HOUSING PRICES KEY SUPPLY-DEMAND FACTORS

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IMPORTS

In [724…

```
import numpy as np
import pandas as pd
import seaborn as sb
import matplotlib.pyplot as plt
%matplotlib inline
from functools import reduce
import requests
```

In [725…

```
sb.set_style("whitegrid")
```

FUNCTIONS

In [726…

```
def cleanup(df, col_name):
    df['DATE'] = pd.to_datetime(df["DATE"])
    df['year'] = df['DATE'].dt.year
    df = df.groupby("year", as_index=True).mean()
    df.rename(columns = {list(df)[0]: col_name}, inplace =True)
    return df
```

In [727…

```
def cleanupIncome(df):
    #df = df[0]
    cols_to_drop=[0,1,2]
    df.drop(columns=df.columns[cols_to_drop],inplace=True)
    df.dropna(inplace=True, axis=0)
    df.drop([0,1], inplace=True)
    df.reset_index(drop=True, inplace=True)
    #return df
```

In [728…

```
def cleanupEdu(df):
    #df = df[0]
    cols_to_drop=[0,1,3]
    df.drop(columns=df.columns[cols_to_drop],inplace=True)
    df.dropna(inplace=True, axis=0)
    df.drop([0,1], inplace=True)
    df.reset_index(drop=True, inplace=True)
    #return df
```

In [729…

```
def cleanupFam(df):
    #df = df[0]
    cols_to_drop=[0,1]
    df.drop(columns=df.columns[cols_to_drop],inplace=True)
    df.dropna(inplace=True, axis=0)
    df.drop([0,1], inplace=True)
    df.reset_index(drop=True, inplace=True)
    #return df
```

HOUSING PRICES

LOAD DATA

In [730…

```
#source: https://fred.stlouisfed.org/

#S&P/Case-Shiller U.S. National Home Price Index (CSUSHPISA)
housing_prices = pd.read_csv("Data/CSUSHPISA.csv")

#Homeownership Rate in the United States (RSAHORUSQ156S)
home_ownership = pd.read_csv("Data/RSAHORUSQ156S.csv")
```

In [731…

```
housing_prices.head()
```

Out[731…

	DATE	CSUSHPISA
0	2002-01-01	117.143
1	2002-02-01	117.845
2	2002-03-01	118.687
3	2002-04-01	119.611
4	2002-05-01	120.724

CLEAN DATA

In [732…

```
housing_prices = cleanup(housing_prices,"median housing price")
home_ownership = cleanup(home_ownership,"home ownership %")
```

In [733…

```
housing_prices
```

Out[733…

year	median housing price
2002	122.279000
2003	133.731417
2004	150.440333
2005	171.737000
2006	183.447833
2007	179.919500
2008	164.058167
2009	148.543583
2010	144.671250
2011	139.259167
2012	140.992833
2013	154.522083
2014	164.700750
2015	172.189917
2016	180.934667
2017	191.408667
2018	202.484333
2019	209.481250
2020	222.144333
2021	260.080667
2022	284.330000

VISUALISE

In [734…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)


#homeownership rate
sb.lineplot(ax=ax[0],data = own_price, x="year", y="home ownership %", linewidth = 2,color='r')
ax[0].set_title("homeownership rate")
ax[0].set(xlabel="year", ylabel = "%")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))


#housing prices
sb.lineplot(ax=ax[1],data = own_price, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("housing price")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[734…

```
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```

```
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```

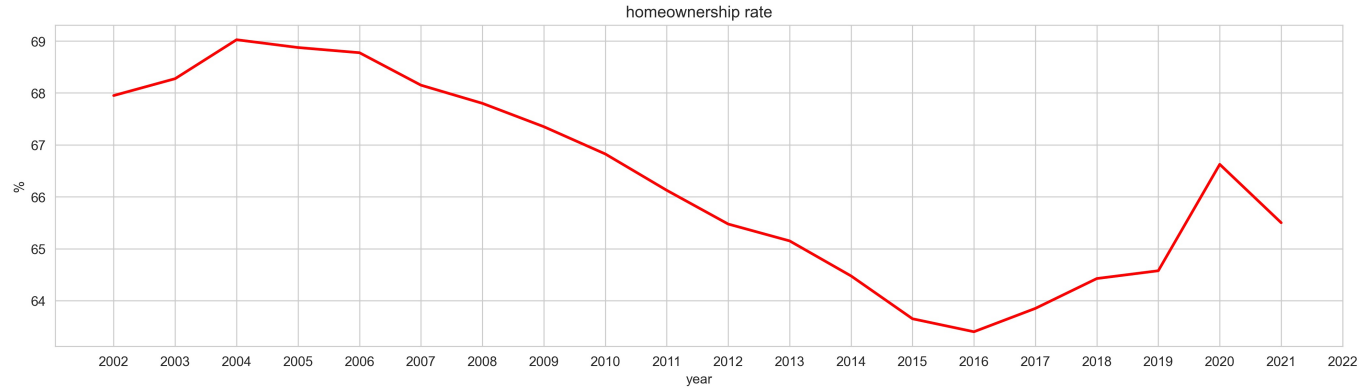

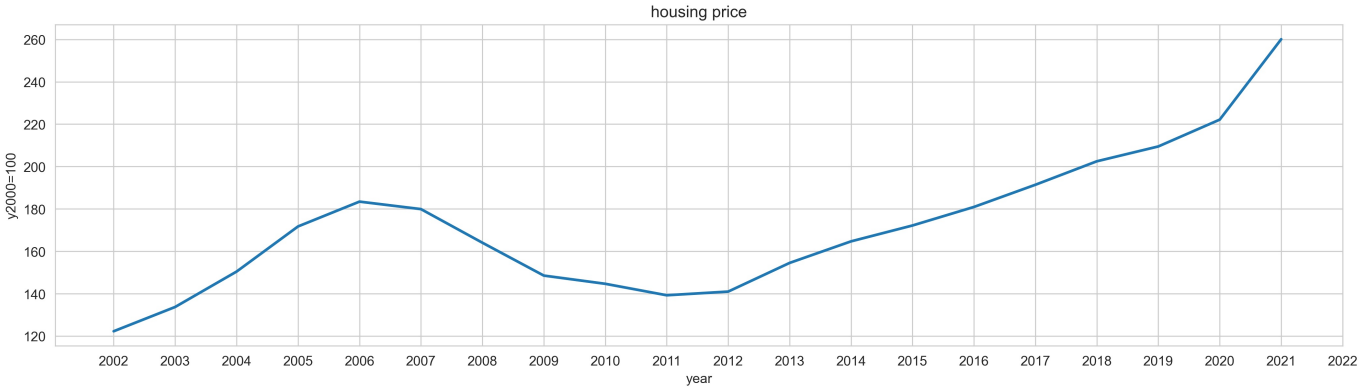

SUPPLY FACTORS:

1. PRODUCTION

1.1 CONSTRUCTION STAGES

LOAD DATA

In [735…

```
#STAGES OF CONSTRUCTION:

#source: https://fred.stlouisfed.org/

#Completed (NHFSEPCS) units *1000

df_stages_completed = pd.read_csv("Data/Supply/Stages/NHFSEPCS.csv")

#Under Construction (NHFSEPUCS)

df_stages_under_const = pd.read_csv("Data/Supply/Stages/NHFSEPUCS.csv")

#Not Started (NHFSEPNTS)

df_stages_not_start = pd.read_csv("Data/Supply/Stages/NHFSEPNTS.csv")
```

In [736…

```
df_stages_completed
```

Out[736…

	DATE	NHFSEPCS
0	2002-01-01	77.0
1	2002-02-01	79.0
2	2002-03-01	80.0
3	2002-04-01	83.0
4	2002-05-01	83.0
...	...	...
236	2021-09-01	34.0
237	2021-10-01	35.0
238	2021-11-01	34.0
239	2021-12-01	33.0
240	2022-01-01	34.0

241 rows × 2 columns

CLEAN DATA

In [737…

```
df_stages_completed = cleanup(df_stages_completed,"completed")
df_stages_under_const = cleanup(df_stages_under_const,"under construction")
df_stages_not_start = cleanup(df_stages_not_start, "not started")
```

In [738…

```
df_supply_house_stages = pd.concat([df_stages_completed, df_stages_under_const,df_stages_not_start]
                                   ,axis=1)
```

In [739…

```
df_supply_house_stages
```

Out[739…

year	completed	under construction	not started
2002	82.500000	199.000000	46.000000
2003	80.833333	213.916667	53.666667
2004	89.916667	243.250000	62.166667
2005	106.750000	279.500000	81.416667
2006	144.083333	318.166667	91.083333
2007	185.416667	267.166667	78.500000
2008	179.083333	190.416667	56.000000
2009	128.000000	115.750000	35.083333
2010	86.500000	97.083333	27.750000
2011	65.500000	77.166667	24.666667
2012	44.500000	77.750000	23.583333
2013	40.000000	99.083333	29.500000
2014	50.250000	117.750000	32.250000
2015	51.583333	127.333333	37.166667
2016	58.333333	146.583333	38.083333
2017	62.250000	165.666667	47.333333
2018	66.500000	191.250000	56.166667
2019	77.500000	198.083333	54.750000
2020	60.416667	184.083333	59.250000
2021	34.583333	224.666667	90.250000
2022	34.000000	265.000000	102.500000

VISUALISE:

In [740…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#homes for sale by construction
```

