Research Application on Price-Earnings (P/E) Ratio

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Price-to-Earnings (P/E) Ratio is one of the most popular and important fundamental valuation tools and widely used to describe a company. P/E ratio divides the overall market value of a company (its market price) by the income flow (earnings) that the company generates. The market price is often a snapshot of stock value, whereas the earnings are usually a measure of net income, which is a flow value over a period of time). A higher P/E ratio means that investors are paying more for each unit of net income, so the stock is more expensive compared to one with lower P/E ratio.

P/E ratio generated a lot of research among both academics and industry practitioners. Academic researchers have interpreted P/E as an earnings growth indicator (Litzenberger and Rao, 1971), a risk measure (Ball, 1978), returns predictor (Basu, 1977; Shiller, 1996, 2005) as well as an indicator of transitory earnings (Beaver and Morse, 1978; Ou and Penman, 1989). Industry practitioners often talk about "multiples" as they use P/E ratio as an important valuation tool. For instance, analysts and investors like to compare P/E ratios against the broad market or against similar companies to derive relative firm valuations or to identify under and overvalued stocks (Welch, 2009; The Washington Times, 2009).

The purpose of this application is to provide WRDS users with a sample methodology and a SAS code for calculating various types of P/E ratios at the firm level as well as demonstrate different approaches in aggregating the P/E ratios (by computing aggregate P/E for the popular S&P 500 index as well as a number of S&P sector indexes based on their individual constituents). The application can be both used as a practical teaching tool to compliment the classroom theoretical exposition of P/E ratio and as a research tool for users interested in details of the algorithm behind computation of both firm-specific as well as index-based P/E ratios and various P/E methodologies.

Versions of P/E ratios calculated in the application are the following:

1. **P/E, Trailing Twelve months** (PE_tt12m), is defined as the market value of the company at the end of the quarter divided by the net income of the firm for the most recent 12 month (four quarter) period. It is the one most often cited in newspapers and other stock tables. This measure of earnings, often based on the past 12 months, has the disadvantage of looking backward while the stock market is often looking forward, trying to predict future trends.

2. **Unlevered P/E, Trailing Twelve months** (unlevered_PE_tt12m)

$$Unlevered\_PE\_tt12m = \frac{Market\ Value_{i,t}/(1-\frac{D_{i,t}}{D_{i,t}+E_{i,t}})}{\sum_{j=0}^{11}(Earnings_{i,t-j}+Interest\ Expense_{i,t-j})}$$

   Since P/E is higher when the firm has lower leverage, to ensure that P/E ratios of companies with different leverage are comparable analysts often calculate unlevered P/E ratio, which adjusts P/E ratios by undoing the effect of leverage (Leibowitz, 2002). Calculation of unlevered P/E is an approximation, since it assumes no taxes (which should be subtracted from the firm value while computing unlevered P/E). Besides, this P/E formula also assumes that the firm continues forever and perpetuity formula can be applied (see more in Welch, 2009)

3. **The "Shiller" P/E ratio** (PE10y), aka Cyclically-Adjusted Price Earnings Ratio (CAPE) or "Normalized P/E Ratio", is a long-term version of P/E, which is calculated as the ratio of the inflation-adjusted market value at the end of a given period over the prior long-run (e.g., ten-year) trailing mean of inflation-adjusted earnings. The main intuition behind the use of this measure is that it smoothes out the extreme peaks and valleys in earnings, giving a better framework for thinking about future earnings power. For example, Shiller P/E ratio is less susceptible to being thrown out of line by the depressed earnings that are sometimes reported as the economy is emerging from a recession.

4. **"Forward" P/E ratio** (PE_forward) – this measure uses consensus analyst forecast of earnings over the next year instead of net income. The primary advantage of this P/E version is that it, arguably, does a better job aligning the price (the discounted value of future income stream) with the forward-looking measure of earnings (such as analyst consensus forecast) as opposed to backward-looking, already reported, earnings that are no guarantee for the future earnings. However, this measure may be sensitive to analyst forecasts bias (Das et al., 1998) and analyst herding (Trueman, 1994).

For "Earnings" in the denominator of P/E users can choose whether they want to use net income including (NIQ) or excluding (IBQ) the effect of extraordinary items and discontinued operations. This can be done by setting the value of macro variable INCOME at the top of the program . In all P/E definitions, the application uses the market value of the firm as of the EAD (earnings announcement date), when available. This should incorporate the market reaction to the most recent earnings, potentially aligning it better with the denominator in P/E. Whenever the firm value (as of EAD) is missing, the market value as of the calendar date of fiscal period end is used (prccq*cshoq).

To link Compustat GVKEY with IBES Ticker the application uses a two-step approach. First, it uses a header map between GVKEY and IBES Ticker provided in Compustat Security table (IBTIC variable). This approach yield 11,869 distinct GVKEYs with IBES Ticker match, but still leaves 17,889 GVKEYs without matched IBES ticker (using mid 2010 vintages of IBES and Compustat). For those GVKEYs that have missing IBTIC in Compustat and a valid PERMNO (12,225 GVKEYs), the existing link is supplemented with additional historical GVKEY-IBES ticker links (7,142 additional GVKEY-IBES Ticker matches) obtained by, first, merging the rest of GVKEYS with PERMNOs on a historical basis using CRSP-Compustat Merged Database (CCMXPF_linktable in /wrds/crsp/sasdata/cc/) and, second, by bringing in additional IBES Tickers from the IBES-PERMNO link (that can be built using WRDS ICLINK application, you can find it here (/wrds/research/applications/linking/IBES_and_CRSP/)).

