Thanks again for this second of three opportunities this month to testify on aspects housing economics and inclusionary zoning policy (IZ) prompted by an HCDA proposal to change its affordable (the adjective) housing (the common noun) production quotas, buyback rules, and shared equity requirements to parallel more closely similar changes being considered by the City & County of Honolulu. In my testimony earlier this month I made several observations which I summarize in the next paragraph for the written record. I appear today at the request of several area residential developers with whom I am engaged in consultation to provide an economic analysis of the proposed HCDA policy changes. I plan to make a report on my findings available to HCDA next week and, at the end of the month, will return to offer my three-minute conclusion in testimony at that time.

To recapitulate, my six observations on May 3, 2017 were: (1) reducing HCDA’s reserved housing adjusted median income (AMI) thresholds will result in less new housing development, not more, as will increasing production quotas as a fixed fraction of proposed new units; (2) restricting homeowners’ leverage (not to exceed 80 percent of original purchase prices and, presumably, a declining fraction of future valuations) will undermine households’ financial flexibility, deter reinvestment in depreciation mitigation, and may undermine mortgage underwriting and securitization; (3) replacing an American (fixed term) buyback option with a European (perpetual) option encumbers more heavily future values of the underlying asset; (4) prior ownership restriction changes on HCDA reserved housing applicants may simply be an invitation for families to game the system; (5) equity sharing may comprise an unconstitutional taking which, if not in violation of housing anti-discrimination principles (in outcome, if not intent), put the state (small s) in the unethical position of profiting on private individuals’ equity investments;¹ and (6) using median existing Oahu home prices as an indexing mechanism ignores higher-order moments of the underlying home price distribution and their potentially pernicious effects.²

¹ Presumably, in social democracies, the wealth transfer would go in the opposite direction, from a polity comprising the public at large, to individuals and their families whose housing needs cannot be fulfilled because of their low incomes or other economic disadvantages, rather than from poor households to the state (small s).

² The resulting distortion might be diminished by using a quality-adjusted price index that relies on broader public-record data such as collateralization amounts underlying mortgage-backed securities, in the spirit of a Case-Schiller index, such as one of the Federal Housing Finance Administration’s house price indexes, in addition to transactions-based data.
I was once “schooled” by Stanford University Economics Professor John Taylor, after whom the Taylor Rule of monetary policy is named, when he was U.S. Undersecretary of Treasury for International Monetary Affairs and I was a commercial bank economist debating exchange rate policy with him in an industry roundtable. His observation was, “perhaps you haven’t been keeping up with the literature.” Boom. In this spirit of collegial critique, let me survey what the housing economics literature says about inclusionary zoning.

First, the housing economics literature is unkind to inclusionary zoning policy. To paraphrase a recent UHERO literature review, inclusionary zoning is a policy fail. It yields less housing, and less affordable (the adjective) housing. In jurisdictions like Oahu, geographic constraints (“steep slopes and water bodies”) complement regulatory constraints to reduce the responsiveness of new housing supply to changes in demand. This yields more volatile prices and valuation cycles of greater amplitude than in places where towns spatially can radiate outward across the flat prairie and where regulatory burdens are minimal. Honolulu and Hawaii distinctively appear in every empirical quantification of regulatory scarcity at the top of U.S. national rankings as the most costly places to build, by far, because of these constraints.

Second, even among my colleagues in what I call “the ULI crowd,” the evaluation of inclusionary zoning is mixed at best. A number of papers, including consultants’ studies posted on the City & County of Honolulu’s web site, conclude their evaluation of the success rate for inclusionary zoning with a resounding “Meh.” It works some places, it doesn’t others, offering little guidance beyond that mediocre assessment. I conjecture that the places IZ doesn’t work most likely have “steep slopes and water bodies” and face a housing regulatory environment notorious as most burdensome nationwide. Even Honolulu’s konohiki of TOD, Harrison Rue, observed (somewhat cavalierly) at the last HCDA public hearing that he can get a 120 percent AMI required to work down on Ala Moana (Boulevard). That is the point, isn’t it: IZ works as long as you are building luxury condominiums down on Ala Moana Boulevard. Not so much up on Beretania where local families are more likely to live.

Third, ironically, IZ obligates developers to build luxury housing units. Only high prices can cross-subsidize the low-cost housing units developers are obligated to build under IZ production quotas. This is why IZ fails: if you have to build high-end units to build any units (since only high-end units will cross-subsidize the low-end units), then you will never build in the middle. We all live in the middle.

---

3 Carl Bonham, Kimberly Burnett, Andrew Kato (February 12, 2010), “Inclusionary Zoning: Implications for Oahu’s Housing Market,” UHERO Project Report 2010-1 (http://www.uhero.hawaii.edu/assets/UHEROProjectReport2010-1.pdf), who write, “Inclusionary Zoning (IZ) policies have failed in other jurisdictions and are failing on Oahu. IZ reduces the number of ‘affordable’ housing units and raises prices and reduces the quantity of ‘market-priced’ …units.”


5 As evidenced by the thousands of new housing units under urban redevelopment along the King Street / Beretania corridors as we speak. OK, I’m being sarcastic. Currently I know of none.
Fourth, HCDA current and proposed policies require that only the new guy has to pay a tax to subsidize low-end housing. Old guys, some in red t-shirts, and the public at large, simply free-ride off the new homebuyers. This is odd redistribution policy construct. Need a new school? Make the new guy pay. Fire Station? The new guy. TheTrain station? “Woah nelly, us old guys no pay for notting.”

The higher the production quota, or the lower the AMI threshold, the more luxury units a developer has to build to fulfill its quota, and the fewer new units will be built for regular people who live in the middle of the housing price distribution. This is upside-down. I can statistically demonstrate, in a plausibly specified long-run framework, that beginning with housing policy changes adopted in the 1970s that included the creation of the Kakaako Redevelopment Authority, HCDA’s precursor, and the embrace of IZ policies in the 1980s, subsequent homebuilding on Oahu contracted from one residential investment cycle to the next over the last four decades. (See Figure 1, appended). Once Honolulu exhausted most urbanizable land in proximity to the urban core during the late-20th century, regulatory restrictions incrementally constrained—in each consecutive cyclical recovery—subsequent new housing flow supply responses. Never in the last half century (between 1956 and 2016) have there been fewer new housing units authorized by building permit on Oahu in any eight continuous years than during the last eight years.

Next time I will offer a constructive alternative to the proposed HCDA policy changes involving a measured reduction to regulatory barriers to entry for development of new housing units priced in lower quantiles of the distribution of existing home prices. Current IZ policy conflates an income problem (not enough of it) for a housing problem (not enough of it). Let’s solve the housing problem.

Mahalo for your time and attention,

Paul H. Brewbaker, Ph.D., CBE
TZ Economics
606 Ululani St.
Kailua, Hawaii 96734
Figure 1. Regulatory constraints are responsible for the break in, and failures to fully recover back to earlier level of, new home construction

New housing units (thousands per year) authorized by building permit on Oahu, and a regression with breakpoints and dummy variables on a low-order polynomial trend component.

Path illustrated uses OLS trend regression on third-order polynomial with endogenous breakpoints and dummy variables (calculated from residuals from first-pass regression) for the Great Depression (1930-1936), World War II (1942-45), ILWU strike (1949), the Volcker Fed (monetary aggregate targeting (1981)), and the Great Recession (2009). All other step-wise breaks are endogenous, with final specification selected to minimize the Akaike Information Criterion. A regulatory break dummy variable is set to the value 1 from 1975 onward, and is set to the value 0.00001 from 1926-1974 (estimating equation is specified in natural logarithms). Shaded blue area is two standard-error bandwidth around model’s estimate.
Housing and land regulation

Econ 311: The Economy of Hawaii
UH Manoa, April 2017

Paul H. Brewbaker, Ph.D., CBE
Consider the image on the title slide

- Traditional Hawaiian culture: land use organized around ahupua‘a concept
  - Hydrology the determinant—flowing water guides spatial location of activities
  - Each ahupua‘a a catchment area, bounded by ridgelines, extending seaward
  - Distribution of economic activity governed by endowment (arable land, ocean resources) under common resource system—common property
  - Management of activity under command structure (konohiki as administrator): benevolently, dictatorially, and sometimes maybe not so benevolently

- Now look at Manoa valley again under Western system
  - Market-oriented system under private property arrangements
  - Distribution of economic activity governed by endowment, boundaries: market transactions (including contractual arrangements government trade)
  - Concentration of high-density urban activities along shoreline, facilitated by transportation infrastructure (scale economies, agglomeration externalities)
  - Medium density activity—including knowledge capital formation at UH—in mid-zone, integrated with transportation network
  - Low density residential activity at distance (congestion externalities)
Land and housing in Hawaii fall under the same policy framework: housing, urbanization, are principle resource management challenge
# Honolulu CPI expenditure shares 2004-05 (%)