```
sb.lineplot(ax= ax[0],data = df_supply_house_stages,
            linewidth = 2)
ax[0].set(xlabel="year", ylabel = "no. units for sale * 1000")
ax[0].set_title("HOMES FOR SALE BY STAGE OF CONSTRUCTION (US, LAST 20 YEARS)")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))


#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[740…

```
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```

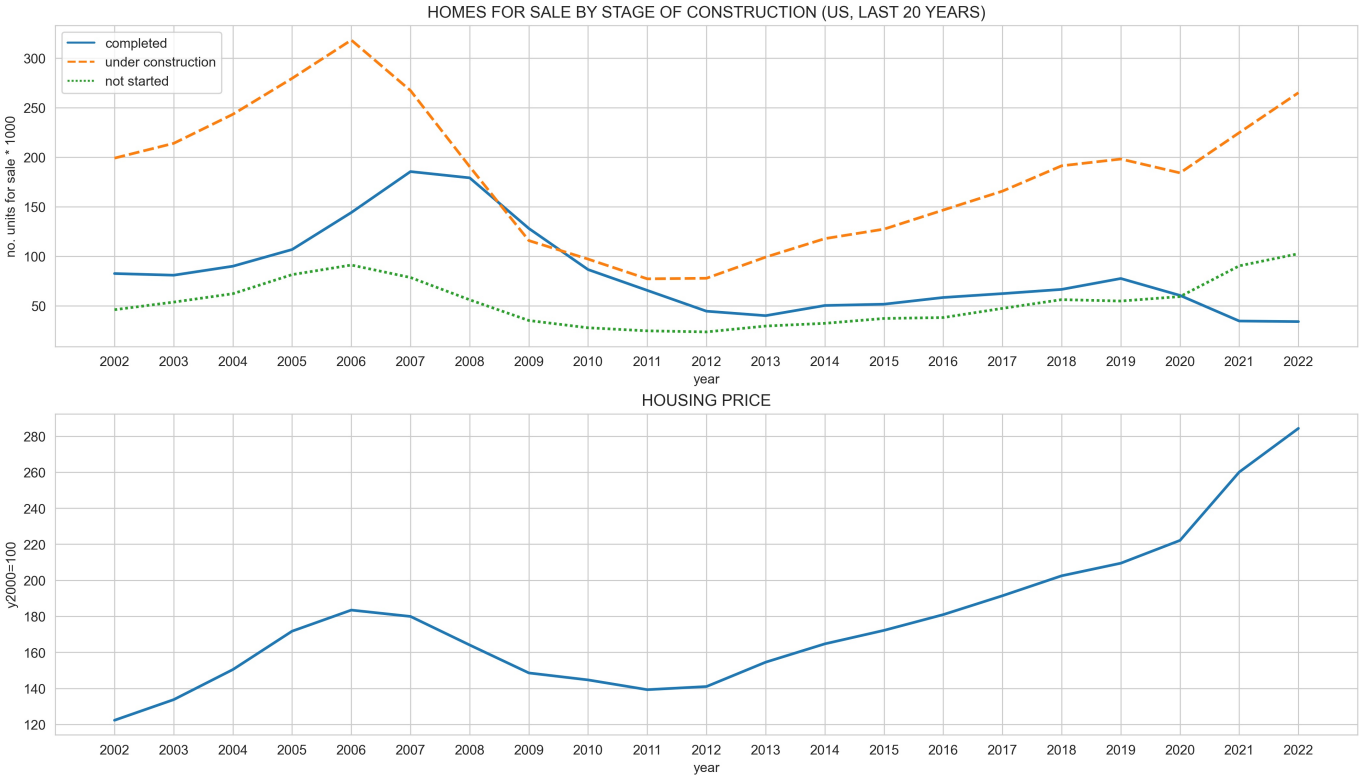

1.2 CONSTRUCTION COSTS

LOAD DATA

In [741…

```
#STAGES OF CONSTRUCTION:

#source: https://fred.stlouisfed.org/

#Producer Price Index by Commodity: Special Indexes: Construction Materials (WPUSI012011)

df_cost_mat = pd.read_csv("Data/Supply/Costs/WPUSI012011.csv")

# Producer Price Index by Industry: Construction Machinery Manufacturing (PCU333120333120)
```

```
df_cost_mach = pd.read_csv("Data/Supply/Costs/PCU333120333120.csv")

# Import Price Index (End Use): Crude Oil (IR10000)

df_cost_oil = pd.read_csv("Data/Supply/Costs/IR10000.csv")

#Import Price Index (End Use): Natural Gas (IR10110)

df_cost_gas = pd.read_csv("Data/Supply/Costs/IR10110.csv")

#All Employees, Residential Building (CES2023610001)

df_cost_labour = pd.read_csv("Data/Supply/Costs/CES2023610001.csv")
```

In [742…]
```
df_cost_mat
```

Out[742…]

	DATE	WPUSI012011
0	2002-01-01	142.000
1	2002-02-01	142.200
2	2002-03-01	143.200
3	2002-04-01	143.500
4	2002-05-01	143.800
...	...	...
236	2021-09-01	317.136
237	2021-10-01	322.120
238	2021-11-01	328.940
239	2021-12-01	335.066
240	2022-01-01	345.359

241 rows × 2 columns

CLEAN DATA

In [743…]
```
df_cost_mat = cleanup(df_cost_mat,"price: construction materials")
df_cost_mach = cleanup(df_cost_mach, "price: construction machinery")
df_cost_oil = cleanup(df_cost_oil,"price: crude oil import")
df_cost_gas = cleanup(df_cost_gas,"price: natural gas import")
df_cost_labour = cleanup(df_cost_labour, "employees: residential construct.")
```

In [744…]
```
df_supply_costs = pd.concat([df_cost_mat,df_cost_mach,df_cost_oil,df_cost_gas,df_cost_labour], axis=1)
```

In [745…]
```
df_supply_costs2 = pd.concat([df_cost_mat,df_cost_mach,df_cost_oil,df_cost_gas,df_cost_labour,housing_prices], ax
```

In [746…]
```
#normalize
df_supply_costs_norm =(df_supply_costs-df_supply_costs.min())/(df_supply_costs.max()-df_supply_costs.min())
```

In [747…]
```
df_supply_costs_norm
```

Out[747…]

year	price: construction materials	price: construction machinery	price: crude oil import	price: natural gas import	employees: residential construct.
2002	0.000000	0.000000	0.000000	0.052609	0.537932
2003	0.015396	0.020554	0.055671	0.262700	0.614850
2004	0.086747	0.067970	0.156204	0.318390	0.745344
2005	0.126893	0.139696	0.317109	0.556326	0.890854
2006	0.179951	0.213620	0.444504	0.460774	1.000000
2007	0.194520	0.262595	0.534092	0.438282	0.862909
2008	0.260408	0.318375	0.878037	0.658733	0.565144
2009	0.224318	0.384289	0.447099	0.173772	0.166707
2010	0.250765	0.378761	0.651244	0.222338	0.015861
2011	0.283668	0.441061	0.991920	0.210013	0.000000

2012	0.307010	0.505771	1.000000	0.053803	0.035161
2013	0.324144	0.537736	0.973678	0.184132	0.104523
2014	0.349846	0.565023	0.898900	0.353245	0.211696
2015	0.345335	0.589546	0.336702	0.069940	0.289929
2016	0.347073	0.605068	0.220523	0.000000	0.373217
2017	0.385563	0.616337	0.359511	0.061429	0.422585
2018	0.455631	0.637104	0.516066	0.090083	0.524440
2019	0.455507	0.732857	0.489339	0.084883	0.574540
2020	0.472683	0.772406	0.236332	0.137262	0.548362
2021	0.791690	0.874761	0.600492	0.506412	0.666153
2022	1.000000	1.000000	0.746183	1.000000	0.721046

In [748…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#housing construction costs
sb.lineplot(ax= ax[0],data = df_supply_costs_norm,
            linewidth = 2)
ax[0].set(xlabel="year", ylabel = "costs & labour normalized")
ax[0].set_title("COSTS AND LABOUR AVAILABILITY FOR HOUSING CONSTRUCTION")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[748…

