Appendix to *Financial Conditions and the Risks to Economic Growth in the United States Since 1875*

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Abstract

This online appendix contains further details on the data and some additional results.

1 Data Sources and Construction

The quarterly data used in this paper comes from FRED, the NBER Macrohistory database, Balke Gordon (1986), and Shiller (2000). Shiller continues reporting data beyond the publication date of his book on his website. See http://www.econ.yale.edu/ shiller/data.htm. For output growth, the term spread and the credit spread, no single source provides a series that spans the whole of 1875 - 2017. Below we outline the variables and our data sources for each of our four sub-samples, and an alternative sub-sample for our second era. We also outline the construction of our quarterly stock market volatility variable from Shiller's S&P index. Table A1 reports summary statistics and Figure A1 plots fitted marginal distributions (plotted as probability density functions, smoothed for illustration) from the ECDFs for our various measures of financial conditions for each era.

1.1 1875:1 - 1913:4

To measure output growth we use annualized one quarter and four quarter growth rates of real GNP. For this sub-sample we use the real GNP series from Balke and Gordon. The data reported in Balke and Gordon is seasonally unadjusted and so we first seasonally adjust in Matlab using a seasonal filter as outlined at https://www.mathworks.com/help/econ/seasonal-adjustment-using-snxd7m-seasonal-filters.html. For the term spread we use data collected from the NBER Macrohistory database. The long and short rates that we use are very similar to those reported by Balke and Gordon, and only differ in the fact that we use the last month of each quarter as the observation for that quarter, rather than the first month. This difference is continued in the construction of all quarterly term and credit spread series used in the paper and this appendix.

First we construct a quarterly Corporate Bond Yield to represent the long-term interest rate using Macaulay's (1938) Railroad Bond Yields Index which is based on all bonds having at least 10 years maturity (NBER Macrohistory database series M13019a). We then use the New York City Commercial Paper Rate from the NBER Macrohistory database (series M13002) to represent the short term interest rate. This is a 60-90 day rate from Macaulay (1938). Subtracting the Commercial Paper Rate from the Corporate Bond Yield gives a term spread. We also use data from the NBER Macrohistory database to construct a credit spread as the Yield on Railroad Bonds minus the Yield on High Grade Railway Bonds. Both of these series are originally from Macaulay (1938) and in the NBER Macrohistory database are M13019a and M13019 respectively. Finally, we use Shiller's S&P Composite Index to create a measure of stock market volatility. Using Shiller's monthly series we calculate the growth rate of the S&P index for each month as:

$$\Delta SPI_t = 100\left(\frac{SPI_t}{SPI_{t-1}} - 1\right) \tag{1}$$

Then, for each quarter, we measure stock market volatility as the standard deviation of ΔSPI_t over the three months of that quarter.

1.2 1919:1 - 1941:3

For output growth and the measure of stock market volatility we use the same sources that we use for our 1875:1 - 1913:4 sample. For the term spread we subtract the NBER Macrohistory database's New York City Commercial Paper Rate from a long-term corporate bond yield. As mentioned before, the Commercial Paper Rate reported in the NBER Macrohistory database is from Macaulay for 1875 to 1936. It is then computed from weekly data by the NBER from 1937 to 1942, and then taken from the Federal Reserve Board from 1943 to 1971. We follow Balke and Gordon (1986) for the choice of long-term corporate bond yield and use the yield on Moody's Baa rated bonds which we obtain from the FRED database (series BAA). For the credit spread we use the difference between the yields on Moody's Baa rated bonds and Moody's Aaa rated bonds (series AAA), both of which are taken from the FRED database.

1.2.1 1914:1 - 1945:4

In this appendix we also report results using an alternative timing for our second sub-sample to include both world wars. That is, 1914:1 to 1945:4. The source for the output growth data and our measure of stock market volatility are the same as for the 1919:1 to 1941:3 sub-sample. For the term spread we follow Balke and Gordon (1986) and use the Yield on Railway Bonds (until 1918:4) and the Moody's Baa Yield (from 1919:1) to represent the Long Term Corporate Bond Yield, and subtract the New York City Commercial Paper Rate from this.

We combine data from the NBER Macrohistory and FRED databases to construct a credit spread. The spread based on railway bond data can be extended to 1934:4 and therefore overlaps with the Baa - Aaa spread from 1919:1 to 1934:4. For this period of overlap the estimated correlation between the two series is 0.90. To create a single series for the credit spread we first scale the credit spread based on the Railway Bond Yields (X_t) for the period 1875:1 to 1918:4 according to:

$$x_t = \frac{X_t - \mu_{Railway}}{\sigma_{Railway}} \tag{2}$$

where $\mu_{Railway} = 0.4763$ and $\sigma_{Railway} = 0.3387$ are the mean and standard deviation of X_t for the period 1919:1 to 1934:4. We then scale x_t according to:

$$z_t = x_t * \sigma_{Moody's} + \mu_{Moody's} \tag{3}$$

where $\mu_{Moody's} = 2.0050$ and $\sigma_{Moody's} = 0.9911$ are the mean and standard deviation of the Baa - Aaa spread for 1919:1 to 1934:4. Finally, a single series is constructed using z_t for 1914:1 to 1918:4 and the Baa - Aaa spread from 1919:1 onwards.

1.3 1946:1 - 1971:2

For 1946:1 to 1971:2 we use the same sources as for 1919:1 to 1941:3 for all variables.

1.4 1971:3 - 2017:4

To measure output growth we use annualized one quarter and four quarter growth rates of real GNP constructed using data from the FRED database (series GNPC96). To construct the term spread we now use data from the FRED database. To be specific, we subtract the 3-Month Treasury Bill, Secondary Market Rate (series TB3MS) from the 10-Year Treasury Constant Maturity Rate (series GS10). For the credit spread and the measure of stock market volatility we use the same sources as for 1946:1 to 1971:2. We also use the Chicago Federal Reserve Bank's National Financial Conditions Index as a measure of financial conditions, taken from the FRED database (series NFCI).

2 Additional Results

2.1 Bandwidth Selection in Copula Estimation

When estimating our copula specifications with non-linear dependence we use a value of $h = 0.01$ as the kernel bandwidth used to smooth over $K = 500$ gridpoints. In this section we discuss bandwidth choice. Selecting a bandwidth that is too high can mean that the resulting density is over smoothed and so features of the underlying dependence between variables are hidden. On the other hand a value of h that is too low can lead to under smoothing and an estimated density that reflects noise in the data rather than the underlying dependence structure.