<table>
<thead>
<tr>
<th>Category</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apparel and services</td>
<td>3.93</td>
</tr>
<tr>
<td>Transportation</td>
<td>18.06</td>
</tr>
<tr>
<td>Vehicle purchases (net outlay)</td>
<td>8.68</td>
</tr>
<tr>
<td>Gasoline and motor oil</td>
<td>3.02</td>
</tr>
<tr>
<td>Other vehicle expenses</td>
<td>4.42</td>
</tr>
<tr>
<td>Public transportation</td>
<td>1.95</td>
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<tr>
<td>Healthcare</td>
<td>4.73</td>
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<tr>
<td>Entertainment</td>
<td>5.69</td>
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<td>Personal care products and services</td>
<td>1.41</td>
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<td>Reading</td>
<td>0.23</td>
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<tr>
<td>Education</td>
<td>2.40</td>
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<tr>
<td>Tobacco products and smoking supplies</td>
<td>0.44</td>
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<tr>
<td>Miscellaneous</td>
<td>1.57</td>
</tr>
<tr>
<td>Cash contributions</td>
<td>2.02</td>
</tr>
<tr>
<td>Personal insurance and pensions</td>
<td>12.28</td>
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<tr>
<td>Life and other personal insurance</td>
<td>0.95</td>
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<tr>
<td>Pensions and Social Security</td>
<td>11.33</td>
</tr>
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</table>

### Average annual expenditures

<table>
<thead>
<tr>
<th>Item</th>
<th>Percentage</th>
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</thead>
<tbody>
<tr>
<td>100.00</td>
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</tr>
<tr>
<td>Food</td>
<td>14.72</td>
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<tr>
<td>Food at home</td>
<td>7.70</td>
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<tr>
<td>Cereals and bakery products</td>
<td>1.01</td>
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<tr>
<td>Meats, poultry, fish, and eggs</td>
<td>1.98</td>
</tr>
<tr>
<td>Dairy products</td>
<td>0.61</td>
</tr>
<tr>
<td>Fruits and vegetables</td>
<td>1.51</td>
</tr>
<tr>
<td>Other food at home</td>
<td>2.58</td>
</tr>
<tr>
<td>Food away from home</td>
<td>7.02</td>
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<tr>
<td>Alcoholic beverages</td>
<td>0.84</td>
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<tr>
<td>Housing</td>
<td>31.67</td>
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<tr>
<td>Shelter</td>
<td>19.82</td>
</tr>
<tr>
<td>Owned dwellings</td>
<td>11.86</td>
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<tr>
<td>Rented dwellings</td>
<td>7.21</td>
</tr>
<tr>
<td>Other lodging</td>
<td>0.75</td>
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<tr>
<td>Utilities, fuels, and public services</td>
<td>5.12</td>
</tr>
<tr>
<td>Household operations</td>
<td>1.26</td>
</tr>
<tr>
<td>Housekeeping supplies</td>
<td>1.49</td>
</tr>
<tr>
<td>Household furnishings and equipment</td>
<td>3.99</td>
</tr>
</tbody>
</table>

Comparing recent DBEDT consumer survey data for Honolulu to 2004-05 C.E.S. data (weights for Honolulu CPI-U)

<table>
<thead>
<tr>
<th>percent of total expenditures</th>
<th>2004-5</th>
<th>2013-14</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>14.7</td>
<td>14.7</td>
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<tr>
<td>Alcoholic beverages</td>
<td>0.8</td>
<td>1.1</td>
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<tr>
<td>Housing</td>
<td>31.7</td>
<td>43.2</td>
</tr>
<tr>
<td>Apparel and services</td>
<td>3.9</td>
<td>1.9</td>
</tr>
<tr>
<td>Transportation</td>
<td>18.1</td>
<td>13.9</td>
</tr>
<tr>
<td>Health care</td>
<td>4.7</td>
<td>5.8</td>
</tr>
<tr>
<td>Entertainment</td>
<td>5.7</td>
<td>2.5</td>
</tr>
<tr>
<td>Personal care products and services</td>
<td>1.4</td>
<td>1.0</td>
</tr>
<tr>
<td>Reading</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Education</td>
<td>2.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Tobacco prod. &amp; smoking supplies</td>
<td>0.4</td>
<td>0.2</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>1.6</td>
<td>1.6</td>
</tr>
<tr>
<td>Cash contributions</td>
<td>2.0</td>
<td>1.7</td>
</tr>
<tr>
<td>Personal insurance and retirement savings</td>
<td>12.3</td>
<td>8.2</td>
</tr>
<tr>
<td>Average annual expenditures</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Western Metropolitan RPP indexes: Honolulu (Oahu) housing contribution to living cost differential is 75% higher than average

Source: Bureau of Economic Analysis (http://bea.gov/iTable/iTableHTML.cfm?reqid=70&step=1&isuri=1&acrdn=8)
Political concern over affordability: more fake news devoid of empirical content? Evolution of Oahu housing affordability for 40 years

Oahu housing affordability index
(1977 = 1.00; higher is more affordable)

More affordable

Less affordable

Sources: Federal Reserve Board, Federal Reserve Bank of St. Louis (mortgage interest rates); Prudential Locations, Bank of Hawaii, Honolulu Board of Realtors (median single-family home prices); U.S. Department of Housing and Urban Development (four-person median family incomes)
The cost of living premium for Honolulu over U.S. metropolitan areas has ranged narrowly 20-25 percent for 70 years by various measures (ranging widely 15-30 percent), less perhaps for the Neighbor Islands but mostly because East Hawaii Island housing is relatively affordable.

Perfect capital and labor mobility within the U.S. (part of the definition of economic union that Makes America Great Already and makes Brexit—as is said in the U.K.—Way Out) means that the living cost differentials are an equilibration mechanism holding at bay net in-migration.

It seems unlikely that solving the “affordable housing” problem in Hawaii, which has little to do with homelessness, per se*, will have a material impact on living cost differentials. It is still worth solving.

---

*Homelessness is primarily a consequence of the de-institutionalization of mental health treatment, the pattern of substance abuse, veterans’ issues (which are not mutually-exclusive with respect to the first two), and economic misfortune characterized by a high degree of economic mobility (today’s bad luck individual is not the same as tomorrow’s), combined with absence of a credible threat of enforcement of protections for private or public property against squatting.
Just to be clear what is the public policy issue

- Populist political approach risks conflating common and proper nouns
  1. I mean “affordable (the adjective) housing (the common noun)”
  2. Regulators usually mean “Affordable Housing,” a proper noun

- From Mayor Caldwell’s State of the City Address, February 16, 2017*
  
  To solve homelessness, the answer is what? More affordable housing. Ask any provider: it’s providing housing for those who don’t have it. And that’s what we’re going to talk about for the rest of tonight. During the next four years this administration is going to focus, laser-like, on getting more affordable housing built [emphasis added]. If we don’t change the course that we’ve been on for a long period of time, this island becomes a de facto gated community only for the exclusive few. And we have huge challenges.

- Policy dilemma: conflating an income problem (not enough it) for a housing problem (not enough of it)—solution to the second defined in terms of the first is a mistake, but that is what jurisdictions do by imposing “inclusionary zoning” requirements that define a housing production quota in terms of quantiles of the income distribution (rather than home price distribution)

*See https://www.honolulu.gov/housing.html
Land area and land use

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Distinguishing Hawaii housing market

- Basic geographic characteristics distinguish Hawaii:
  1. Geographic isolation (some impediment to mobility, but not capital mobility)
  2. Non-contiguous markets—cannot drive from one island to another
  3. Developable areas bounded by (high) mountains and (deep) ocean
  4. Further resource constraints: preservation of upland watershed, lowland wetlands, environmentally-sensitive and dynamic shorelines

- Basic regulatory characteristics distinguish Hawaii:
  1. Only state with single, statewide Land Use Law
  2. All land use district amendments require Land Use Commission approval
  3. Each County has its own land use, zoning regulatory requirements, codes
  4. Jurisdictions are notoriously inefficient in handling approvals, changes

- Historical legacies in Hawaii
  1. Private property introduced under Great Mahele (1848)
  2. Concentration of landownership under Plantation Era oligarchies
  3. Populist political use of “police powers of state” as countervailing force*
  4. “California-style” politics of NIMBY (Not In My Back Yard)
  5. Cultural preservation takes on unique characteristics (e.g. Hawaiian burials)

*Note: Under the U.S. Constitution’s 4th amendment, “takings” must be accompanied by just compensation, are available to jurisdictions only for a “valid public purpose,” and must be shown to satisfy “rational nexus” when involving exactions
<table>
<thead>
<tr>
<th>Island</th>
<th>Total area 1/</th>
<th>Urban</th>
<th>Conservation</th>
<th>Agricultural</th>
<th>Rural</th>
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</thead>
<tbody>
<tr>
<td>State total</td>
<td>4,112,388</td>
<td>200,439</td>
<td>1,973,846</td>
<td>1,926,502</td>
<td>11,602</td>
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<tr>
<td>Hawaii</td>
<td>2,573,400</td>
<td>54,145</td>
<td>1,304,347</td>
<td>1,212,886</td>
<td>2,023</td>
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<tr>
<td>Maui</td>
<td>465,800</td>
<td>24,191</td>
<td>194,836</td>
<td>242,720</td>
<td>4,053</td>
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<tr>
<td>Kahoolawe</td>
<td>28,800</td>
<td>-</td>
<td>28,800</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lanai</td>
<td>90,500</td>
<td>3,330</td>
<td>38,197</td>
<td>46,566</td>
<td>2,407</td>
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<tr>
<td>Molokai</td>
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<td>2,539</td>
<td>49,768</td>
<td>111,627</td>
<td>1,866</td>
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<td>Oahu</td>
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<td>101,661</td>
<td>156,829</td>
<td>127,698</td>
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<td>Kauai</td>
<td>353,900</td>
<td>14,573</td>
<td>198,769</td>
<td>139,305</td>
<td>1,253</td>
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<td>Niihau</td>
<td>45,700</td>
<td>-</td>
<td>-</td>
<td>45,700</td>
<td>-</td>
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<tr>
<td>Kaula and Lehua</td>
<td>400</td>
<td>-</td>
<td>400</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other islands</td>
<td>1,900</td>
<td>-</td>
<td>1,900</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

[As of December 31. Total acreage, including inland water, as classified by the Hawaii State Land Use Commission under the provisions of Chapter 205, Hawaii Revised Statutes, as amended. All data are approximate]

Source: Hawaii DBEDT State of Hawaii Data Book Section 6 (http://hawaii.gov/dbedt/info/economic/databook/2010-individual/06/)
No, this is not a graph by Mark Rothko: this is how Hawaii land use districts have changed since the Land Use Law was adopted.