```
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```

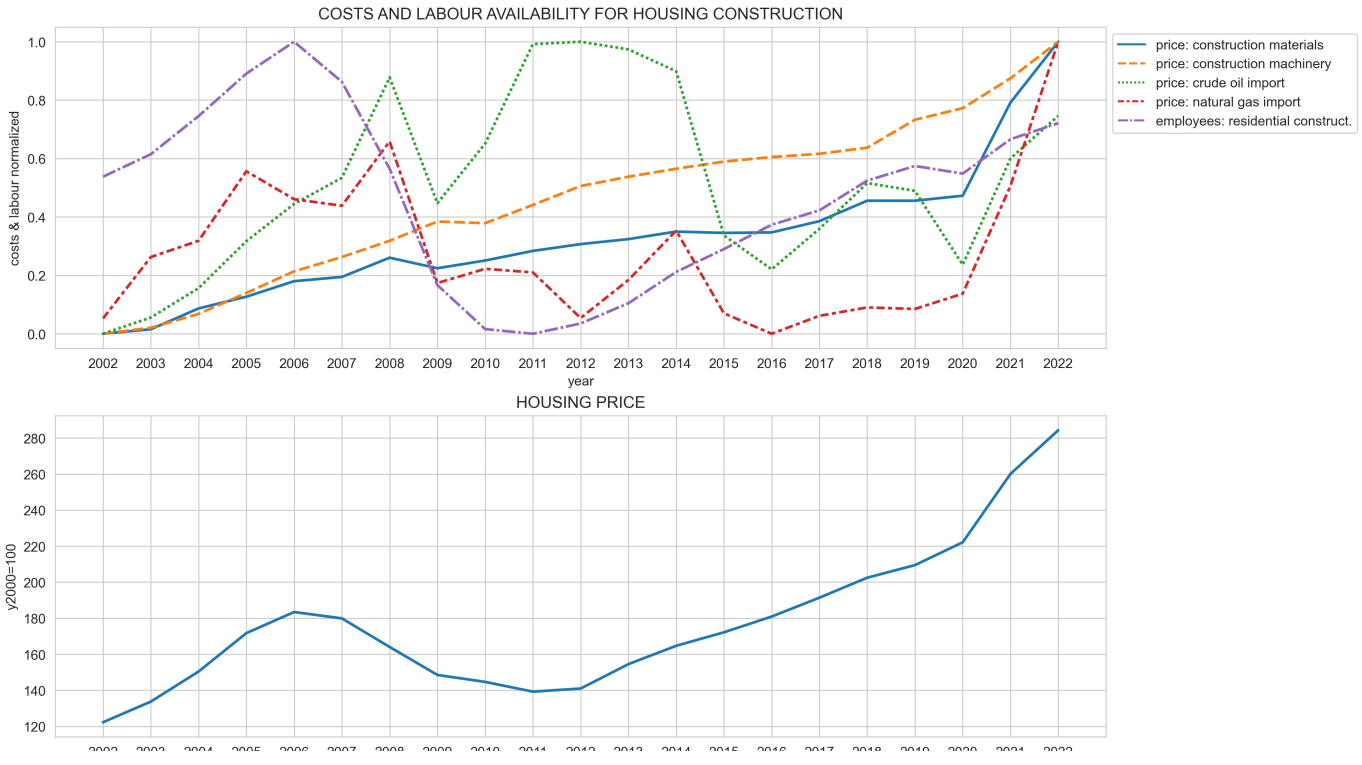

2. POLICY:

2.1 ZONING

LOAD DATA

In [753…
```
#source: https://fred.stlouisfed.org/

#New Privately-Owned Housing Units Authorized in Permit-Issuing Places: Single-Family Units (PERMIT1)

df_zone_1 = pd.read_csv("Data/Supply/zone/PERMIT1.csv")

#New Privately-Owned Housing Units Authorized in Permit-Issuing Places: Units in Buildings with 2-4 Units (PERMIT

df_zone_24 = pd.read_csv("Data/Supply/zone/PERMIT24.csv")

#New Privately-Owned Housing Units Authorized in Permit-Issuing Places: Units in Buildings with 5 Units or More (

df_zone_5 = pd.read_csv("Data/Supply/zone/PERMIT5.csv")

# New Privately-Owned Housing Units Authorized in Permit-Issuing Places: Total Units (PERMIT)

df_zone_tot = pd.read_csv("Data/Supply/zone/PERMIT.csv")
```

In [750…
```
df_zone_1
```

Out[750…

	DATE	PERMIT1
0	2002-01-01	1285.0
1	2002-02-01	1401.0
2	2002-03-01	1289.0
3	2002-04-01	1285.0
4	2002-05-01	1289.0
...	...	...
236	2021-09-01	1041.0
237	2021-10-01	1074.0
238	2021-11-01	1106.0
239	2021-12-01	1128.0
240	2022-01-01	1213.0

241 rows × 2 columns

CLEAN DATA

In [30]:
```
df_zone_1 = cleanup(df_zone_1,"single family unit")
df_zone_24 = cleanup(df_zone_24,"2-4 units")
df_zone_5 = cleanup(df_zone_5, ">5 units")
df_zone_tot = cleanup(df_zone_tot, "total units")
```

In [31]:
```
merge_dfs = [df_zone_1, df_zone_24,df_zone_5,df_zone_tot]
```

In [530…
```
df_zoning = pd.concat(merge_dfs,axis=1)
```

In [751…
```
df_zoning
```

Out[751…

year	single family unit	2-4 units	>5 units	total units
2002	1335.500000	73.333333	340.166667	1749.000000

2003	1461.083333	82.583333	344.750000	1888.416667
2004	1604.250000	90.333333	363.000000	2057.583333
2005	1684.500000	84.083333	391.500000	2160.083333
2006	1380.416667	77.166667	386.083333	1843.666667
2007	971.583333	59.416667	360.500000	1391.500000
2008	567.416667	34.166667	294.250000	895.833333
2009	439.583333	20.750000	121.666667	582.000000
2010	448.000000	21.833333	133.833333	603.666667
2011	420.000000	21.666667	182.333333	624.000000
2012	519.666667	25.916667	282.916667	828.500000
2013	619.083333	28.833333	340.083333	988.000000
2014	639.833333	29.500000	382.750000	1052.083333
2015	694.583333	31.500000	451.416667	1177.500000
2016	750.666667	34.583333	420.166667	1205.416667
2017	823.000000	37.500000	424.000000	1284.500000
2018	853.750000	40.083333	434.916667	1328.750000
2019	863.500000	41.916667	479.833333	1385.250000
2020	988.166667	47.333333	443.500000	1479.000000
2021	1116.833333	52.333333	544.666667	1713.833333
2022	1213.000000	57.000000	625.000000	1895.000000

VISUALISE

In [752…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#housing zoning
sb.lineplot(ax= ax[0],data = df_zoning,
            linewidth = 2)
ax[0].set(xlabel="year", ylabel = "no. of units")
ax[0].set_title("HOUSING PERMITS AUTHORISED")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[752…

```
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```

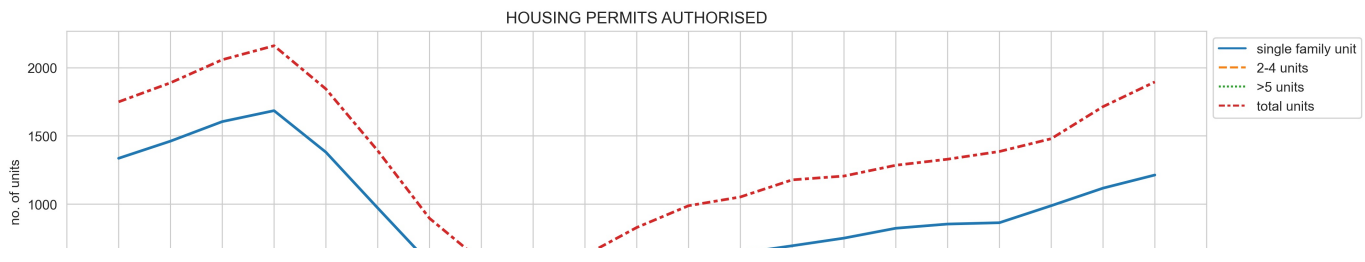

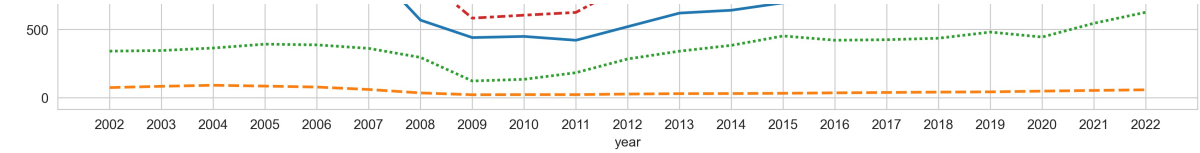

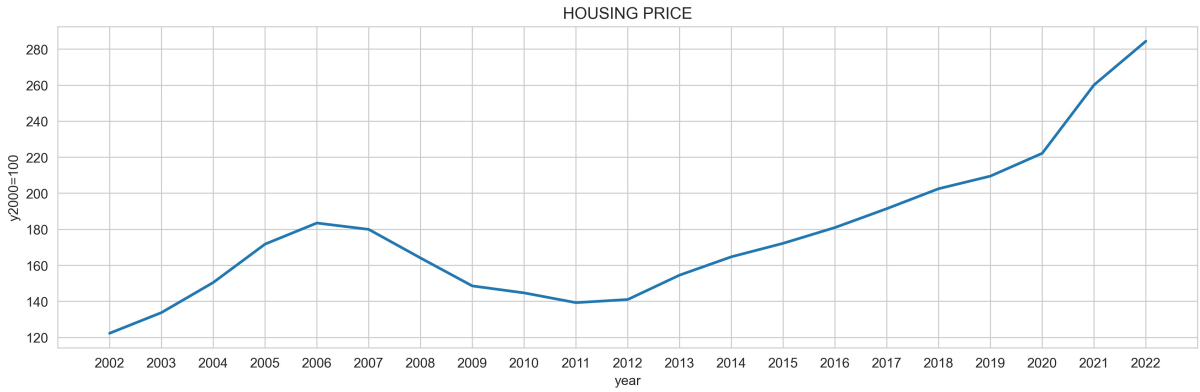

3. MARKET

LOAD DATA

In [758…

```
#Data from Redfin

# Data for new vs existing sale nos. 2012-2022:
df_mark_sales = pd.read_csv("Data/Supply/Market/sales.csv", encoding='utf-16', sep= '\t')

#Data for new vs existing sale median prices 2012-2022:
df_mark_prices = pd.read_csv("Data/Supply/Market/median price.csv", encoding='utf-16', sep= '\t')
```

In [759…