To explore this issue we performed an out of sample forecasting exercise based on our copula specification that uses ECDF marginals and allows for non-linear dependence. In this exercise we use data from our fourth subsample, namely 1971:3 to 2017:4. We begin by estimating the copula without financial conditions using data from 1971:3 to 1990:1 and then we use these estimates to predict output growth in 1990:2. We then expand the estimation sample one quarter, and estimate using data from 1971:2 to 1990:2 and use these new estimates to forecast 1990:3. We continue this recursive process to obtain out of sample forecasts for 1990:2 to 2017:4.

We repeat this exercise using a number of different values for h in our copula estimation. Table A2 presents root mean squared errors and KLIC based measures of predictive accuracy for out of sample forecasts for various bandwidth choices. For each alternative bandwidth these statistics are reported relative to the bandwidth choice of $h = 0.01$ that we employ in the main text. For the values of h from 0.001 to 1.28 we see very little difference in these measures of out of sample fit relative to our chosen value of $h = 0.01$. It is not until we lower the bandwidth to $h = 0.0001$ that we see the significant worsening of out of sample forecasting performance that we would associate with in sample overfitting. In addition, we do not see any significant improvement in fit when we use values of h above $h = 0.01$.

2.2 Alternative Interwar Period 1914:1 to 1945:4

In this appendix we report results for an alternative second sub-sample in which the years of the first and second world wars are included. Table A3 reports summary statistics for our output growth and financial conditions measures for 1914:1 to 1945:4. A comparison of the summary statistics for output growth in this table with those reported for 1919:1 to 1941:3 in Table A1 indicates that the inclusion of the data from the war years raises the mean growth rates by about one percentage points, but that the standard deviation, skewness and kurtosis are largely unchanged. The Shapiro-Wilk statistics continue to point to a rejection of normality. Similarly, the statistics for the measures of financial conditions are largely unchanged. Nevertheless, there is less evidence against normality for the term spread in this extended second sub-sample. Table A4 reports the in sample RMSE and KLIC based measures of fit. The results are very similar to those reported in Table 1 of the main text.

2.3 Alternative Measures of Financial Conditions

2.3.1 Assessing Predictive Content

Table A5 reports RMSE for all measures of financial conditions that we discuss. Table A6 performs the same task for our KLIC based measure of fit. In both cases we see results that are consistent with those reported in the paper for our preferred measures of financial conditions. That is, the addition of financial conditions in our specifications with non-linear dependence leads to a substantial improvement in in-sample fit.

2.3.2 Conditional Output Growth Densities

Figures A2 and A3 plot the means of the conditional distributions and the 5th and 95th percentiles using alternative measures of financial conditions from those reported in the paper. Figure A2 reports these objects for one quarter growth and Figure A3 does the same for four quarter growth. For the sub-sample 1875 to 1913 financial conditions are measured by the credit spread and stock market volatility. For the sub-sample 1919 to 1941 financial conditions are measured by the term spread and stock market volatility, and by the same two variables for the sub-sample 1946 to 1971. Finally for the modern era, 1971 - 2017, financial conditions are measured by the term spread, the credit spread and stock market volatility. The results in this appendix are consistent with those in the paper, that is, with the addition of a measure of financial conditions, the conditional mean of the distribution for output growth tracks the out-turn more closely.

2.3.3 Selected Financial Crises

Figure A4 shows predictive densities for the quarter and for the year following our four selected financial crises using alternative measures of financial conditions. For the 1893 crisis we see a similar conditional density for the credit spread and stock market volatility, with much more probability mass in the negative range of the distribution. For the two measures used in this appendix we see slightly less evidence of bi-modality at the one quarter horizon that we see for the term spread, but for the one year horizon there is much more evidence of bi-modality when we represent financial conditions by the credit spread or stock market volatility. For the 1907 crisis the addition of financial conditions leads to more pessimistic predictive density for the quarter after the crisis, but does not have much of an impact on the probability of negative growth in the year after the crisis. This is the case when using the term spread, and when using either the credit spread or stock market volatility. We see some evidence of bi-modality at the one year horizon in this appendix when we use stock market volatility, which is absent when we use the term spread. The addition of financial conditions continues to lead to a considerable increase in the probability of negative growth both in the quarter and the year after the 1929 stock market crash. Finally, for the 2008 crisis, we generally see a slight movement to the left of the predictive density with the addition of financial conditions. This is similar to the NFCI results reported in the paper.

2.4 Common Dependence Across Eras

In this appendix we report results based on era specific marginal distributions, either gaussian or non-gaussian, but common dependence, either linear or non-linear across all eras. Our use of era specific margins is motivated by the differences in the means and standard deviations of the data across eras. Table A6 reports the in sample RMSE and KLIC based measures of fit. As with the results reported in Table 1 of the main text we see gains in both measures of fit with the inclusion of financial conditions in the specifications that allow for non-linear dependence. However, these gains from adding financial conditions are not as great as those reported in the main text where we allow dependence to vary across eras.

2.5 Recursive RMSE and KLIC

In the main text we report RMSE and KLIC based measures of fit which indicate that the addition of a measure of financial conditions greatly improves in-sample fit in our preferred specification with ECDF marginals and non-linear dependence. In this appendix we plot recursively calculated RMSE and KLIC based measures in Figures A5 and A6. We do this for our baseline specification which uses Gaussian marginals and linear dependence, but not financial conditions, and compare this with our preferred specification which uses ECDF marginals and non-linear dependence. In this exercise we consider our preferred specification with and without financial conditions. These plots show that the recursive measures of fit are superior for our preferred specification with financial conditions throughout the various sub-samples. Furthermore, changes in relative performance across specifications tend to be relatively small and gradual, consistent with performance gains being robust to outliers.

References

Nathan S. Balke and Robert J. Gordon (1986) “Appendix B: Historical Data” in Robert J. Gordon ed. *The American Business Cycle: Continuity and Change* University of Chicago Press, Chicago.

Macaulay, Frederick R. (1938) *The Movement of Interest Rates, Bond Yields and Stock Prices in the United States Since 1856* NBER.

Shiller, Robert J. (2000) *Irrational Exhuberence*, Princeton University Press, Princeton.

Shimazaki, Hideaki and Chigger Shinomoto (2010) “Kernel Bandwidth Optimization in Spike Rate Estimation” *Journal of Computational Neuroscience* 29(1-2) pp171-182.