Once the map between Compustat and IBES Ticker is constructed, to calculate forward P/E ratio at the firm level, we use adjusted summary history table in IBES (STATSUM in /wrds/ibes/sasdata) for the purpose of identifying consensus forecasts of company's future EPS. Every "GVKEY-DATADATE" pair is matched with the latest annual EPS consensus forecast which falls between the calendar date of the fiscal period end (DATADATE) and EAD (RDQ) and has Forecast Period Indicator FPI='2' (the latter ensures that the earnings forecast is for the subsequent fiscal year rather than FOR the current one). Consensus EPS forecast is carried forward in time until either there is a new EPS consensus forecast for the company meeting the criteria above or at least 15 months elapsed since the moment the latest available consensus was calculated by IBES (the latter requirement is to ensure that stale EPS consensus forecasts are not carried forward). If more than 15 months elapsed since the consensus format date and there is no new annual consensus, then forecast is set to missing.

Averaging P/E Ratios

Now that the firm-level versions of P/E are calculated, the next task is to calculate P/E for the market and various sectors. The application uses the popular S&P 500 index as well as ten S&P 500 sectors, historical constituents of which can be found in IDXCST_HIS table in /wrds/comp/sasdata/na/index/ directory on the WRDS server. In doing so, it is important to keep in mind that P/E ratio behaves as 1/X function which is discontinuous at zero and very steep when the denominator is close to zero.

This creates serious issues when one tries to average P/E ratios across a large number of firms (say, calculate P/E ratio for S&P 500 or other composite/sector indices). Generally speaking, simple averaging can lead to disastrous estimates as it overlooks the fact that earnings can be (temporarily) zero, close to zero, or negative, which can totally mess up any P/E-based analysis, including P/E aggregation exercise. In such situations the price-to-earnings ratio is often void meaning, whereas the earnings-to-price ratio (earnings yield) can take negative values and remains meaningful. Strictly speaking, although neither P/E ratios nor E/P yields can be formally value-weighted or averaged, for a lack of better alternative, averaging is still often performed. At the end of the day, there is no entirely satisfactory method to fix 1/X problem, however, there is a number of common procedures that attempt to deal with it.

The WRDS P/E Research application applies several methods that can help alleviate (albeit, not fix) "1/X" issue mentioned above used by researchers before (Welch, 2009). None of these methods is perfect and each has its own pitfalls; they primarily aim to help avoid the problem of excessive influence of a small number of negative (or small) earnings firm included in the average. Ultimately, the judgment on the part of researcher is required when interpreting the results of aggregated P/E values as they can never be taken literally. Methods mentioned below may help only if a very few among firms have negative earnings. If this is not the case, it is better not to use the P/E ratios in the first place (see more on this in this Businessweek article (http://www.businessweek.com/investor/content/jul2008/pi20080718_837276.htm)). The used aggregation methods are as follows:

Method 1 uses median, rather than the mean in aggregation. Median P/E is unlikely to be based on negative earnings firm.

Method 2 ignores non-positive earnings firms. This seems to be the common industry practice, though, as Welch (2009) points out, when this approach is used "a small change in the earnings of just one comparable could still have a very large impact on your comparables valuation due to arbitrary inclusion/exclusion of comparables (rather than closeness of earnings to zero).

Method 3 averages E/P yields and then inverts the average E/P to arrive at the aggregate P/E ratio. It helps avoid 1/X problem since earnings yield is guaranteed to have a positive denominator.

Method 4 works with sums. In other words, for all firms in, say, S&P 500 index, the overall market value is calculated and divided by the total earnings of S&P 500 constituents. The potential drawback of this approach is that firms are essentially weighted by their relative market valuation with larger firms influencing the outcome more than smaller firms. Due to the lack of data on forecasted earnings (the numerator in the EPS forecast), the application does not use this method for the forward P/E ratio.

The program performs the averaging exercise using constituents of S&P 500 and member of ten S&P 500 sectors. Datasets containing the "average" P/E ratios have the following name structure:

<Type of P/E ratio>_<Name of S&P 500 sector in Compustat>

For instance, PE10y _Financials contains Shiller P/E ratio for S&P500 Financials sector for all 4 aggregation methods (1 being median to 4 being "sums" approach). The program is presented below:

```
/* ************************************************************************** */
/* ************* W R D S   R E S E A R C H   A P P L I C A T I O N S ************* */
/* ************************************************************************** */
/**************************************************************************** */
/*Program      : PE.sas                                                       */
/*Author       : Denys Glushkov, WRDS                                         */
/*Date Created : Oct 2010, Last Modified: Sep 2011                            */
/*Last Modified: Oct 2010                                                     */
/*Location     : /wrds/comp/samples                                           */
/*                                                                            */
/*Input  : Specify beginning (BEGINDATE) and ending (ENDDATE) for             */
/*         sample dates for P/E rati calculation, type of Compustat income variable  */
/*        (macro variable INCOME) to be used (IBQ - excluding extraordinary items or */
/*         NI - including extraordinary items)                                */
/*         The horizon for long-term P/E ratio (PY) - number of past years over */
/*         which income will be averaged)                                     */
/*                                                                            */
/*Output : The program calculates 4 types of P/E ratios:                      */
/*         a) Trailing 12 months (PE_tt12m)                                   */
/*         b) Shiller's long-term P/E (PE10y)                                 */
/*         c) Unlevered P/E (PE_Unlevered)                                    */
/*         d) Forward-looking P/E (PE_forward)                                */
/*                                                                            */
/*         Values of P/E ratios will be stored in the datasets with respective names */
/*         P/E ratios are calculated both at the firm level as well as for S&P 500   */
```

```
/*         Index and major ten S&P 500 sectors.                                */
/*                                                                             */
/*         Firm-specific P/E ratios  are aggregated using 4 different methods  */
/*         1) Median                                                           */
/*         2) Mean of positive-only P/E ratios                                 */
/*         3) Inverted Mean Earning Yield (EY)                                 */
/*         4) Total Market Value/Total Earnings                                */
/*                                                                             */
/* Examples of output datasets:                                                */
/* PE_tt12m_Financials contains trailing 12 months P/E for S&P500 Financials sector  */
/* PE_PE10y_CompLtd contains Shiller P/E ratio for S&P 500 Composite Index     */
/* PE_Forward_Energy contains Forward P/E ratio for S&P 500 Energy Sector      */
/*                                                                             */
/* Numbers at the end of variable name in a dataset refer to the method used for P/E */
/* aggregation within the index                                                */
/*  E.g., PE_tt12m_heathcare3 variable in PE_tt12m_Healthcare file is aggregate P/E  */
/*  for S&P 500 HealthCare sector calculated using inverted E/P yield method   */
/*                                                                             */
/*                                                                             */
/*IMPORTANT : To be able to run the program, a user should have access to CRSP,      */
/*            Compustat, CRSP-Compustat Merged and IBES                        */
/*******************************************************************************/

libname home '~'; /*home directory*/

%let begindate=01jan1950; /* start calendar date of fiscal period end               */