- Conservation (1.973 million)
- Agriculture (1.927 million)
- Urban (0.200 million)
- Rural (0.0116 million)

*Resident population growth rate 1970-2015 was 1.39% per annum

Estimated acreage share of statewide Land Use Districts by island, end-December 2015

[As of December 31. Total acreage, including inland water, as classified by the Hawaii State Land Use Commission under the provisions of Chapter 205, Hawaii Revised Statutes, as amended. All data are approximate]

<table>
<thead>
<tr>
<th>Island</th>
<th>Total area 1/</th>
<th>Classification by State Land Use Commission 2/</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Urban</td>
</tr>
<tr>
<td>State total - 2015</td>
<td>100.0</td>
<td>4.9</td>
</tr>
<tr>
<td>Hawaii</td>
<td>62.6</td>
<td>1.3</td>
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<tr>
<td>Maui</td>
<td>11.3</td>
<td>0.6</td>
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<tr>
<td>Kahoolawe</td>
<td>0.7</td>
<td></td>
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<tr>
<td>Lanai</td>
<td>2.2</td>
<td>0.1</td>
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<tr>
<td>Molokai</td>
<td>4.0</td>
<td>0.1</td>
</tr>
<tr>
<td>Oahu</td>
<td>9.4</td>
<td>2.5</td>
</tr>
<tr>
<td>Kauai  4/</td>
<td>8.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Niihau  4/</td>
<td>1.1</td>
<td></td>
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</table>

Source: Hawaii DBEDT State of Hawaii Data Book Section 6 (http://files.hawaii.gov/dbedt/economic/databook/db2015/section06.xls)
Estimated acreage share of each island’s Land Use Districts, end-December 2015

[As of December 31. Total acreage, including inland water, as classified by the Hawaii State Land Use Commission under the provisions of Chapter 205, Hawaii Revised Statutes, as amended. All data are approximate]

<table>
<thead>
<tr>
<th>Island</th>
<th>Total area 1/</th>
<th>Classification by State Land Use Commission 2/</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Urban</td>
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<tr>
<td>State total - 2015</td>
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<td>4.9</td>
</tr>
<tr>
<td>Hawaii</td>
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<td>2.1</td>
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<tr>
<td>Maui</td>
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<td>5.2</td>
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<td>Kahoolawe</td>
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<td>100.0</td>
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<td>Lanai</td>
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<td>3.7</td>
</tr>
<tr>
<td>Molokai</td>
<td>100</td>
<td>1.5</td>
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<tr>
<td>Oahu</td>
<td>100</td>
<td>26.3</td>
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<td>Kauai</td>
<td>100</td>
<td>4.1</td>
</tr>
<tr>
<td>Niihau</td>
<td>100</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Source: Hawaii DBEDT State of Hawaii Data Book Section 6 (http://files.hawaii.gov/dbedt/economic/databook/db2015/section06.xls)
Land use characteristics of Oahu: City & County of Honolulu definitions—12% of island and 28% of Town comprise urbanized acreages

<table>
<thead>
<tr>
<th>Subject</th>
<th>June 1994</th>
<th>June 1998</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oahu total</td>
<td>Oahu total</td>
</tr>
<tr>
<td>Land use in acres</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>31,110</td>
<td>32,110</td>
</tr>
<tr>
<td>Industrial</td>
<td>8,658</td>
<td>9,571</td>
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<tr>
<td>Commercial</td>
<td>4,177</td>
<td>4,277</td>
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<tr>
<td>Hotel</td>
<td>319</td>
<td>315</td>
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<tr>
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<td>Other</td>
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Source: Hawaii DBEDT State of Hawaii Data Book Section 6 (http://files.hawaii.gov/dbedt/economic/databook/db2015/section06.xls)
<table>
<thead>
<tr>
<th>Rank</th>
<th>Landowner</th>
<th>Total acres</th>
<th>Hawaii</th>
<th>Kahoolawe</th>
<th>Kauai</th>
<th>Lanai</th>
<th>Maui</th>
<th>Molokai</th>
<th>Niihau</th>
<th>Oahu</th>
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</table>

[In acres. As of November 2009 for Kauai County, June 2011 for Maui County and July 2011 for Hawaii and Honolulu counties]

Major landowners by island, by type, 2013

[In acres. As of January 2012 for Kauai County, June 2013 for Hawaii County and July 2013 for Maui and Honolulu counties]

<table>
<thead>
<tr>
<th>Rank</th>
<th>Landowner</th>
<th>Total acres</th>
<th>Hawaii</th>
<th>Kahoolawe</th>
<th>Kauai</th>
<th>Lanai</th>
<th>Maui</th>
<th>Molokai</th>
<th>Niihau</th>
<th>Oahu</th>
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<tbody>
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<td>1</td>
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<td>1,565,538.0</td>
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</tr>
</tbody>
</table>

Distribution of landownership in Hawaii: top 20 owners and all others (Other 23.4%)

- State of Hawaii: 33.3%
- Federal government: 12.9%
- DHHL: 4.8%
- Top private 5-20: 14.2%
- Kamehameha Schools: 8.8%
- Parker Ranch: 2.6%
- Other: 23.4%

### Changes in land holdings (acres) among the top 20 landowners, 2009-11 – 2013

<table>
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<tr>
<th>Rank</th>
<th>Landowner</th>
<th>Change (acres)</th>
</tr>
</thead>
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<td>Gov't State including DHHL</td>
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<td>Gov't. - State (excluding DHHL)</td>
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<td>Govt. Federal</td>
<td>(668.8)</td>
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<td>3</td>
<td>Kamehameha Schools</td>
<td>50.1</td>
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<tr>
<td>4</td>
<td>Parker Ranch</td>
<td>(145.9)</td>
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<tr>
<td>5</td>
<td>Lanai Resorts LLC</td>
<td>89,184.1</td>
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<td>Alexander &amp; Baldwin</td>
<td>(24,371.4)</td>
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<td>7</td>
<td>Molokai Ranch</td>
<td>(1,674.0)</td>
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<td>Robinson Family</td>
<td>(56.3)</td>
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<td>9</td>
<td>Robinson Aylmer</td>
<td>(3.5)</td>
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<td>Castle &amp; Cooke</td>
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<tr>
<td>17</td>
<td>W.H. Shipman</td>
<td>(3.4)</td>
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<td>18</td>
<td>Kahuku Aina Properties</td>
<td>0.1</td>
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<tr>
<td>19</td>
<td>McCandless Ranch</td>
<td>(565.6)</td>
</tr>
<tr>
<td>20</td>
<td>Finance Factors</td>
<td>8.3</td>
</tr>
</tbody>
</table>

Numbers in parentheses denote decreases

Land ownership in Upcountry Maui
Oahu land ownership
Government land ownership on Oahu
State land use classifications

Agricultural

Conservation

Urban
Stock-flow interaction: an increase in the stock demand for housing raises the flow supply

Responsiveness is determined by the price elasticity of the flow supply of new housing.

Housing stock

Flow supply of new housing
Over time (n periods), the extent of price increases is determined by the interaction of stocks and flows.

Housing stock

Flow supply of new housing

Responsiveness is determined by the price elasticity of the flow supply of new housing.
Lower flow supply elasticity with respect to prices implies less new housing, larger price increases: restrictions reduce elasticity of flow supply

Housing stock

Flow supply of new housing

Less elastic flow supply means a higher price rise for a given stock demand increase
Supply constraints (regulatory; natural)

“Steep slopes and water bodies” complement gate-keeping regulatory postures towards urbanization to generate more volatile home prices
Basic findings in the land economics literature

- Geographic and regulatory constraints associated with one of more of following:
  1. Higher prices
  2. Higher volatility

- Jurisdictions have increasingly relied on exactions to require developers to make social contributions as condition of development entitlement (see your readings—or any recent writings—by U.H. Law Professor David Callies)

  Examples: “affordable” housing requirements (quotas), public schools, etc.

- Example from Jim Mak’s book: one resort project (Ewa) was required by the LUC to create “one non-tourism job for each tourism job” (whatever that is)

- Regulatory process in Hawaii is a “gatekeeping” process intended to maximize the opportunity for opponents to obstruct development

- Unclear if *bona fide* natural resource stewardship objectives are achieved

Empirical estimates of housing supply “elasticity:” among urban markets, Hawaii’s near bottom of list

Dallas
Tampa
Phoenix
Charlotte
Oklahoma City
Kansas City
Portland
St. Louis
Detroit
Los Angeles
Philadelphia
Boston
San Jose
San Francisco
**Honolulu**
Miami


Top 25 states, Wharton Residential Land Use Regulatory Index (0 = national average); higher is more restrictive

Index values are from the Wharton Residential Land Use Regulation Project. An index value of 0 implies the average level of regulation in the country. An index value of 1 implies a level of regulation one standard deviation above the national average. An index value of −1 implies a level of regulation one standard deviation below the national average.