Table A1: Summary Statistics – Output Growth

1 Quarter Growth	1875:3-1913:4	1919:2-1941:3	1946:2-1971:2	1971:4-2017:4
Mean	4.08	2.75	3.31	2.77
Standard Deviation	8.43	12.5	4.47	3.22
Skewness	-0.37	-0.41	-0.51	-0.53
Kurtosis	5.34	2.70	4.61	5.67
Shapiro-Wilk p-value	< 0.001	0.133	0.011	< 0.001
4 Quarter Growth	1877:1-1913:4	1920:1-1941:3	1947:1-1971:2	1972:3-2017:4
Mean	4.26	2.81	3.51	2.80
Standard Deviation	6.02	9.07	3.12	2.22
Skewness	-0.23	-0.40	0.05	-0.52
Kurtosis	3.59	2.21	3.23	4.00
Shapiro-Wilk p-value	0.031	0.009	0.728	< 0.001
Term Spread	1875:1-1913:4	1919:1-1945:3	1946:1-1971:2	1971:3-2017:4
Mean	-0.27	3.22	1.38	1.72
Standard Deviation	1.23	1.85	0.80	1.27
Skewness	-0.21	0.20	0.38	-0.71
Kurtosis	3.26	2.33	4.05	3.41
Shapiro-Wilk p-value	0.424	0.089	0.022	< 0.001
Credit Spread	1875:1-1913:4	1919:1-1945:3	1946:1-1971:2	1971:3-2017:4
Mean	0.81	1.99	0.66	1.09
Standard Deviation	0.32	0.86	0.20	0.46
Skewness	0.56	1.64	1.42	1.82
Kurtosis	2.88	6.89	6.31	7.57
Shapiro-Wilk p-value	< 0.001	< 0.001	< 0.001	< 0.001
S&P Volatility	1875:1-1913:4	1919:1-1945:3	1946:1-1971:2	1971:3-2017:4
Mean	2.42	4.20	2.54	2.64
Standard Deviation	1.48	3.60	1.40	1.69
Skewness	1.45	2.71	0.87	1.04
Kurtosis	6.21	14.1	3.92	4.26
Shapiro-Wilk p-value	< 0.001	< 0.001	0.001	< 0.001
NFCI	1875:1-1913:4	1919:1-1945:3	1946:1-1971:2	1971:3-2017:4
Mean				0.013
Standard Deviation				0.99
Skewness				1.90
Kurtosis				6.15
Shapiro-Wilk p-value				< 0.001

Notes: (1) 1 quarter growth rates are reported at an annualized rate. (2) The Shapiro-Wilk p-value refers to a test of the null hypothesis that the variable is Gaussian distributed.

Table A2: Out of Sample Forecast Performance and Bandwidth

	Root Mean Squared Errors		KLIC Based Measure	
Bandwidth	1 Quarter Growth	4 Quarter Growth	1 Quarter Growth	4 Quarter Growth
$h = 0.0001$	1.759	1.790	5.251	5.270
$h = 0.001$	1.017	1.063	1.041	1.230
$h = 0.005$	1.007	1.029	1.007	1.027
$h = 0.01$	1.000	1.000	1.000	1.000
$h = 0.02$	0.993	0.967	0.995	0.983
$h = 0.04$	0.988	0.937	0.989	0.970
$h = 0.08$	0.990	0.929	0.985	0.961
$h = 0.16$	0.997	0.956	0.984	0.960
$h = 0.32$	1.006	1.004	0.986	0.964
$h = 0.64$	1.014	1.047	0.989	0.970
$h = 1.28$	1.022	1.071	0.991	0.974

Note: Root mean squared errors and KLIC based measure of fit are reported relative to the copula using a bandwidth of $h = 0.01$.

Table A3: Summary Statistics – Alternative Second Sub-Sample 1914:1 to 1945:4

	Mean	Standard Deviation	Skewness	Kurtosis	Shapiro-Wilk p-value	Number of Observations
1 Quarter Growth Rate	3.15	12.6	-0.51	2.84	0.011	127
4 Quarter Growth Rate	3.85	9.11	-0.38	2.25	0.002	124
Term Spread	2.74	1.93	0.14	2.63	0.728	128
Credit Spread	1.87	0.80	1.60	7.70	< 0.001	128
Stock Market Volatility	3.74	3.18	3.13	18.2	< 0.001	128

Notes: 1 Quarter growth rates are reported at an annualized rate. The Shapiro-Wilk p-value refers to a test of the null hypothesis that the variable is Gaussian distributed.

Table A4: Root Mean Square Error and KLIC-Based Measures of Predictive Accuracy For Alternative Sub-Sample

	Root Mean Squared Errors		KLIC Based Measure	
	1 Qtr Growth	4 Qtr Growth	1 Qtr Growth	4 Qtr Growth
	1914:2-1945:4	1915:1-1945:4	1914:2-1945:4	1915:1-1945:4
Gaussian Marginals and Linear Dependence				
No Financial Conditions	1.000	1.000	1.000	1.000
Term Spread	0.994	1.038*	0.998	1.001
Credit Spread	0.999	1.029	0.999	1.001
S&P Volatility	1.000	1.000	1.000	0.999
Non-Gaussian Marginals and Linear Dependence				
No Financial Conditions	1.001	0.883***	0.993*	0.965**
Term Spread	0.995	0.866***	0.991*	0.960***
Credit Spread	0.999	0.873***	0.992*	0.963**
S&P Volatility	1.001	0.881***	0.992*	0.964**
Gaussian Marginals and Non-linear Dependence				
No Financial Conditions	0.951*	0.857***	0.953***	0.939***
Term Spread	0.734***	0.635***	0.836***	0.822***
Credit Spread	0.753***	0.666***	0.847***	0.845***
S&P Volatility	0.713***	0.729***	0.863***	0.879***
Non-Gaussian Marginals and Non-linear Dependence				
No Financial Conditions	0.940**	0.862***	0.955***	0.938***
Term Spread	0.718***	0.586***	0.831***	0.803***
Credit Spread	0.679***	0.585***	0.830***	0.806***
S&P Volatility	0.598***	0.585***	0.819***	0.819***

Notes: (1) Root Mean Squared Errors are reported relative to the benchmark model with Gaussian marginals, linear dependence and no financial conditions. As a rough guide to statistical significance, p-values of a Harvey, Leybourne, and Newbold (1997) small-sample adjustment of the two-sided Diebold and Mariano (1995) test are denoted by $*$ ($< 10\%$), $**$ ($< 5\%$) and $***$ ($< 1\%$). (2) The KLIC based measures are average log scores relative to the benchmark model with Gaussian marginals, linear dependence and no financial conditions. As a rough guide to statistical significance, p-values of a two-sided Diebold-Mariano (1995) type test for the log score are denoted by $*$ ($< 10\%$), $**$ ($< 5\%$) and $***$ ($< 1\%$).