%let enddate=30jun2011;   /* end calendar date of fiscal period end                 */
%let income=ibq;          /* use Income Before Extraordinary Items                  */
%let PY=10;               /* years to go back in calculating long-term Shiller's P/E */
%let Comp=Compq;          /* Annual or Monthly updates for Compustat data           */
%let Crsp=Crspq;          /* Annual or Quarterly updates for CRSP data              */

/*Retrieve basic fundamental data from Compustat Quarterly  */
/*Unlevered Earnings=Earnings+Interest Expense (Welch, 2009)*/
data Comp_Earnings; set &Comp..Fundq;
  where "&begindate"d<=datadate<="&enddate"d and consol='C'
        and popsrc='D' and indfmt='INDL' and datafmt='STD';
  keep gvkey ajexq niq ibq xiq xintq dlttq rdq saleq atq prccq cshoq conm
       cshoq_adj fyearq fqtr datadate fyr epsx12 mcap prccq_adj
       unlevered_&income leverage rdq_new;
  mcap=abs(prccq*cshoq);
  prccq_adj=abs(prccq/ajexq);cshoq_adj=abs(cshoq*ajexq);
  unlevered_&income=sum(&income,xintq);leverage=(dlttq/atq);
  /* if RDQ is missing, assume earnings become public */
  /* 45 days following the fiscal year end            */
  rdq_new=coalesce(rdq, intnx('day',datadate,45));
  format rdq_new date9.;
run;

/* Determine the closest trading date following a known or an imputed EAD*/
proc sql;
 create view Eads as select distinct rdq_new from comp_earnings;
 create view Close_Trade_Date
  as select a.*, b.date as close_trade_day format=date9.
  from eads a left join
  (select distinct date from &Crsp..dsi where "&begindate"d<=date<="&enddate"d) b
  on b.date-a.rdq_new>=0
  group by rdq_new
  having (b.date-a.rdq_new)=min(b.date-a.rdq_new);

/* Supplement missing market values from Compustat Security Monthly           */
/* Calculate market values as of the end of the month of earnings announcement */
/* as it includes price response to the most recent earnings announcement      */
 create table Comp_Earnings (drop=close_trade_day)
  as select a.*, coalesce(b.prccd*a.cshoq,mcap) as mcap_final,
  (b.prccd/b.ajexdi) as prccd_adj
  from (select c.*, d.close_trade_day from Comp_Earnings c
        left join Close_Trade_Date d on c.rdq_new=d.rdq_new) a
  left join
  &Comp..Sec_Dprc (keep=gvkey iid datadate prccd ajexdi where=(iid='01')) b
  on a.gvkey=b.gvkey and a.close_trade_day=b.datadate;
quit;

/*Merge in CRSP identifiers. Needed later to merge GVKEY with IBES Ticker*/
proc sql;
 create view Crsp_IDs
  as select a.*, b.lpermno as permno, b.lpermco as permco
  from Comp_Earnings a left join &Crsp..Ccmxpf_Linktable b
  on a.gvkey=b.gvkey and (b.linkdt<=a.rdq_new<=b.linkenddt
     or (b.linkdt<=a.rdq_new and missing(b.linkenddt)))
    and b.usedflag=1 and b.linkprim in ('P','C')
  group by a.gvkey, datadate, permno
  having fyearq=min(fyearq);

/*If firm has duplicate gvkey-datadate observations due the fiscal year change  */
/*keep the record with the latest fiscal quarter for a given gvkey-datadate pair*/
 create table Comp_Earnings
  as select a.*, b.ibtic
  from Crsp_IDs a left join
  (select distinct gvkey, ibtic from &Comp..Security
  where not missing(ibtic) and iid='01') b
  on a.gvkey=b.gvkey
  group by a.gvkey, a.datadate
  having fqtr=max(fqtr)
 order by a.gvkey, a.datadate;
quit;

/*Sanity check: are there duplicate gvkey-datadate observations*/
/*should be zero duplicates                                    */
proc sort data=Comp_Earnings nodupkey; by gvkey datadate;run;

/*CRSP-IBES link  table */
%iclink;
```

```
/*which firms have permnos, but have no matching IBES ticker*/
data Noticker/view=noticker; set Comp_Earnings;
 where not missing(permno) and missing(ibtic);
 drop ibtic;
run;
/*link in additional IBES ticker-PERMNO  matches*/
proc sort data=Home.Iclink (where=(score in (0,1))) out=Ibeslink;
 by permno ticker score;
run;
data Ibeslink; set Ibeslink;
 by permno ticker; if first.permno;
run;
proc sql; create table Noticker1
 as select a.*, b.ticker as ibtic
 from Noticker a left join Ibeslink b
 on a.permno=b.permno
 order by gvkey, datadate;
quit;

/*append the additional GVKEY-IBES Ticker links*/
data Comp_Earnings; set Comp_Earnings
(where=(missing(permno) or not missing(ibtic))) Noticker1;
