Problem1

(a).

Stock Returns = Monthly stock closing price (i.e. mclsprc) / Monthly stock opening price (i.e. mopnprc) -1

Monthly P/E ratios = 3*Monthly stock closing price / EPS of last quarter (i.e. EPS)

We generate a new column representing the corresponding latest quarter with complete EPS data. Since the quarterly EPS data is the cumulative earnings from a share during the whole quarter, we multiply 3 in the numerator to eliminate the influence of different time units.

Monthly P/B ratios (i.e. PB_Ratios) = Monthly stock closing price / Book value per share (i.e. Book_Value_PS)

In this problem, we derive the data of book value per share through following formulas:

Total number of shares = Market Value of Tradable Shares/ Monthly stock closing price

Book value per share = (Total assets – Total liabilities) / Total number of shares

RD_TotalAsset_Ratios = Quarterly R&D expense / Total assets

Quarterly firm ages (i.e. age_in_xxx) = Current date – Establishment data

In this problem, we denote the current date as **2024, 5th March**, providing answers in three different time units: daily, monthly, and yearly.

(b).

In this problem, we list the required monthly and quarterly summary statistics below. (i.e. "Retnfstc" means *stock returns*, RD_TotalAsset means *R&D expense/total asset ratios.*)

Monthly descriptive statistics

Market types	Variables	N	Mean	Median	P25	P75	Standard Deviation	Variance
GEM	Retnfstc	115277	0.01	-0.0085	-0.091	0.08	0.21	0.045
	PB_Ratios	115277	2.62	1.85	1.11	3.08	19.91	396.37
	PE_Ratios	115277	491.45	228.00	108.56	497.44	51192.57	2620000000
SME	Retnfstc	536813	0.01	-0.0025	-0.071	0.07	0.16	0.02
	PB_Ratios	536813	0.97	1.57	0.90	2.74	644.88	415871.60
	PE_Ratios	536813	466.51	145.25	58.06	355.18	18002.54	324000000

Quarterly descriptive statistics

Market types	Variables	N	Mean	Median	P25	P75	Standard Deviation	Variance
GEM	ROA	25,409	0.023	0.021	0.005	0.046	0.065	0.004
	ROE	25,409	0.016	0.031	0.008	0.068	0.395	0.156
	RD_TotalAsset	25,409	0.021	0.015	0.007	0.026	0.022	0.0005
	age_in_year	1,935	20.058	20	16	23	5.682	32.280
SME	ROA	54,668	0.025	0.019	0.005	0.043	0.087	0.008
	ROE	54,668	0.012	0.036	0.010	0.076	1.729	2.990
	RD_TotalAsset	54,668	0.013	0.008	0.013	0.017	0.016	0.0002
	age_in_year	3,661	25.087	25	21	30	6.064	36.772

Findings and discussion:

The monthly summary shows no apparent differences in the stock returns of the two markets' stocks. However, using mean-variance analysis, we can find that stocks in SME boards have lower P/B ratios with more significant dispersion, while their P/E ratios are higher and more discrete than those in the GEM board. All these findings are reasonable since most companies on the SME board have stepped into a stable stage, meaning that their growth rate will be lower than companies on the GEM board. On the other hand, GEM companies are mostly emerging high-tech enterprises that are small in scale, market value, and low in trading volume. Though they have higher growth potentials, their book values may be lower, and stock prices may fluctuate more. Another point is the big gap between the median and mean value of the P/E ratios in both markets. Their enormous variance and standard deviation illustrate that the upper half of the P/E ratios may increase extremely fast in both markets.

In the quarterly summary, gaps between the two boards are unnoticeable regarding ROA and ROE. Notably, the median of R&D expense/total asset ratios in the GEM board is almost double that in the SME board, denoting that enterprises on the GEM board are more devoted to researching and developing new technology or products. Moreover, GEM companies' average execution ages are five years shorter than those of the SME board enterprises, which indicates

they may stay in comparable high-growth stages. All these findings make sense with the monthly discoveries.

Problem2

In this problem, we first use the month as our unit of time. Here are the two time-series plots we get (i.e., Figure 1 2). However, several extreme values and strange periodicities exist due to the incompleteness of monthly EPS and the issue of disclosure frequency.

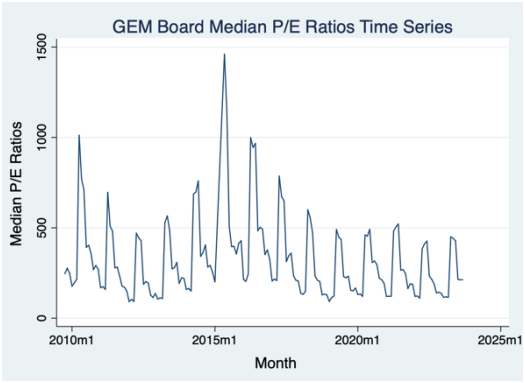

Figure 1

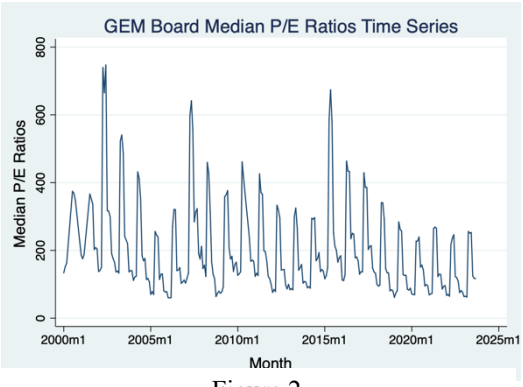

Figure 2

Therefore, we adjust the time unit to semi-annual, which primarily increases the completeness of EPS. Then we get Figure 3 4. The issue of disclosure frequency still puts up the large variation in median P/E ratios within one year in both markets, but this won't influence our analysis.