Table A5: Root Mean Square Errors

	1 Quarter Growth				4 Quarter Growth			
	1875:3-1913:4	1919:2-1941:3	1946:2-1971:2	1971:4-2017:4	1877:1-1913:4	1920:1-1941:3	1947:1-1971:2	1972:3-2017:4
Gaussian Marginals and Linear Dependence								
No Financial Conditions	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Term Spread	0.947*	0.998	0.985	0.989	0.884***	0.971	0.937*	0.920***
Credit Spread	0.998	1.002	1.001	0.996	0.985	0.988	0.999	1.001
S&P Volatility	0.994	0.999	0.979	0.988	0.998	1.003*	0.956*	0.996
Chicago Fed NFCI				0.956*				0.953*
Non-Gaussian Marginals and Linear Dependence								
No Financial Conditions	0.999	1.003	1.005	1.005	1.002	1.005	1.001	0.993
Term Spread	0.945*	1.002	0.993	0.997	0.887***	0.977	0.955	0.925***
Credit Spread	0.998	1.004	1.009	0.997	0.994	0.991	0.998	0.994
S&P Volatility	0.993	1.002	0.978	0.996	1.000	1.007	0.947	0.989
Chicago Fed NFCI				0.974				0.955**
Gaussian Marginals and Non-linear Dependence								
No Financial Conditions	0.982	0.928**	0.942**	0.988	0.963**	0.943*	0.875***	0.939***
Term Spread	0.784***	0.672***	0.758***	0.805***	0.628***	0.673***	0.713***	0.714***
Credit Spread	0.857***	0.669***	0.693***	0.822***	0.708***	0.724***	0.678***	0.808***
S&P Volatility	0.853***	0.698***	0.657***	0.824***	0.805***	0.762***	0.687***	0.807***
Chicago Fed NFCI				0.836***				0.691***
Non-Gaussian Marginals and Non-linear Dependence								
No Financial Conditions	0.969**	0.919**	0.955**	0.990	0.954**	0.950**	0.889**	0.936***
Term Spread	0.757***	0.632***	0.668***	0.764***	0.619***	0.623***	0.531***	0.684***
Credit Spread	0.802***	0.584***	0.665***	0.778***	0.621***	0.574***	0.577***	0.742***
S&P Volatility	0.753***	0.549***	0.624***	0.780***	0.733***	0.621***	0.569***	0.783***
Chicago Fed NFCI				0.752***				0.681***

Note: Root Mean Squared Errors are reported relative to the benchmark model with Gaussian marginals, linear dependence and no financial conditions. As a rough guide to statistical significance, p-values of a Harvey, Leybourne, and Newbold (1997) small-sample adjustment of the two-sided Diebold and Mariano (1995) test are denoted by $*$ (< 0.10), $**$ (< 0.05) and $***$ (< 0.01).

Table A6: KLIC-Based Measure of Predictive Accuracy

	1 Quarter Growth				4 Quarter Growth			
	1875:3-1913:4	1919:2-1941:3	1946:2-1971:2	1971:4-2017:4	1877:1-1913:4	1920:1-1941:3	1947:1-1971:2	1972:3-2017:4
Gaussian Marginals and Linear Dependence								
No Financial Conditions	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Term Spread	0.982**	1.000	0.995	0.996	0.969***	0.993	0.983	0.980**
Credit Spread	0.997*	1.000	0.999	1.000	0.996	0.998	1.000	1.000
S&P Volatility	0.998	1.000	0.993	0.994*	0.999	1.001**	0.989*	1.000
Chicago Fed NFCI				0.987**				0.987*
Non-Gaussian Marginals and Linear Dependence								
No Financial Conditions	0.980**	0.995	0.991	0.982**	0.991**	0.993	0.998	0.983***
Term Spread	0.967**	0.995	0.985**	0.980***	0.961***	0.986	0.986	0.968***
Credit Spread	0.979**	0.995	0.990*	0.980*	0.990**	0.990	0.998	0.984***
S&P Volatility	0.979**	0.995	0.982**	0.980**	0.991**	0.994	0.985*	0.983**
Chicago Fed NFCI				0.975***				0.976***
Gaussian Marginals and Non-linear Dependence								
No Financial Conditions	0.942***	0.942***	0.945***	0.993	0.943***	0.958***	0.957**	0.951***
Term Spread	0.804***	0.820***	0.812***	0.860***	0.809***	0.832***	0.862***	0.818***
Credit Spread	0.822***	0.830***	0.823***	0.891***	0.814***	0.869***	0.843***	0.848***
S&P Volatility	0.841***	0.845***	0.814***	0.866***	0.863***	0.876***	0.849***	0.840***
Chicago Fed NFCI				0.915***				0.860***
Non-Gaussian Marginals and Non-linear Dependence								
No Financial Conditions	0.935***	0.945***	0.949***	0.951***	0.939***	0.953***	0.934***	0.936***
Term Spread	0.794***	0.815***	0.796***	0.798***	0.802***	0.803***	0.781***	0.781***
Credit Spread	0.793***	0.809***	0.798***	0.800***	0.790***	0.809***	0.785***	0.807***
S&P Volatility	0.790***	0.805***	0.791***	0.801***	0.808***	0.812***	0.777***	0.802***
Chicago Fed NFCI				0.800***				0.804***