 unlevered_mcap=mcap_final/(1-leverage);
 if unlevered_mcap<0 then unlevered_mcap=.;
 label ibtic='IBES Ticker';
 drop leverage ajexq dlttq xintq;
run;

/*Bring in closest available analyst consensus estimate */
/*for future EPS before earnings announcement           */
proc sql; create view Forecasts
 as select a.*, b.statpers, b.numest, b.medest, b.meanest, b.fpedats
 from Comp_Earnings a left join
  (select ticker, statpers, numest, medest, meanest, anndats_act, fpedats, fpi
   from Ibes.Statsum_EpsUS
   where fiscalp='ANN' and fpi='2' and statpers=min(statpers, anndats_act)) b
 on a.ibtic=b.ticker and a.datadate < b.statpers <=a.rdq_new
 group by gvkey,datadate
 having statpers=max(statpers) /*this would pick the consensus to closest to EAD*/
 order by gvkey, datadate;
quit;

/*Push the available consensus forecasts forward until either the next one is*/
/*available or 15 months have passed, whichever happens first                */
/*15 months is based on the average forward duration of issued forecasts     */
data Comp_Earnings_Ibes; set Forecasts;
 by gvkey datadate;
  retain statpers1 numest1 medest1 meanest1 fpedats1;
  if first.gvkey or not missing(statpers) then do;
  statpers1=statpers; numest1=numest; medest1=medest;
  meanest1=meanest; fpedats1=fpedats;end;
  statpers=statpers1; numest=numest1; medest=medest1;
  meanest=meanest1; fpedats=fpedats1;
  if intck('month',statpers, datadate)>15 then do;
  statpers=.;fpedats=.;medest=.;meanest=.;numest=.;end;
 drop statpers1 numest1 medest1 meanest1 fpedats1;
run;

/*Adjusting "P" and "E" Components of P/E Ratio for Inflation as in Shiller(2005) */
/*CRSP CPI data has more history compared to Compustat (the latter starts in 1981)*/
proc sql; create table Final
 as select a.*, b.cpiind/100 as cpi,
(a.&income/(b.cpiind/100)) as &income._infladj label='Inflation-Adjusted Earnings',
(a.mcap_final/(b.cpiind/100)) as mcap_infladj label='Inflation-Adjusted Market Value'
 from Comp_Earnings_Ibes a left join &Crsp..Mcti (keep=caldt cpiind) b
 on put(a.rdq_new, yymmn.)=put(b.caldt, yymmn.)
 order by a.gvkey, a.datadate;
quit;

/* Sanity check: should be no duplicates before proc expand is run*/
proc sort data=Final nodupkey; by gvkey datadate;run;

/*Calculate Trailing-Twelve Months Earnings                */
/*Nomiss ensures that 4 non-missing income numbers are used*/
proc printto log=junk;run;
proc expand data=Final out=Final method=none;
 by gvkey; id datadate;
 convert &income=&income._tt12m/
         transformout=(nomiss movsum 4 trimleft 3);
 convert unlevered_&income=unlevered_&income._tt12m/
         transformout=(nomiss movsum 4 trimleft 3);
 convert &income._infladj=&income._infladj_tt12m/
         transformout=(nomiss movsum 4 trimleft 3);
quit;

/* Sorting ensures that seasonal averaging is performed      */
proc sort data=Final; by gvkey fqtr datadate;run;

/* Averaging "Trailing 12 months" earnings for Shiller's P/E */
proc expand data=Final out=Ready_For_Ratios;
by gvkey fqtr; id datadate;
convert &income._infladj_tt12m=&income.&py.y/
        transformout=(nomiss movave &py trimleft %eval(&py-1)) method=none;
quit;
proc printto;run;

proc sort data=Ready_For_Ratios; by gvkey datadate;run;

/*now calculating different types of P/E Ratios at the firm level:*/
/* 1) Shiller Long-Term P/E Ratios                                */
/* 2) P/E ratio,TTM                                               */
/* 3) Levered vs Unlevered PE                                     */
/* 4) Forward looking P/E, Analyst-Based                          */
data PEs/view=PEs; set Ready_For_Ratios;
```

```
 if missing(prccd_adj) then prc_adj=prccq_adj; else prc_adj=prccd_adj;
 pe&py.y=mcap_infladj/&income.&py.y;
 ey&py.y=&income.&py.y/mcap_infladj;
 pe_tt12m=mcap_final/&income._tt12m;
 ey_tt12m=&income._tt12m/mcap_final;
 pe_unlevered=unlevered_mcap/unlevered_&income._tt12m;
 ey_unlevered=unlevered_&income._tt12m/unlevered_mcap;
 pe_forward=prc_adj/medest;
 ey_forward=medest/prc_adj;
 label pe&py.y="Shiller's Long-Term P/E"
       ey&py.y="Shiller's Long-Term Earnings Yield"
       pe_tt12m='P/E, trailing 12 months'
       ey_tt12m='Earnings Yield, trailing 12 months'
       pe_unlevered='Unlevered P/E, trailing 12 months'