Why housing price cycles? A structural interpretation

- Some markets exhibited steady log-linear appreciation until sub-prime mortgage lending turned them into bubblicious markets (examples: Phoenix, Loss Vegas)
- Some markets cyclical because geographic constraints (mountains, ocean) interact with regulatory constraints (environmental authoritarianism*) to restrict the housing production response—low price elasticity of new housing supply in Hawaii
- Absent “frothy” credit conditions, geographic constraints, and regulatory impediments, bubbles/cycles dampened, smoother price trajectories (e.g. Iowa)
- Constraints—geographic and regulatory—on new home supply “bandwidth” imply that macroeconomic drivers for housing demand such as low interest rates or microeconomic drivers (sub-prime mortgage lending), cause faster short-run house price increases in constrained markets (Hawaii) than in unconstrained markets (Iowa) even through longer run rates of home price appreciation often converge via arbitrage because of capital and labor mobility (plus return premiums attributable to land scarcity as a consequence of its status as a nonrenewable natural resource with few substitutes, i.e. once geographic constraints are binding)

*Using legal process as a coercion tool when neither preference revelation through popular, democratic political institutions, market-based allocation or development entitlement (e.g. eBay auctions of the right to build), nor hierarchical economic governance mechanisms—for example, decisions within large landholder institutions or large corporate structures—will suffice.
Two examples familiar to Hawaii, Phoenix and Las Vegas (the 9th island), since 1970s inflation and absent a housing bubble: log-linear prices

FHFA home value indexes (2000 = 100)
(all transactions incl. sales, collateral valuations, s.a.)

Phoenix, AZ
Las Vegas, NV

Sub-prime Bubble

3.22%*

*For comparison, U.S. CPI-U inflation, annualized, 1982-2016, was 2.7 percent

Sources: Federal Housing Finance Administration; rebasing, seasonal adjustment, regression on average of the two indexes by TZ Economics

Slide copyright 2017 TZ Economics
An even better example absent “steep slopes and water bodies;;” if you want a permit to build house they ask “what’s a permit?”

FHFA home value indexes (2000 = 100)
(all transactions incl. sales, collateral valuations, s.a.)

Sub-prime Bubble

*U.S. CPI-U inflation, annualized, 1982-2016, was 2.7 percent; compare to composite Las Vegas + Phoenix annualized house price appreciation rate as shown

Sources: Federal Housing Finance Administration; rebasing, seasonal adjustment, regression on average of the two indexes by TZ Economics
“The affordable housing debate should be broadened to encompass zoning reform, not just public or subsidized construction programs...we believe the evidence suggests that zoning is responsible for high housing costs, which means that if we are thinking about lower housing prices, we should begin with reforming the barriers to new construction in the private sector”

Edward L. Glaeser and Joseph Gyourko
“The Impact of Building Restrictions on Housing Affordability”

“I find that supply constraints increase volatility through two channels: First, regulation lowers the elasticity of new housing supply by increasing lags in the permit process and adding to the cost of supplying new houses on the margin. Second, geographic limitations on the area available for building houses, such as steep slopes and water bodies, lead to less investment on average relative to the size of the existing housing stock, leaving less scope for the supply response to attenuate the effects of a demand shock. My estimates and simulations confirm that regulation and geographic constraints play critical and complementary roles in decreasing the responsiveness of investment to demand shocks, which in turn amplifies house price volatility.”

Andrew D. Paciorek
“Supply Constraints and Housing Market Dynamics”
_Federal Reserve Board Finance and Economics Discussion Series WP 2012-01_ (December 2011)
1. “Inclusionary Zoning (IZ) policies have failed in other jurisdictions and are failing on Oahu. IZ reduces the number of ‘affordable’ housing units and raises prices and reduces the quantity of ‘market-priced’ …units.”

2. Housing un-affordability is cyclical; in the 20-teens not too bad on Oahu

3. IZ policies in Kakaako and elsewhere reduce profitability (including margin for risk) and pre-empt capital markets financing new housing

4. “Eliminating IZ and easing development regulations will result in more housing units and lower housing prices.”

IZ is not currently working on Oahu. Overall, IZ policies reduce the number of “affordable” housing units, while raising prices and reducing the number of “market-priced” housing units. Eliminating inclusionary zoning and easing development regulations will result in more housing units and lower housing prices (UHERO 2010).

Recapping the literature and recommendation

- In the long-run, labor (population) and capital mobility imply that total returns on housing as an asset class will broadly match those elsewhere within an economic union:
  1. Total return is sum of capital gain and dividend
  2. Capital gain is house price appreciation
  3. Dividend comprises housing services (you get to live in the asset, unlike stocks)
  4. Risk-adjusted returns equate over time—housing earns a risk premium

- “Steep slopes and water bodies” impose natural, geographic constraints on development that the housing economics literature identifies in amplification of house price volatility

- Inclusionary zoning (Affordable Housing quotas), other regulatory constraints, aggravate the consequences of natural constraints, even when well-intentioned (agricultural preservation, watershed conservation, “ua mau ke ea o ka aina i ka pono,” etc.)

- The cyclical window of affordability is going to slam shut, again—even with (and faster without) accommodative interest rates—it’s only open momentarily once a cycle

- Turn housing policy on its head: make it as easy as is possible for builders to respond to incipient price rise below some arbitrary threshold (e.g. the median price)—THINK eBay, “you know there is enough entitlement when its price in the secondary market is zero”
Summarizing, thus far

- The cost of living premium for Honolulu over U.S. metropolitan areas has averaged around 20-25 percent for 70 years by a variety of measures (ranging as widely as 15-30 percent), less perhaps for the Neighbor Islands (East Hawaii Island (Hilo side) is relatively affordable), mostly because of housing cost.

- Perfect capital mobility within the United States (part of the definition of economic union that Makes America Great Already) means that arbitrage drives Hawaii and Oahu home prices—adjusted for inflation—towards annual appreciation similar to the long-run real rate of return on capital in the U.S., approximately 2 percent.

- It is unlikely that solving the “affordable housing” problem in Hawaii, which has little to do with homelessness, *per se*, may or may not have a material impact on living cost differentials, which may be a long-run equilibrium condition balancing intrastate migration flows. Still, such a solution (more housing) can’t hurt.

- Simply enabling the production of more, *much more*, new housing of *any* kind will materially contribute to affordable housing access, which economics literature suggests is constrained in Hawaii by unusually restrictive development entitlement allocation, an artificial form of regulatory scarcity that compounds the effects of geographic scarcity (“steep slopes and water bodies”). Public policy cannot change geography. What’s left?

*Homelessness is primarily a consequence of the de-institutionalization of mental health treatment, the pattern of substance abuse, veterans’ issues (which are not mutually-exclusive with respect to the first two), and economic misfortune characterized by a high degree of economic mobility (today’s bad luck individual is not the same as tomorrow’s), combined with absence of a credible threat of enforcement of protections for private or public property against squatting.*
Pau (lecture 1 of 2)
Take a moment to think about the difference (if one exists) between “resilience” and LR convergence to an asset price trajectory.

More on housing asset price dynamics.
Visualizing long-term trend deceleration of nominal Oahu housing valuations: progress toward lower inflation

Index, 1995Q2 = 100, log scale

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<tr>
<td>2015</td>
<td>80</td>
</tr>
<tr>
<td>2020</td>
<td>90</td>
</tr>
</tbody>
</table>

20-year home value multiples:

- 1977-1997: 4.3 X
- 1997-2017: 2.6 X

Source: Federal Housing Finance Administration (https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index.aspx), a weighted, repeat-sales (all-transaction) index of Urban Honolulu MSA home prices; seasonal adjustment by TZE
Adjust Honolulu home valuations for consumer price inflation so that they are re-stated in real terms, in constant 2016 prices.

Real index, 2016 = 100, log scale

Source: FHFA (https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index.aspx), BLS (https://data.bls.gov/cgi-bin/surveymost?r9); seasonal adjustment, quarterly interpolation of semi-annual Honolulu CPI, deflation of home price index, and log-linear trend estimates by TZE.
Taking into account time-varying volatility: Oahu home prices adjusted for inflation appreciated at about a 2% real rate

Real index, 2016 = 100, level scale

Source: FHFA (https://www.fhfa.gov/DataTools/Downloads/Pages/House-Price-Index.aspx), BLS (https://data.bls.gov/cgi-bin/surveymost?r9); seasonal adjustment, quarterly interpolation of semi-annual Honolulu CPI, deflation of home price index, and log-linear trend estimates by TZE, data through 2016Q4
CONDO MANIA!

The nearly 5,000 units planned for the city's urban core are expected to meet pent-up demand — or could even fall short

By Andrew Gomes
agomes@staradvertiser.com

Lanikai, Hoku, Ko'olani, Capitol Place, Keola La'i, Moana Pacific, The Watermark, Allure Waikiki, Pacifica Honolulu, Holomua.

These condominium towers in Honolulu were the product of the last real estate market boom, which prompted developers to build close to 4,000 new units in more than a dozen towers that also included The Pinnacle, 909 Kapiolani and 215 N. King.

number of high-rise homes — almost 5,000, including 1,000 rental units — in Oahu's urban core?

To some observers it's hard to imagine demand meeting such a supply.