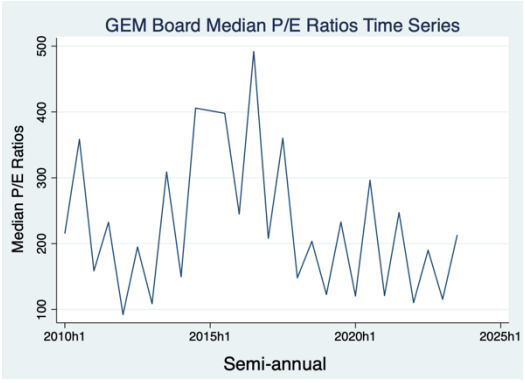

Figure 3

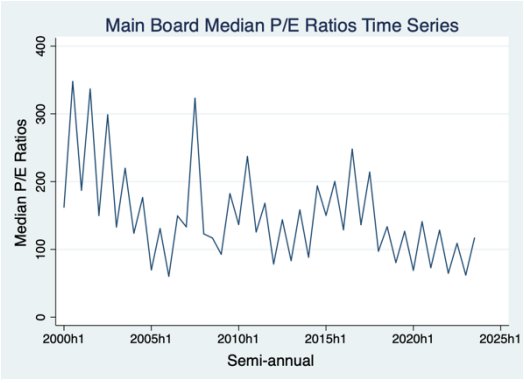

Figure 4

(i). It is advisable to consider new investments in both GEM and SME markets as of Sep. 2023, especially the main board since the median value of P/E ratios in the main board is currently at a historically low level. Also, although historical data on the P/E ratios in GEM markets is less abundant and more undulate than those in the SME markets, we can still see that

2014-2018 is the golden age of the GEM board. Currently, it still has immense growth potential.

(ii). Based on the different characteristics of the GEM board and the main board, we should adopt different trading strategies in these two markets.

Regarding SME markets, since we have sufficient data to output a more appropriate valuation and the stability of mainboard P/E ratios, it is more suitable for long-term trading. By holding EFT products based on the main index for a long time, we can better avoid currency depreciation caused by inflation.

The GEM board's high volatility and growth potential tailor it to a qualified object of short - and medium-term investments. It is advisable to continuously track the median P/E ratios and trade follow a buy-the-dips, sell-the-rallies strategy.

Problem3

Here, we list the data we get and the corresponding time series figures (Figure 5 6); the unit of the vertical axis is a percentage.

Companies consistently surpass the median

Year		**2011**	**2012**	**2013**	**2014**	**2015**
ROE	Number of companies	1041	823	685.00	597	515
	Percentage	50.90%	40.24%	33.50%	29.19%	25.18%
Growth rate	Number of companies	1023	489	360	266	193
	Percentage	50.02%	23.91%	17.60%	13.01%	9.44%
Year		**2016**	**2017**	**2018**	**2019**	**2020**
ROE	Number of companies	448.00	390.00	334	293	242
	Percentage	21.91%	19.07%	16.33%	14.33%	11.83%
Growth rate	Number of companies	133	82	57	34	26
	Percentage	6.50%	4.01%	2.79%	1.66%	1.27%

We can see that the resulting time series plots are decaying over time, strictly satisfying

the construction requirements.

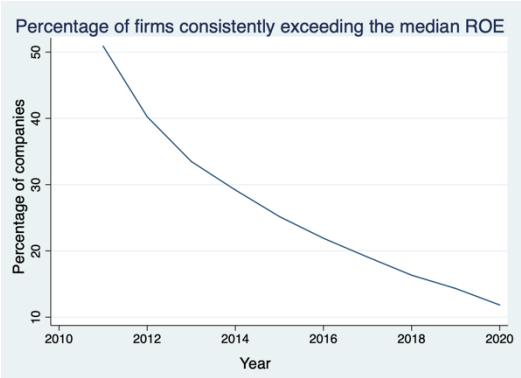

Figure 5

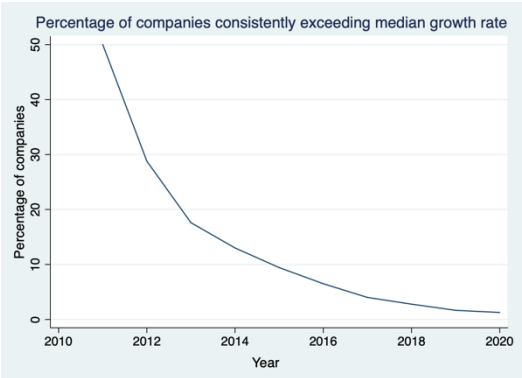

Figure 6