       ey_unlevered='Unlevered Earnings Yield, trailing 12 months'
       pe_forward='Forward P/E'
       ey_forward='Forward Earnings Yield';
 format pe&py.y best6. ey&py.y best12. pe_tt12m best6. ey_tt12m best12. rdq date9.
        rdq_new date9. pe_unlevered best6. ey_unlevered best12. pe_forward best6.
    ey_forward best12.;
 keep   gvkey datadate conm rdq rdq_new fyearq fqtr pe&py.y ey&py.y pe_tt12m
        &income._tt12m ey_tt12m pe_unlevered ey_unlevered pe_forward ey_forward
    mcap_infladj mcap_final unlevered_mcap permno unlevered_&income._tt12m
    unlevered_mcap &income.&py.y &income._infladj_tt12m;
run;

/*Example: P/E ratios for S&P sector composite indexes*/
/*Constituents of S&P 500 sectors and S&P 500 index   */
proc sql;
 create table SP_Sectors
 (where=((index(conm,'500')>0 and index(conm,'1500')=0
 and index(conm,'.S')>0 and index(conm,'.SI')=0) or gvkeyx='000003'))
 as select distinct a.gvkeyx, a.gvkey, a.from format=date9., b.conm,
 coalesce(a.thru, .E) as thru format=date9.
 from &Comp..Idxcst_his a left join &Comp..Idx_Index b
 on a.gvkeyx=b.gvkeyx
 order by a.gvkeyx, a.from;

 create table PE_Ratios
 as select a.*, b.conm as index_name, b.gvkeyx,
 year(datadate)*100+qtr(datadate) as yearqq, qtr(datadate) as qtr
 from PEs a left join SP_Sectors b
 on a.gvkey=b.gvkey and
 (b.from<=a.datadate<=b.thru or (b.from<=a.datadate and b.thru=.E))
 order by yearqq, gvkeyx, gvkey;
quit;

/*Define percentiles for P/E ratios for handling outliers later*/
proc rank data=PE_Ratios out=PE_Ratios groups=100;
 by yearqq;
 var pe&py.y pe_tt12m pe_unlevered pe_forward
     ey&py.y ey_tt12m ey_unlevered ey_forward;
 ranks pe&py.y_rank pe_tt12m_rank pe_unlevered_rank pe_forward_rank
       ey&py.y_rank ey_tt12m_rank ey_unlevered_rank ey_forward_rank;
 run;

/*Extracting forecast for S&P 500 earnings*/
data EPS_SP500; set Ibes.StatSum_epsus;
 where ticker='SAP5'; *IBES ticker for S&P 500;
  if measure='EPS' and fiscalp='ANN' and fpi='1'
  and "&begindate"d<=statpers<="&enddate"d;
 keep ticker statpers medest meanest numest;
run;

/*Prepare for aggregation of firm-specific P/E's for different indexes*/
%let ratios=PE&py.y PE_tt12m PE_unlevered PE_forward;
%let eys=EY&py.y EY_tt12m EY_unlevered EY_forward;
%let numerator=&income._infladj_tt12m &income._tt12m unlevered_&income._tt12m;
%let denominator=mcap_infladj mcap_final unlevered_mcap;

/*Store S&P index gvkeys in a separate macro variable "indexes"*/
/*Store S&P index names in a separate macro variable "indnames"*/
proc sql noprint;
select distinct gvkeyx into: indexes separated by " " from pe_ratios ;
select distinct
compress(compress(substr(conm,index(conm,'500')+4, index(conm,'.')-
    index(conm,'500')-4), " "),"-") into: indnames separated by ' ' from sp_sectors;
quit;

/*Various methods of aggregating firm-level P/E Ratios to alleviate 1/X issue     */
/* 1) Median                                                                      */
/* 2) Omitting firms with negative P/E and taking the mean                        */
/* 3) Invert Aggregate Earnings yield (E/P)                                       */
/* 4) Divide aggregate market value by aggregate earnings                         */
proc printto log=junk;run;
%macro PE_Tables;
%do i=1 %to %nwords(&ratios);
 %let ratio=%scan(&ratios, &i, %str(' '));
 %let ey=%scan(&eys, &i, %str(' '));
 %let earn=%scan(&numerator, &i, %str(' '));
 %let value=%scan(&denominator, &i, %str(' '));

 proc sql; create table &Ratio
 as select distinct yearqq from pe_ratios order by yearqq;
 quit;

  %do j=1 %to %nwords(&indexes);
   %let index=%scan(&indexes,&j, %str(' '));
   %let indname=%scan(&indnames,&j, %str(' '));

 /*Method 1: Taking the median P/E for an index*/
 proc means data=PE_Ratios noprint;
  where gvkeyx="&index";
  by yearqq; var : id datadate;
```

```
 output out=&Ratio._Method1 median=&ratio._&indname.1;
run;

/*Remove firm-level outliers in P/E values*/
data PE_Ratios1/view=PE_Ratios1; set PE_Ratios;
if &ratio._rank in (98,99) then &ratio=.;
if &ey._rank in (0,1) then &ey=.;
run;

/*Method 2: Ignore Non-Positive Earnings firms*/
proc means data=PE_Ratios1 noprint;
 where gvkeyx="&index" and &ratio>0;
 by yearqq; var &
 output out=&Ratio._Method2 mean=&ratio._&indname.2;
run;