```
df_mark_prices
```

Out[759…

	Region	Period End	Is New Construction Transaction	Measure Names	Measure Values
0	National	31/01/2022	New Construction	Median Sale Price	462202
1	National	31/01/2022	Existing	Median Sale Price	364864
2	National	31/12/2021	New Construction	Median Sale Price	454040
3	National	31/12/2021	Existing	Median Sale Price	371363
4	National	30/11/2021	New Construction	Median Sale Price	448327
...	...	...	...	...	...
1205	West Region	31/03/2012	Existing	Median Sale Price	219000
1206	West Region	29/02/2012	New Construction	Median Sale Price	295000
1207	West Region	29/02/2012	Existing	Median Sale Price	203000
1208	West Region	31/01/2012	New Construction	Median Sale Price	289900
1209	West Region	31/01/2012	Existing	Median Sale Price	200000

1210 rows × 5 columns

CLEAN DATA

In [760…

```
df_mark_sales.drop(["Region","Measure Names"], axis=1,inplace=True)
df_mark_prices.drop(["Region","Measure Names"], axis=1,inplace=True)
```

In [761…

```
df_mark_sales['New Construction Sales'] = None
df_mark_sales['Existing House Sales'] = None

df_mark_prices['New Construction Median Sale Price'] = None
df_mark_prices['Existing House Median Sale Price'] = None
```

In [762…

```
df_mark_sales["New Construction Sales"] = df_mark_sales.loc[0::2, "Measure Values"]
df_mark_sales["Existing House Sales"] = df_mark_sales.loc[1::2, "Measure Values"]
df_mark_sales.drop(columns=["Is New Construction Transaction","Measure Values"], inplace=True)
```

```
df_mark_prices["New Construction Median Sale Price"] = df_mark_prices.loc[0::2, "Measure Values"]
df_mark_prices["Existing House Median Sale Price"] = df_mark_prices.loc[1::2, "Measure Values"]
df_mark_prices.drop(columns=["Is New Construction Transaction","Measure Values"], inplace=True)
```

In [763…
```
df_mark_sales["Existing House Sales"] = df_mark_sales['Existing House Sales'].shift(-1)
df_mark_prices["Existing House Median Sale Price"] = df_mark_prices['Existing House Median Sale Price'].shift(-1)
```

In [764…
```
df_mark_sales.dropna(axis=0,inplace=True)
df_mark_prices.dropna(axis=0,inplace=True)
```

In [765…
```
df_mark_sales['Period End'] = pd.to_datetime(df_mark_sales["Period End"])
df_mark_sales['year'] = df_mark_sales['Period End'].dt.year
df_mark_sales = df_mark_sales.groupby("year", as_index=True).mean()

df_mark_prices['Period End'] = pd.to_datetime(df_mark_prices["Period End"])
df_mark_prices['year'] = df_mark_prices['Period End'].dt.year
df_mark_prices= df_mark_prices.groupby("year", as_index=True).mean()
```

In [766…
```
df_mark_sales
```

Out[766…

year	New Construction Sales	Existing House Sales
2012	34580.750000	369505.583333
2013	39387.500000	405019.666667
2014	42371.000000	399952.333333
2015	47698.916667	439496.250000
2016	54597.416667	460166.250000
2017	60085.583333	469820.000000
2018	63256.083333	463107.833333
2019	67262.333333	463471.916667
2020	73824.583333	485277.416667
2021	63876.833333	537522.250000
2022	47406.000000	359777.000000

VISUALISE

In [769…
```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#housing market
sb.lineplot(ax= ax[0],data = df_mark_sales,
            linewidth = 2)
ax[0].set(xlabel="year", ylabel = "no. of units")
ax[0].set_title("HOUSING MARKET BY HOUSE SALES, EXISTING VS NEW")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[769…
```
[<matplotlib.axis.XTick at 0x7fa3f49e9160>,
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```

```
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```

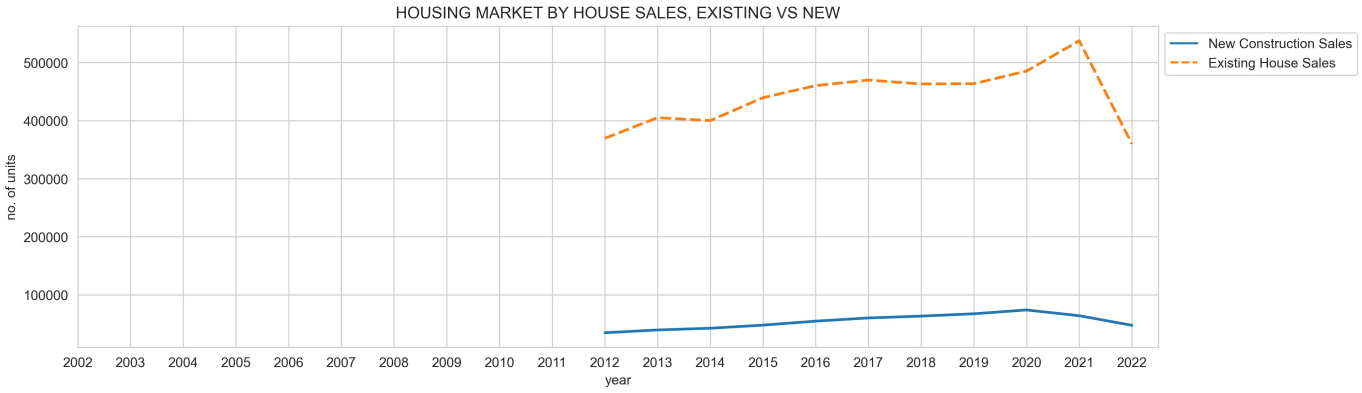

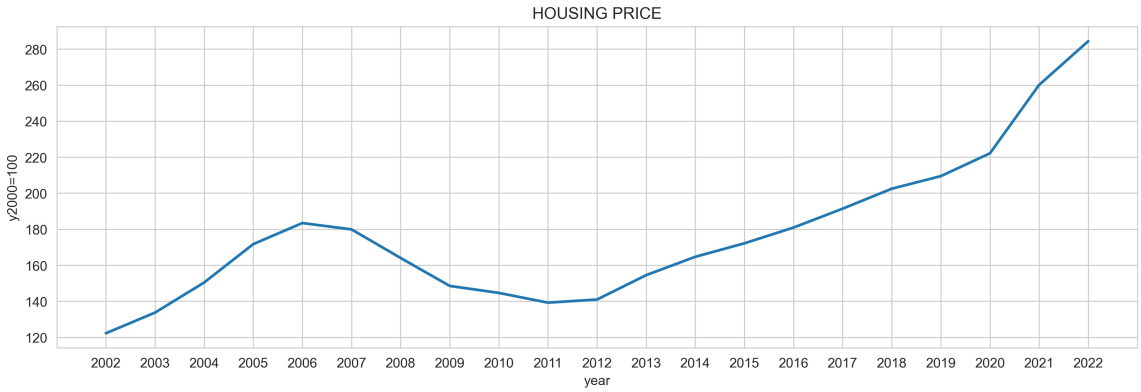

In [770…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#housing market
sb.lineplot(ax= ax[0],data = df_mark_prices,
            linewidth = 2)
ax[0].set(xlabel="year", ylabel = "price of units")
ax[0].set_title("HOUSING MARKET BY HOUSE PRICES, EXISTING VS NEW")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[770…

```
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```

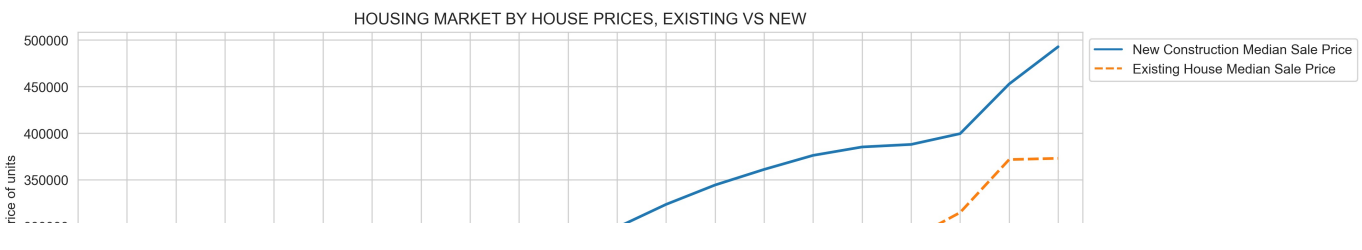

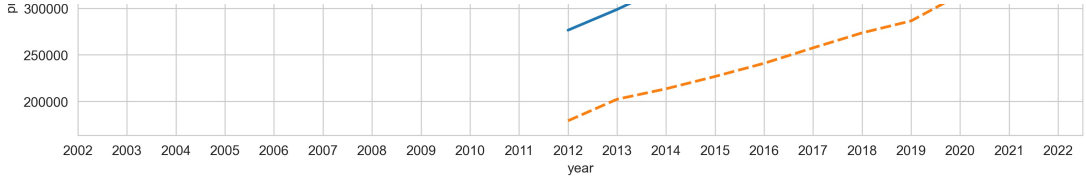

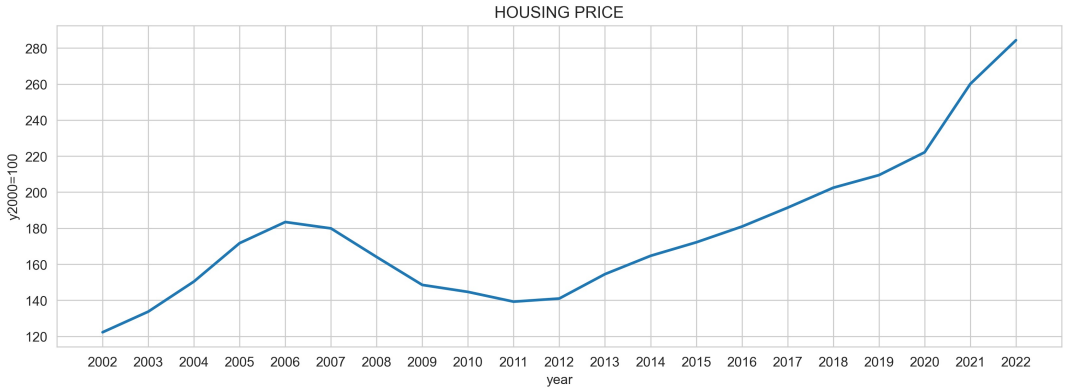

DEMAND FACTORS:

1. ECONOMY

LOAD DATA

In [771…