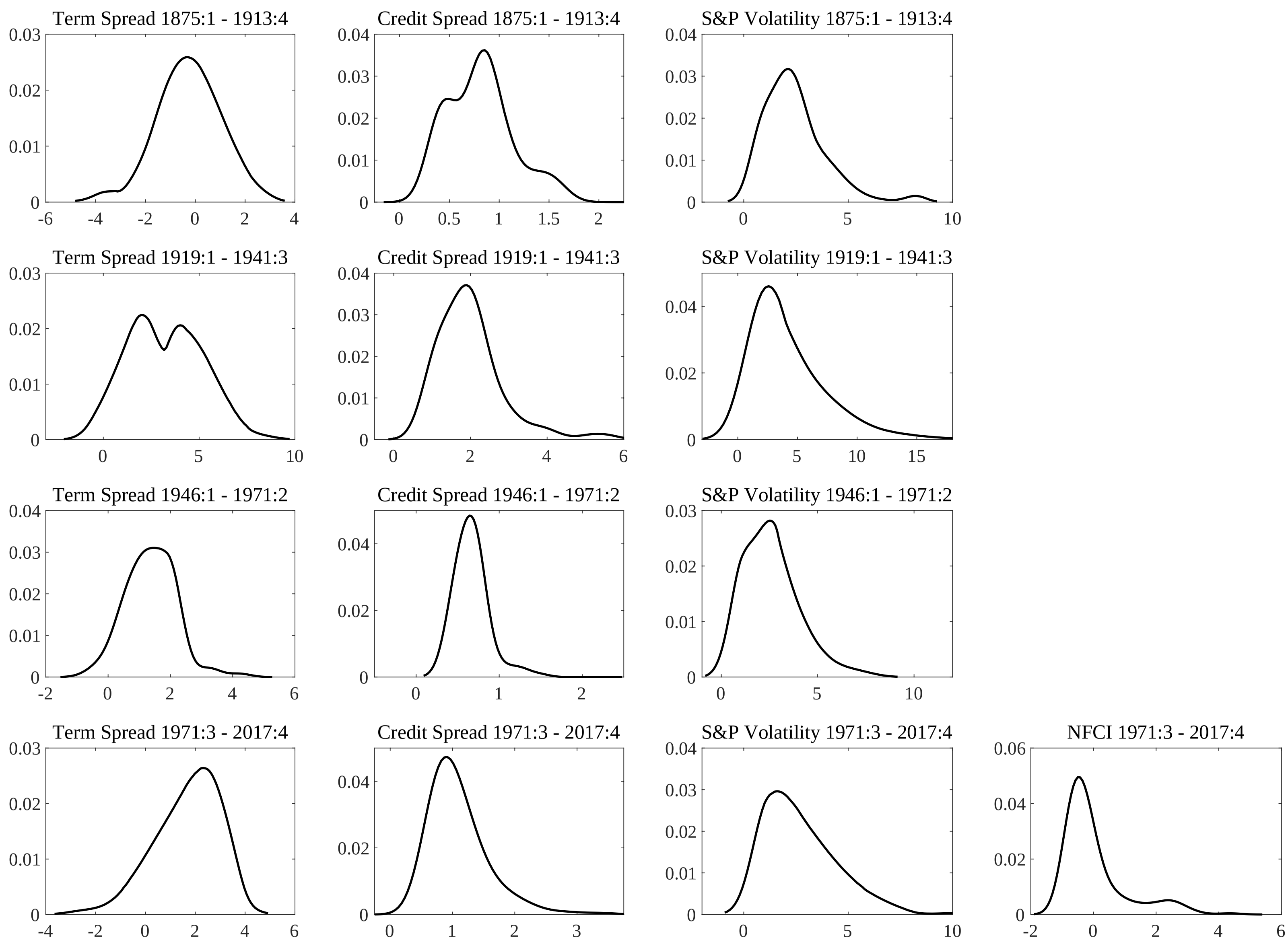
Note: This table displays average log score relative to the benchmark model with Gaussian marginals, linear dependence and no financial conditions. As a rough guide to statistical significance, p-values of a two-sided Diebold-Mariano (1995) type test for the log score are denoted by $*$ (< 0.10), $**$ (< 0.05) and $***$ (< 0.01).

Table A7: Root Mean Square Error and KLIC-Based Measures of Predictive Accuracy For Specification with Common Dependence Across Sub-Samples

	Root Mean Squared Errors		KLIC Based Measure	
	1-Qtr Growth	4-Qtr Growth	1-Qtr Growth	4-Qtr Growth
Gaussian Marginals and Linear Dependence				
No Financial Conditions	1.000	1.000	1.000	1.000
Term Spread	0.984	0.955**	0.992**	0.983***
Credit Spread	1.002	0.997	0.997	1.000
S&P Volatility	0.995	0.998	0.996*	0.998
Non-Gaussian Marginals and Linear Dependence				
No Financial Conditions	1.002	1.001	0.983***	0.989***
Term Spread	0.986	0.953*	0.978***	0.974***
Credit Spread	1.001	0.999	0.982***	0.990***
S&P Volatility	0.997	1.000	0.981***	0.989***
Gaussian Marginals and Non-linear Dependence				
No Financial Conditions	0.989	0.984*	0.984	0.982***
Term Spread	0.905***	0.844***	0.894***	0.878***
Credit Spread	0.926***	0.897***	0.909***	0.898***
S&P Volatility	0.937***	0.926***	0.911***	0.917***
Non-Gaussian Marginals and Non-linear Dependence				
No Financial Conditions	0.997	0.986	0.968***	0.968***
Term Spread	0.916***	0.854***	0.881***	0.862***
Credit Spread	0.948***	0.909***	0.881***	0.869***
S&P Volatility	0.917***	0.912***	0.879***	0.876***