/* Method 3: aggregating earnings yield and then inverting*/
proc means data=PE_Ratios1 noprint;
 by yearqq; where gvkeyx="&index";
 var &ey;
 output out=EY mean=/autoname;
run;

data &Ratio._Method3; set EY;
 by yearqq;
 &ratio._&indname.3=1/&ey._mean;
 format &ratio._&indname.3 best5.;
 keep  _freq_ _type_ &ratio._&indname.3 yearqq;
run;

/*Method 4: Work with sums, add up all P's and all E's before aggregate P/E ratio*/
/*is calculated. Merge in forecasts of EPS for S&P 500 index from IBES           */
%if &index=000003 and &ratio=PE_forward %then %do;
 %let sums="";
 proc sql; create table &Ratio._Method4
  as select c.*, count(*) as _freq_, 1 as _type_,
  d.&ratio._&indname.4 format=best5. label="Forward P/E Ratio for &indname"
  from &Ratio c left join
    (select b.statpers, a.prccm/b.medest as pe_forward_&indname.4
    from &Comp..Idx_mth (where=(gvkeyx='000003')) a
  right join EPS_SP500 b on put(a.datadate, yymmn.)=put(b.statpers, yymmn.)
  group by put(a.datadate, yyq.) having statpers=max(statpers)) d
  on c.yearqq=year(d.statpers)*100+qtr(d.statpers)
  order by yearqq;
 quit;%end;
%else %do;

%if &ratio ne PE_forward %then %do;
proc means data=PE_Ratios noprint;
 where gvkeyx="&index"; id qtr;
 by yearqq;
 where nmiss(&earn, &value)=0;
 var &earn &value;
 output out=Sums sum=/autoname;
run;
%end;

/*Long-term average of total annual inflation-adjusted earnings for S&P sector indexes*/
%if &ratio=PE&py.y %then %do;
%let sums=sums1;
proc sort data=sums; by qtr yearqq;run;
proc expand data=Sums out=&Sums;
by qtr; id yearqq;
convert &income._infladj_tt12m_sum=&income.&py.y_&indname/
        transformout=(movave &py trimleft %eval(&py-1)) method=none;
run;quit;
proc sort data=&Sums; by yearqq qtr;run;
%end;%else %let sums=sums;

%if &ratio ne PE_forward %then %do;
proc sort data=&Sums; by yearqq;run;
  data &Ratio._Method4; set &Sums;
   &ratio._&indname.4=&value._sum/&earn._sum;
   format &ratio._&indname.4 best5.;
   keep &ratio._&indname.4  _type_ _freq_ yearqq;
 run;
proc sql; drop table &sums;quit;
%end;%end;

data &Ratio._&Indname; merge &Ratio (in=a)
 &Ratio._Method1 (drop=_type_ rename=(_freq_=N))
 &Ratio._Method2 (drop=_freq_ _type_)
 &Ratio._Method3 (drop=_freq_ _type_)
 &Ratio._Method4;
 by yearqq; format datadate yyq.;
 keep yearqq N datadate &ratio._&indname.1
 &ratio._&indname.2 &ratio._&indname.3 &ratio._&indname.4;
 Label N="Number of non-missing security records for index &indname"
       &ratio._&indname.1="Median P/E for &indname"
       &ratio._&indname.2="Mean P/E for &indname, Positive-only P/E included"
       &ratio._&indname.3="Mean P/E for &indname, Inverted Earnings Yield"
       &ratio._&indname.4="Mean P/E for &indname, Aggregate Earnings/Aggregate Value";
run;
%end;
proc sql; drop table &Ratio, &Ratio._Method1,&Ratio._Method2,
                     &Ratio._Method3,&Ratio._Method4, Sums;quit;
 %end;%mend;
%PE_Tables;
proc printto;run;

/*Plot some examples*/
/*Select the method: 1- for median; 2-for positive P/E only  */
/*                   3-for inverted E/P; 4- for Sums Approach*/
%let method1=2;%let method2=1;
```

```
%let vars1=pe&py.y_compltd&method1 pe_tt12m_compltd&method1
          pe_unlevered_compltd&method1 pe_forward_compltd&method1;
%let vars2=pe_tt12m_energy&method2
          pe_tt12m_financials&method2 pe_tt12m_informationtech&method2;

data Sample_Plot1; merge
 PE&py.y_compltd PE_tt12m_compltd PE_unlevered_compltd PE_forward_compltd;
 by yearqq; where datadate>='01jan1976'd;
 keep datadate &vars1;
 label pe&py.y_compltd&method1="Shillers Long-Term P/E"
       pe_tt12m_compltd&method1="P/E, Trailing 12 months"
       pe_unlevered_compltd&method1="Unlevered P/E, Trailing 12 months"
       pe_forward_compltd&method1="Forward P/E";
run;

/*Example 2: Median P/E for some industry sectors*/
data Sample_Plot2; merge
 PE_tt12m_energy PE_tt12m_financials PE_tt12m_informationtech;
 by yearqq;where datadate>='01jan1976'd;
 keep datadate &vars2;
run;

options nodate orientation=landscape;
ods pdf file="SP500_method&method1..pdf";
goptions device=pdfc; /* Plot Saved in Home Directory */
axis1 label=(angle=90 "Value of P/E");
axis2 label=("Year-Quarter");
symbol interpol=join w=4 l=1;
proc gplot data =Sample_Plot1;