But developers, along with a local economist and a real estate market analyst, contend that all the projects planned to date won't produce a glut.

"It's not a question of will there be enough buyers," said economist Paul Brewbaker of Honolulu-based TZ Economics. "The problem is, will there be enough condos?"

City kills attempt to reduce habitual 911 calls

Paramedics would have visited the most frequent users of ambulances to get them appropriate care

By Susan Essoyan
essaoyan@staradvertiser.com

A "community paramedic" program intended to reduce overuse of ambulances by chronic 911 callers has been dropped by the new city administration, but the state hopes to start a similar effort.

The Honolulu Emergency Services Department, led at the time by Dr. James Ireland, created a community paramedic team in November after research revealed that the top 10 callers to 911 had taken an average of 52 ambulance rides per year. One logged 142 trips in the year before he died.

The plan was for two community paramedics to
House values weighted average of values structure and land; land weight rising

Supply and demand for housing:
1. **Demand**: structure is capital input in home production, leisure; land capitalizes value of schools, commuting distances, views, microclimates, *etc.*
2. **Supply**: structures are easily reproduced; desirable residential land is not; asymmetry means demand increases have different effects on components

Cost of new structures = construction cost + cost of acquiring entitlement

Land is non-reproducible, land prices three times as volatile as prices of structure
1. Land’s share of new home prices is relatively small, larger share of the entire housing stock, explaining why price growth for existing homes outpaces new
2. Regions where land is large share of housing value (HNL, SFO, BOS) more sensitive to demographics, interest rates, demand-side drivers rather than construction costs, and experience higher appreciation and greater volatility
3. Land’s value share trending upward; implications for portfolio allocation (incentive for people in high-priced areas to buy more low-risk bonds and fewer risky stocks)

“Clearly, land is something that home-buyers are willing to pay handsomely for, and that developers cannot cheaply incorporate in new homes. This scarcity requirement suggests that attributes such as good local schools, low crime, or a pleasant climate are by themselves insufficient to generate high long-term land values, because as long as developers can keep building new homes in low-crime, good-school, sunny-weather neighborhoods, house prices will not rise far above construction costs. There are two ways scarcity can arise. First, land-use restrictions may prevent developers from building enough new homes to align prices with construction costs. Second, scarcity can arise naturally. Suppose that part of the iconic middle-class lifestyle to which many Americans aspire is to own a detached house with a yard for the children and a short commute to work. In many cities developers cannot increase the supply of these homes for the simple reason that all the relatively central land has already been developed...”

“We have in mind a simple story than can perhaps account both for the decline in land prices between 1930 and 1950 and the upward trend since then. The interpretation of the decline is not new. As the cost of automobiles fell over the first half of the twentieth century car ownership surged, such that by 1950 there were almost as many cars as housing units in the United States: 40.3 million versus 46.1 million. As new roads were built, the quantity of land within reasonable commuting distance of city centers expanded rapidly. This increase in the supply of potential residential land has been put forward as a likely explanation for the decline in land prices over this period. Since the widespread adoption of the automobile there have been no further significant technological innovations in passenger transportation. Over time, more and more cities have either developed most of the land within reasonable commuting distance of the city center, or in a few cases have implemented policies to slow further development. Thus growth in the supply of desirable residential land has not been sufficient to accommodate growth in demand for housing, and land and house prices have risen. This explanation for the u-shape in the value of land over the past century awaits a more formal evaluation in the context of an explicit quantitative theoretical model.”

Three core facts about housing supply:
1. When building is unrestricted by regulation or geography, housing supply curves seem relatively flat (in our stock-flow model, the path of the housing stock)
2. Where binding, constraints from geography and regulation severely restrict the ease of building, limiting land, lengthening time-to-build, reducing new house flow
3. Stock supply of housing is kinked and vertical downwards (housing is durable capital, so when demand falls, housing stock does not decline (e.g. Detroit))

Honolulu is a housing market with prices well above “minimum profitable production cost (MPPC),” limited by land availability and land use regulations, causing widening divergence between market prices and fundamental production costs

Inelastic housing supply is a late-20th century urban phenomenon
1. Essentially, property rights transferred from land owners to wider community
2. Power of anti-growth political movements, environmentalism more broadly
3. Marginal social costs overwhelming marginal private benefits of marginal house

Economic consequences: contribution to rise in capital share of aggregate income, gains among richest members of oldest cohorts, reduction in housing wealth of young adults, wealth redistribution from buyers to select group of sellers, lower output

Long-run investment evidence (ΔK_t) for Hawaii framing the recent, investment-led upswing

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Statewide existential test: if we build for the future, what future? Real contracting receipts test a trend hypothesis.

If Hawaii’s long-term steady-state economic growth rate is lower than in the late-20th century, construction activity need not be as large a share of output as in the past.
Hawaii statewide real contracting receipts are running out of headroom: turning point or another 2012-13 head fake?

Sources: Hawaii Department of Taxation, Hawaii DBEDT, U.S. Bureau of the Census; seasonal adjustment and deflation using construction cost deflator through September 2016 by TZE
Extracting the cycle in the constant-dollar, monthly (s.a.) value of private building permits with a band-pass filter.

Fixed Length Symmetric (Christiano-Fitzgerald) Filter

Sources: County Building Departments, Hawaii DBEDT, U.S. Bureau of the Census; seasonal adjustment and deflation using construction cost deflator through December 2016, symmetric band-pass filter with a range of durations from 4 years to 12 years, lead-lag of 36 months, calculated by TZE
The cycle in Hawaii real private construction commitments jumps out of the data: now past the turning point in current cycle?

Monthly, million 2016$, s.a., log scale

Sources: County Building Departments, Hawaii DBEDT, U.S. Bureau of the Census; seasonal adjustment and deflation using construction cost deflator through December 2016 by TZE
The cycle in Hawaii real private construction commitments jumps out of the data: now past the turning point in current cycle?

Monthly, million 2016$, s.a., log scale

Sources: County Building Departments, Hawaii DBEDT, U.S. Bureau of the Census; seasonal adjustment and deflation using construction cost deflator through December 2016 by TZE
The cycle in Hawaii real private building permit values and U.S. recession dates: is current downturn precursor, anomaly (like '01)?

Sources: County Building Departments, Hawaii DBEDT, U.S. Bureau of the Census; seasonal adjustment and deflation using construction cost deflator through December 2016 by TZE
Quarterly real government construction contracts through 2016: procyclical until the 21st century, then?

Quarterly, million 2016$, s.a.

Catch-A-Wave Japan Bubble Catching Up?

Sub-Prime?


Sources: Bank of Hawaii, Hawaii DBEDT, U.S. Bureau of the Census; seasonal adjustment and deflation using construction cost deflator through fourth quarter 2016 by TZE
Combined County, State, Federal construction contracts in Hawaii as percent of GDP: after the ’70s infrastructure investment faded

Hawaii new housing units / existing inventory: the investment / capital ratio ($\Delta K_t / K_t$); too low, and not by accident

Production has fallen because of regulatory restriction from two to three times the population growth rate to a pace less than population growth, a pace that does not even endow the newborn with the existing per capita housing stock.

Sources: County Building Departments; Bank of Hawaii; U.S. Bureau of the Census; Hawaii DBEDT; TZE
Neighbor Island quarterly new housing units authorized by building permit have only recovered slightly from deep trough.

New housing units (000, s.a., right scale)

Trend deviations (left scale)

Source: County building departments, Hawaii DBEDT; seasonal adjustment and Hodrick-Prescott filter trend extraction by TZE
Oahu quarterly new housing units authorized:  
Q: up or down?  A: yes (lumpy high-rises)  
Recovery still volatile, obscuring trend

Source: County building departments, Hawaii DBEDT; seasonal adjustment and Hodrick-Prescott filter trend extraction by TZE
Shift in real residential private building consistent with the New Urbanism: agglomeration externalities in services-, information-producing economy

Monthly, million 2016$, s.a. (log scale)

U.S. recessions shaded

Sources: County Building Departments, seasonal adjustment, deflation using U.S. construction cost implicit price deflator, and cycle-trend component extracted with Hodrick-Prescott filter estimated by TZE; data through February 2017
Shift in real residential private building consistent with the New Urbanism: agglomeration externalities in services-, information-producing economy

Monthly, million 2016$, s.a. (log scale)

Sources: County Building Departments, seasonal adjustment, deflation using U.S. construction cost implicit price deflator, and cycle-trend component extracted with Hodrick-Prescott filter estimated by TZE; data through February 2017
Longer history: homebuilding flows experienced a structural break after 1974: de facto cap at one-third or less production volume.

Oahu homebuyers are primarily of local origin (87 percent local, 2012-2015)

Sources: Hawaii DBEDT (Title Guaranty compilation of Bureau of Conveyances data); seasonal adjustment by TZE
Neighbor Island homebuyers have shifted from about half offshore to about 40 percent.