```
#source: https://fred.stlouisfed.org/

#30-Year Fixed Rate Mortgage Average in the United States (MORTGAGE30US) %
df_eco_mort = pd.read_csv("Data/Demand/Economy/MORTGAGE30US.csv")

#Consumer Price Index for All Urban Consumers: Owners' Equivalent Rent of Residences in U.S. City Average (CUSR0
df_eco_rent_eqv = pd.read_csv("Data/Demand/Economy/CUSR0000SEHC.csv")

#Consumer Price Index for All Urban Consumers: Rent of Primary Residence in U.S. City Average (CUSR0000SEHA)
df_eco_rent = pd.read_csv("Data/Demand/Economy/CUSR0000SEHA.csv")

#Real Gross Domestic Product (GDPC1): Billions of chained USD
df_eco_gdp = pd.read_csv("Data/Demand/Economy/GDPC1.csv")
#Inflation, consumer prices for the United States (FPCPITOTLZGUSA) %
df_eco_inf = pd.read_csv("Data/Demand/Economy/FPCPITOTLZGUSA.csv")
#Unemployment Rate (UNRATE)
df_eco_unemp = pd.read_csv("Data/Demand/Economy/UNRATE.csv")
```

In [772…

```
df_eco_mort
```

Out[772…

	DATE	MORTGAGE30US
0	2003-04-18	5.82
1	2003-04-25	5.79
2	2003-05-02	5.70
3	2003-05-09	5.62
4	2003-05-16	5.45
...	...	...
987	2022-03-17	4.16
988	2022-03-24	4.42
989	2022-03-31	4.67

990	2022-04-07	4.72
991	2022-04-14	5.00

992 rows × 2 columns

CLEAN DATA

In [781…
```
df_eco_mort = cleanup(df_eco_mort,"30y fixed mortgage %")
df_eco_rent_eqv = cleanup(df_eco_rent_eqv,"owner's rent equivalent")
df_eco_rent = cleanup(df_eco_rent, "rent")
df_eco_gdp = cleanup(df_eco_gdp, "real gdp")
df_eco_inf = cleanup(df_eco_inf,"inflation %")
df_eco_unemp = cleanup(df_eco_unemp,"unemployment %")
```

In [782…
```
df_economy_rent = pd.concat([df_eco_rent,df_eco_rent_eqv],axis=1)
```

In [783…
```
df_economy_rates = pd.concat([df_eco_mort,df_eco_inf,df_eco_unemp],axis=1)
```

In [773…
```
df_economy_rates
```

Out[773…

year	30y fixed mortgage %	inflation %	unemployment %
2002	NaN	1.586032	5.783333
2003	5.822632	2.270095	5.991667
2004	5.839231	2.677237	5.541667
2005	5.866731	3.392747	5.083333
2006	6.413269	3.225944	4.608333
2007	6.337308	2.852672	4.616667
2008	6.027170	3.839100	5.800000
2009	5.036538	-0.355546	9.283333
2010	4.689808	1.640043	9.608333
2011	4.447885	3.156842	8.933333
2012	3.657500	2.069337	8.075000
2013	3.975577	1.464833	7.358333
2014	4.168868	1.622223	6.158333
2015	3.850577	0.118627	5.275000
2016	3.654038	1.261583	4.875000
2017	3.989808	2.130110	4.358333
2018	4.544615	2.442583	3.891667
2019	3.935769	1.812210	3.675000
2020	3.111698	1.233584	8.091667
2021	2.957692	NaN	5.358333
2022	3.960667	NaN	4.000000

VISUALISE

In [774…
```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#economy_rent:
sb.lineplot(ax= ax[0],data = df_economy_rent,
            linewidth = 2)
ax[0].set(xlabel="year", ylabel = "cost index")
ax[0].set_title("RENT VS OWNERSHIP COST OF HOUSE")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
```

```
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[774…
```
[<matplotlib.axis.XTick at 0x7fa3dca299a0>,
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```

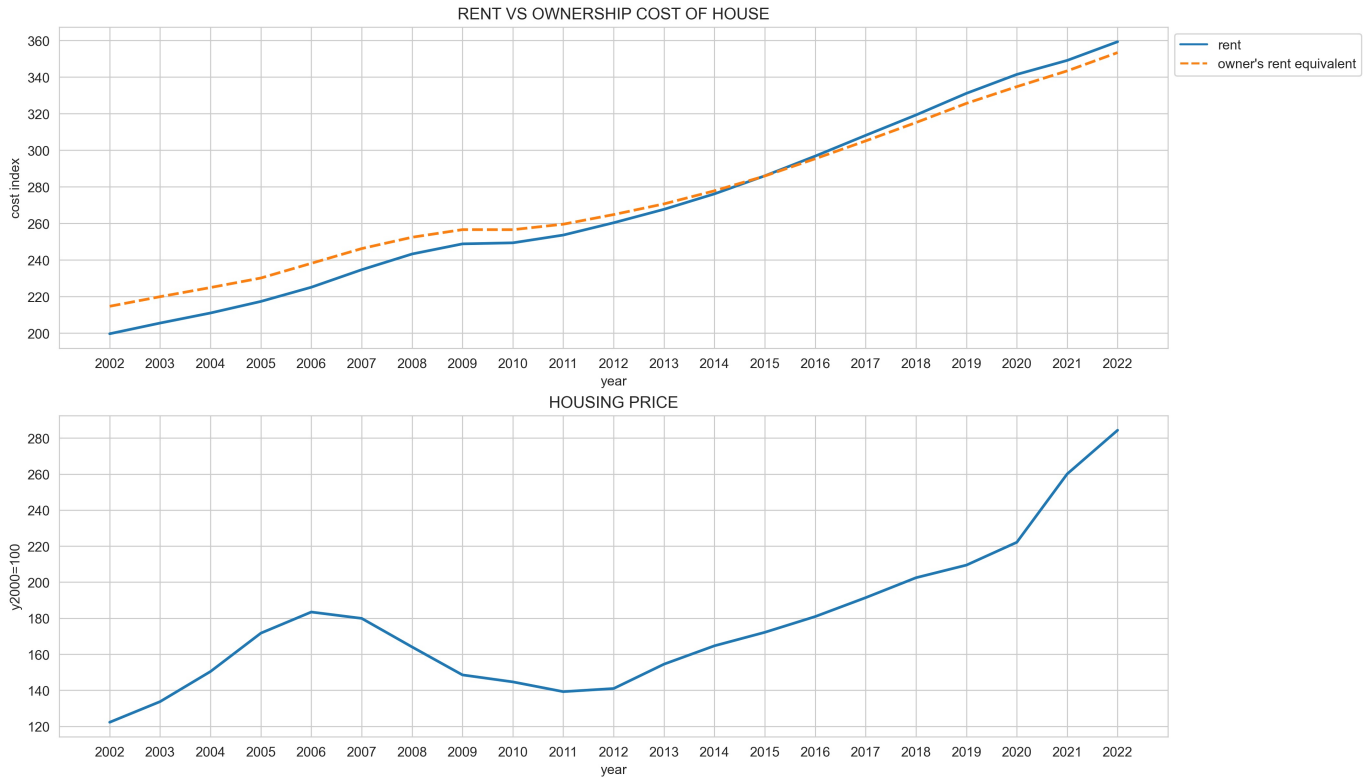

In [775…
```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#economy_rent:
sb.lineplot(ax= ax[0],data = df_economy_rates,
            linewidth = 2)
ax[0].set(xlabel="year", ylabel = "%")
ax[0].set_title("ECONOMY (Mortgage,Inflation,Unemployment)")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[775…
```
[<matplotlib.axis.XTick at 0x7fa3f48c9e20>,
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```