 Title 'Various types of P/E Ratio for S&P 500 ("P/E>0" method)';
 plot (&vars1)*datadate /overlay legend vaxis=axis1 haxis=axis2;;
run;quit;
ods pdf close;
ods pdf file="SP500sectors_method&method2..pdf";
proc gplot data =Sample_Plot2;
 Title 'Mean P/E Ratio for sample S&P sectors';
 plot (&vars2)*datadate /overlay legend vaxis=axis1 haxis=axis2;;
run;quit;
ods pdf close;

/*House Cleaning*/
proc sql;
 drop view close_trade_date,comp_earnings1,eads,forecasts,pes,pe_ratios1;
 drop table comp_earnings,comp_earnings_ibes,dups,eps_sp500,ey,final,
            sample_plot1, sample_plot2, sp_sectors, ready_for_ratios;
quit;

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```
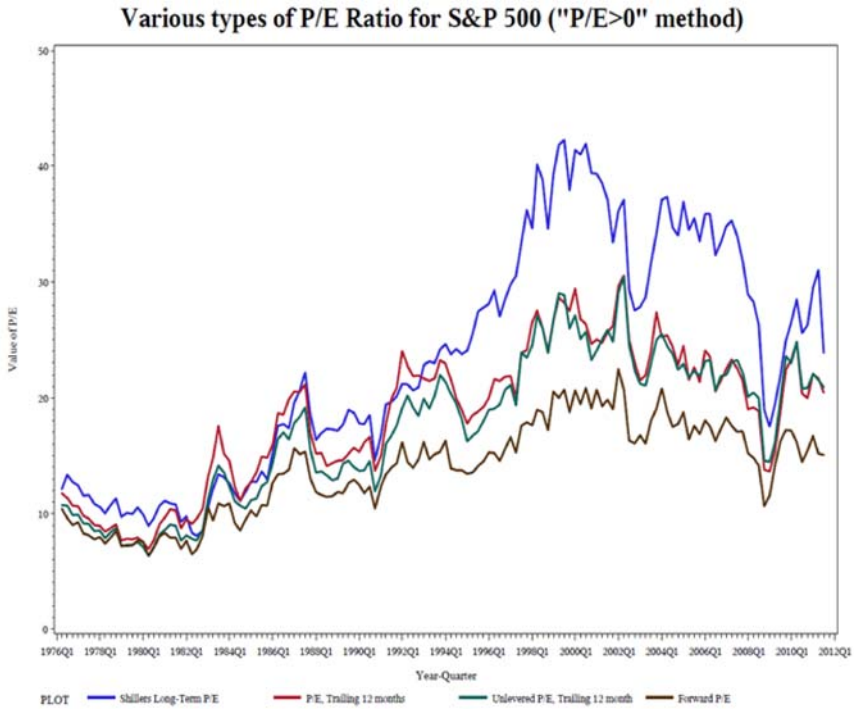
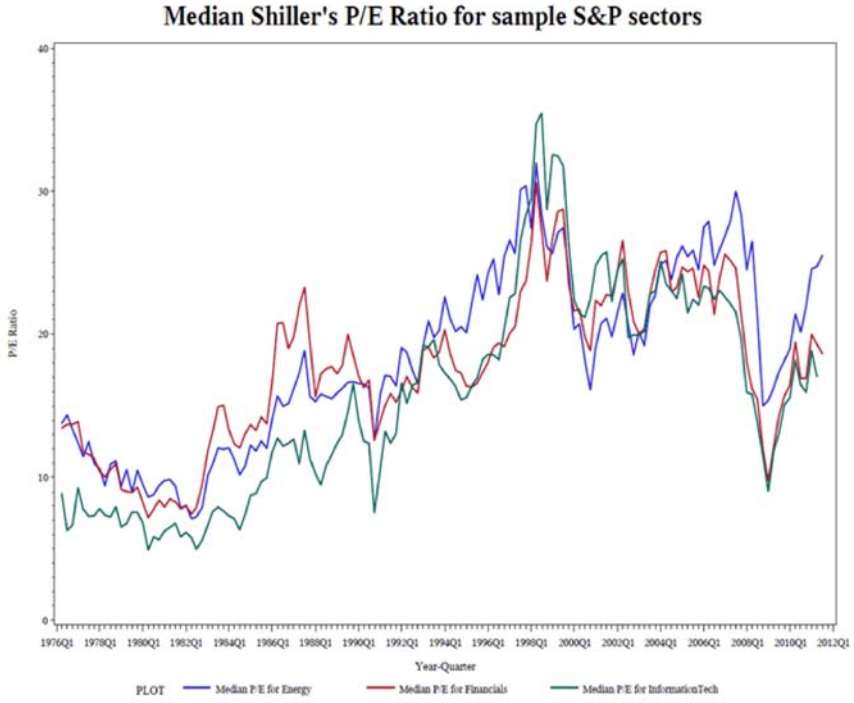

Results

Below are the few plots showing the Shiller P/E vs. P/E TT12M vs. Forward P/E at the quarterly frequency since 1976 using method 2 (i.e., removing negative P/E ratios when averaging):



This figure demonstrates the dynamics of the Shiller P/E ratio (computed using method 1) for 3 S&P 500 sectors, Energy, Information Technology and Financials at the quarterly frequency starting from 1976:



A spike in the valuations for the information technology around 1999-2000 (as well as the subsequent sharp drop) and the run-up in valuations for the energy sector around 2007-2008 followed by a dramatic decline are clearly seen in the plot above.

A simplified version of the P/E Research Application is also available (PE_COMP.SAS in /wrds/comp/samples). It relies only on Compustat data to compute all P/E versions mentioned above, except for forward P/E. The reason why forward P/E is excluded from the simplified version of the application is because, even though Compustat's header map between GVKEY and IBES Ticker IBTIC is quite extensive (total of 16,254 GVKEYs have non-missing IBES tickers as of Oct 2010 out of 37,237, roughly 44%), use of CRSP-Compustat Merged table (CCM) in combination with WRDS ICLINK program appears to add a substantial chunk of additional GVKEY-IBES Ticker links, increasing the number of valid GVKEY-IBES Ticker matches by approximately 50%. Therefore, using the PE.SAS code that relies on Compustat, IBES, CRSP and CCM databases provides a significantly greater coverage of firms for which forward P/E can be calculated.

References

Ball, R., 1978. "Anomalies in Relationships between Securities Yields and Yield-Surrogates", Journal of Financial Economics (June/September).

Basu, S., 1977. "Investment Performance of Common Stocks in Relation to their Price-Earnings Ratios: A Test of the Efficient Market Hypothesis", Journal of Finance, Vol. XXXII, No. 3, June.

Beaver, W.H., and Morse, D. 1978. "What determines Price-Earnings Ratios?", Financial Analysts Journal, July/Aug.

Das, S., Levine, C. and Sivaramakrishnan, K., 1998. "Earnings Predictability and Bias in Analysts' Earnings Forecasts", Accounting Review, Vol. 73, No. 2.

Litzenberger, R.H., and Rao, C.U., 1971. "Estimates of the Marginal Rate of Time Preference and Average Risk Aversion of Investors in Electric Utility Shares: 1960-1966", Bell Journal of Economics and Managerial Science, Spring.

Leibowitz, M., 2002. "Levered P/E Ratio", Financial Analysts Journal, Vol. 58, No. 6.

Ou, J. and Penman, S., 1989. "Accounting Measurement, Price-Earnings Ratio, and the Information Content of Security Prices", Journal of Accounting Research, Vol. 27.

Shiller, R., 1996. "Price-Earnings Ratios as Forecasters of Returns: Stock Market Outlook in 1996", available at http://www.econ.yale.edu/~shiller/data/peratio.html (http://www.econ.yale.edu/~shiller/data/peratio.html).

Shiller, R., 2005. "Irrational Exuberance", second edition, Crown Publishing Group.

Trueman, B., 1994. "Analyst Forecasts and Herding Behavior", Review of Financial Studies, Vol. 7, No.1.

Versace, Chris, 2009. "P/E ratios put stocks into context", The Washington Times, July 24.

Welch, I., 2009. "First Course in Finance", Preview 2004 Preview available at http://www.freeinfosociety.com/pdfs/misc/introtofinance.pdf (http://www.freeinfosociety.com/pdfs/misc/introtofinance.pdf).

Wikipedia, "P/E Ratio", available at http://en.wikipedia.org/wiki/P/E_ratio.

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