Sources: Hawaii DBEDT (Title Guaranty compilation of Bureau of Conveyances data); seasonal adjustment by TZE
Some current aspects of housing valuation dynamics on Oahu, Hawaii’s main metro area

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Oahu home valuations on stable path with modest rates of appreciation facing a gradual anticipated interest rate rise

Source: Honolulu Board of Realtors, monthly data; seasonal adjustment and trend regressions June 2011 through February 2017 by TZE, trend estimates assume constant volatility
Oahu home valuations on stable path with modest rates of appreciation facing a gradual anticipated interest rate rise

Thousand $, s.a., log scale

\[ \hat{p}_{\text{sfam}} = 4.6\% \]

\[ \hat{p}_{\text{condo}} = 5.3\% \]

Source: Honolulu Board of Realtors, monthly data; seasonal adjustment and trend regressions June 2011 through February 2017 by TZE, trend estimates take into account time-varying conditional volatility.
Honolulu home price appreciation in 20-teens approximates longer-run appreciation rates

Monthly, thousand $, s.a. (log scale)

U.S. recessions shaded

Single-family 4.0%

Condominium 3.8%

Source: Honolulu Board of Realtors, monthly data; seasonal adjustment and trend regressions January 1987 through February 2017 by TZE
De-trended Oahu median existing single-family home and condominium prices: bubbles ± 2 standard errors around trend

Oahu single-family homes

Oahu condominiums

Source for underlying data: Prudential Locations, UHERO, National Association of Realtors; seasonal adjustment and normalization by TZE
Estimated gamma distributions for Oahu existing single-family home sales prices in the “trend cross-over” years

\[ f(x|s, r) = s^{-r}(x)^{r-1} e^{-x} / \Gamma(r) \]
Assumes quantiles appreciate at average annual rate of 3.8% (long-run projection)

Assumes quantiles appreciate at average annual rate of 5.9% (actual annualized increase 2003-2023)

Source for underlying data: Honolulu Board of Realtors; gamma distributions estimated by TZE
Quantile thresholds from the inverse gamma distribution of Oahu home prices; (single-family homes)

<table>
<thead>
<tr>
<th>Quantile</th>
<th>2003</th>
<th>2013</th>
<th>2023(\text{a}^*)</th>
<th>2023(\text{b}^\dagger)</th>
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<tbody>
<tr>
<td>Top 0.01%</td>
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<td>3.055</td>
<td>4.380</td>
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<td>0.823</td>
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<td>0.991</td>
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<tr>
<td>Top 40%</td>
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<td>0.569</td>
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<td>1.019</td>
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<tr>
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<td>0.265</td>
<td>0.477</td>
<td>0.702</td>
<td>0.860</td>
</tr>
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Actual median ($) 239,000 449,500 - -
Actual mean ($) 312,302 559,917 - -
Mean from log distn ($) 242,567 439,480 - -

\(\text{a}^*\) Quantiles appreciate at (unweighted) average annual rate of 3.8% (2013-2023)

\(\text{b}^\dagger\) Quantiles appreciate at (unweighted) average annual rate of 5.9% (2013-2023)

\(\ddagger\) Median price from synthetic (empirical gamma) distribution

Source for underlying data: Honolulu Board of Realtors; cumulative distributions estimated by TZE
Honolulu’s effective residential property tax rates remain among the lowest nationwide

Effective tax rates in the largest cities in the 50 states and D.C.

<table>
<thead>
<tr>
<th>Rate/$100</th>
<th>Rate/$100</th>
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<td><strong>Detroit, MI</strong></td>
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<td><strong>Houston, TX</strong></td>
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<tr>
<td><strong>Burlington, VT</strong></td>
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</tbody>
</table>

Unweighted average 1.56 Median 1.400

Breakdown of Oahu “Sklarz Curve”—historical inverse relationship between remaining inventory and price appreciation

*Oahu single-family homes

Source: Honolulu Board of Realtors, monthly data; seasonal adjustment by TZE
Kauai’s housing market case study

- Demand side of market
  1. Strong absorption as buyers flock to affordable, low-end units
  2. Supported by favorable mortgage rates, subject to future headwinds
  3. Underlying economic fundamentals for Kauai modestly improved

- Supply side
  1. Inventory statistics suggest market balanced but “taught”
  2. New authorizations by building permit at historic lows
  3. Incremental housing stock growth less than population growth rate
Kauai monthly real private residential building permits: very slow recovery, with a more recent quickening of commitments

Million constant, 2015$, s.a.

Sources: County Building Department, Hawaii DBEDT, Bureau of the Census; seasonal adjustment, trend and deflation calculations by TZE
Kauai new housing units authorized by building permit—good news and bad news: rising; as good as worst prior cyclical low

Quarterly new units, s.a. (log scale)

Source: Kauai County, DBEDT; seasonal adjustment calculations for Kauai by TZE, data through third quarter 2016
Kauai quarterly existing home sales (velocity) outstrip new homes authorized by building permit (production intention); unit counts

Source: Data through 2016Q4 from Hawaii Information Service and Kauai Board of Realtors, County Building Department, Hawaii DBEDT, TZE database; seasonal adjustment and trend/cycle extraction by TZE
Incremental capital ratios for housing: new units (building permits) as % of (prior year) housing stock

Source: Bureau of the Census, U.S. Department of the Census, Hawaii DBEDT, Kauai Building Department, TZE database
Mix of Kauai homebuyers has shifted from more than one-half offshore to about 40 percent since post-recession “fire sale”

Sources: Hawaii DBEDT (Title Guaranty compilation of Bureau of Conveyances data); seasonal adjustment by TZE
At quarterly frequencies, Kauai single-family existing home sale prices exhibit long-run trend convergence to 5% appreciation.

Quarterly, thousand dollars, n.s.a. (log scale)

U.S. recessions shaded

Mean

Median

5.25% annualized appreciation

Source: Hawaii Information Service; trend regressions by TZE
At quarterly frequencies, Kauai condominium sale price long-run appreciation rate may be biased upward by bubbliciousness.

Quarterly, thousand dollars, s.a. (log scale)

5.7% appreciation

Mean

Median

U.S. recessions shaded

Source: Hawaii Information Service; seasonal adjustment and trend regressions by TZE
Kauai single-family home price empirical gamma distributions (along trend) exhibit increasing skewness in 20-teens transactions prices.

\[ f(x|s, r) = s^{-r} (x)^{r-1} e^{-x} / \Gamma(r) \]

Source: Hawaii Information Service; empirical distribution estimates by TZE.
Problem with 25% affordable housing quotas (Kauai SF home price distribution 2010-12): middle cannot cross-subsidize low-end

Series: SF <$2mil
Observations 1085

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<tr>
<td>Probability</td>
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</table>

(Excludes 58 trades $2.04 - $20.0 mil)

If one of these is required...
...for three of these to be built...
...FEW of these ever will be built

Shaded dark blue (lower four quantiles): at a 4-person family income of $86,500 about $300,000 in house can be acquired*

*Estimate from Zillow.com (July 18, 2013) assuming a $50,000 down payment, 36% debt/income ratio, 680-600 FICO score, property tax rate of 0.575%/year, homeowner insurance premium of $1,500/year, $1,000 in other monthly debts, giving a $1,600 monthly mortgage payment @ 4.284%
**Single-family home price cross-correlations 2008-2013: a high degree of co-movement**  
(range is −1 to +1; these are all > 0.9)

<table>
<thead>
<tr>
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<th>SFO</th>
<th>SNA</th>
<th>OGG</th>
<th>LIH</th>
<th>KOA</th>
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<tr>
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<td>0.952</td>
</tr>
<tr>
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<tr>
<td>KOA</td>
<td>0.929</td>
<td>0.952</td>
<td>0.982</td>
<td>0.971</td>
<td>1</td>
</tr>
</tbody>
</table>

*Where:*
- SFO: San Francisco, Oakland, Fremont
- SNA: Anaheim, Santa Ana, Irvine
- OGG: Maui
- LIH: Kauai
- KOA: Hawaii Island TMK 5-8 (Kona Side)
Vector autoregression impulse responses: lag between Oahu and California price changes

Response of D(LOG(OSFP_SA)) to Cholesky
One S.D. D(LOG(SNA_SA)) Innovation

Months after impulse

Vector autoregression model (VAR)
Orange County, CA → Honolulu County, HI

Vector error-correction model (VEC)
Orange County, CA → Honolulu County, HI

Regressions from 1980.1 through 2011.3; data sources: National Association of Realtors, Honolulu Board of Realtors, Prudential Locations, Inc.; data seasonally-adjusted by TZE using Census X-12 ARIMA filter
Kauai single-family median existing home prices also “arbing” plausibly to California; time suggestive of long-run convergence

Sources: Hawaii Information Service, National Association of Realtors; seasonal adjustment by TZE
Maui single-family median existing home prices had slipped behind the No-CAL rally, but surged back during 3rd quarter 2016

Quarterly, thousand $, s.a. (log scale)

San Francisco-Oakland-Fremont
Anaheim-Santa Ana-Irvine
San Diego-Carlsbad-San Marcos

U.S. recessions shaded

Sources: Realtors Association of Maui, National Association of Realtors; seasonal adjustment by TZE
Big Island single-family median existing home prices also approximate those of San Diego; displaying similar long-run convergence

Quarterly, thousand $, s.a. (log scale)

Sources: Hawaii Information Service, National Association of Realtors; seasonal adjustment by TZE
Hilo side of Big Island (not to mention Ka‘u (not shown)) systematically cheaper than elsewhere (implying what?)

Monthly, thousand $, s.a.

Sources: Hawaii Information Service, Realtors Association of Maui, Honolulu Board of Realtors, Hawaii DBEDT; seasonal adjustment by TZE
Oahu home prices also correlate highly with most Neighbor Island markets (incl. Kona side of Big Isle), exhibit more resilience

Monthly, thousand $, s.a.