```
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```

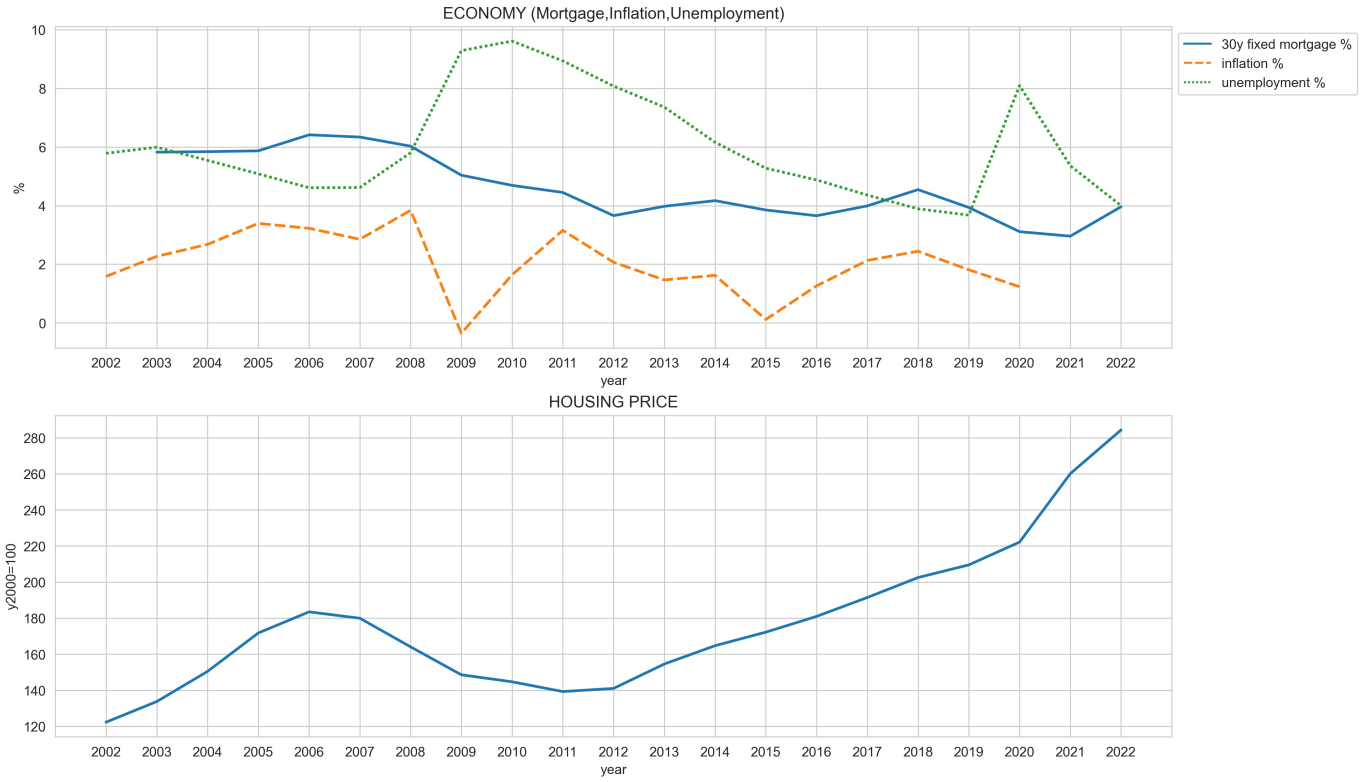

In [785…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#economy_rent:
sb.lineplot(ax= ax[0],data = df_eco_gdp,
            linewidth = 2)
ax[0].set(xlabel="year", ylabel = "billions of chained USD 2012")
ax[0].set_title("ECONOMY (GDP)")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[785…

```
[<matplotlib.axis.XTick at 0x7fa3ca807e80>,
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```
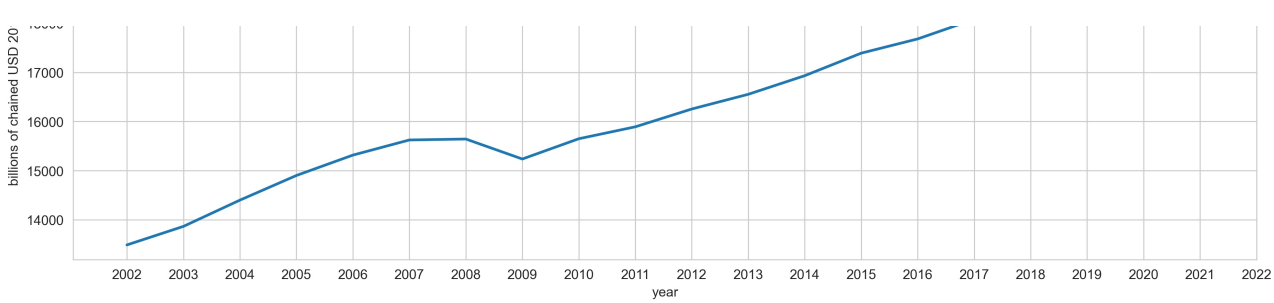
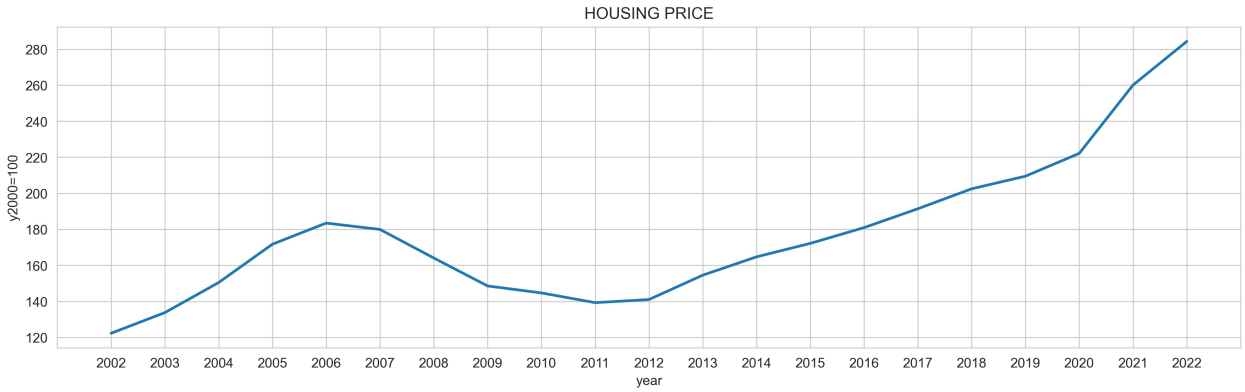





2. DEMOGRAPHICS - HOUSEHOLD

Data availability : 2008-2012

2.1 INCOME

LOAD DATA

In [790…

```
#source: CENSUSACS: ACS PUMS: https://data.census.gov/mdat/#/

hh_inc_list = []
for i in range(2008,2020):
    globals()["hh_inc_%s" % i] = pd.read_html("Data/Demand/Demo/Buyer/income/"+str(i)+".html")[0]
    hh_inc_list.append(globals()["hh_inc_%s" % i])
```

CLEAN DATA

In [791…

```
columns_hh_inc = ['<50,000','50,001-100,000','100,001-150,000','150,001-200,000','200,001-500,000','>500,000']
df_demo_hh_inc = pd.DataFrame(index=range(2008,2020,1), columns = columns_hh_inc)
df_demo_hh_inc.index.rename('year', inplace=True)
```

In [792…

```
for item in hh_inc_list:
    cleanupIncome(item)
```

In [793…

```
for i in range(0,12):
    df_demo_hh_inc.iloc[i,:] = hh_inc_list[i].iloc[1]
```

In [794…