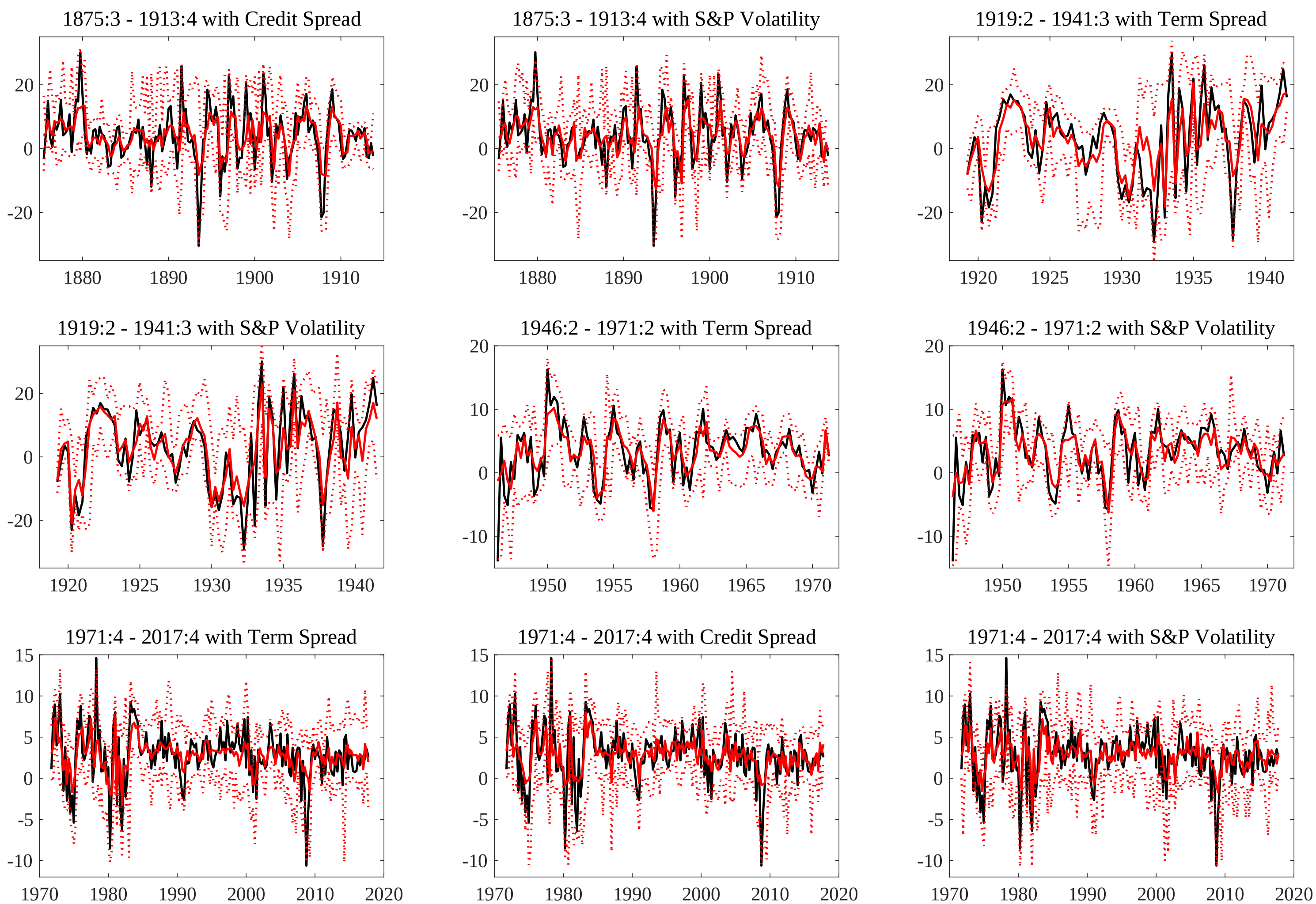
Notes: (1) Our sample for 1-quarter growth is 1875Q3-1913Q4, 1919Q2-1941Q3, 1946Q2-1971Q2 and 1971Q4 to 2017Q4, and our sample for 4-quarter growth is 1877Q1-1913Q4, 1920Q1-1941Q3, 1947Q1-1971Q2 and 1972Q3 to 2017Q4. (2) Root Mean Squared Errors are reported relative to the benchmark model with Gaussian marginals, linear dependence and no financial conditions. As a rough guide to statistical significance, p-values of a Harvey, Leybourne, and Newbold (1997) small-sample adjustment of the two-sided Diebold and Mariano (1995) test are denoted by $*$ ($<10\%$), $**$ ($<5\%$) and $***$ ($<1\%$). (3) The KLIC based measures are average log scores relative to the benchmark model with Gaussian marginals, linear dependence and no financial conditions. As a rough guide to statistical significance, p-values of a two-sided Diebold-Mariano (1995) type test for the log score are denoted by $*$ ($<10\%$), $**$ ($<5\%$) and $***$ ($<1\%$).

Figure A1: Fitted Marginal Distributions



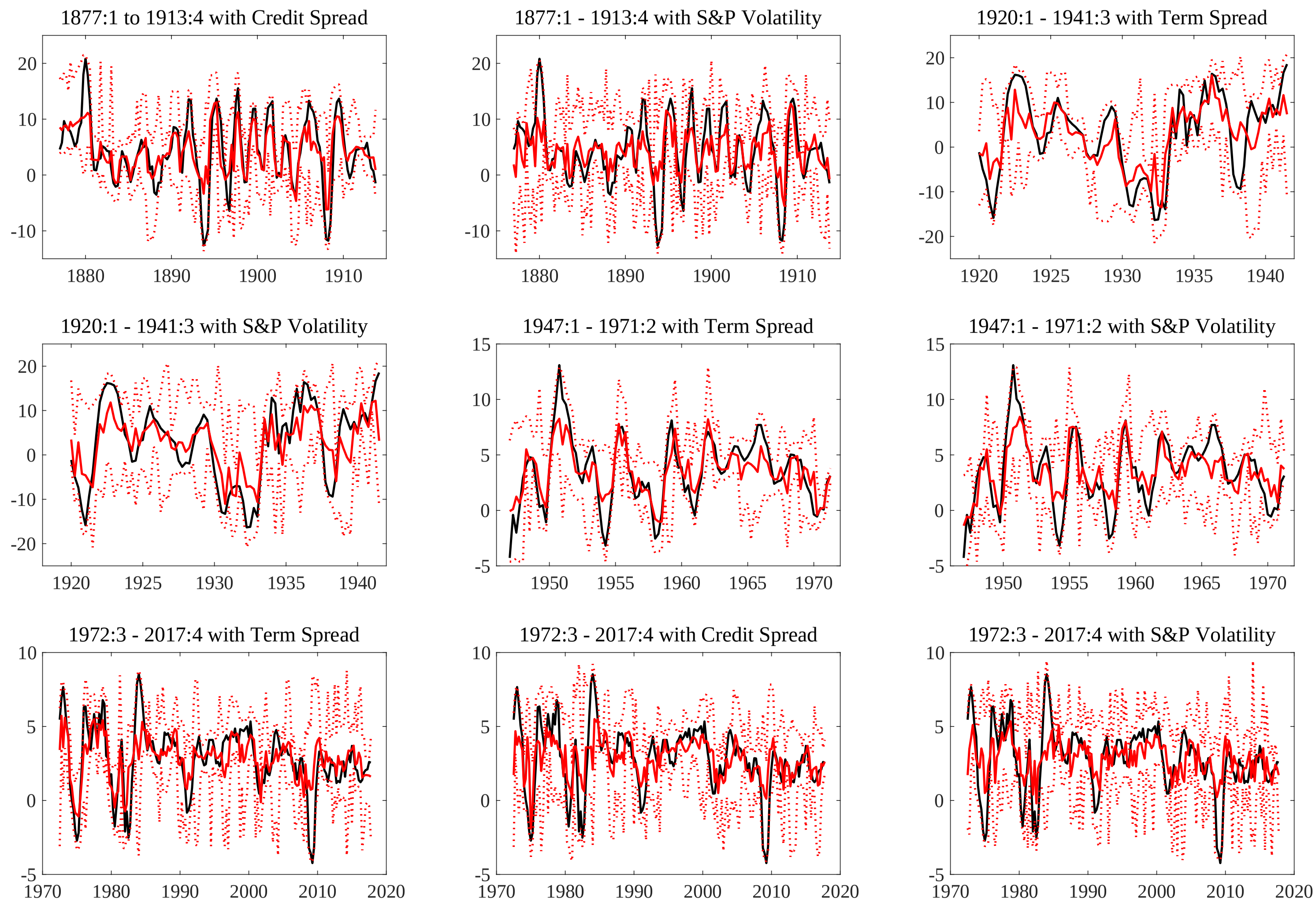
Note: The panels depict the marginal distribution for output growth in each era, fitted using the SSV method of Shimazaki and Shinomoto (2010) and plotted as PDFs.