Sources: Hawaii Information Service, Realtors Association of Maui, Honolulu Board of Realtors, Hawaii DBEDT; seasonal adjustment by TZE
Key issues confronting Kauai in 20-teens cycle: lack of inventory, low production; no quantitatively material increment to housing stock; still, existing home price acceleration has *not* been more acute than during the last two housing cycles.

Question: will appreciation persist through a late-20-teens recession (if any)?

Housing policy strategy based on “inclusionary zoning” (arbitrary housing production quotas as a condition of development entitlement allocation): a notorious economic policy FAIL that has *increased* the amplitude of the valuation cycle [http://www.uhero.hawaii.edu/assets/UHEROProjectReport2010-1.pdf](http://www.uhero.hawaii.edu/assets/UHEROProjectReport2010-1.pdf)

Kauai existing home price distribution characteristics, similar to all the islands (same on Oahu) commend an alternative, hybrid policy approach:

1. Ease restriction on development below some quantile threshold, *e.g.* lower half of the distribution of the natural logarithm of Kauai existing home prices
2. Complementary spatial strategy: ease restrictions near likely nodes of conurbation (*e.g.* defined within arbitrary walk- or drive-time radii)
High Hawaii housing prices (vs. mainland), in economic union with perfect capital and labor mobility, are an equilibration mechanism discouraging net in-migration

Amplitude of housing’s asset-pricing cycle in Hawaii exacerbated by two factors:
1. Geographic scarcity (mountains, oceans) ultimately prevents urban footprint from radiating spatially across cheaply developed, flat land
2. Regulatory scarcity (barriers to entry) imposed for good reasons (agricultural land preservation) as well as bad (oligopolistic rivalry; The Politics of NIMBY)

Constraints reduce the price elasticity of the flow supply of housing: facing rising demand, the housing market “clears” via home price acceleration

Good economic fundamentals—rising exports (tourism), employment, income, wealth (stock + home prices), offshore investors—raise urban housing demand

The single most important policy change to reduce the amplitude of an incipient house price cycle would be to reduce regulatory restrictions on new housing supply

*Investors should get the same long-run total return on housing (capital gain—price appreciation—plus “the dividend” of living in the house) regardless of whether it is in Hawaii or Iowa, no offense to either location, up to idiosyncratic risk premia
Complex dynamics: overshooting + oscillation

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“Overshooting” models of asset price dynamics

The key implication is that supply or demand shocks must be absorbed on short notice by a limited set of investors. The risk aversion or limited capital of the currently available investors, including intermediaries, leads them to require a price concession in order to absorb the supply or demand shock. They plan to ‘lay off’ the associated risk over time as other investors become available. As a result, the initial price impact is followed by a price reversal that may occur over an extended period of time.


1941-43 = 10 (log scale)

Trading range prior to the August 3, 2011 federal debt ceiling deadline

*Federal debt ceiling “deadline”

Sources: Standard & Poor’s, Federal Reserve Bank of St. Louis; daily closing data through June 21, 2012
Exchange rate depreciation, overshooting and oscillatory convergence in the Asian Financial Crisis

Initial, precipitous depreciation of the Thai baht was quickly followed by the Malaysian ringgit and shortly after by the Korean won.

Shaded areas denote Asian Financial Crisis

*Malaysia closed the capital window in August 1997 and suspended Ringgit convertability at that time for several years

Source: FRED II; indexes of currency values in January 1997 – June 1997 U.S. dollars calculated by TZE
S&P 500 Index through Lehman Bros. collapse

Sources: Standard & Poor's, Federal Reserve Bank of St. Louis; daily data through Monday, November 14, 2011
Change in daily Japanese passengers to Hawaii

Thousands per day, net
(Current minus year-earlier day)

Great Tohoku Japan seismic event (March 11)
Overshooting

Sources: Hawaii DBEDT; calculations on daily passenger counts by TZ Economics through mid-September 2011
Intra-day S&P 500 May 6, 2010 “Flash Crash”

Source: http://www.marketoracle.co.uk/images/2010/Jun/flash-crash-4-2.jpg
S&P Case-Shiller price indexes (relative to Jan 2000): “double-dip” is same as overshooting + oscillation

January 2000 = 100, s.a., log scale

Los Angeles
San Diego

San Francisco
Denver (relatively stable)
Phoenix

Las Vegas

Sources: Standard & Poor’s; seasonal adjustment using Census X-12 filter by TZ Economics
Median CA existing single-family home prices: “double-dip” or “overshooting + oscillation?”

Quarterly, thousand $, s.a. (log scale)

Oahu (Honolulu) its own private Idaho

San Jose, Sunnyvale, Santa Clara

Anaheim, Santa Ana, Irvine

San Francisco, Oakland, Fremont

San Diego, Carlsbad, San Marcos

Los Angeles, Long Beach, Santa Ana

U.S. recession shaded

Sources: Honolulu Board of Realtors, National Association of Realtors; seasonal adjustment by TZE using Census X-12 ARIMA filter, data through first quarter 2012
Oahu housing market most resilient—relatively—of Hawaii Islands and many mainland urban markets

**Sources:** Honolulu Board of Realtors, Realtors Association of Maui, National Association of Realtors, Kauai Board of Realtors / Hawaii Information Service; seasonal adjustment by TZE using Census X-12 ARIMA filter
Pau (lecture 2 of 2)
Appendix: Aspects of the 2007-08 housing-led financial crisis impacts in Hawaii

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Regional variation in home price movements and contagion through financial channels of transmission

- Mortgage lenders historically have relied on geographic diversity of housing market performances as one source of *portfolio* risk mitigation (why?*)
- Financial innovation introduced increasingly complex structures through which to hold housing market risk exposure with superior risk-adjusted returns
- Mortgage-backed securities (MBS) issued from geographically diverse pools of underlying mortgages have lower risk than holding the individual mortgage assets
- Collateralized debt obligations (CDO) constructed from MBS tranche and prioritize risk exposures: large AAA-rated pools created by subordinating risk into higher-risk mezzanine (A) and equity (B) tranches
- Credit default swaps (CDS) “wrapped” as insurance around MBS and CDO exposures, allowing counterparties to exchange default exposure positions (in the event of default, one counterparty compensates the other)
- Problem: regionally correlated home price movements set off a contagion event, asset price declines were then exacerbated by “fire sales” externality, exposures concentrated in systemically-important financial institutions (SIFIs)

*Varying house price movements from region to region or, ideally, *negative covariation* (movements in *opposite* directions) can reduce the variance of portfolio returns when mortgage loan assets originated in different regions are blended together. Correlated house price declines *amplify* risk into a contagion event.
MBA refinancing index and regression model: when interest rates go down, refi volume goes up (adjusted for home price movements)

\[ d(\ln(MBAVREFI)) = -0.1236 + 7.2008 \cdot d(\ln(OFHEO)) - 0.1335 \cdot d(GS3M) - 1.0601 \cdot d(GS10) \]

\[ (-2.6724) \quad (2.3162) \quad (-1.7223) \quad (-11.4826) \]

Source: Mortgage Bankers Association, Bloomberg, Office of Federal Housing Enterprise Oversight; author’s calculations (t-statistics in parentheses)
FFIEC-reporting home mortgage lenders

2006: 8,848 institutions
- Subsidiary lenders: 8%
- Commercial banks: 43%
- Independent lenders: 15%
- Credit unions: 23%
- Savings institutions: 11%

2009: 8,124 institutions
- Subsidiary lenders: 5%
- Commercial banks: 48%
- Independent lenders: 11%
- Credit unions: 25%
- Savings institutions: 11%

Distributions of mortgage-backed securities: “ex ante” risk in 2007

Hawaii $44.387 billion

U.S. total $6.607 trillion

Sources: Loan Performance; calculations courtesy Liang Lee, Bank of Hawaii
Securitization complexity—read from left to right

Securitisation markets: key participants
Stylised overview of the “players” involved in securitisations and of their respective roles

Rating agencies
evaluate credit risk/deal structure, assess third parties, interact with investors and issue ratings

Asset manager
trades assets

Financial guarantor
insures particular tranches

Special purpose vehicle
funds

Assets
claims

Liabilities
tranches

Servicer

Monitors compliance

Trustee

Collected and makes payments

Originator

Arranger
funds

Investors
Senior
Mezzanine
Junior

Source: Adapted from Fender and Mitchell (2005).

http://www.bis.org/publ/qtrpdf/r_qt0909e.pdf
Tranching and subordination of risk into designated high-risk/high-yield buckets does not fully insulate junior tranches from valuation losses ordinarily concentrated in senior tranches if correlated default amplifies overall risk exposure.
Mortgage credit default swap (CDS) ABX indices: ABX 7-1 series initiated in January 2007 reveals what happened to values of underlying CDO tranches

Each ABX line is based on a basket of 20 credit default swaps referencing asset-backed securities containing subprime mortgages. Investor pays fee (spread) to guarantee index price of 100. After initiation protection buyer pays (100−ABX price); as ABX price drops, fee rises and previous CDS sellers suffer losses.