```
df_demo_hh_inc = df_demo_hh_inc.astype(float)
```

In [795…

```
df_demo_hh_inc
```

Out[795…

year	<50,000	50,001-100,000	100,001-150,000	150,001-200,000	200,001-500,000	>500,000
2008	1586586.0	1682551.0	613997.0	219877.0	225819.0	30758.0
2009	1369993.0	1375313.0	551160.0	194925.0	190465.0	21442.0
2010	1391802.0	1329459.0	533419.0	177024.0	185289.0	15683.0
2011	1252841.0	1180014.0	488612.0	191240.0	202934.0	16374.0
2012	1269922.0	1231884.0	512552.0	207367.0	223129.0	22485.0

2013	1318973.0	1302084.0	602408.0	254910.0	269201.0	30954.0
2014	1271413.0	1369577.0	692825.0	280154.0	315249.0	41125.0
2015	1300464.0	1500206.0	765502.0	333471.0	353151.0	52393.0
2016	1348119.0	1601850.0	865475.0	364247.0	389122.0	61157.0
2017	1350681.0	1750044.0	958062.0	414165.0	449957.0	65115.0
2018	1340211.0	1702021.0	979609.0	442987.0	474925.0	86939.0
2019	1216360.0	1677332.0	1009241.0	489835.0	526242.0	89982.0

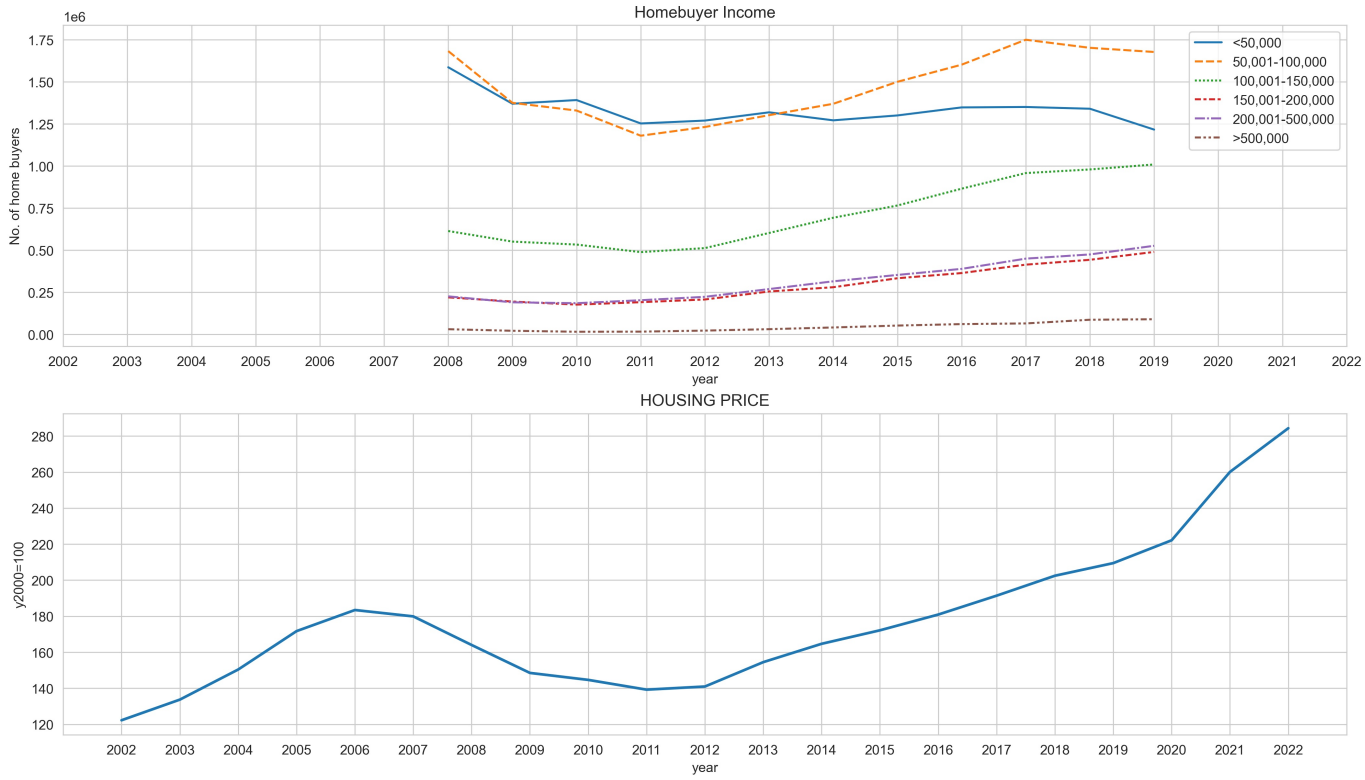
VISUALISE

In [796…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#buyer_demographic_household_income:
sb.lineplot(ax= ax[0],data = df_demo_hh_inc)
ax[0].set(xlabel="year", ylabel = "No. of home buyers")
ax[0].set_title("Homebuyer Income")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[796…

```
[<matplotlib.axis.XTick at 0x7fa3cd16d880>,
 <matplotlib.axis.XTick at 0x7fa3cd16d850>,
 <matplotlib.axis.XTick at 0x7fa3cd2d8df0>,
 <matplotlib.axis.XTick at 0x7fa3cd2e3c40>,
 <matplotlib.axis.XTick at 0x7fa3cd2ed3d0>,
 <matplotlib.axis.XTick at 0x7fa3cd2edb20>,
 <matplotlib.axis.XTick at 0x7fa3cd2ed700>,
 <matplotlib.axis.XTick at 0x7fa3cd2f41c0>,
 <matplotlib.axis.XTick at 0x7fa3cd2f4850>,
 <matplotlib.axis.XTick at 0x7fa3cd2f90a0>,
 <matplotlib.axis.XTick at 0x7fa3cd2f9730>,
 <matplotlib.axis.XTick at 0x7fa3cd165490>,
 <matplotlib.axis.XTick at 0x7fa3cd2e3070>,
 <matplotlib.axis.XTick at 0x7fa3cd30e1c0>,
 <matplotlib.axis.XTick at 0x7fa3cd30ee80>,
 <matplotlib.axis.XTick at 0x7fa3cd316610>,
 <matplotlib.axis.XTick at 0x7fa3cd316d60>,
 <matplotlib.axis.XTick at 0x7fa3cd31c4f0>,
 <matplotlib.axis.XTick at 0x7fa3cd316a60>,
 <matplotlib.axis.XTick at 0x7fa3cd30e790>,
 <matplotlib.axis.XTick at 0x7fa3cd308c70>]
```



2.2 EDUCATION

LOAD DATA

In [797…

```
hh_edu_list = []
for i in range(2008,2020):
    globals()["hh_edu_%s" % i] = pd.read_html("Data/Demand/Demo/Buyer/education/"+str(i)+".html")[0]
    hh_edu_list.append(globals()["hh_edu_%s" % i])
```

CLEAN DATA

In [798…

```
columns_hh_edu = ['Less than HighSchool','High School/GED',"Associate's deg","Bachelor's deg",
                  "Doctorate","Master's/Professional"]
df_demo_hh_edu = pd.DataFrame(index=range(2008,2020,1), columns = columns_hh_edu)
df_demo_hh_edu.index.rename('year', inplace=True)
```

In [799…

```
for item in hh_edu_list:
    cleanupEdu(item)
```

In [800…

```
for i in range(0,12):
    df_demo_hh_edu.iloc[i,:] = hh_edu_list[i].iloc[1]
```

In [801…

```
df_demo_hh_edu = df_demo_hh_edu.astype(float)
```

In [802…

```
df_demo_hh_edu
```

Out[802…

year	Less than HighSchool	High School/GED	Associate's deg	Bachelor's deg	Doctorate	Master's/Professional
2008	3378861.0	1888760.0	715286.0	1870723.0	126084.0	930229.0
2009	2760182.0	1581912.0	609108.0	1641047.0	111831.0	833709.0
2010	2606062.0	1500487.0	588002.0	1651490.0	119560.0	830017.0
2011	2525082.0	1412344.0	538212.0	1482568.0	111436.0	789527.0
2012	2587545.0	1454005.0	574294.0	1582611.0	120380.0	831510.0
2013	2839022.0	1529502.0	659584.0	1763113.0	141410.0	968443.0
2014	2824550.0	1574518.0	688833.0	1920183.0	155093.0	1083541.0
2015	3088150.0	1724164.0	757459.0	2107935.0	168209.0	1176410.0
2016	3326450.0	1857134.0	834047.0	2278276.0	170189.0	1285130.0
2017	3575501.0	1982403.0	890690.0	2480290.0	188476.0	1423229.0
2018	3543240.0	2043102.0	939028.0	2499275.0	196462.0	1432822.0
2019	3515571.0	2005228.0	927792.0	2515415.0	198226.0	1416212.0

VISUALISE

In [803…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#buyer_demographic_household_education:
sb.lineplot(ax= ax[0],data = df_demo_hh_edu)
ax[0].set(xlabel="year", ylabel = "No. of home buyers")
ax[0].set_title("Homebuyer Education")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[803…

```
[<matplotlib.axis.XTick at 0x7fa3cfb268b0>,
 <matplotlib.axis.XTick at 0x7fa3cfb26880>,
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```

```
<matplotlib.axis.XTick at 0x7fa3cfd16670>,
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<matplotlib.axis.XTick at 0x7fa3cfd16e20>,
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<matplotlib.axis.XTick at 0x7fa3cfd38e50>,
<matplotlib.axis.XTick at 0x7fa3cfd405e0>,
<matplotlib.axis.XTick at 0x7fa3cfd40d30>,
<matplotlib.axis.XTick at 0x7fa3cfd464c0>,
<matplotlib.axis.XTick at 0x7fa3cfd40a30>,
<matplotlib.axis.XTick at 0x7fa3cfd22a60>,
<matplotlib.axis.XTick at 0x7fa3cfd46490>]
```
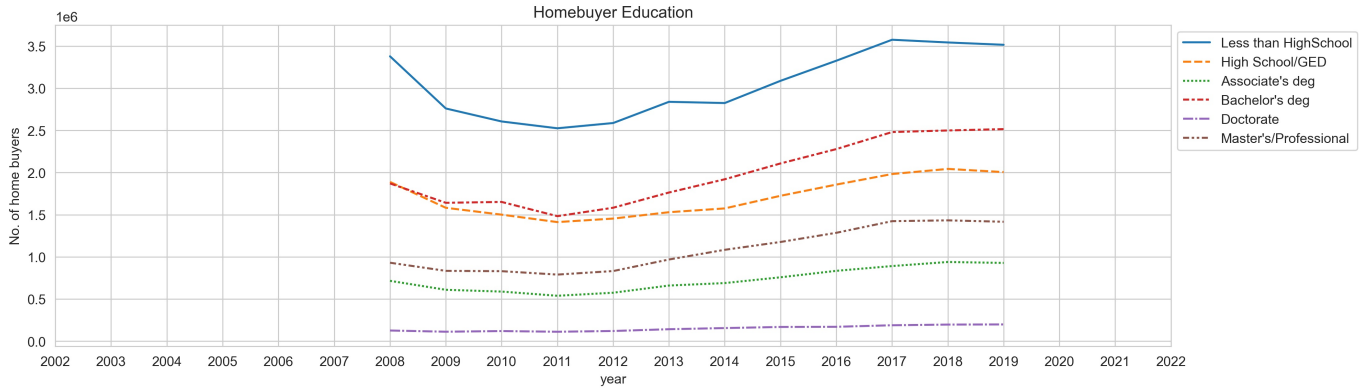
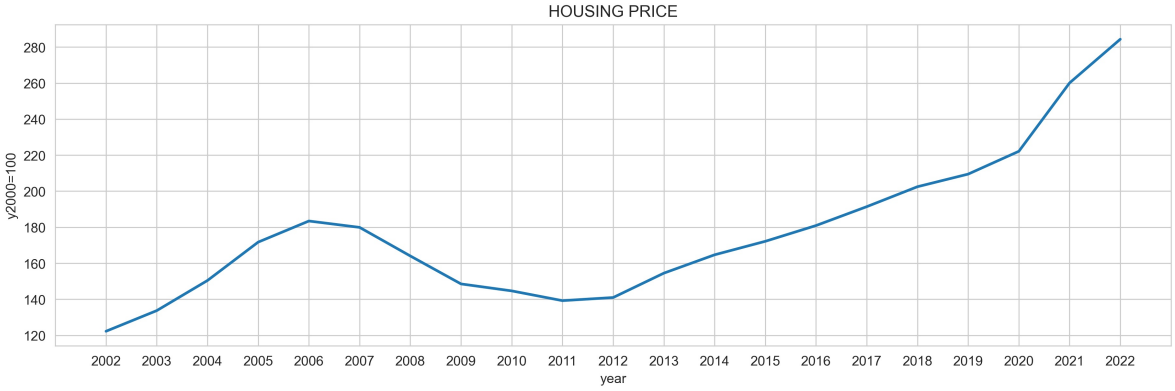