Figure A2: Conditional Densities for One Quarter Growth



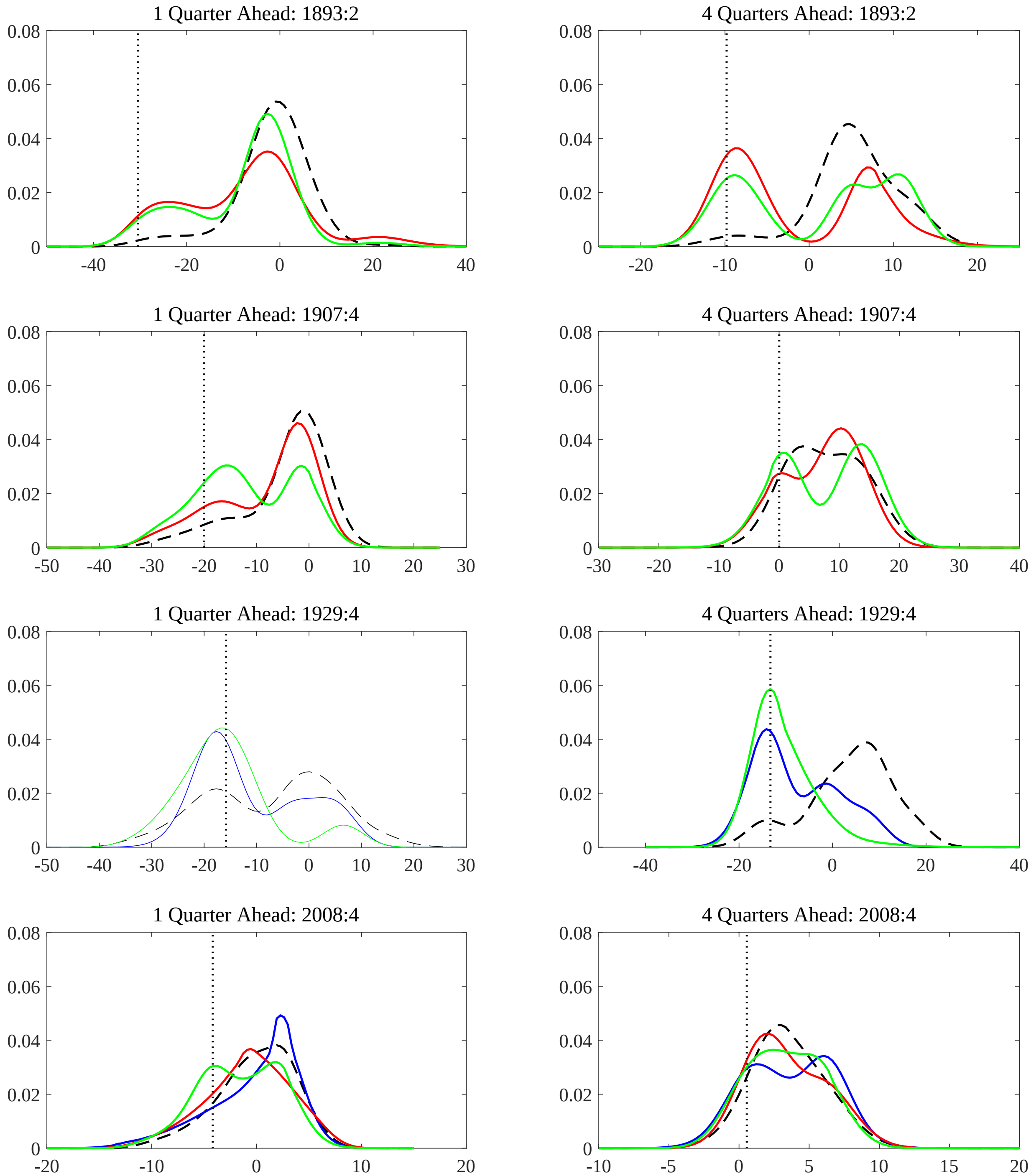
Note: The solid line black line depicts the realizations and the solid red line depicts the mean of the conditional density for output growth based on a model with non-Gaussian marginals and non-linear dependence. The dotted red lines depict the 5^{th} and 95^{th} percentiles.

Figure A3: Conditional Densities for Four Quarter Growth



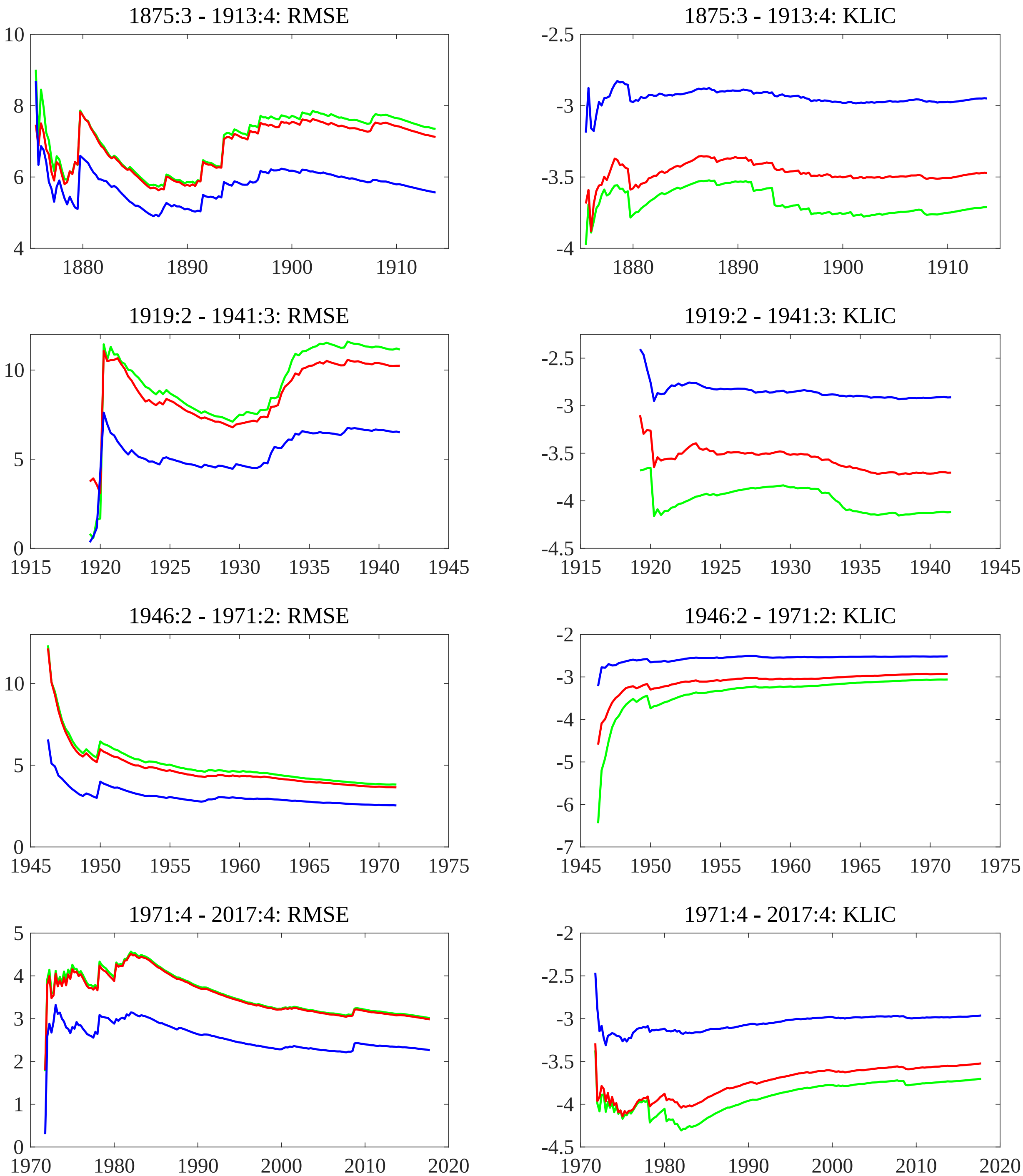
Note: See note to Figure A4a.