Sub-prime mortgage-related risk pricing also revealed severed loss of value in 2007-09—precipitating liquidity crisis after Lehman (Sep 08)

Based on baskets of 20 CDS-referencing asset-backed securities containing sub-prime mortgages and home equity loans of different ratings; after initiation, fee (spread) that buyer pays is (100 – ABX price), plus, the upfront fee that previous sellers pay rises if ABX falls


Note: Time (horizontal) scales are slightly different, as in originals
Implosion in financially-innovative credit channels (securitization)

Billions of dollars

- Collateralized debt obligation (CDO)
- Asset-back security (ABS)
- Commercial mortgage-backed security (CMBS)
- Residential mortgage-backed security (RMBS)
- Term asset-backed security lending facility (TALF)
- Federal Reserve Board (FRB)

$150 billion, mostly TALF-funded by FRB

Mortgage delinquency near cyclical peak (2010Q3)

≥90 days past due by county (darker is higher)

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<tr>
<th>County</th>
<th>Delinquency</th>
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<tr>
<td>Dade, FL</td>
<td>22.7</td>
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<tr>
<td>Broward, FL</td>
<td>18.3</td>
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<tr>
<td>Palm Beach, FL</td>
<td>15.9</td>
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<tr>
<td>Clark, NV</td>
<td>15.6</td>
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<tr>
<td>Riverside, CA</td>
<td>13.6</td>
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<td>Bronx, NY</td>
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<td>Maricopa, AZ</td>
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<tr>
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Sources: Federal Reserve Bank of New York based on credit-reporting agency TransUnion LLC’s Trend Data database

(http://data.newyorkfed.org/creditconditionsmap/)
Bank failure surged during the financial crisis, but better managed based on lessons from prior experiences.

Annual U.S. bank failures

- Great Depression (second wave 1937-38)
- S&L crisis 1980s
- Sub-prime financial Crisis (2007-2009)

Hawaii statewide mortgage delinquency
30 days past due, completing cycle around declining LR trend

Sources: Mortgage Bankers Association, Guy Sakamoto, Bank of Hawaii, seasonal adjustment and trend regression by TZE
Migration to 90 days past due was a secular event associated specifically with the sub-prime financial crisis.

Percent of Hawaii loans past due, quarterly, s.a.

Sources: Mortgage Bankers Association, Guy Sakamoto, Bank of Hawaii, seasonal adjustment and trend regression by TZE
Transition rates for mortgage accounts: after getting worse, getting better with economic recovery

**Source:** Federal Reserve Bank of New York (FRBNY Consumer Credit Panel/Equifax)
(http://data.newyorkfed.org/research/national_economy/householdcredit/DistrictReport_Q12012.xls)
Correlating the valuation cycle to mortgage delinquencies—velocity or acceleration?

The valuation cycle (home prices)

- Single-family home prices (log scale)
- Rates of home price increase, and acceleration, are associated with lower delinquency (inverse relationship)

The delinquency cycle (% past due)

- Percent of loans past due
- Actual delinquency
- Trend component

Sources: Honolulu Board of Realtors, Prudential Locations, UHERO, Mortgage Bankers Association, seasonal adjustment and calculation of Hodrick-Prescott filter trends by TZE; mahalo to Guy Sakamoto, Bank of Hawaii
Literature at time suggested that high sub-prime delinquency rates were associated with low rates of home price appreciation, and increases in delinquencies were associated with home price *deceleration*.

Changes in house prices and the subprime delinquency rate

Pre-crisis literature suggested that high sub-prime delinquency rates were associated low rates of home price appreciation, and increases in delinquencies were associated with home price deceleration.

Statewide changes in SF home prices and the mortgage delinquency rate in Hawaii

Pre-crisis literature suggested that high sub-prime delinquency rates were associated low rates of home price appreciation, and increases in delinquencies were associated with home price deceleration.

Replicating the FRBSF (2007): inverse relationship
Hawaii price acceleration and change in delinquency

Lagged inverse relationship between mortgage delinquency and home price appreciation in Hawaii

*Mean statewide single-family existing home sales prices

Log change in prices (lagged 8 quarters)*

Hawaii 90+ day delinquency

*Median Oahu single-family existing home sales prices

Log change in prices (lagged 8 quarters)*

Hawaii 90+ day delinquency

*All data seasonally-adjusted, 1980-2008 (statewide) and 1979-2008 (Oahu)

Source: Regressions by TZE; data from Mortgage Bankers Association, UHERO, Prudential Locations, TZE
Lagged inverse relationship between mortgage delinquency and FHFA home price change in Hawaii

Source: Regressions and seasonal adjustment by TZE; data from Mortgage Bankers Association, Federal Housing Finance Authority, TZE
Lagged inverse relationship between mortgage delinquency, FHFA home price change; pre-crisis

Note that increasing dispersion at higher delinquency (heteroskedasticity) implies that there is a less stable inverse relationship.

Source: Regressions and seasonal adjustment by TZE; data from Mortgage Bankers Association, Federal Housing Finance Authority, TZE
Using trend data: the inverse relationship between changes in home prices and delinquency rates appears cyclically in diagonal, flattened orbits.

Sources: Prudential Locations, UHERO, Mortgage Bankers Association, Guy Sakamoto (Bank of Hawaii); all calculations by TZE.
Reverse the axes, using FHFA prices

- Test of “Granger causality” points to a causal relationship running *from* lagged changes in home prices *to* delinquency levels with a lag of 8 quarters (2 years)
- Let’s visualize in the form $y = f(x)$ where $x = (\log)$ changes in home prices (lagged eight quarters) and $y =$ delinquency rates (graphed in logarithms) so that the “slope” of each regression is an “elasticity:” relative proportionate responses
- (This reverses the axes in the previous graphs, starting with the images taken from Doms and Furlong (FRBSF 2007))
- Working with the FHFA quarterly data set on house prices, taken from mortgage information including sales prices as well as appraisals, back to 1975, extract the “trend component” of the house price time series to dampen the noise introduced by data pre-1985 (as illustrated on the next slide)
- This noise in the early-1980s introduces a statistical problem called “heteroskedasticity” seen in the previous slides, where in the dispersion of the actual data around the regression line changes, moving from left to right
- Make inferences from the extracted *trend* relationship between home price movements ($x$-axis), 2-year lags, and mortgage delinquency rates ($y$-axis)
Home price changes (left) and delinquency (right)

Source: Regressions and seasonal adjustment by TZE; data from Mortgage Bankers Association, Federal Housing Finance Authority, TZE
Lagged inverse relationship between FHFA home price change trend and mortgage delinquency in HI

Source: Regressions and seasonal adjustment by TZE; data from Mortgage Bankers Association, Federal Housing Finance Authority, TZE
Toxicity: learning from mortgage delinquency

- The Great Recession, concluding the sub-prime mortgage lending-driven housing "bubble" that preceded it:
  1. Wide geographic variation in mortgage delinquency
  2. Notable for anomalous spike in serious delinquency
- Correlated house price declines across different regions of the economy, and correlated increases in mortgage delinquency, meant that the benefits of geographic diversification to mortgage pools (portfolio risk reduction) was actually reversed: correlated movement led to a contagion event
- Unwinding of house price bubbles in active regional markets (Las Vegas, Phoenix, Central California, Florida) radiated outward spatially and through the financial system as a contagion—price declines, increased delinquency, higher mortgage default, impaired values for mortgage-backed securities, collateralized debt obligations (built from MBS), credit default swaps (CDS counterparty risk)
- Fire sales externality: selling assets to raise cash pushes down asset values, leading others also to sell to raise cash, exacerbating valuation declines
Digging deeper into linkages: house price movements and changes in delinquency

- Rising prices are associated with falling delinquencies (up to lags, etc.)
- In cyclical markets, rising phase of house price cycle has similar inverse relationship with falling phase of mortgage delinquency cycle (up to lags)
- Some evidence that price deceleration raises the pace of increase in delinquency (i.e. prices rising at a decreasing rate of increase can precede, precipitate a delinquency rise)
- Complex nonlinearity actually masks underlying orbit—embedding inverse relationship—in delinquency-price change space
- Evidence now clearly shows incipient improvement—higher house prices, lower delinquencies for some time to come is the indication of current momentum
Adjusted for inflation: asset-pricing bubbles? or garden-variety valuation cycles?

\[
\ln(P_t^H) = 5.3701 + 0.0235 t + u_t \\
\text{(32.3522) (5.0935)}
\]

\[
u_t = 0.7917 u_{t-1} + \varepsilon_t \\
\text{(9.4051)}
\]

Source: TZ Economics; deflation using the Honolulu and U.S. All-City CPI-U; thousand 2007 dollars, log scales

Mean Oahu real *existing* SF home prices

Median U.S. real *new* SF home prices

1963-2009 annualized appreciation: ≥ 1.3%

1984-2008 annual appreciation: ≤ 2.1%
Regression of Oahu single-family median existing home prices on payroll employment (and lags): popular correlation with jobs not adequate

\[
\text{LOG}(P) = -13.44718509 + 2.115735061 \times \text{LOG}(\text{JOBC (-1)}) + 0.1813978443 \times \text{LOG}(\text{JOBC(-2)}) + 0.2386012886 \times \text{LOG}(\text{JOBC (-3)}) + 5.263170009 \times \text{LOG}(\text{HCPIU(-1)}) + 0.071227734 \times \text{LOG}(\text{HCPIU(-2)}) - 4.55245973 \times \text{LOG}(\text{HCPIU(-3)})
\]

Residual cycle (difference between actual and fitted values is highly autocorrelated) broadly consistent with macro cycles—early-80s recovery, late-80s Japan Bubble, late-1990s economic stagnation (as in the title of your textbook by Chris Grandy, *Hawaii Becalmed*), early-2000s Subprime Bubble (microeconomic adverse selection/moral hazard event), the Great Recession (Dec. 2007 – Jun. 2009), early 20-teens turbulence (so-called “double-dip” discussed in section on overshooting and oscillation); data through early-2012