2.3 FAMILY TYPE

LOAD DATA:

In [805…

```
hh_fam_list = []
for i in range(2008,2020):
    globals()["hh_fam_%s" % i] = pd.read_html("Data/Demand/Demo/Buyer/family type/"+str(i)+".html")[0]
    hh_fam_list.append(globals()["hh_fam_%s" % i])
```

CLEAN DATA:

In [806…

```
columns_hh_fam= ["married couple", "male householder no spouse","female householder no spouse",
                 "male householder living alone","female householder living alone",
                 "male householder not living alone","female householder not living alone"]
df_demo_hh_fam = pd.DataFrame(index=range(2008,2020,1), columns = columns_hh_fam)
df_demo_hh_fam.index.rename('year', inplace=True)
```

In [807…

```
for item in hh_fam_list:
    cleanupFam(item)
```

In [808…

```
for i in range(0,12):
    df_demo_hh_fam.iloc[i,:] = hh_fam_list[i].iloc[1]
```

In [809…

```
df_demo_hh_fam = df_demo_hh_fam.astype(float)
```

In [810…

```
df_demo_hh_fam
```

Out[810…

year	married couple	male householder no spouse	female householder no spouse	male householder living alone	female householder living alone	male householder not living alone	female householder not living alone
2008	2392104.0	215063.0	440059.0	509690.0	213868.0	477297.0	141478.0
2009	2014090.0	188100.0	361357.0	446107.0	200180.0	391329.0	129703.0
2010	1925505.0	188186.0	376944.0	450633.0	193054.0	398769.0	135324.0
2011	1824638.0	177654.0	341714.0	401622.0	161543.0	350171.0	113572.0
2012	1889012.0	186221.0	365762.0	401870.0	174217.0	364632.0	122677.0
2013	2085683.0	197581.0	368132.0	429951.0	191023.0	414761.0	131903.0
2014	2260838.0	197340.0	365071.0	435211.0	191146.0	429083.0	131393.0
2015	2483323.0	213395.0	388986.0	447192.0	210493.0	458403.0	144035.0
2016	2643212.0	221433.0	419482.0	489109.0	231354.0	503964.0	159079.0
2017	2851403.0	258357.0	452832.0	520970.0	243403.0	540321.0	172670.0
2018	2830086.0	253425.0	461229.0	547031.0	256380.0	546320.0	180292.0
2019	2820357.0	254641.0	445595.0	537202.0	259747.0	547655.0	184885.0

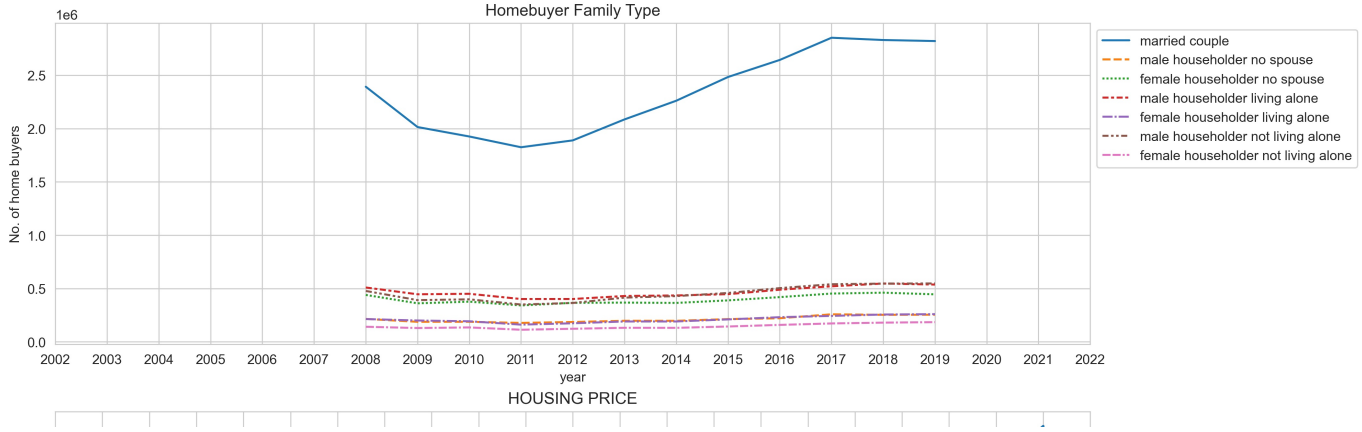
VISUALISE:

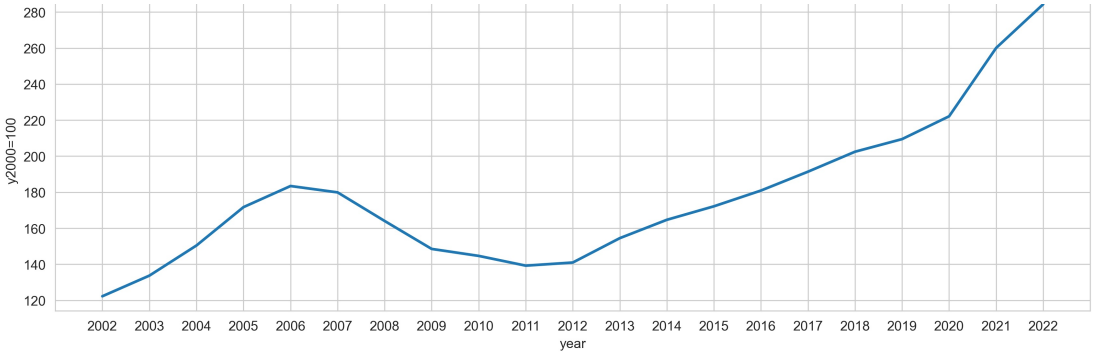
In [811…

```
figure,ax = plt.subplots(2,1,constrained_layout=True,figsize=(14,8),dpi=300)

#buyer_demographic_household_education:
sb.lineplot(ax= ax[0],data = df_demo_hh_fam)
ax[0].set(xlabel="year", ylabel = "No. of home buyers")
ax[0].set_title("Homebuyer Family Type")
ax[0].set_xticks(np.arange(2002, 2023, 1.0))
ax[0].legend(loc='best', bbox_to_anchor=(1, 1))

#housing prices
sb.lineplot(ax=ax[1],data = housing_prices, x="year", y="median housing price", linewidth = 2)
ax[1].set_title("HOUSING PRICE")
ax[1].set(xlabel="year", ylabel = "y2000=100")
ax[1].set_xticks(np.arange(2002, 2023, 1.0))
```

Out[811…

```
[<matplotlib.axis.XTick at 0x7fa3d25bcdc0>,
 <matplotlib.axis.XTick at 0x7fa3d25bcd90>,
 <matplotlib.axis.XTick at 0x7fa3d26eba90>,
 <matplotlib.axis.XTick at 0x7fa3d26fa310>,
 <matplotlib.axis.XTick at 0x7fa3d26faa60>,
 <matplotlib.axis.XTick at 0x7fa3d26fe1f0>,
 <matplotlib.axis.XTick at 0x7fa3d26fe940>,
 <matplotlib.axis.XTick at 0x7fa3d27030d0>,
 <matplotlib.axis.XTick at 0x7fa3d26fe9a0>,
 <matplotlib.axis.XTick at 0x7fa3d26fa700>,
 <matplotlib.axis.XTick at 0x7fa3d2703820>,
 <matplotlib.axis.XTick at 0x7fa3d25bcc10>,
 <matplotlib.axis.XTick at 0x7fa3d271e160>,
 <matplotlib.axis.XTick at 0x7fa3d271e790>,
 <matplotlib.axis.XTick at 0x7fa3d271abe0>,
 <matplotlib.axis.XTick at 0x7fa3d26fe3a0>,
 <matplotlib.axis.XTick at 0x7fa3d271e7f0>,
 <matplotlib.axis.XTick at 0x7fa3d2728100>,
 <matplotlib.axis.XTick at 0x7fa3d2728790>,
 <matplotlib.axis.XTick at 0x7fa3d2728ee0>,
 <matplotlib.axis.XTick at 0x7fa3d272c670>]
```





In [813…

```
#END OF PROJECT
```