Figure A4: Predictive Densities For Selected Financial Crises



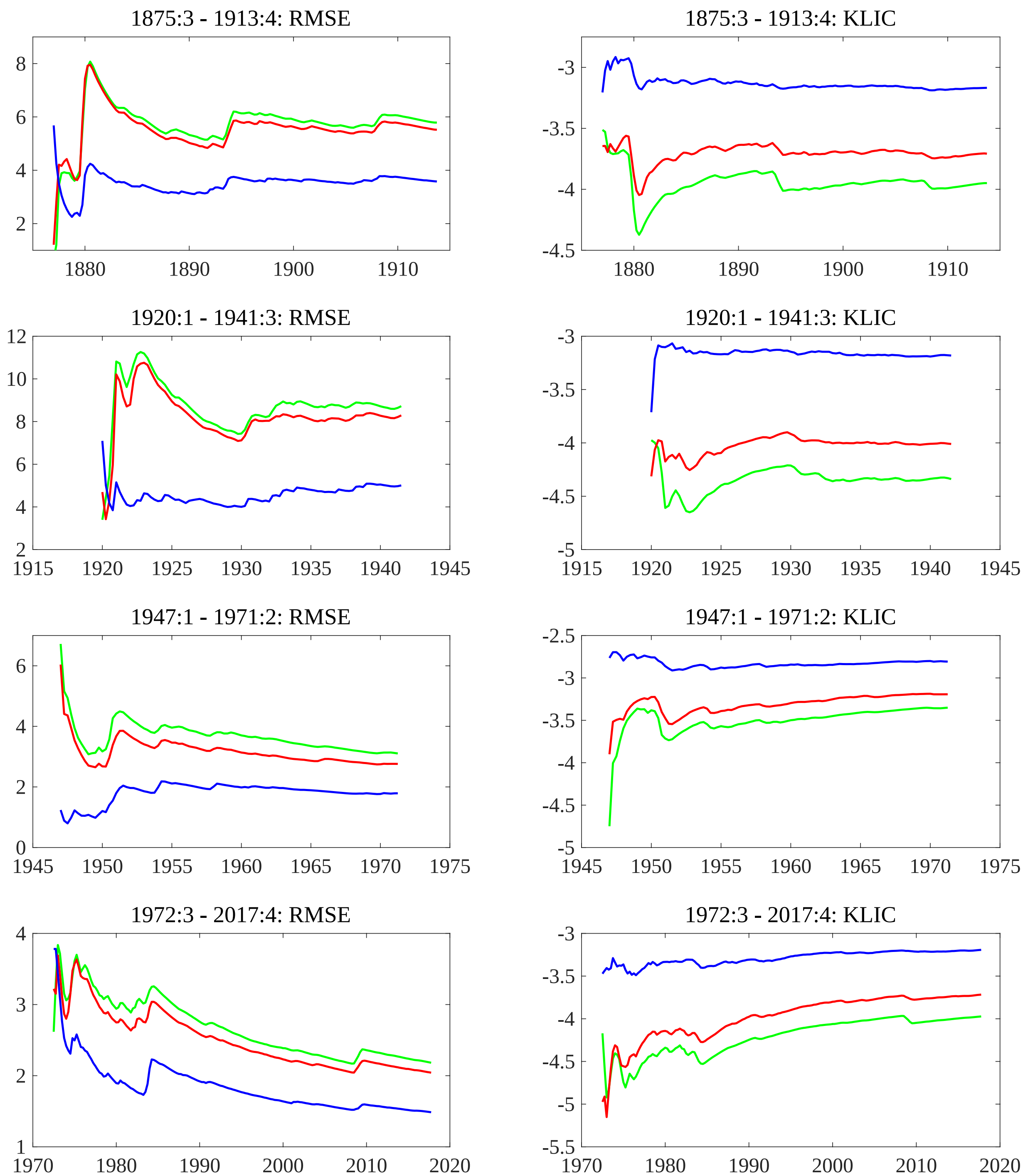
Note: The dashed black line depicts the conditional density based on the specification with non-Gaussian marginals and non-linear dependence, without financial conditions. The solid blue, red and green lines depict the equivalent densities accounting for financial conditions as represented by the term spread, the credit spread and stock market volatility respectively. The left panels display the densities for output growth in the subsequent quarter; and the right panels correspond to the subsequent year.

Figure A5: Recursive Measures of Fit: One Quarter Growth



Note: The green line represents the measure of fit from the specification with Gaussian marginals and linear dependence, but no measure of financial conditions. The red and blue lines plot our preferred specification with (blue) and without (red) financial conditions, the term spread.

Figure A6: Recursive Measures of Fit: Four Quarter Growth



Note: The green line represents the measure of fit from the specification with Gaussian marginals and linear dependence, but no measure of financial conditions. The red and blue lines plot our preferred specification with (blue) and without (red) financial conditions, the credit spread.