J21]: Again, you need to maintain verb consistency. I would recommend changing everything to past tense like it is here.

Commented [J22]: Combine footnotes.

[8] http://www.pablopicasso.org/picasso-and-chagall.jsp

[9] http://www.theartstory.org/artist-chagall-marc.htm

[10] http://www.infoplease.com/encyclopedia/people/chagall-marc.html

exhibitions[11] [12], perhaps even more so ~~often~~ than Dali and Miro ~~are~~, and the works of Picasso and Chagall often fetch 7- and even 8-figure sums at auction.

Overall, Q_1 and Q_2 give very similar results for this comparison (Tables 20 and 21). Anchoring is strong and significant in this comparison between Picasso and Chagall. It is also associated with the presence of significant control terms this time, which suggests that even after controlling for substitution, anchoring is still very much at play. Also, the coefficients are large: if the price of the substitute is 10% higher than the hedonic value of the current good, we should expect to see a 15% increase in the current good's price due to anchoring (if we use Q_1; 25% increase if we use Q_2). In case, the intercept is also much stronger and highly significant, compared to that of Q_1. We are also explaining a huge amount of variation in the data: the R^2 values are extremely low. This indicates that for Picasso and Chagall, prices for their artwork are probably affected by other ~~other~~ influences ~~are probably at work~~, and that our two measures of substitution, although significant and generally a step in the right direction, could be improved. Time effects are fairly small, and do not seem to affect price much if at all.

While anchoring effects were less conclusive for Miro and Dali than they are ~~,~~ for Picasso and Chagall, we do see here highly significant evidence of strong anchoring

[11] http://www.operagallery.com/catalogues/picasso_chagall_dubai/cata.pdf

[12] http://pueblopulp.com/picasso-matisse-chagall

Commented [J23]: Combine footnotes

Commented [J24]: Q1 and Q2 themselves are similar? Or they give results similar to the case of Dali and Miro?

Commented [J25]: Awkwardly worded. Are you trying to say that you are ABLE to explain the variation in the data?

cross-effects. Thus, we should expect prices for one artist's works to noticeably impact those for the other's pieces.

SUBSTITUTION EXPERIMENT #3:

EDVARD MUNCH (1863) AND HENRI DE TOULOUSE-LAUTREC (1864-1901)

We were suggested to pair together Munch and Toulouse-Lautrec because, as contemporaries in Europe, they met with similar levels of economic and critical success during their lifetimes. However, their artistic styles seem to somewhat differ. Munch, a Norwegian artist associated with Expressionism and Symbolism, is known for the intensely psychological and brooding themes he imbued into his paintings and prints[13]. On the other hand, Toulouse-Lautrec is known for his Post-Impressionist, drawing-like depictions of people, often those from lower-class, urban environments.[14] It seems that Munch and Toulouse-Lautrec are featured together less frequently than Miro and Dali or Picasso and Chagall: a quick Google search only turns up a single 1965 exhibition at the Metropolitan Museum of Art that featured both their artworks.[15] Nevertheless, both artists pull in hefty sums: Toulouse-Lautrec's work "Au Lit: Le Baiser" fetched $16.3 million at Sotheby's in early 2015,[16] and Munch's Internet-famous "The Scream" sold for nearly $120 million at Sotheby's in 2012.[17]

Commented [J26]: I think you need to further elaborate why this is a convincing reason to pair them together. Why do their differing art styles not suggest that they SHOULDN'T be paired together?

[13] http://www.theartstory.org/artist-munch-edvard.htm

[14] http://www.toulouse-lautrec-foundation.org/biography.html

[15] http://libmma.contentdm.oclc.org/cdm/ref/collection/p16028coll12/id/1460

[16] http://www.theguardian.com/artanddesign/2015/feb/04/sothebys-auction-highest-sales-total-ever

[17] http://www.nytimes.com/2012/05/03/arts/design/the-scream-sells-for-nearly-120-million-at-sothebys-auction.html?_r=0

Tables 22 and 23 show the respective Q_1 and Q_2 anchoring regression results for Munch and Toulouse-Lautrec in our assorted art dataset. No significant or strong anchoring effects appear this time, regardless of whether we use Q_1 or Q_2. Even if the two artists did enjoy comparable success during their concurrent lifetimes, their artistic styles may be too different to permit anchoring cross-effects. It is also possible that the comparison between Munch and Toulouse-Lautrec is less conducive to anchoring in light of even more renowned artists during the same time period, such as Vincent Van Gogh (1853-1890) and Paul Gauguin (1848-1903). Works by Toulouse-Lautrec, in particular, seems to be auctioned off alongside those Impressionist artists[18]. Our measure of substitution is insignificant in both the Q_1, Q_2 cases, which seems to further suggest that Munch and Toulouse-Lautrec are not particularly close hedonic substitutes. That said, Q_2 has a somewhat larger coefficient, which could be due to its inclusion of near-significant time effects (p-value: 5.38). The R^2 value indicates that we do seem to explain more variation in the data than we did for other artist pairs, but relatively low F-statistics suggest that our model is not as relevant for the Munch/Toulouse-Lautrec pair. In fact, the only significant variable is the hedonic price prediction. Hence, we do not find any evidence of anchoring between Munch and

Commented [J27]: I don't quite understand the conclusion here. Why would Van Gogh's fame affect the pricing of Munch's painting? Or why would it affect the relationship between Munch and Toulouse-Lautrec's paintings?

Commented [J28]: What does it mean if your model is not relevant? Does it mean that your model can't be used when there aren't similar hedonic qualities in the artwork? I think there needs to be a futher conclusion here.

[18] http://www.bloomberg.com/news/articles/2015-02-05/here-s-why-sotheby-s-and-christie-s-just-sold-444-8-million-in-impressionist-art

Toulouse-Lautrec – which is understandable, given their relatively divergent artistic styles.